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PRACTICAL ELECTRONICS

SCIENCE & TECHNOLOGY

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From smart cards to teleshopping

DIGITAL MULTIMETERS

Know the essential facts

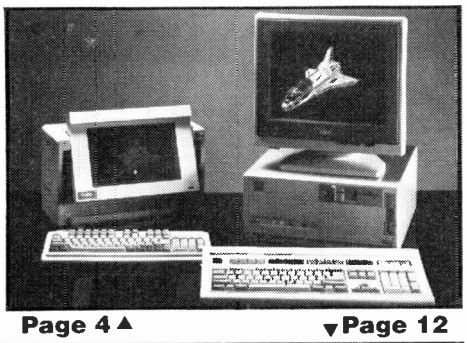
NEW QUICK-CHIP SERIES

Simple circuits and practical projects

TELL US WHAT!

Help us plan the 1990s

WIN TELEPOINT PERSONAL TELEPHONES



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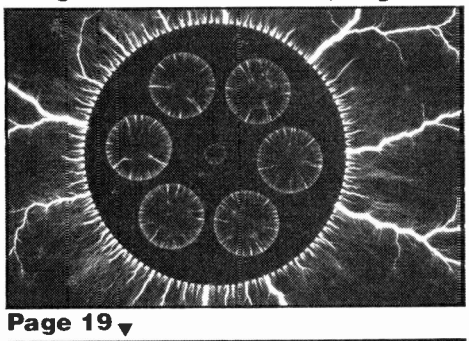

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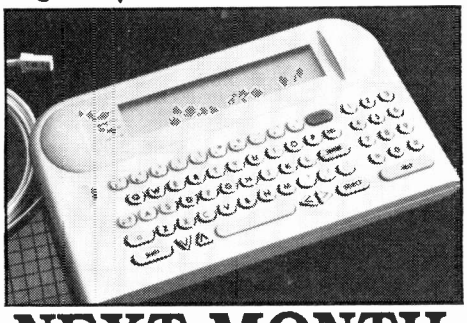

NEXT MONTH

Musicians need never be barred for lateness again - there's a high precision metronome to build. May the sun shine into your wallet when you build the solar heating controller. And discover that Britains can rule the waves even better now that microchips tune into Neptune - we've an in-depth report on leisure marine electronics. All this, and more in the June 1989 issue. Order it from your newsagent, take out a subscription, queue on our doorstep, what ever you do:

★ DON'T MISS OUR JUNE 1989 ISSUE
★ ON SALE FROM FRIDAY MAY 5TH
★ AND STILL AT ONLY £1.25
★ YOU CAN'T BEAT OUR VALUE
★ OR OUR NEW GOOD LOOKS!

PRACTICAL ELECTRONICS

VOL 25 NO 5 MAY 1989

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PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!

NEWS

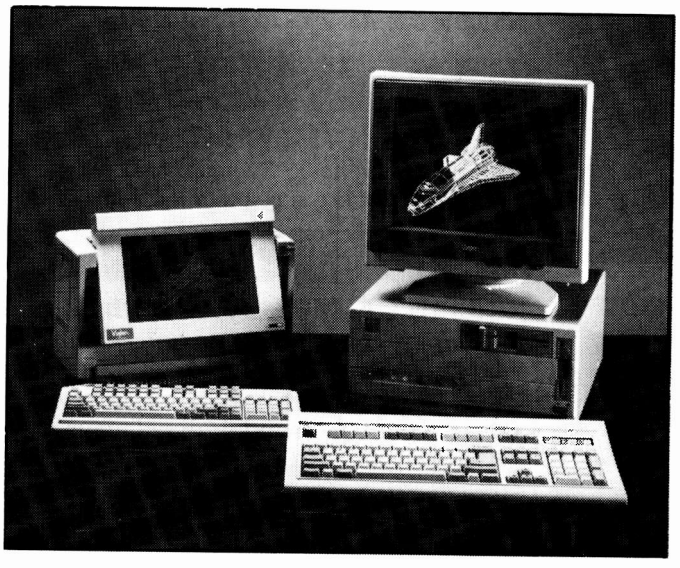
VIGLEN'S VIGOROUS PCS

Viglen have sent us details of the five IBM compatible PCs in their VIG range, all of which have been designed to provide fast, flexible and reliable desk top processing.

The range commences with the VIG I, which is the fastest IBM XT compatible currently on the market. Two versions are available with 12 MHz and 15 MHz switchable speeds, each in various configurations. Both versions offer 640 KB of ram as standard and can house up to 1 MB on the motherboard.

The VIG II Elite is an IBM AT compatible, and is based upon the very latest NEAT (new enhanced AT) technology chip. It is available at 12 MHz and 16MHz switchable speeds and has the flexibility for further expansion. The memory can be set up as extended or expanded using the very latest EMS LIM Version 4. The motherboard allows up to 8MB of ram, thus making it an ideal computer for OS/2.

At the top of the range is the VIG III Cache, which is one of the highest performance 386 machines on the market. It offers 2 MB of memory as standard, and this may be expanded to 16 MB by the addition of a memory expansion card. This 386 features 64K of fast access static ram giving it 0 wait state. This makes the 20 MHz speed equivalent to 30 MHz Landmark speed.



A recent addition to the range is the VIG II portable. It may be switched from 8 MHz to 12 MHz and is supplied with 1MB of ram as standard, and, like the VIG II Elite, the motherboard can be expanded to 8MB, and benefits from the same advanced features. A VIG Laptop will soon be available.

The range of Viglen computers can be supplied with both 5.25" and 3.5" disk drives as an optional extra. The PCs are able to run all the best known software packages and are fully compatible with the equilavent IBM PC/XT/AT models. As standard, each computer comes complete with MS.DOS 3.30 and GW Basic. Viglen, however, are one of the few UK companies now supplying MS.DOS version 4.

For Further information, please contact Diran Kazandjian at Viglen, Unit 7, Trumpers Way, Hanwell, London W7 2QI. Tel: 01-574 5126.

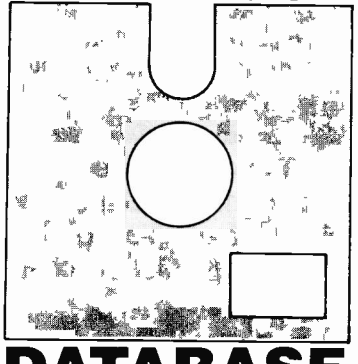
INDICATING HARRIS PANEL METERS

Harris have a wide range of analogue and digital panel meters available to suit all applications. Analogue models feature wide angle, easy viewing and shadow free dials. Digital models have 3¾ digits with 3999 count, bright orange leds and conform to DIN sizes.

Moving coil panel meters come in four basic formats. All have a full scale accuracy of 2.5% and operate as microammeters, milliammeters, ammeters or voltmeters for both ac and dc. Bench stand meters are available, and specials to suit individual requirements can be supplied on request and are just part of the comprehensive service offered.

Sixteen basic digital models are available for alternating and direct current and voltage. Options to the basic range enable these high quality digital meters to directly replace analogue models in existing equipment. Basic dc voltage accuracy is 0.2% with a best resolution of 0.1mV. Maximum voltages are 1000V ac and 400V dc while maximum current is 1000A direct and 100A for alternating.

Literature showing the wide range of sizes, scale lengths and mounting details is freely available from Harris Electronics (London) Ltd, Building 3, GEC Estate, East Lane, Wembley, Middx, HA9 7PT. Tel: 01-908 3355.



We have recently received the following literature:

Livingstone Hire's 1989 rental catalogue is an ideal source of information for those looking to use an item of **test equipment without actually owning it.** Their 124-page colour catalogue shows an enormous range of products, covering general purpose test equipment, logic analysers, microprocessor development systems, prom programmers and computers. They have several offices in the UK, and phoning on the **FREE helpline 0800 886000** will locate your nearest branch.

Antex have sent another **leaflet on precision soldering** and some of their related products. It's a useful short guide to what to look out for when choosing soldering equipment. **Antex Electronics,** Mayflower House, Armada Way, Plymouth, Devon. Tel: 0752 667377.

Ceka Works tell us they have their new price list available and that it covers their **entire product range.** It's a pity they didn't tell us what's in the range! Why not ask for the list any way, it could be interesting. **Ceka Works Ltd.,** Pwllheli, Gwynedd. Tel: 0758 701070.

Unitel's complete resistive products range is covered in their new 60 page illustrated catalogue. It also covers precision and panel controls and trimmers, plus rf inductors and filters. **It's free of charge** and full technical support is provided on the ranges. They've got a new 56 page capacitor catalogue as well. **Unitel Ltd,** Fishers Green Road, Stevenage, Herts, SG1 2PT. Tel: 0438 312393.

The IR Group catalogue offers a **complete guide to instrument sales.** Its 110 pages feature oscilloscopes, signal sources, multimeters, counter timers, psus, logic analysers, etc. Many of the products are also available for renting or leasing. **IR Group,** Dorcan House, Meadfield Road, Langley, Berks, SL3 8AL. Tel: 0753 580000.

TK Electronics, one of our many respected advertisers, have sent a **leaflet describing three of their latest kits,** a door chime, a whistle switch, and a sound generator. The kits are only £3.90 each and are **ideal beginner's material.** Ask for details on these and other products from **TK Electronics,** 13 Boston Road, London W7 3SJ. Tel: 01 579 9794.

NEWS

3½-DIGIT, HANDHELD MULTIMETER

A handheld, digital multimeter which costs only £39.95, is now available from Global Specialities.

The meter features a 3½-digit liquid crystal display, and has six functions.

The ranges are 200mV to 1000V dc, 200mV to 750V ac, 200µA, to 20A dc and ac, 20 ohm to 20 Mohm and, finally, pnp/npn transistor testing, easuring hFE from 0 to 1000 at an Ib of 10µA, plus diode test.

The Model 6022A is powered by a 9V alkaline battery providing in excess of 150 hours continuous use. The meter is supplied with test leads, and a carrying case is available as an option.

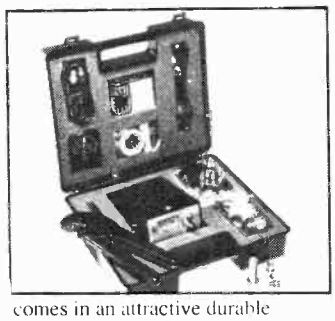
Contact: Global Specialities, 2nd Floor, 2-10 St. Johns Street, Bedford, MK42 0DH. Tel: 0234 217856.

KITTING-UP SATELLITES

You may recall that a Connexions' satellite tv receiver was one of our competition prizes last year. The company have now introduced a satelite tv installation kit, principally aimed at professional installers.

The installation kit comprises: antenna setting meter, inclinometer, compass, crimp tool, multimeter, inline amplifier, insertion tool, 2 way splitter, F type connectors, F type coupler, weather boots, F to N adaptor, N to F adaptor.

Of special interest is the insertion tool, exclusive to Connexions - for quick and easy application of F type connextors to RG6 coaxial cable. All components are available separately and can be purchased from all Connexions distributors. The kit



comes in an attractive durable polypropylene case and is available at a trade price of £129.95 plus vat.

For further information: Connextions (UK) Plc, Unit 3, South Mimms Distribution Centre, Huggins Lane, Welham Green, Herts, AL9 7LE. Tel: 07072 72091.

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

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

Apr. 11-13 Portable Computing and Data Capture 89. Conference and exhibition. Rivermead, Reading. RMDP. 0273 722687.

Apr. 25-27. British Electronics Week. Olympia. 0799 26699.

May 8-10. Eurobus 89 – German Conference. Munich Sheraton Hotel, Munich. 01-940 4625.

May 9-12. Automan. Robotics and automation exhibition. NEC, Birmingham. 01-891 5051.

May 31-Jun 2. Computer Training Show. Olympia 2, London. 01-486 1951.

Jun. 5-9. Lasers, Optoelectronics, Microwaves. 9th International Trade Fair and Congress. Munich Fair Centre. 01-948 5166.

Jun. 6-8. Computer North. G-Mex, Manchester. 061 832 4242.

Jun. 13-15. Software Tools 89. Wembley Conference Centre. 01-868 4466.

Jun. 14-15. Instrumentation Scotland. The Forum, Livingstone. 0822 614671.

Jul. 10-13. EWEC '89. European wind energy conference and exhibition. Scottish Conference and Exhibition Centre, Glasgow. No reference tel. known.

Jul. 24-26. Vacuum Microelectronics – 2nd International Conference. Bath. Contact Dr R.A. Lee, GEC Hirst Research Centre, Wembley, Middx, HA9 7PP. 01-908 9000.

Aug. 25-Sep 3. International Audio and Video Fair. Berlin. 01-408 0111.

Sep. 4-6. Eurobus 89 – UK Conference. Novotel Hotel, London. 01-940 4625.

Sep. 12-15. EPOS 89. The World's largest exhibition of retail information systems. Alexandra Palace, London. RMDP. 0273 722687.

Oct. 16-20. Systems, Computers and Communications. 11th International Trade Fair and Congress. Munich Trade Fair Centre. 01-948 5166.

Oct. 24-26. Sensors and Systems – International Transducer Exhibition and Conference. Wembley Conference Centre. 0822 614671.

Nov. 7-11. Productronica. 8th International Trade Fair for Electronics Production. Munich Trade Fair Centre. 01-948 5166.

BTEC CONTINUING EDUCATION CERTIFICATE COURSES. Starting dates Jan11 and Apr 26 – each course 2 days per week Wed/Fri for 13 weeks. London Electronics College, 20 Penywern Road, London SW5 9SU. 01-373 8721.

NEWS

SKYPHONE TAKES OFF!

British Telecom's Skyphone, the world's first satellite telephone communications system for airline passengers, started trial operations in mid-February on an intercontinental British Airways Boeing 747. Skyphone will allow passengers to make in-flight calls to anywhere in the world.

Anthony Booth, Managing Director of BT International said, 'Skyphone is another excellent addition to BT's wide range of international services, and its successful development illustrates our intention to provide customers, wherever they may be, with rapid and reliable communications'.

Calls are transmitted via the Inmarsat satellite system and then routed into BT's worldwide network. In conjunction with partners in Norway and Singapore, BT is due to complete the worldwide Skyphone network by the end of 1989. The system has been developed and tested under a collaborative agreement between British Telecom, Racal and British Airways.

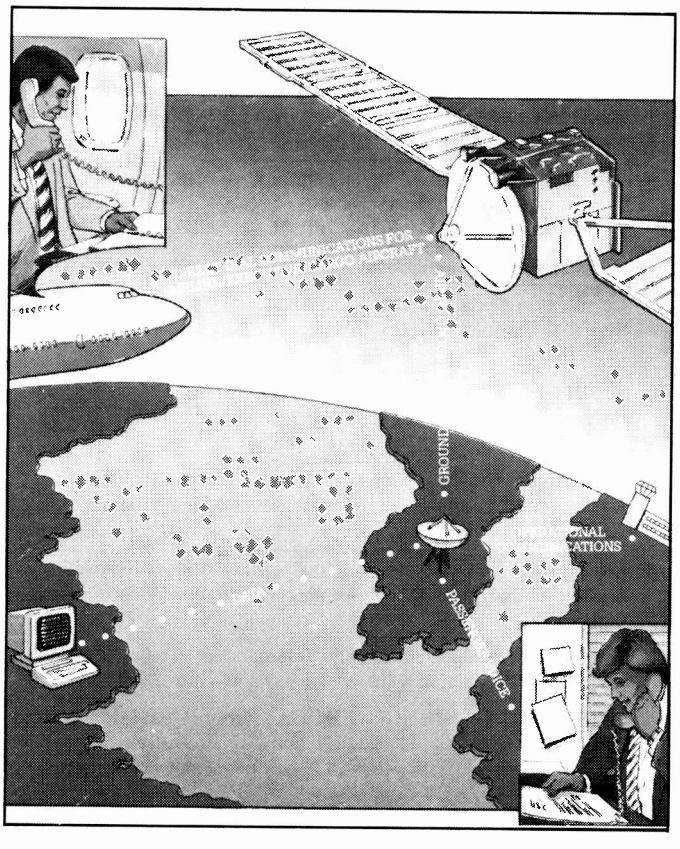
The pioneering technique developed by scientists at British Telecom's Research Laboratories for converting telephone speech to digital form has been adopted as the world standard by the Airlines Electrical Engineering Committee. It will be used by pilots when they talk to air traffic controllers as well as by passengers.

BT's speech coder was adjudged the best in an international competition, in which more than 20 different designs from all over the world were considered. The four best - from the USA and Japan as well as the UK - were comprehensively tested under simulated operating conditions.

Tests were carried out by telecommunications network operators in the three countries. In addition, the Civil Aviation Authority conducted extensive tests with pilots from international airlines. The BT design emerged as the clear winner in both types of tests.

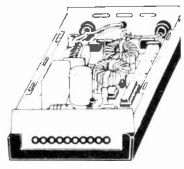
The coder converts the analogue waves of telephone speech into a series of digital impulses. These are generated at a rate of 9,600 per second, the lowest rate so far used in public civil telecommunications. It compares to the 64 kbit/s used as standard for speech encoding in modern digital networks.

Operation at these low rates reduces the size and weight of the airborne encoding equipment, while at the same time maintaining high speech quality.



POWER CONDITIONER

FEATURED IN ETI JANUARY 1988



The ultimate mains purifier. Intended mainly for lowering the noise floor and improving the analytical qualities of top flight audio equipment.

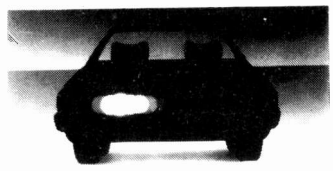
The massive filter section contains thirteen capacitors and two current balanced inductors together with a bank of six VDRs to remove every last trace of impulsive and RF interference. A ten LED logarithmic display gives a second by second indication of the amount of interference removed.

Our approved parts set consists of case, PCB, all components (including high permeability toroidal cores, ICs, transistors, class X and Y suppression capacitors, VDRs etc.) and full instructions.

PARTS SET **£29.80** + VAT

A low cost (but high performance) mains conditioner is also available.

MAINS CONDITIONER PARTS SET £5.40 + VAT
RUGGED PLASTIC CASE £1.80 + VAT



KNIGHT RAIDER

FEATURED IN ETI JULY 1987

The ultimate in lighting effects for your Lamborghini, Maserati, BMW (or any other car, for that matter). Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip the switch again and the point of light becomes a bar, bouncing backwards and forwards along the row. Press again and try one of the other six patterns. An LED display on the control box let's you see what the main lights are doing.

The Knight Raider can be fitted to any car (it makes an excellent fog light!) or with low powered bulbs it can turn any child's pedal car or bicycle into a spectacular TV-age toy!

The parts set consists of box, PCB and components for control, PCB and components for sequence board, and full instructions.

Lamps not included.

PARTS SET **£24.80** + VAT

RAINY DAY PROJECTS

All can be built in an afternoon!

JUMPIN' JACK FLASH (ETI March 1988)
Spectacular rock stage and disco lighting effect! £6.90 + VAT

CREDIT CARD CASINO (ETI March 1987)
The wicked pocket gambling machine £5.90 + VAT

MAINS CONTROLLER (ETI January 1987)
Isolated logic to mains interface £6.20 + VAT

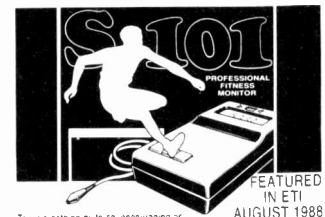
MATCHBOX AMPLIFIERS (ETI April 1986)
Listen: 50W of Hi-Fi power from an amp small enough to fit in a matchbox!

Matchbox Amplifier (20W) £6.50 + VAT
Matchbox Bridge Amplifier (**50w**) £8.90 + VAT
L165V Power Amplifier IC with data and circuits £3.90 + VAT

TACHO/DWELL METER (ETI January 1987)
Turn your Metro into a Porsche! £16.40 + VAT

HI-FI POWER METER (ETI May 1987)
Measures Hi-Fi output power up to 100W – includes PCB components, meters

Mono power meter £3.90 + VAT
Stereo power meter £7.20 + VAT



FEATURED IN ETI AUGUST 1988

There's nothing quite so encouraging as having a quantifiable result to show for your training efforts. If you are not participating in your resting heart rate will be around 80 beats per minute. As your jogging, aerobics or sport strengthens your heart, the rate will drop dramatically – possibly to 60bpm or less. With the S101 you can watch your progress day by day.

Breathing is important too. How efficiently do you take up oxygen? How quickly do you recover from oxygen debt after strenuous activity? The S101 will tell you know.

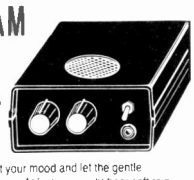
The approved parts set consists of case, 3 printed circuit boards, all components including 7 ICs, quartz crystal, 75 transistors, resistors, diodes and capacitors, LCD switches, plugs, sockets, electrodes and full instructions for construction and use.

PARTS SET **£33.80** – VAT

Some parts are available separately. Please send S.A.E. for lists.

THE DREAM MACHINE

FEATURED IN ETI DECEMBER 1987



Adjust the controls to suit your mood and let the gentle relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistably into a peaceful, refreshing sleep.

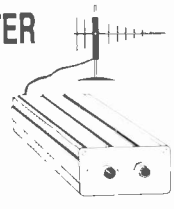
For many, the thought of waking refreshed and alert from perhaps the first truly restful sleep in years is exciting enough in itself. For more adventurous souls there are strange and mysterious dream experiences waiting. Take lucid dreams, for instance. Imagine being in control of your dreams and able to change them at will to act out your wishes and fantasies. With the Dream Machine it's easy!

The approved parts set consists of PCB, all components, controls, loudspeaker, knobs, lamp, fuseholders, fuse, mains power supply, prestige case and full instructions.

PARTS SET **£19.80** + VAT

Ben Sweetland's best seller GROW RICH WHILE YOU SLEEP is now in stock. **£2.95** (NO VAT)

TV BOOSTER



Good TV pictures from poor aerials is what this project is all about. Keith Brindley's Aerial Booster gives a massive 23dB gain to ensure good viewing for campers and caravanners, from indoor aerials, or wherever a properly positioned high-gain antenna is not practical.

Based on the OM335 hybrid amplifier, the booster has specifications to rival the best: wideband operation from 10MHz to 1.4 GHz, mid-band gain of up to 26dB and a wide supply range of 9V to 26V (it will run from car batteries for caravanners, dry batteries for campers, or a mains "battery eliminator" in the home). No special UHF construction skills are needed — the project could be made by a careful beginner.

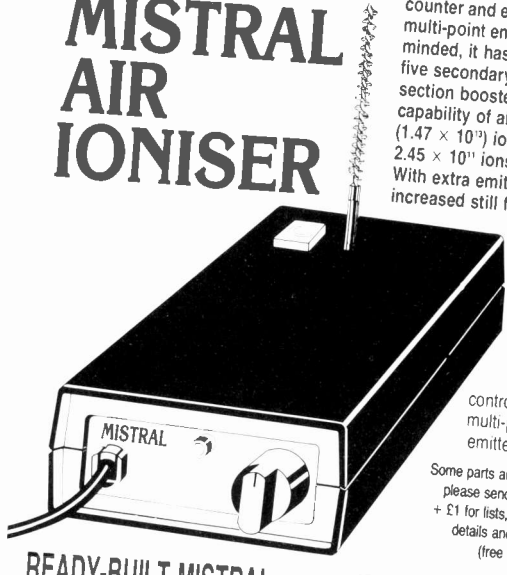
There are two parts sets for the project. AA1 contains the printed circuit board, OM335 hybrid amplifier, components and instructions. AA2 is the optional case set: rugged screened box, front and rear panels, waterproofing gaskets, feet, sockets and hardware.

AA1 PARTS SET **£12.80** + VAT

AA2 PARTS SET **£4.80** + VAT

AA3 OPTIONAL MAINS POWER SUPPLY PARTS SET **£6.80** + VAT

THE MISTRAL AIR IONISER



The best ioniser design yet – this one has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters. For the technically minded, it has nine main drive stages, five secondary drives, and a four section booster to give an output capability of almost fifteen billion (1.47×10^{13}) ions every minute, or 2.45×10^{11} ions per second. With extra emitters this can be increased still further!

PARTS SET £28.40 + VAT

The parts set includes case, printed circuit boards, 126 top grade components, all controls, lamps, hardware, a multi-point phosphor-bronze emitter and full instructions.

Some parts are available separately — please send SAE for lists, or SAE + £1 for lists, circuit and construction details and further information (free with parts set).

READY-BUILT MISTRAL

The Mistral Ioniser (and most of our other projects) can now be supplied built, tested and ready to go. For details, please contact *Peter Leah at P.L. Electronics, 8 Woburn Road, Eastville, Bristol BS5 6TT. Tel: 0272 522703.* Evenings Only.

INTERNAL EMITTER £2.80 + VAT

Can be used in place of the P-B external emitter, or both can be used together for the highest ion output. Parts set includes PCB, ion emitters, components and instructions.

IPA BOARD CLEANER £0.98 + VAT

Essential for removing grease and flux residues from the Mistral PCB to achieve peak performance. Applicator brush supplied.

ION FAN £9.80 + VAT

An almost silent piezo-electric fan, mains operated, to pump ions away from the emitter and into the room. Increases the effectiveness of any ioniser by five times!

ION DISPERSION METER

FEATURED IN ETI FEBRUARY 1989

The G-ion is a hand-held meter which sniffs out ions in the air. It can tell the good ones from the duds if you're thinking of buying a commercial ioniser, check the efficiency and output of one you've made yourself, help you set up fans and position the ioniser for best effect, do an ion-survey of your house or office — in short, it will tell you anything you want to know about ions in the air.

In direct mode the bar-graph readout will detect the presence of negative or positive ions and measure neg-ion strengths from 5×10^7 to 10^{10} ions per second, which covers the levels you can expect when an air ioniser is in use. For the smaller concentrations of natural air ions, integrate mode will increase the sensitivity as far as you like.

Our approved parts set comprises: case, ion collector, printed circuit board, all components (including six ICs, schottky diode, cermets, VDR, zener, 37 resistors and capacitors, LEDs, plug, socket, earth lead, etc.) and full instructions.

PARTS SET **£18.40** + VAT

Some parts are available separately — please send SAE for lists, or SAE + £1 for lists, circuit, construction details and further information (free with parts set).

BIO-FEEDBACK

FEATURED IN ETI DECEMBER 1986

Bio-feedback comes of age with this highly responsive, self-balancing skin response monitor! The powerful circuit has found application in clinical situations as well as on the bio-feedback scene. It will open your eyes to what GSR techniques are really all about.

The complete parts set includes case, PCB, all components, leads, electrodes, conductive gel and full instructions.

PARTS SET **£16.80** + VAT

BIO-FEEDBACK BOOK **£4.50** (no VAT)

Please note: the book by Stern and Ray is an authorised guide to the potential of bio-feedback techniques. It is not a hobby book and will only be of interest to intelligent adults.

POWERFUL AIR IONISER

FEATURED IN ETI JULY 1986

Ions have been described as "vitamins of the air" by the health magazines and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer and seems much more invigorating than "dead" air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products was reliable, good to build and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead and even the parts for the tester. According to one customer, the set costs about a third of the price of the individual components. What more can we say?

Instructions are included

PARTS SET WITH BLACK CASE **£12.60** + VAT

PARTS SET WITH WHITE CASE **£12.80** + VAT

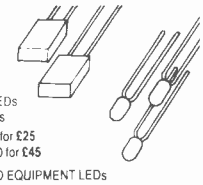
BURGLAR BUSTER

Be safe from intruders with our Burglar Buster alarm system! It has all the features you'd expect from a high-tech alarm: entry and exit delay, anti-tamper loop, delay warning and control-box protection.

The parts set includes *all four* PCBs and all components to go on them. Other parts (case, switches, etc.) are available separately, if you haven't got anything suitable in your spares box. Set contains 4 PCBs, ICs, transistors, relays, capacitors, resistors, diodes, regulator, piezo sounder and full instructions.

BB1 PARTS SET **£12.80** + VAT

LEDs



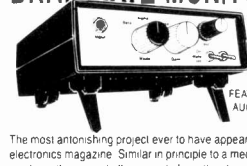
Green rectangular LEDs for bar-graph displays

50 for **£3.50** 500 for **£25**
100 for **£6** 1000 for **£45**

DIGITAL AND AUDIO EQUIPMENT LEDs
Assorted 3mm LEDs: red, green, yellow and orange
25 of each (100 LEDs) for **£6.80**

U.K. orders: please add 80p post and packing and 15% VAT to total.
Eire and overseas: no VAT. Carriage and insurance £4.50.
Please allow up to 14 days for delivery.

BRAINWAVE MONITOR



FEATURED IN ETI AUGUST 1987

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LEADING EDGE

Japanese electronics companies are now ready to launch a compact disc that records music and computer data, for replay on a conventional cd player. A twin deck machine, which pairs a recorder with a player, so that commercially pressed cds can be copied onto blank discs, will cost only £80 or £100 more than a conventional cd player. The blank discs will cost under £5. A modified system will be in future be able to record video.

Although the new generation of technology will change the face of the consumer electronics industry, by ousting tape as the most convenient recording medium, Philips of the Netherlands has taken a surprising policy decision not to get involved in the new market until the copyright issues which it raises have been resolved. The chances of resolution are slim, because any cd which records cds inevitably infringes copyright. So although Philips' stance wins the company high moral ground, it may well number Philips' days as a manufacturer of consumer electronics.

BEHAVIOURAL MORALITY

BY BARRY FOX
Winner of the
UK Technology Press Award

Tapes and cds – capable of digital recording in your own home – cause the recording industry so much anxiety that one major manufacturer may choose to miss the boat rather than be embroiled.

All the major electronics companies, including Philips, have developed optical discs which can either record once, (cd-r) or erase and record several times (cd-e). But the technology has been seen as too expensive to compete with dat, a digital audio tape cassette the size of a credit card which records several hours of hifi stereo in digital code. Although dat is the ideal medium for releasing 'long form' pre-recorded musical works, such as operas and concerts, the record companies worried about home taping and killed dat by refusing to make programme material available for release.

This cleared the way for cd-r and cd-e which the record companies' trade body the IFPI, (International Federation of Phonogram and Videogram Producers) now describes as "an even greater potential threat than dat". Because the record companies already release their music on cd, a recordable cd offers no new advantages to the record industry.

The IFPI says it learned about the new threat from an internal memo provided by Philips. The memo was written by Angelique Hoogakker, a lawyer who worked for the IFPI before joining Philips in Eindhoven. The Hoogakker memo tells how cheaply cd recorders and blank discs can be made. The Philips memo was triggered by an announcement from Japanese chemical company Taiyo Yuden that it is now ready to manufacture a recordable cd system.

The Taiyo disc is a blank pressed from polycarbonate, superficially similar to a cd, but with a coating of softer plastics and a spiral groove moulded in the surface. This groove guides the laser during recording. A laser of around 7-9mW is used to record music or data pits by modifying a layer of dye, with a 2mW used for play back. Once made, the recording cannot be erased.

Taiyo claims that shelf life of a blank disc, before recording, is at least ten years, and archival life after recording is at least another ten years. The only proviso is that the discs should not be left in direct sunlight for long periods.

Philips gamely confirms that it will not launch cd-r or cd-e technology until the hardware and software industries have agreed on a copyright strategy. This could take many years because the software industry is in a weak position to bargain and fight the new technology. As most music is already available on cd, there is no permission to refuse.

If Far Eastern firms make cd-e and cd-r the dominant recording media of the future, Philips could be squeezed out of the consumer electronics business altogether. PE

ED-LINES

SWEET SATAFAX

We have previously commented in PE's pages of the probability of news texts being distributed by electronic methods rather than in newspaper form. I had expected that this subject would have been one of those discussed at the Home Automation conference on which we reported in PE Apr-May 89. Although this turned out not to be the case, it appears that another of PE's entrepreneurial heroes, Alan Sugar of Amstrad fame, appears to be regarding the electro-news scene with an eagle eye.

Normally reliable sources inform us that Alan Sugar may well enter into the Satafax market, combining the technologies of satellite transmission, computers and fax into a news text distribution facility. And of course the options for such a service don't end with news texts; books and magazines represent some of the other possible candidates for satafax disemination, and on a worldwide basis. As long as there is power available to run a computer terminal and receiver, the service can be received virtually anywhere around the surface of the globe.

Of course worldwide fax transmission is nothing new, Inmarsat, to whom we refer in the forthcoming Leisure Marine Electronics series of Jun-Jul 89, is one of those companies who already offer the facility for trans-satellite faxing. The implementation of satellite newspaper transmission, though, is one that could reap fortunes for the operating companies. That is, of course, on the assumption that readers will accept the limited convenience of having to read from a vdu screen, however portable it may be.

I know that commuting business men use portable computers while travelling by train, and so have the hardware for news browsing already under their arm, so to speak. But will they really carry a satafax in place of a paper, even though perhaps the computer might hold all of the day's papers in its memory? I suspect not. Or am I overlooking the undoubted possibility that advances in technology will eventually make satafax terminals as small and convenient as a newspaper? Could be.

Indeed, on this score, I may have an answer to one reader who recently asked what feature and constructional articles PE might be publishing in another 25 years, at the time of our Golden Anniversary. Perhaps we may be publishing a single-chip satafax project that can receive the news, not only from around the globe, but from one or two of the colonised planets as well. If that's the case, then PE itself will possibly be available, not only as a paper-printed magazine, but as a multi-megabyte burst of electronic signals from our own satellite channel.

"The time has come," your Ed has said,
"To talk of many things;
Of whose - and which - and crucial facts -
Of theories - and computerings -
And why PE cares every jot
On what you think our future brings."

Lewis Carroll would probably set an automated Jabberwock on me for reprogramming his immortal lines, ("Off with this Ed!" do I hear another voice cry?), but the time has indeed come when we should ask you to talk with us on many things.

Regular readers of PE will have seen that we have been making various changes to both content and appearance. We think that they are improvements, but I'm not going to get pious about it. We could blow our own trumpets until we are blue in the face, announcing how brilliant each change is and how irresistible you should find it. Codswallop! You know it, and we know it, that at the end of the day, however good we may think our publication is, if you don't like it, you won't buy it.

Well, this issue we've taken further steps along the path of what we believe is the right direction. The cover change is the first thing that should strike you. Ever since Issue One, the relative sizes and styles of the two words "Practical Electronics" have

PRACTICAL ELECTRONICS

EDITORIAL

remained constant. We've now upped the size of "Practical", enhanced the lettering, and increased the descriptive captions. Inside, we have reappraised the layout style and many of the type faces have been changed. This, we feel, gives the contents more visual appeal.

So how right are we? You are the final arbiters on that. We recognise that the changes in this issue are largely cosmetic. The structure remains similar to that found in other recent issues. The balance of constructional projects, technology features, informative theory and product news is largely unaltered, though the new Quick Chip series is one of which we hope you will approve.

What we want to know is, do you think that the structural content of PE should be changed? *And we want to know now!* We ran a survey in 1981 and another in 1986, but the world continues to change, and possibly, you the readers have changed too. During the 80s there has been an upheaval in society; employment patterns have altered drastically; new leisure activities are being catered for; many consumer goods are available which, in some areas, make diy less of an appealing activity; and the trend for instant access to condensed information seems to be increasing, placing question marks over detailed examinations of specific aspects of technology.

My belief is that there will always be a significant core of people who want the pleasure of building things themselves and who enjoy learning by doing. That core, I further believe, includes those who want to be more deeply informed about technology but without having to wade through scores of academic text books, which in any case can seldom be as topical as a monthly magazine.

But, I can only assess the truth of my beliefs by checking my source material. In other words, by asking you, the ones who matter, what you want. Hence the survey questionnaire on pages 35 and 36. Don't ignore it, tell me some answers!

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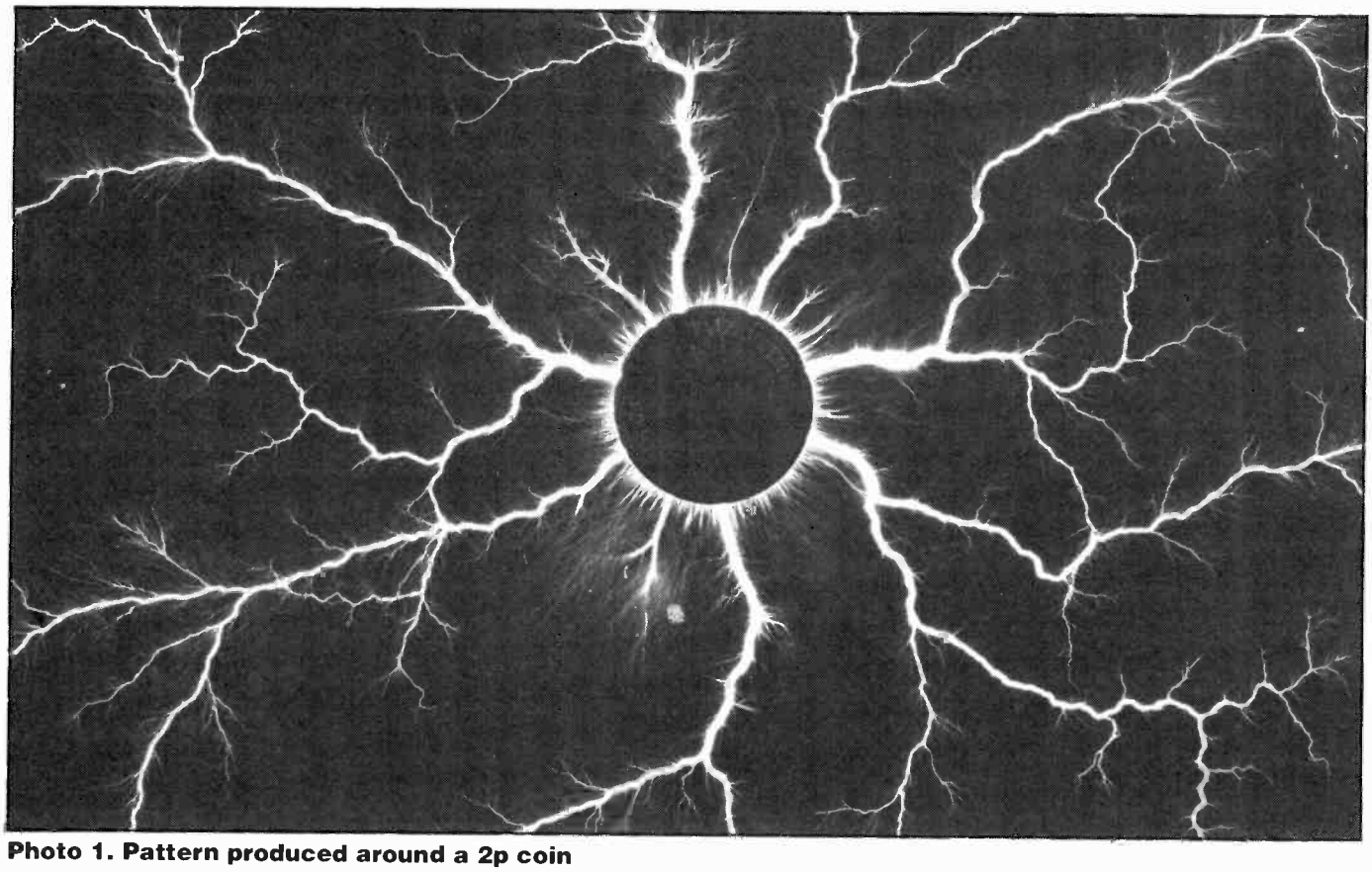


Photo 1. Pattern produced around a 2p coin

KIRLIAN CAMERA

MAY THE FORCE BE WITH YOU

BY DON PHILLIPS

Life force or dark horse? A mysterious 'energy corona' – is detected around objects in an ionising field. Is this the psychic aura of old? If so, why do nuts and bolts too? Try it for yourself.

Claims that all living things have an aura or resonating bio-energy field are frequently made by psychic-sensitive people. In general, until about 25 years ago most other people considered the concept as mere speculation or the crazy delusion of credulous table-rapping mediums.

Then an accidental discovery was made in the USSR by Semyon and Valentina Kirlian. They found that when certain biological specimens were placed in an ac ionising field of around 200kHz strange patterns were to be seen around them. The Kirlians claimed that these patterns proved the existence of bio-energy fields and represented scientific evidence of auras.

Following this discovery, researchers in the West, particularly in America, have built their own photographic equipment to verify these claims. They have found that the same sort of patterns can be produced in ionising fields at frequencies as low as 20Hz.

Many American researchers, such as Johnson and Moss, have used low frequency cameras on a wide variety of animate and inanimate objects, and even on human volunteers. They have satisfied themselves that the images produced cannot be explained in terms of the normal effects produced by high voltages, chemicals from the photographic process, perspiration or other moisture, and that other conventional explanations are unsatisfactory.

BIOPLASMIC FIELD

Although some researchers in the West believe that the explanation will ultimately be due to a purely physical effect, those in the USSR have put forward the suggestion that it may be due to a "bioplasmic" field. For example, there have been reports that a Kirlian photograph of a leaf section will show the full outline of the original leaf before being cut. There have been suggestions that there is an invisible matrix underlying all matter and that maybe this what many mediums have called the 'etheric' effect.

Following on from this is the suggestion that the Kirlian effect might validate the existence of the 'Chi' and 'Ki' energy as used in acupuncture. If this is the case, perhaps the imaging might be due to a heterodyning effect between the applied frequency and the inherent frequency of the imaged field. In this event it should be possible to image different parts of the surrounding field by altering the frequency of the applied ionisation.

POLYGRAPHY

In support of this, Johnson and Moss have found that different frequencies can reveal different aspects of the field surrounding objects. In particular they have found that the 'phantom leaf' effect only occurs at specific frequencies, evidence which tends to support the heterodyning effect. Many researchers are now investigating the effects produced by very high frequencies, even into the radio frequency ranges.

I have been researching into this fascinating field since 1981 but though I originally experimented with existing circuits for Kirlian cameras, I found they had limited parameters and were unreliable. Consequently, I designed and built my own cameras, and have had some startling results.

Experimentation showed that Kirlian photography could be achieved not only in the presence of ac fields, but also with a pulsed dc field. The latter produced some very strange and at present inexplicable patterns. How this effect ties in with the heterodyning principle is as yet unclear.

However, certain facts became obvious when using both ac and dc cameras. One of the differences is the way in which the cameras and specimens mutually interact. For example, the dc pulse cameras tend to throw the corona away from the specimen and leave the internal structure less defined.

This effect may not be entirely due to the separate applications of either dc or ac in the pure sense, but rather may be due to the initial loading surge through iron cored eht transformers. Further data on this should become available once we have developed an efficient air cored eht transformer for experiments in the rf range. So far, though, certain tests that have been carried out support this idea, including the fact that short ac exposures also divert the energy away from the specimen. It is pertinent to remember that a dc pulse is simply a special case of an ac waveform and that additionally it may cause 'ringing' at certain harmonics due to the inductive nature of the transformer.

PRACTICAL CAMERA

During my research I have had to build many types of camera. In addition to the pulsed dc version, I built an ac one that was powered from a 12V car battery, then a more ambitious one combining the ac and dc into one unit, and am currently working on an rf camera.

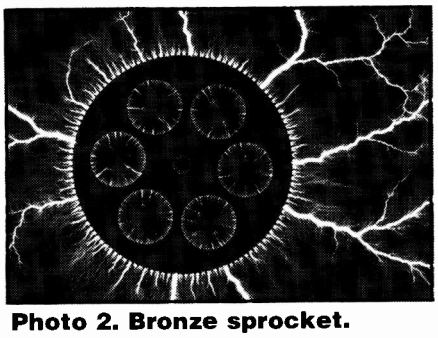


Photo 2. Bronze sprocket.

The circuit I shall describe here, though, is a somewhat simpler one of the ac type. It is powered from the normal 240Vac supply, and is capable of operating at 20Hz to 700Hz. It has the same circuit as one camera I have been using throughout much of my research and has proved to be very reliable. It is of a similar type to those seen and used at various Mind and Body festivals, but I believe it to be more reliable, and it certainly has wider parameters. The main circuit is shown in Fig.1 and its power supply is in Fig.2.

You may wonder why I have used transistors instead of integrated circuits. The reason is due to the transients generated by the high voltage generator and which are difficult to suppress simply and cheaply. Many ics died in my early days of experimenting! The robustness of the transistors I have used has saved them from the same fate.

Photos 1 to 4 were taken on a dc camera, but photos 5 to 8 were all taken on this ac camera and give an idea of the type of results than can be expected. What the photos *actually* show still needs to be interpreted. However, I am satisfied that the normal explanations offered by critics do not hold water - you must judge for yourself once you have built the camera!

The unit basically comprises a mains operated power supply producing a smoothed but unregulated 37Vdc power rail, a high voltage generator operating at variable frequencies, and a timing circuit.

TIMED EHT GENERATOR

The eht voltage generator consists of a variable rate multivibrator formed around TR3, TR4, T1, and the associated capacitors C16 to C25 selectable by S3. The frequency range is selectable in ten steps between 20Hz and 700Hz, with an additional position for 'off'. Since T1 actively affects the frequency, a high performance coil of the type recommended in the parts list should be used. During frequency generation, the voltage across the primary of T1 swings between +37V and about -37V. The secondary winding then steps up the ac voltage to between about -40kV to -50kV with irregular damped oscillations occuring at 3kHz to 10kHz.

The duration of eht generation is controlled by the gated timing circuit around TR1 and TR2, and is dependent on the charging rate of C4 to C15 as selected by S2. With S1 open, the timing circuit is in its standby state, the relay coil is inactive, and the relay contacts are open, so inhibiting the eht oscillator. On closing S1, the pulse generated across C1 causes TR2 to switch on, so drawing current through the relay coil. The relay contacts close, so allowing

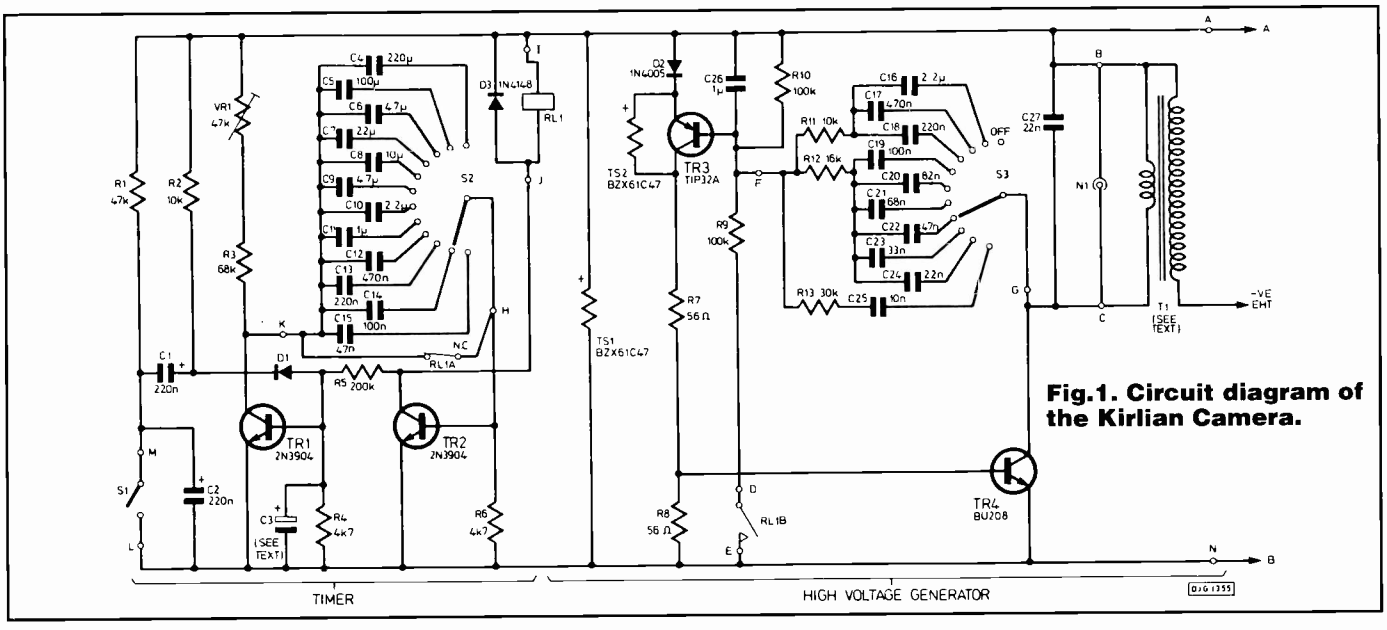


Fig.1. Circuit diagram of the Kirlian Camera.

the eht generator to function. The coil remains active until the capacitor selected by S2 has recharged, so turning off TR2.

The timing range is selectable between about 0.003 sec to 8 secs in twelve steps. VR1 is used to preset the maximum charge rate. Note that C1 and C2 should be high quality tantalum capacitors otherwise the circuit triggering may be inconsistent. C3 is used to damp stray transients that may be radiated by the eht generator so disrupting the timing period. Additional transient suppression is performed by TS1, TS2, C27 and the neon across the primary of T1. The neon has the additional function of providing visual indication that the frequency generator is functioning.

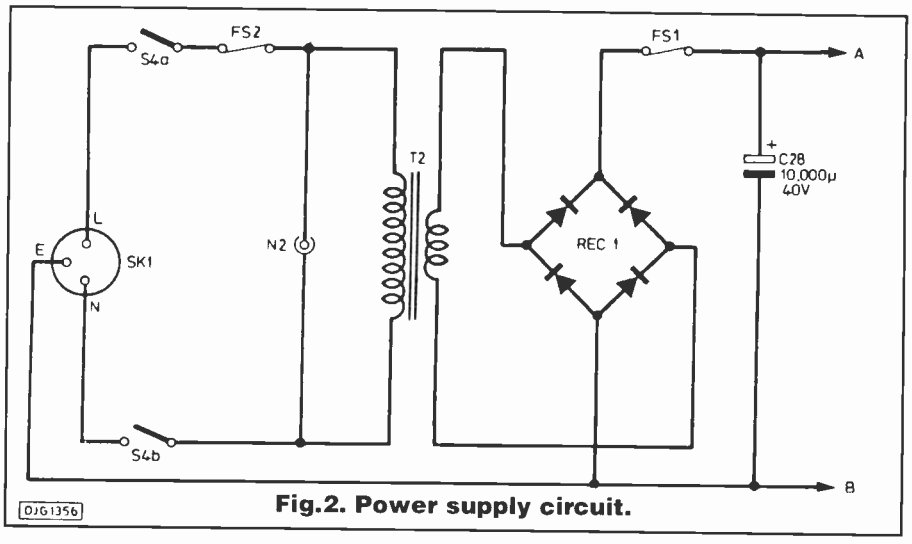


Fig.2. Power supply circuit.

CONSTRUCTION

IT IS IMPORTANT TO NOTE THAT THE UNIT GENERATES VERY HIGH VOLTAGES. EXTREME CARE MUST BE TAKEN DURING TESTING AND USE. KEEP HANDS AWAY FROM THE EHT COIL AND THE ELECTRODE PLATE.

There are three pcbs, as shown in Fig.3. PCB 1 should be mounted as shown in Photo 9; the other two boards are mounted behind the control panel. The mounting platforms should be made from a non-conductive material - I used plywood and chipboard, though srbp board would be equally suitable. When wiring the pcbs together and to the control panel, care should be taken to keep the leads clear of the assembly and box edges to prevent possible chafing. The connections to be made are obvious from the circuit and pcb diagrams - just follow them logically.

Although not used on the prototype, D3 should be soldered across the relay coil, with its positive end on the positive supply tag. Ed.

The unit housing is shown in Photo 10, and it too should be made from a non-metallic material. The prototype box size was 21 x 11 x 5.5 inches, plus a 2.5 inch high lid. Take care when planning the box layout. On my unit, after allowing enough room for an 8 x 10 inch electrode plate, I had just 7 x 10 x 4 inches in which to mount the electronics assembly - a bit of a tight fit. The ignition coil T1 is mounted under the electrode plate, as shown in Photos 10 and 11.

To prevent tracking between the primary and secondary windings, a tight fitting rubber tube some 12 inches long should be pushed over the eht coil nozzle after connecting the eht lead. Then connect the lead to the electrode plate and fill the space between the coil and the plate with layers of rubber foam.

Fig.4 shows the construction of the electrode plate and its mountings. As seen in Photo 11, it is essential to leave a space of at least one inch all around the edges of the plate to prevent field breakdown when large specimens are photographed.

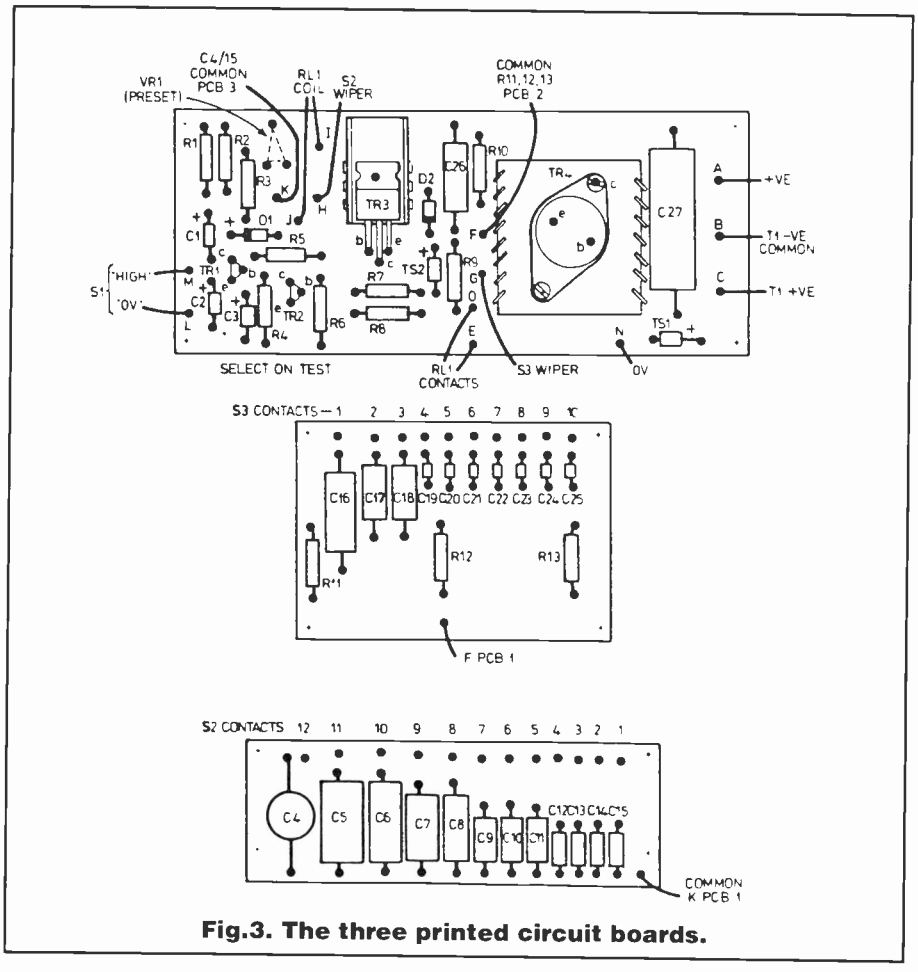


Fig.3. The three printed circuit boards.

Plate glass of at least 2mm thick is placed over the electrode to insulate it; this too should extend around the plate by at least one inch. It should be secured in place by quarter inch hardwood battens screwed to the sides of the box. Acrylic sheeting could be used as an alternative, but plate glass is preferable since acrylic tends to become etched with markings caused by the ionising field.

Photo 12 shows the completed unit and a guide to the control legends, though note that this is a photo of the prototype and the final legends will differ slightly.

TESTING

Timer setting is best done with the frequency control in the off position. VR1 is used to adjust the timing range, using the one second position as the reference. While observing the neon and preferably using a digital stop watch, repeatedly trigger the circuit and adjust VR1 until a delay of precisely one second is obtained. Within the normal tolerances of the other capacitors, the other ranges should follow proportionately. Though a nominal value of 2µF is quoted for C3, it is best to select its

ideal value on test. With the timing switch set for one second, switch the frequency control from setting to setting, each time triggering the circuit and timing its delay on a stop watch. If the timing terminates before one second has lapsed, C3 may be increased in value up to a maximum of 10uF. Increasing it beyond 10uF could affect the triggering.

PHOTOGRAPHY

Photographs are taken by first laying a sheet of photographic bromide film on the electrode plate cover, emulsion side up, (Fig.5). The specimen is placed on the film, the ionising frequency selected and the unit

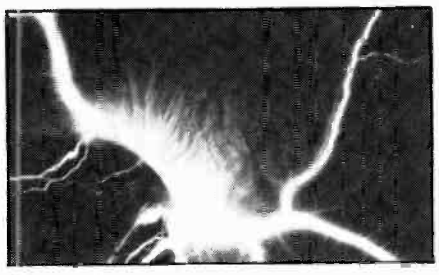


Photo 3. Panadol tablet

triggered for the desired time. The exposure is then developed in a normal bromide developer. Naturally, the exposing and developing must be done under suitable safelight conditions. Panchromatic sheet film may be used instead if more detailed imaging is desired, but exposing and developing must done under total darkroom

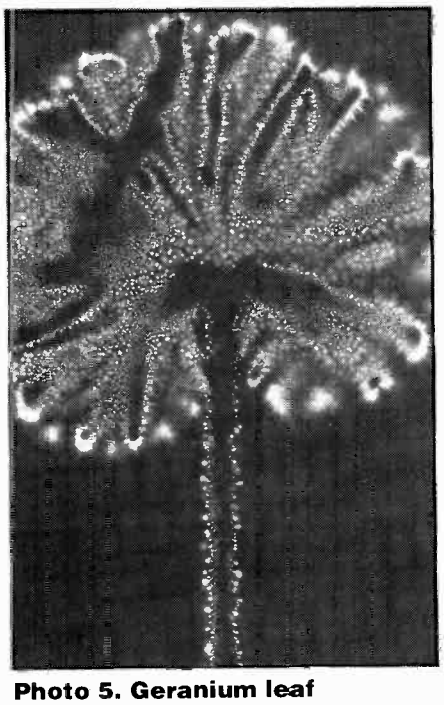


Photo 5. Geranium leaf

conditions. Though film is more expensive than photographic paper it has the advantage of allowing enlargement prints to be made of selected areas.

When photographing inanimate objects, such as leaves, metallic specimens, chemical compounds, etc, the ground lead (marked as the negative electrode on the panel) may be connected to the upper surface of the specimen to enhance the discharge path.

ON NO ACCOUNT MUST THE GROUND CONNECTION BE USED IF PHOTOGRAPHING ANY PART OF THE HUMAN BODY.

(I feel obliged to warn against using the unit to photograph any living creature. Ed).

Providing you do not earth yourself in any way, finger tips may be photographed by lightly touching them to the paper or film (Fig. 6) - the body's natural capacitance allows for completion of the ionising path.

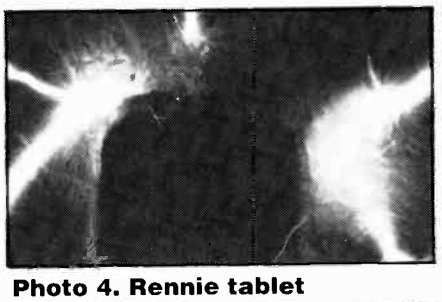


Photo 4. Rennie tablet

Photographing the complete hand is not recommended since the hand will dissipate the energy too much to produce satisfactory results. Be warned against attempting to increase the unit's energy output since this could be dangerous.

I am sure that Don Phillips will be pleased to hear about interesting results produced by readers using this Kirlian camera. He can be contacted at Aldon Paraphysical Research, 147 Butchers Road, Canning Town, London E16 1NE. Ed.

SUGGESTED EXPERIMENTS

Your Ed suggests that some of the questions you might care to seek answers to when using your camera are :

1. How different are the images produced by the same object at different frequencies and timing periods?

2. Are the images different when different photographic materials are used, eg, bromide or pan film?

3. Does humidity or temperature have an effect on the images? Don says this may be difficult to arrange but is essential, if only to rule out that moisture makes no valid difference.

4. Do the images change if the object is placed in different positions on the electrode plate? "A waste of time", says Don, "it will make no difference". Do you agree?

5. In the finger experiment, does the state of mind or physical well-being of the subject have any effect on the images? Don comments that this is the best test of all but is difficult to assess unless carried out

Photo 7. Finger tips

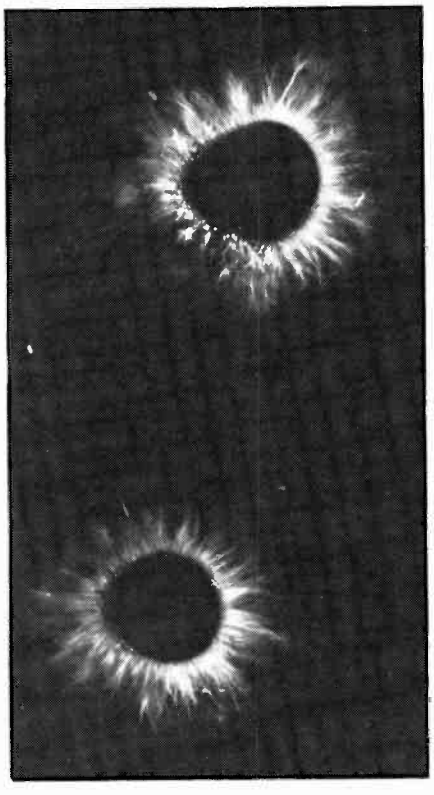
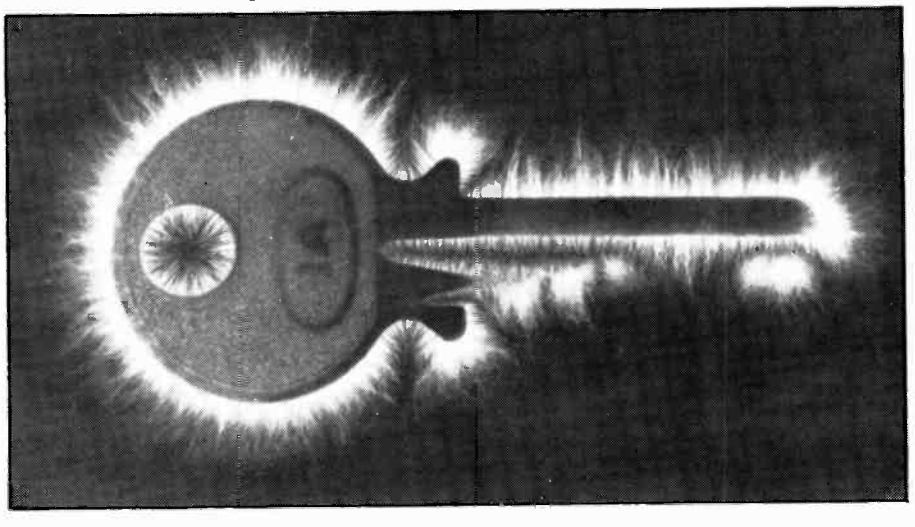


Photo 6. House key



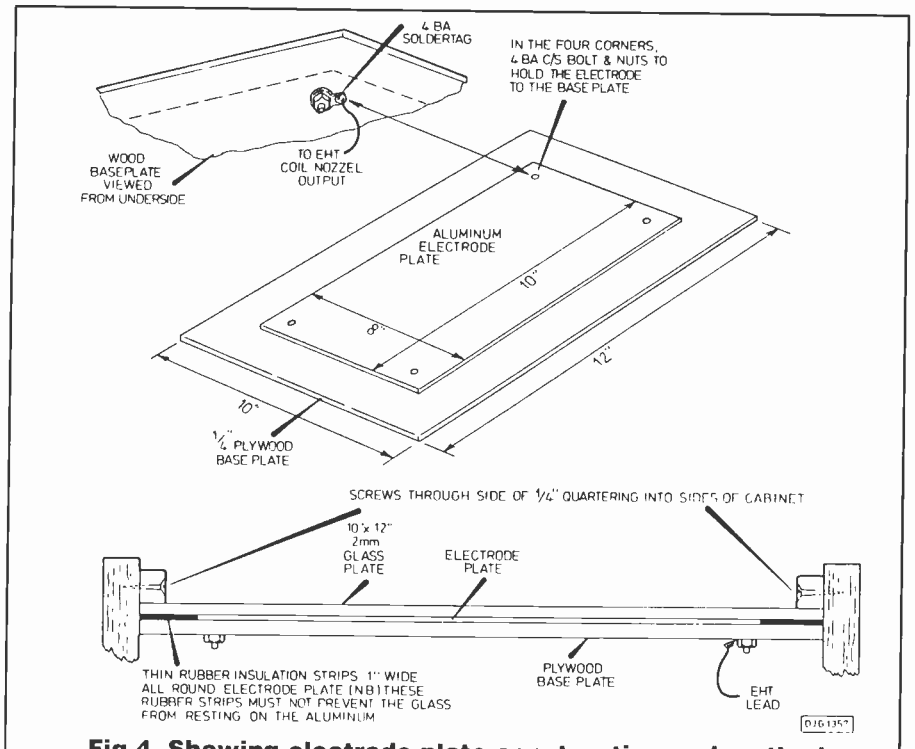


Fig.4. Showing electrode plate construction and method of fitting glass to electrode area

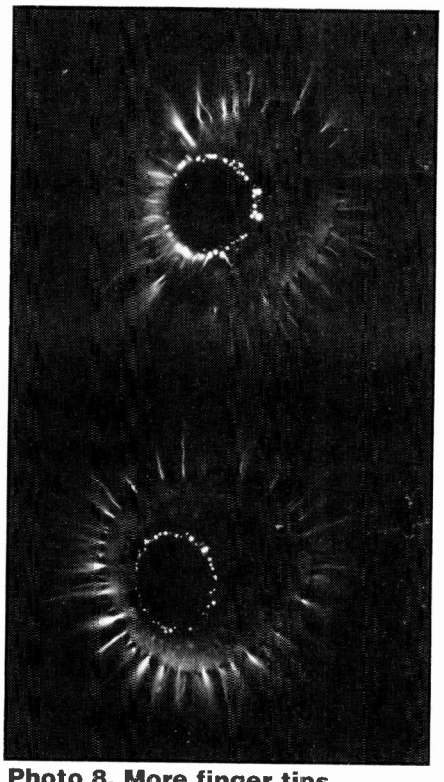


Photo 8. More finger tips

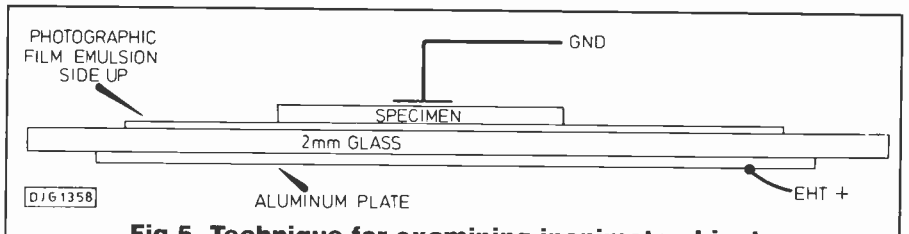


Fig.5. Technique for examining inanimate objects

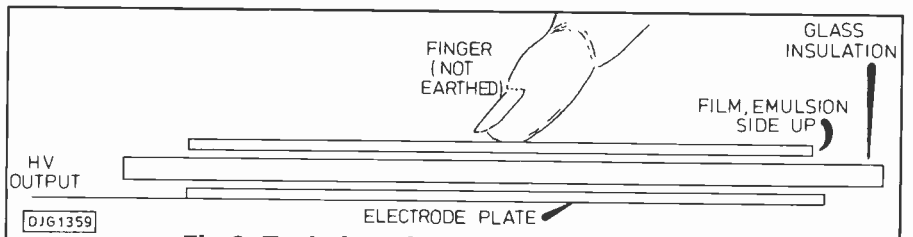


Fig.6. Technique for examining finger-tips

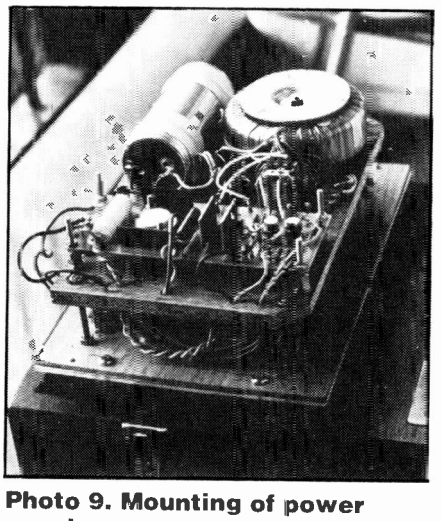


Photo 9. Mounting of power supply

under medical supervision and performed on numerous occasions to establish a statistically significant data base.

FURTHER READING

The Dark Side of the Brain (major discoveries in the use of Kirlian Photography and electrocrystal therapy). Harry Oldfield and Roger Coghill. Element Books. (Harry Oldfield is reputedly the leading researcher in Britain on Kirlian photography.)

Galaxies of Life. Krippner and Rubin. Anchor Books.

Photographing the Non-material World. Kendal Johnson. Aquarian Press.

COMPONENTS

RESISTORS

R1	47k
R2,R11	10k (2 off)
R3	6k8
R4,R6	4k7 (2 off)
R5	200k
R7,R8	56R (2 off)
R9,R10	100k (2 off)
R12	16k
R13	30k

All resistors 0.5W 5% carbon.

POTENTIOMETER

VR1	47k horiz preset

CAPACITORS

C1,C2,C13	220n 35V tantalum (3 off)
C3	2µF to 10µF 35V tant (see text)
C4	220µF 63V
C5	100µF 63V
C6	47µF 63V
C7	22µF 63V
C8	10µF 63V
C9	4.7µF 63V
C10	2.2µF 63V
C11	1µF 63V
C12	470n 63V
C14,C19	100n polyester (2off)
C15	47n polyester
C16	2.2µF polyester

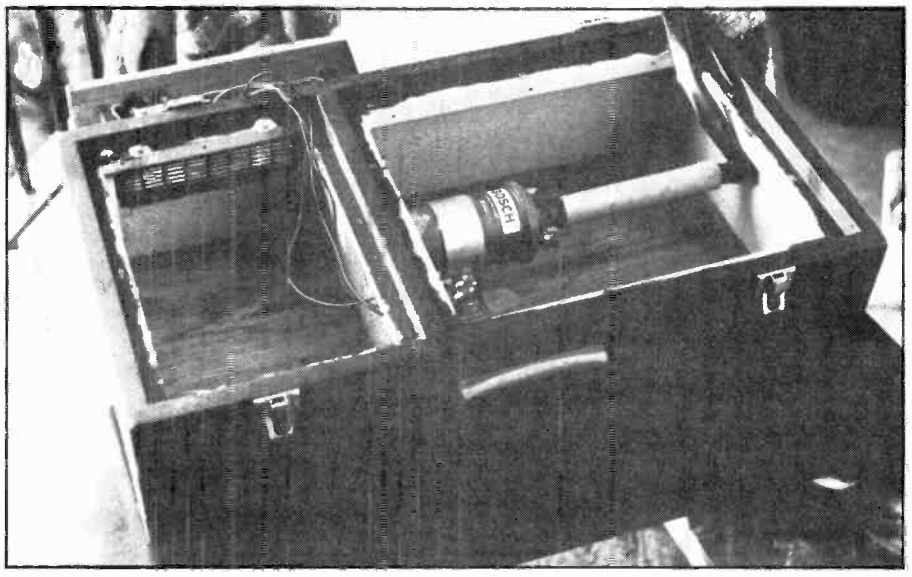


Photo 10. Interior box showing coil mounting

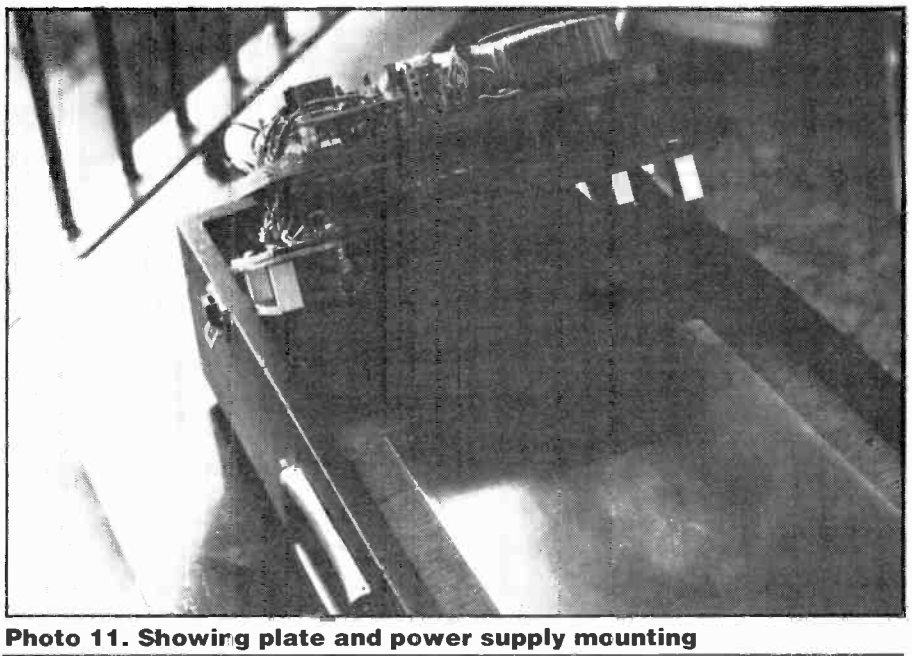
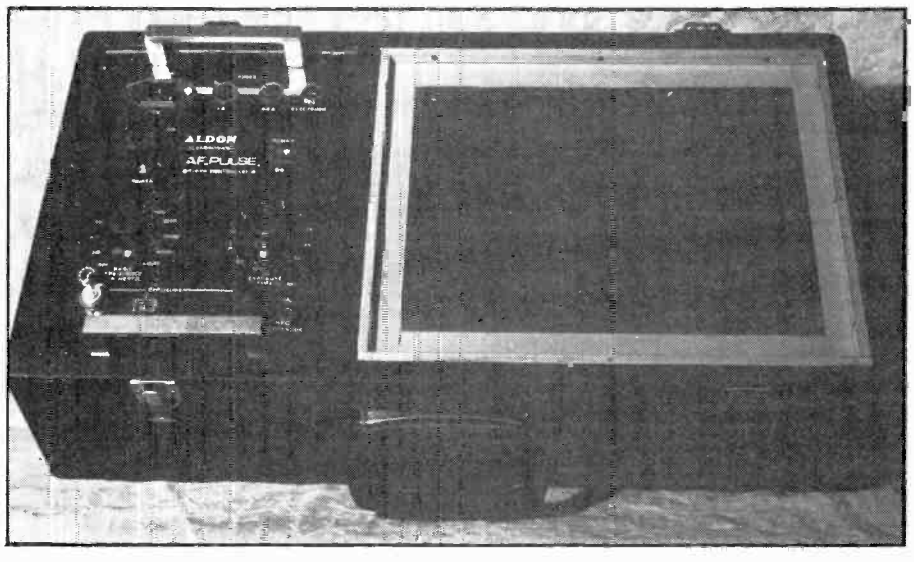


Photo 11. Showing plate and power supply mounting

Photo 12. Author's complete Kirlian dc camera



C17	470n polyester
C18	220n polyester
C20	82n polyester (or 47n + 33n in parallel)
C21	68n polyester
C22	47n polyester
C23	33n polyester
C24	22n polyester
C25	10n polyester
C26	1µF 63V metal film
C27	22n 1500V polypropylene
C28	10,000µF 40V elect

All 63V caps are single ended electrolytics unless marked. Polyester capacitors shown have a 250V rating.

SEMICONDUCTORS

D1,D3	1N4148 (2 off)
D2	1N4005
TS1,TS2	BZX61C47 transient suppressors (2 off)
TR1,TR2	2N3904 (2 off)
TR3	TIP32A
TR4	BU208
REC1	50V 6A bridge rectifier

SWITCHES

S1	sp push make, or microswitch
S2,S3	1p12w rotary (2 off)
S4	dpst rotary mains
RL1	24V 650R dpdt relay

TRANSFORMERS

T1	12V ignition coil (Lucas super energy)
T2	25V + 25V 80VA toroidal, 1.6A per winding (ILP Electronics 3X016)

SOCKETS

SK1	IEC mains connnectors
SK2	BNC 50 ohm socket (and plug)
SK3	4mm banana socket and plug (NEG electrode)

ELECTRODE ASSEMBLY

Electrode plate 204 x 254 x 1.2mm aluminium sheet (see text)
Electrode insulation 300 x 252 x 2mm plate glass (see text)

MISCELLANEOUS

FS1	2.5A antisurge fuse and holder (20mm)
FS2	1A antisurge fuse and holder (20mm)
LP1	mains neon (red)
LP2	mains neon (orange)

Capacitor clip for C28. Heatsink TO3 7.2 °C vained for TR4 (eg. Maplin FL59P). Heat sink 17 °C vained for TR3 (eg. Maplin FL58N). Knobs (3 off). EHT lead 30kV 300mm length. Case materials to suit.

PE

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JVC type 751-7 5" ultra compact black & white chassis monitor for 12v 0.7a DC operation Dim cm 11h,14w,18d. Simple DIY circuit data included to convert data and separate sync input to composite video Input. Ideal portable equipment etc. Supplied with full data. **Brand New £65.00 (B)**
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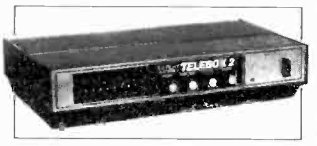

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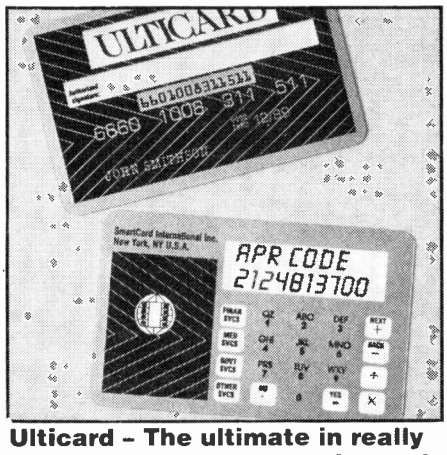
SMART HOME CARDS

Roy Bright of Smart Card International coined the name "Smart Card" for its first international showing in 1980 and has been heavily involved in its world-wide commercialisation since then. He began his conference presentation with a brief look at the

Roland Moreno pioneered the technology and filed his first patents in the mid 1970s. Following the successful conclusion to trials by licensed suppliers in France, banks adopted the technology and, using Honeywell Bull's technology, implemented the new point of sale service using a "mixed card" comprising a magnetic stripe, microprocessor and an 8K memory. 16.4 million cards, plus associated reader etc, were ordered for delivery over a three year period commencing 1986.



Ulticard – The ultimate in really smart cards. The same size and thickness as an ordinary credit card, but has microprocessor built into it providing high protection of security codes.

Meanwhile, Flonic Schlumberger was developing a pre-programmed card which, though less sophisticated, had the advantages of low cost, rapid development, and met ISO thickness requirements. Adopted by French Telecom for their Card-Phone service, 25 million cards have been supplied.

Prior to 1985, manufacturers had little choice but to use non-reprogrammable memory in their cards. With the greater reliability of eeproms, cards are now available with up to 64K of reprogrammable memory.

Conventional smart cards are passive, that is they can only be activated by insertion into a terminal having keyboard and display facilities, and capable of supplying power to the card. The high cost of terminals restricts the number of locations in which they can be placed, so restricting their convenience. To meet this problem, active cards are being developed, containing their own terminals and power source. They can be regarded as the "missing link" between passive cards and personal computers.

Effectively, an active smart card is a pocket-sized pc, but with the added benefit of being highly secure, while retaining compatibility with the interface standards for conventional smart cards. Like a pc, active cards have read-in, read-out facilities; use data-file structures with logical indexing; provide powerful processing features including scratch pad memory, and can communicate externally. Active smart cards are now currently marketed under the trade marked name of Ulticard, and have such diverse applications as welfare services, libraries, employment seeking, cinema attendance, car parking and medical treatment. They are also highly suited to applications in an automated home.

Before considering suitable applications in the home, it is important to understand some of the unique features which could be exploited in this environment.

A major attribute of any smart cart is its inherent security. First, the authentication of the card holder requires the correct Personal Identity Number (PIN) to be entered. Then the card is equipped to authenticate itself to the system before it is accepted as legitimate. It is important to note that the latter secret identity code never leaves the highly protected memory zone in the card. When challenged by the system, the card's microprocessor conducts the interrogation internally and transmits an encrypted response, so avoiding disclosure of the actual code outside the card.

These outstanding security features, and many others, are achieved by the card's embedded microprocessor. It is this which sets the smart card apart from other plastic card technologies and justifies the use of the term "smart". The microprocessor is used to control the various card functions as well as provide a variety of services, such as calculations, which can be programmed according to the particular needs of the application.

Applications to which the card can be put in the automated home are likely to be initiated by the building industry. The smart card industry itself is unlikely to take the initiative in this area, though many possible applications are foreseen. For example, it is likely that "smart homes" will be designed in which the various functions may be controlled via an active smart card. This would provide a set of easily comprehended prompts to guide the householder through a routine of keyboard entries to produce a master control program for the house, protected by the householder's PIN. Smart cards could be used for gaining access to the house and garage, for operating the alarm system, and for activating high value consumer items such as tv, video, hifi, etc. With the cooperation of equipment manufacturers this would be a major deterrent to burglars. Using a suitable home-based terminal, the enhanced security also allows for fund transfers in both telebanking and teleshopping, as the French are already discovering.

These innovations are unlikely to occur overnight, though an increasingly rapid proliferation of smart card technology is expected.

HOME AUTOMATION

BY JOHN BECKER

PART TWO

THE LINE, THE SWITCH AND THE AUTOMATED WARDROBE.

Continuing our report on how leading experts regard the future for home automation.

DISPLAYS IN TOMORROW'S HOME

Peter Forster has worked for Philips Electronics for the past 24 years, occupying his present position as Strategic Planning Manager since 1984. During this time he has been an active member of NEDO Interactive Home Systems Task Force . . .

Displays are now an integral part of the home and 97 per cent of the 20 million homes in the UK have a tv, and many have more than one. This has implications for the family unit for the tendency is for the family to split into separate cells for discrete viewing.

In the simplest situation, ie, with entertainment, transmission is basically one way. Teletext represented an important step forward in that users can interactively search for external data when required. The integrated home systems concept takes us another stage further as the tv can now monitor sensors around the home and display their status or images on the screen.

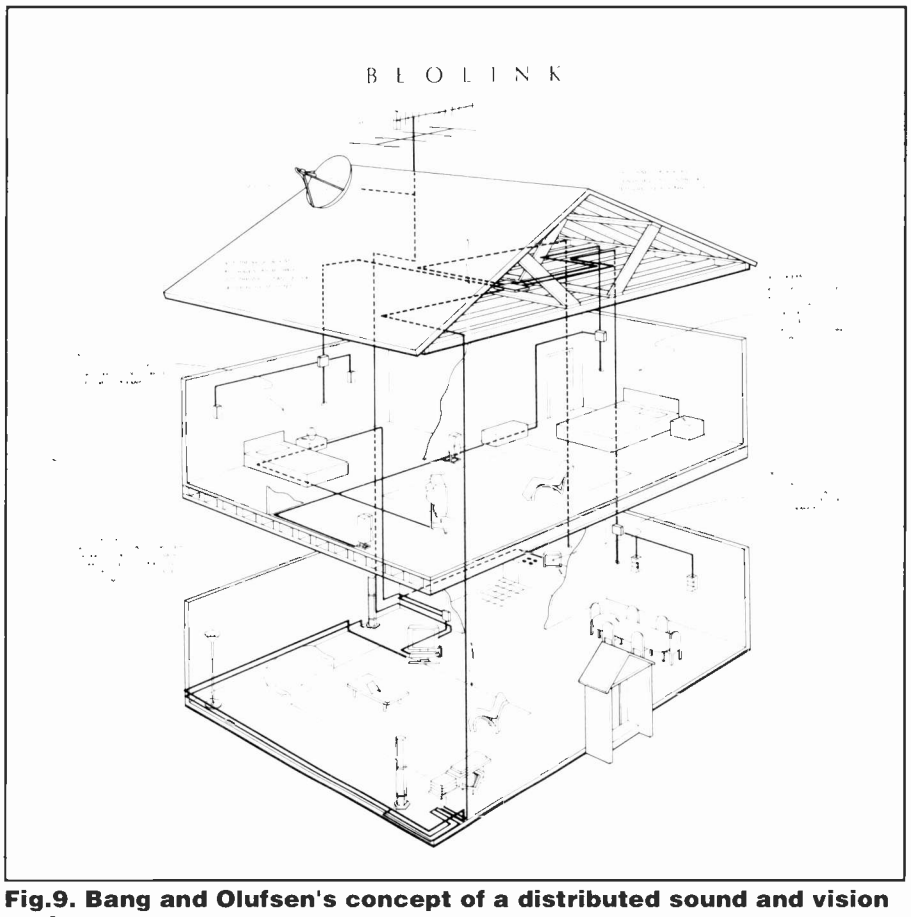


Fig.9. Bang and Olufsen's concept of a distributed sound and vision system

We can go on from that stage and build in other options allowing the user to remotely take action in respect of the displayed status.

LCDs could be dotted around the house at easily accessibly points, such as at each light switch. Each room has at least one light switch and represents a convenient access point to a home data bus via existing or additional wires. It is technically possible to install sensors which determine the whereabouts of any person and activate an audio or video message according to locality.

HDTV is important in the context of automating the home. Pilot transmissions should start this year, and services start in 1992. The number of lines will double from 625 to 1250, the pixels will increase from 180,000 to more than 700,000 and further improvements will give strikingly detailed, clearer, crisper pictures. These improvements will make it possible to view much bigger screens. Today's screens still use the same format as in 1936, an aspect ratio of 4 by 3, but with hdtv the format will be 16 by 9. The extra width will make the format compatible with film so the screen will not cut off detail to either side as currently occurs in many instances. HDTV will also bring superb digital sound of cd quality, and surround sound to give cinema style effects in the home.

In the longer term we can expect further developments. As the use of optical fibres is extended in cable tv, the extra bandwidth will allow an increase in the picture data transmitted. For example, picture in picture facilities with the home viewer able to zoom or shift images across the screen according to whim. The increased use of projectors for tv displays is another possibility foreseen, resulting in much larger images, projected perhaps onto the livingroom wall.

These improvements will only be beneficial if the consumer accepts their desirability. It is likely that consumers will be encouraged in this by the falling real costs of electrical goods, accompanied by an increase in functionality – a form of efficiency, since the equipment can do more. It has been calculated that had the same results been achieved in the automobile industry, the price of a Rolls Royce would be £3.75 and it would travel three million miles to the gallon!

DISTRIBUTED SOUND AND VISION

Keld Harder has worked for Bang and Olufsen for thirty years and is currently project manager of the Home Information Network project in which several large Danish companies participate. Though his comments relate specifically to Bang and Olufsen, other companies in the field have similar viewpoints . . .

"Give freedom to consumers to compose individual system solutions" is Bang and Olufsen's view. The Beolink system represents this philosophy, being a totally integrated audio/video system with distributed sound, picture and operation. (Photos).

It comprises a central audio/video system with which consistent high quality picture and sound equipment can be available in, and controlled from, every room in the house. The concept is an integration of data, control, sound and picture. Video signals are distributed through a coax cable, and data and sound are distributed via a shared 7-conductor cable. In order to ensure the consumer's simple use of the system, however complex, the number of buttons has been reduced to a minimum and made readily accessible. The user can also communicate with the system via infrared remote controls. The system is not restricted to entertainment purposes and it additionally allows control and monitoring of security and other home automation functions, plus a connection to the telecommunications network.

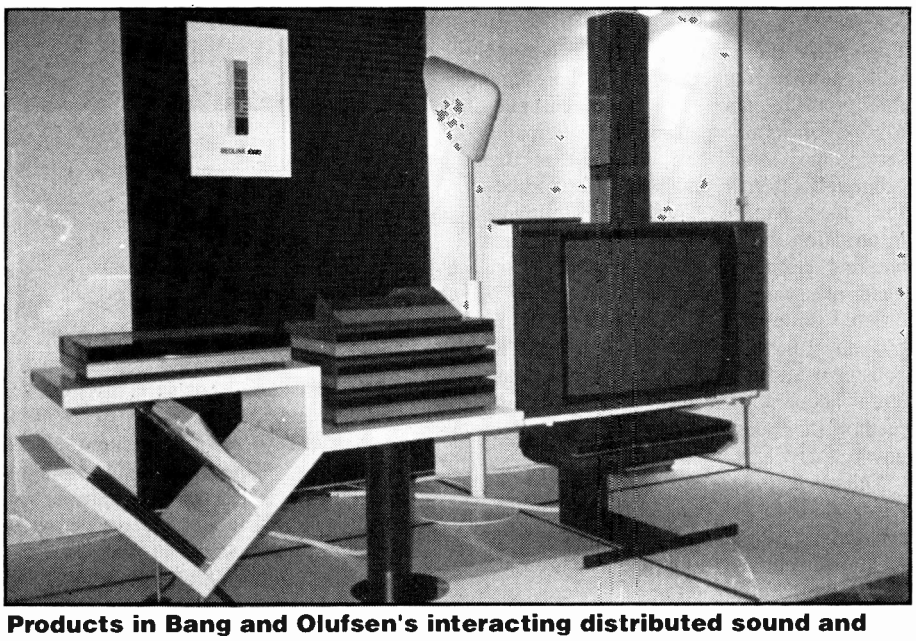
To ensure the widest possible perspective for Beolink, B&O entered into cooperation with several Danish companies, including one of the telephone companies. The collaboration has two objectives – to ensure that the products of individual firms are adapted to the home automation market, and to coordinate product developments so that they collectively form a total system comprising entertainment, information, telecommunications, teleoperation, energy control and security. With the additional cooperation of the Danish Ministry of Industry considerable finance has been invested in the "Handbook Project". This will contain guidelines on the design and implementation of home information networks so encouraging Danish industry to meet the requirements for complete automated homes.

INTERACTIVE VIDEO

Bryan Quilter is Chairman of National Interactive Video Centre Ltd, a government/industry supported organisation for the encouragement and development of interactive video in the UK. He presented a video in which several key points were made . . .

Interactive video brings together the power of the computer combined with the highest quality motion pictures. This unique combination has to date been expensive and more suitable for industry, education and institutions rather than the home consumer market.

Technical innovations can find early markets in one section and migrate to another. Computers reached the consumer in micro form after decades of development in industrial, scientific and similar



Products in Bang and Olufsen's interacting distributed sound and vision range

applications. Video travelled from consumer to industry. Technology is being transferred more widely and more quickly than previously. USA, Japan and Europe follow in quick succession. Standards battles may well be resolved at pre-competitive stages.

The key to the use of interactive video will be software. This could be entertainment, information or knowledge led and could reach the home from school or work. CDI is about to be launched and could be the first interactive visual medium for the home, if the performance and price expectations are realised. In any event the demand for IV software is very large and growing, and there is an immense opportunity for the UK.

At the training level, managers and government can solve many problems and potential problems by a bold and vigorous use of IV now. The benefits in the home will follow logically as the various elements fit into the market place.

HOME BANKING

Jonathan Reynolds is currently Researc h Fellow in Retailing at Templeton College, Oxford. He believes that the future of home banking in the long term can be said to be tied in with the future of consumer interactive services more generally.

According to a recent pronouncements by all the leading UK clearing bank retail banking directors, the future is not technology-led: "The nature of branches many well change. In the long term, there will be greater emphasis on self-service of all kinds and we will certainly see unmanned branches. But you cannot ignore the fact that the branch network is a very important sales force."

The future of home banking services using new technologies such as videotex, voice synthesis and voice recognition has demonstrated two key advantages to those involved : greater accessibility and speed of control for consumers over their financial affairs; for the financial institutions a potentially drastic fall in the cost of paper-based processing. But the cost to the institutions and customers is still questionable - home banking using any of the newer technologies is an extraordinarily expensive capital investment.

Banks have been progressively moving towards automation since the 1960s, and "like old age, home banking is inevitable, but nobody wants to get there first". Using the home for banking affairs appears intuitively more attractive in the US than perhaps anywhere else in the world. In reality, the experience has been rather different. The estimate is that there are fewer than 80,000 subscribers to bespoke home banking services at present. The results are as yet inconclusive, and it might be said that the jury is still out.

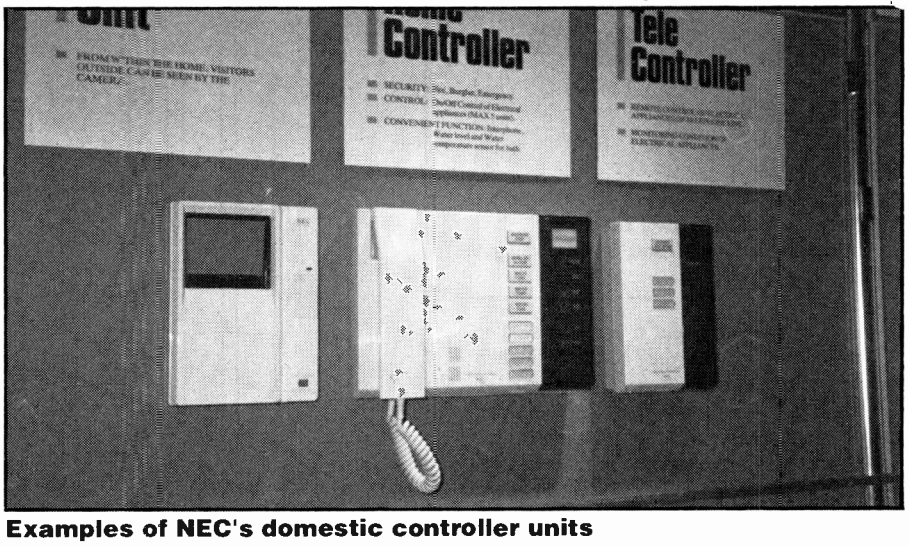
In France it appears that the jury has been rigged! As a result of considerable state subsidisation of videotex terminal distribution, one of the major cost barriers to the banks, the provision of terminal equipment in the home, has been largely overcome. At the end of 1987 there were some 850,000 customers of home banking services in France – one customer in 25 households.

Home banking in the UK has been characterised by early pioneering developments, followed by a disparate range of schemes and technologies advanced by banks and building societies. The lack of a large terminal population working to a common standard has prevented the kinds of scale economies and exponential growth of home banking services experienced in France – as it has prevented growth in other home-based teleservices.

Currently, home banking services in the UK are offered by the Bank of Scotland, Barclays Bank (pilot scheme for staff only), Clydesdale Bank, Lloyds Bank, Midland Bank (pilot scheme for selected customers only), Nationwide Building Society, Nottingham Building Society, Royal Bank of Scotland, and TSB/Speedlink.

When asked by Gallup in 1987 "which are you most likely to use computer shopping for?", 28 percent of UK respondents quoted banking affairs, second only to groceries. Popular support exists in principle for home banking, but a series of paradoxes dominate consumer issues in this area : consumers require the assurance of a secure system, but without the attendant complexity; they demand speed of access and interrogation of account information, but without the loss of the "float"; they demand a service at a low (or at no) cost, but one which is of high quality. These conflicts are not irreconcilable, but may be costly and complex for suppliers to introduce.

Despite some negative aspects, there are genuine opportunities for growth in home banking services, but as part of a broader strategy. It was never envisaged that home banking would ever replace conventional retail banking activities, but that it might enhance and complement it.



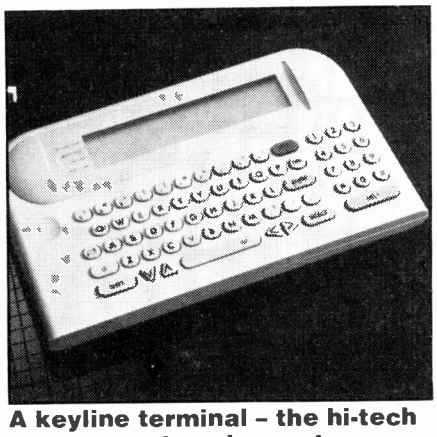
Examples of NEC's domestic controller units

HOME SHOPPING

Richard Poynder is Managing Director of Keyline Shopping Ltd. He described a unique concept in home service, which is being launched in the UK by Keyline in Autumn 1989. The company's product is an electronic communication system linking domestic consumers to wide variety of retail and financial services. The system comprises home terminals, an electronic delivery network accessed by a local telephone line, and a main computer system installed within the service provider's premises. Keyline was founded in November 1978 by Christopher Curry, co-founder of Acorn Computers and inventor of the BBC microcomputer.

Keyline consider that a home service should be seen as complementary to more traditional forms of shopping, and that three types of service are needed : shopping for and purchase of retailed products – home shopping; acquisition of financial services – home banking; obtainment of useful information – home information. These services are needed 24 hours a day, seven days a week, and in the case of tangible goods, there needs to be an efficient delivery or collection service.

The objective is to distribute 2.5 million terminals to consumers and, through the participation of major retailers and financial institutions, to enable the consumers to shop for, compare prices of, order and pay for a large variety of products and services. The terminals are inexpensive to manufacture, portable, intelligent and able to be used by inexperienced operators – ordinary people in their own homes. The range of uses for the terminal when connected through the normal modern BT wall socket is almost unlimited – bounded only by the range offered by the service providers. The process of obtaining goods and services is intended to be simple, fast, convenient and cheap.



A keyline terminal – the hi-tech answer to shopping and information services every day of the year.

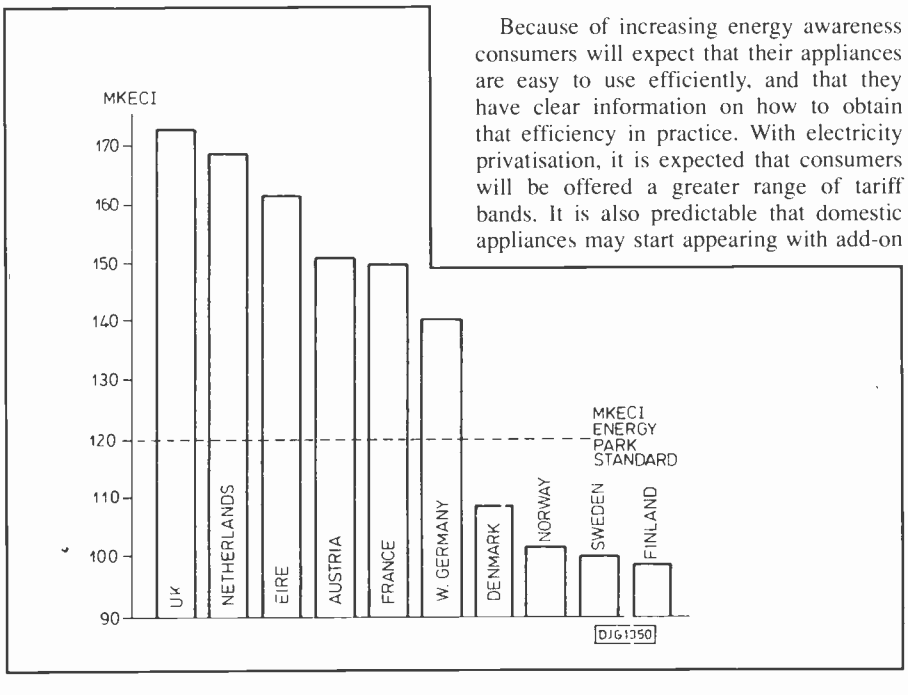
The terminal is battery-powered and enables requests to be entered in simple English. At the right moment, the terminal will automatically connect the consumer, through the telephone line at local call rates, to one or more appropriate participating service providers. The customer is then prompted through the acquisition process for the required product, following information displayed on the terminal and entering simple English responses. Then, under password control, products can be ordered through the terminal, and paid for by any method agreed between the consumer and the supplier, eg, credit card, store account or current account. The method of goods delivery will also be by any mutually agreeable method.

Other facilities are offered by the terminal, both for local off-line use as a calculator, alarm clock, list storage, telephone number look-up, and for use connected to other domestic systems such as intruder or smoke detection devices.

Consumers may acquire the terminals at no capital cost, simply on application and payment of a small returnable deposit (around £35). They will then only need to pay for batteries (say 4 x AA batteries twice a year), and local telephone call charges for the time during which the terminal is on-line. Optional printers will also be offered to consumers, at a price of about £50.

The system has been designed specifically to protect consumers, retailers and financial institutions from fraudulent misuse. Features include both hardware and software tamper-resistance, as well as three levels of encryption depending upon the type of transaction being undertaken. User authentication will be by passwords issued secretly to users.

Fig.10. Comparison of building regulation standards in ten European countries using the Milton Keynes Energy Cost Indicator (MKECI)



DOMESTIC ENERGY CONTROL

Brenda Boardman is an independent energy consultant who has researched into energy use in the home for the last six years and is a member of many related organisations.

The best known method of auditing energy is the Milton Keynes Energy Cost Indicator (MKECI), which is an index based on cost. Fig.4 shows the MKECIs for identical three bedroom, five person, end of terrace houses, if built in Britain to the standards of the present building regulations of ten European countries. The lower the MKECI the less energy is used – so Britain is the worst of the countries illustrated, and Finland the best.

In a typical house about 12 per cent of the energy comes from electricity, but this represents 40 per cent of the costs. Fig.5 shows the way in which electricity is used by appliances in an average house in north-west England, excluding heating and cooking. Fig.6 shows the electricity demand over a 24-hour period in England and Wales.

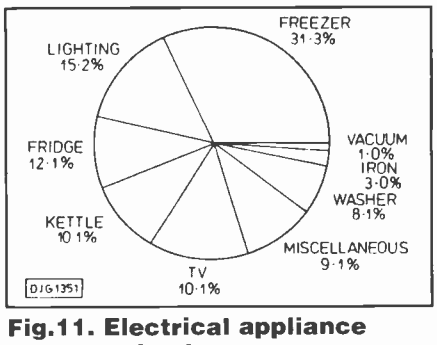


Fig.11. Electrical appliance consumption in an average house (excluding space/water heating and cooking)

Because of increasing energy awareness consumers will expect that their appliances are easy to use efficiently, and that they have clear information on how to obtain that efficiency in practice. With electricity privatisation, it is expected that consumers will be offered a greater range of tariff bands. It is also predictable that domestic appliances may start appearing with add-on

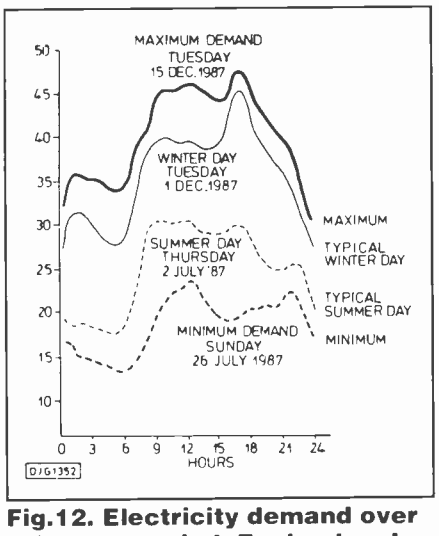


Fig.12. Electricity demand over a 24-hour period, England and Wales

displays showing the price of the present band to enable more precise energy management and establish which appliances could be switched off to save consumption during peak periods.

It is known that consumers value immediate control in central heating systems and gas central heating, the most responsive of systems, has continued to increase in popularity in all income groups (Fig.7).

Another force for change may come from increasing concern for the environment, both globally and within buildings. Such factors as depletion of the ozone layer and the greenhouse effect will have an impact on the techniques used to insulate homes and reduce energy consumption.

However, there are two other social factors that influence successful home automation. There can be considerable difficulties and expense involved in getting appliances repaired, consequently products must be reliable. Secondly, for products to be acceptable they must be as much designed for use by people with disabilities as for the able-bodied. Careful thought must be given to products intended for achieving energy efficiency.

AUTOMATION FOR THE DISABLED

Elizabeth Fanshawe OBE DipCOT has been Director of the Disabled Living Foundation since 1983, and is a member of many organisations to do with improving the quality of life for disabled people. The Foundation is a national information resource on the non-medical resolution of the daily living problems facing the disabled.

The bulk of her remarks were addressed to the problems of disability as whole rather than to how automation might help the disabled. They were a chastening reminder that society has still not made adequate provision for the disabled in many areas. She made the point that due to the aging process alone nearly all of us may become disabled in some way. A DoH survey shows that six million adults in Britain have disabilities. This is a large market to explore, even though the disabilities do not conform to a designer's ideal requirement for standardisation.

Initially, she pointed out, the mass market appliance manufacturers can help the disabled by ensuring that control knobs are of a size suitable to those with impaired grasp; that control legends and instruction documents have letters large enough for those with restricted vision to read and that they contrast well with their background.

She declined to give "a list of wizzy automated items that disabled people need because if such items are designed with the needs of ALL in mind they will be of just as much use to (the majority of) disabled people as they are to everyone else." Though she went on to say that the DLF can discuss various needs with interested companies, I was disappointed that at a conference of this calibre, to which the press were invited, she did not itemise and gain greater publicity for some of the less obvious applications for technology in aid of the disabled.

AUTOMATION FOR THE ELDERLY

Nigel Appleton is the Projects Director for the Anchor Housing Trust. His comments were largely related to defining old age and examining the economic situation for older people. He acknowledged that there is an undoubted role for automation and information systems in the field of specialised housing for the elderly . . .

To date the greatest penetration has been in communication and security systems. A major area of concern is the need to cope with increasing levels of frailty and confusion. Applications include supervision of residents, monitoring of self-administered medication, and control of mobility equipment. Many older people live alone or with one other elderly person, and are often at a distance from supportive family or friends. For the future their capacity to cope may depend upon a mix of human and technological support systems.

The problems are relatively basic. The need to control their environment, ie, heating and ventilation control and monitoring. The need for security and safety – alarm systems, smoke detectors and low temperature monitors. The need for communication – telephone and intercom systems, emergency call systems, computer banking and shopping. The need for low level support in personal care – activity monitoring, "vital signs" self-monitoring, and medication prompting. In all four areas the technology is already available and much of it is unsophisticated. The immediate future in this market lies not with new frontier technology but in the answers to two crucial problems : acceptability and affordability.

The resistance of older people to the acceptance of the new is probably no greater than for other age groups. But it may be that the way forward is to build on two pieces of equipment with which most older people are already familiar – the tv

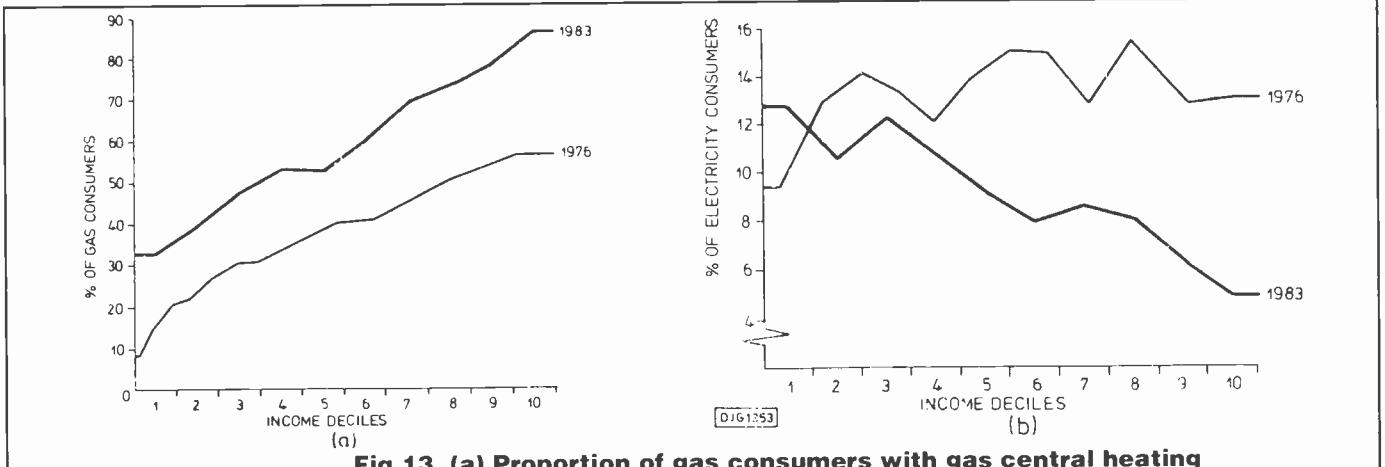


Fig.13. (a) Proportion of gas consumers with gas central heating (b) Proportion of electricity consumers with electric central heating

and the telephone. On affordability, there is the question of whether the market will be exploited solely for profit or whether there would be some intention of meeting need. The telephone is vital to the independence of elderly people, but many cannot afford it. Other systems and equipment which the majority of those who need them cannot afford will be seen as no more than rich geriatrics toys. Products and services must be affordable by a substantial number of those who actually need them.

There is a defined market for information and automation technology in specialised housing for older people. The greater challenge is in meeting the needs of the 95 per cent of elderly people who remain in their own homes. The need is for systems which will supplement or replace human support systems. Some needs and products are already identified but further product development is required and the future depends upon industry's ability to respond to the challenge of acceptance and affordability.

CONSUMER VIEWS

Dr Liz Mandeville joined RMDP's research department in 1985 and has been closely involved with the field of home automation. She has just completed a second programme of research on the same subject among consumers to establish their interests, attitudes, expectations, fears and concerns.

TABLE 1
IMAGES OF THE AUTOMATED HOME

Image	Attractive %	Unattractive
Home-accessed facilities	58.5	14
Remote control	57	15
Armchair control	52	18
Programmable home	75	7
Robot aids	17	55
Automated furniture	24	52
Talking appliances	40	39

Table 1 shows the percentages of all participants who found the listed images attractive or unattractive. From the table it is apparent that the more "science fiction" images of robots and automated furniture are generally disliked, though opinion is divided on the merits of appliances capable of conversing with the householder.

This suggests that people like the idea of exerting greater control over their home, but don't like "gadgets". Fear was also expressed of a Sorcerer's Apprentice situation with unstoppable machines forever turning the tv on and off, pumping water, opening and shutting windows, and even answering back when told to desist. As it emerged in discussions, programmability is a double-edged concept: control is good in human hands, but extremely threatening when handed over to a machine.

TABLE 2
APPLICATION AREAS: LEVEL OF INTEREST

Area	Average Number of Mentions for Services
Household security	74.5
Energy management	67.5
Working from home	60
Financial services	54.5
Household management	53.5
Entertainment, education and culture	44.5
Health monitoring	41

Interestingly, the concept of home automation evoked certain initial responses, but attitudes changed when people began to consider some of the areas where home automation can be expected to have an influence. This is probably partly because it takes the subject out of science fiction or hobbyist atmosphere which tends to surround it – people began to think in detail how it might really affect their lives. Table 2 shows the levels of interest in particular areas as revealed by the number of mentions made during the discussions. The limited nature of this information is recognised.

TABLE 3
MOST AND LEAST POPULAR APPLICATION AREAS

Area	% of 'High' Responses	% of Low Responses
Entertainment, education & culture	37	3
Household security	23	–
Energy management	23	3
Financial services	7	9
Household management	7	13
Health monitoring	2	38
Working from home	1	34

Participants were asked to say which application areas they thought would prove most popular, and which the least. Table 3 shows the ranking order of the areas. The results indicate that there are clear winners and losers in the popularity stakes. Significantly, working from home, which has received a relatively large amount of publicity in discussions of home automation, fares very badly. *(Strangely, considering the current media coverage relating to healthy living, so does health monitoring. Ed)*

Discussions about who will benefit most from specific areas of home automation revealed the information in Table 4.

To assess participant's fears, the members of the groups were offered eight statements about home automation, each embodying a distinct attitude towards the subject, and asked which, if any, they agreed with. All except the last began "I think home automation ..."

1... represents progress in life styles. I look forward to its introduction.
2... is the latest fad, and will go the same way as other fads. I do not think it is something to take seriously.

TABLE 4
WHO WILL BENEFIT MOST FROM HOME AUTOMATION?

Area	Main Beneficiaries
Education, entertainment & culture	Everyone - 50% The young - 40%
Household security	Everyone - 48% The old - 26% The rich - 26%
Energy management	Everyone - 38%
Financial services	Everyone - 30% The rich - 40%
Health monitoring	Hypochondriacs/ health freaks - 33% The old - 29%
Household management	No particular pattern
Working from home	No particular pattern

3... has a lot to offer, but I am concerned about its implications for privacy and security of the home.
4... is likely to appeal only to technology enthusiasts.
5... is of great benefit to housebound and disabled people, but am not convinced that it has much to offer the population in general.
6... will change people's lives in ways we cannot yet foresee. I am concerned that many of the changes will be for the worse.
7... will make the task of running a home efficiently much easier and more cost effective. I welcome this development.
8... I regard the home as a private and relaxed place. I do not welcome the intrusion of high technology into the home.

Table 5 shows how participants responded to these statements.

TABLE 5
ATTITUDINAL STATEMENTS ON HOME AUTOMATION

Statement	% of Respondents agreeing
Look forward to progress	41
Unserious fad	8
Concerned about privacy & security	48
Only for enthusiasts	27
For housebound and disabled	52
Concerned about changes	47
Welcome household help	39
Intrusion on privacy	29

Fewer than a third of participants think home automation is only for high tech enthusiasts or worry about its intrusion into the home, and fewer than one in twelve consider that it is a fad which will go away. The highest support is for those statements which reflect uncertainty and reservation. The task of companies entering this market will be to identify and address major areas of concern, so that their products may be received as helpful rather than threatening. This research is designed to help with that task.

Both as PE's Editor and as an interested individual, I would have additionally liked to know the social and age groupings of the participants in relation to their answers.

TOTAL CONTROL

Colin Blake describes himself as an automated home owner! Like many PE readers, he loves inventing, making and installing almost anything electronic or mechanical that takes his fancy. What he has designed for his home holds many possibilities for the advancement of future living.

Home automation has the ability to allow people to lead a more organised, secure and stressless lifestyle. It also has a novelty factor – capability to control appliances that most of us regard as only suitable for human intervention.

Automation of the home has a personality extension – to some people their image must be reflected in the home and they draw inspiration from the James Bond examples so much admired on the screen. The entertainment world has been prone to showing home automation in a negative light – gaining humour from situations where automation goes wrong. The real world is not usually like that – if automation constantly went wrong no-one would buy washing machines, toasters and other electro-mechanical devices.

I started automating my home by installing infrared light controllers, adjustable lampshades, video cabinet with opening doors and sliding table, and provided the windows with electric curtains! It was soon apparent that each function needed separate controllers and that finding the appropriate one took longer than manually performing the same function. The implementation of a single master controller was the next objective.

Demobbing the home computer from the space-wars front, I built an interface, wrote software and converted the system to generate patterns of control sequences for lights and curtains. But it was limited – freedom of control was needed, a method of communicating with the computer that didn't restrict access.

The humble telephone – that was the answer, a means of communication from almost anywhere to the home. A second interface was built linking the phone to the computer via dtmf (dual tone multifrequency) across a conventional voice link. A dtmf tone pad placed over the handset would send coded data to the computer, which would reply with menus and prompts generated by digitally assemble human voice. In 1987 the next module was built, and control of a table lamp in the living room became telephone active!

Currently I have control of central heating, hot water, house lighting, curtains and what must be a first – an underground plumbed sprinkler system to water the lawn. And all controllable at any time of day from anywhere in the world by the push of a button over the telephone.

May that be inspiration to all PE readers!

PE

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Thorn-EMI, 01-848 9779. John Ryan.

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Unless otherwise stated, all the clearance parcels we offer contain brand new, top grade components. If some of the offers look too good to be true, all I can say is that the optimists will get some stunning bargains, the cynics will never know what they've missed, so everybody will be happy! All offers apply only while current stocks last – watch out for next month's parcels or, better still, be the first to hear about any new offers by putting your name on our mailing list. (Please write in, or 'phone Pete Leah on 0272 522703 after 6.30 pm).

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This one contains some of just about any component you care to name! There are passives (resistors, capacitors, tants, presets), opto devices (couplers, LEDs of all shapes and sizes, infra-red components, 7-segment displays), semiconductors (transistors, diodes, ICs, rectifiers), and all kinds of other odds and ends (relays, VDRs, neons, battery connectors, mixed components packs). A stunning range of components – enough to get a workshop or lab started – at a ridiculously low price.

The components are of excellent quality, in packs originally intended to sell at £1 each. To make sure you get a good variety, the 20-pack parcel will have no more than two of any one pack, the 100 pack parcel will have at most five of any one pack. Packs supplied as they come – our choice.

PARCEL 1A: 20 PACKS for £10 + VAT
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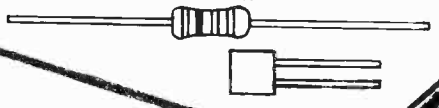
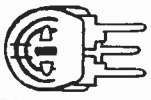


MASSIVE CLEARANCE SALE

Once again, a general purpose parcel containing a huge variety of components: resistors, capacitors, ICs, transistors, electrolytics, tants, triacs, LEDs, diodes, thermistors, trimmers, VDRs, all sorts. All new, top quality components. This is mostly remainders from our own stock – stuff we forgot to advertise, or have in too small a quantity to sell individually. Guaranteed to be worth at least eight times the price if valued from any standard component catalogue! What more can I say?

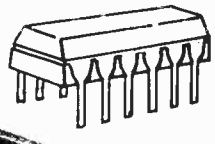
PARCEL 2A: 1000+ top grade components for £12! + VAT (Value £100+)
PARCEL 2B: 5000+ top grade components for £49! + VAT (Value £500+)



INTEGRATED CIRCUITS

This parcel contains nothing but ICs. The mixture offers TTL and CMOS logic, interface ICs, linear, data converters, op-amps, special functions, and so on. Some of the ICs are pre-packed with data sheets, some (TTL, CMOS, op-amps) we expect you to identify for yourself, others will be covered by the free *data pack* provided, and the rest you'll have to identify under your own steam. If you know your ICs you'll be in for a few nice surprises.

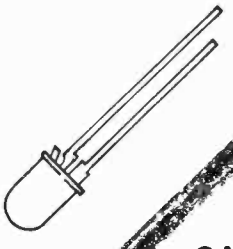
PARCEL 3A: 100 ICs for £12! + VAT
PARCEL 3B: 500 ICs for £49! + VAT



LEDs

All shapes, sizes and colours of LEDs. Round ones in various sizes, rectangular ones, red, green, amber and yellow ones, clear and tinted lenses, all sorts.

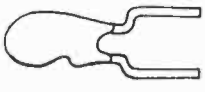
PARCEL 7A: 100 LEDs for £5.90 + VAT
PARCEL 7B: 500 LEDs for £24.90 + VAT



TANTALUM CAPACITORS

A nice range of tants in values up to 47µF. Lots of useful caps, and we're not mean with the most expensive ones. A fine selection.

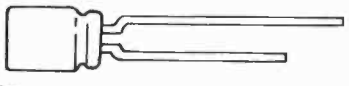
PARCEL 4A: 100 TANTS for £6.80 + VAT
PARCEL 4B: 500 TANTS for £29! + VAT



ELECTROLYTICS

A first class selection of good, modern electrolytics. The mixture ranges from small coupling caps up to huge power supply electrolytics – you'll be hard pressed to find any value between 1µF and 2200µF that isn't represented. A wide range of very useful components. Go for it!

PARCEL 5A: 1000 ELECTROLYTICS for £8 + VAT
PARCEL 5B: 2500 ELECTROLYTICS for £16 + VAT



CAPACITORS

An exciting selection of capacitors. There are ceramics for decoupling and general use, Polystyrenes for high performance circuits, dipped and moulded polyesters in values from a few nF up to 2.2µF (very expensive!), tants and aluminium electrolytics – just about any capacitor you'll ever need. Don't miss this one!

PARCEL 8A: 1000 CAPACITORS for £6.50 + VAT
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TRANSISTORS

A mix of general purpose silicon transistors, mostly bipolar NPN and PNP, with a few FETs and unijunctions thrown in (when available) to spice the mixture. The contents vary from month to month – at the moment there are BC212s, BC213s, BC548s, BC238Bs, MTJ210s, and so on. Next month – who knows? All top quality components.

PARCEL 6A: 200 TRANSISTORS for £7.80! + VAT

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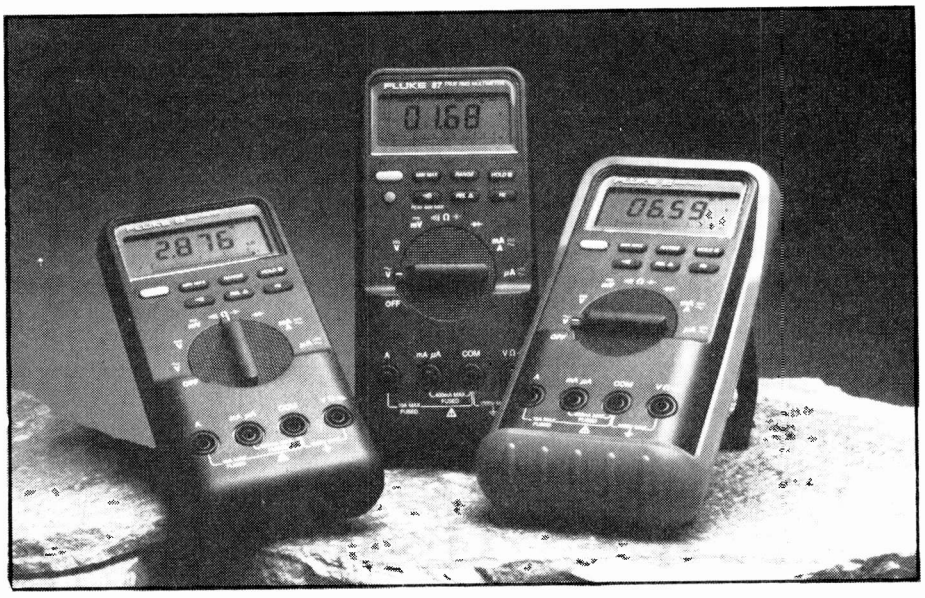
Unit 108, 8 Woburn Road, Eastville, Bristol BS5 6TT

Test gear is an important part of any engineer's toolkit and, like any other tool, having the right pieces of test gear can save a lot of time. The quality of gear is important, too. Ever tried using a soft-metal screwdriver?

One of the most fundamental items in the toolkit is the meter. A few years ago, the meter would almost certainly have been an analogue one. Now the most common type seems to be the digital multimeter. Originally, these were expensive and were only seen in professional use. However, they have dropped in price and are now easily afforded by the keen amateur.

Choosing which meter you want to buy might seem like a simple task – but as you delve into the jargon you might discover that meters, analogue and digital, have a lot more to them than meets the eye. Some modern digital meters can appear to be very complex – but is the complexity worth it?



DIGITAL MULTIMETERS

BY SAMUEL DICK

Digital meters don't do magic, but they can do some tricks that analogue meters find hard to match, and are increasingly applicable to today's developments.

There are three quick reasons why, in most instances, a digital meter is better than an analogue meter. The first of these is accuracy. Accuracy is usually expressed as a percentage of the value read plus or minus one or two digits. For measuring dc voltages, a manufacturer might specify ±0.3% + 1 digit. This means that if we were measuring, say, 2Vdc the error would be (2*(0.3/100))=0.006V from the first part of the specification and to this 0.006V we would have to add 0.001V if we were using a "3½" digit meter on, say, a 4 volt scale.

WHY DIGITAL

By a 3½ digit meter, the manufacturer means that the meter will display three digits with 0 and 9 capability but there will be another digit which will only be able to display 0, 1, or 2 (typically). Hence, the meter will read from 0000 to 2999 but the exact range covered will depend on which range is selected by the user. So it might be 0.000 to 2.999Volts or 00.00 to 29.99 mA or 000.0 to 299.9 Ohms. The decimal point can move around to accommodate different ranges.

This level of accuracy is far above what analogue meters can manage – typically a few percent accuracy. But be careful. If you use a 000.0 to 2999.9 mA range to measure a current of only 3 mA then the digital meter's accuracy will fall. Using the same specified accuracy as above, 0.3% of 3mA is 0.009mA. Remember that we have to add the "1 digit" (which is always the least significant). The accuracy is now 0.009mA *plus* 0.1mA which represents 3.6% of the reading. So with a digital meter you have always to remember to use the most sensitive range which will cope with the quantity being measured.

The next advantage of a digital meter is the resolution If you have to measure small fluctuations in a constant signal then the higher resolution will enable you to see the changes where small movements of a panel meter's needle would never be spotted.

The digital meter converts the analogue signal from the test-prods using an analogue-to-digital converter (adc). The output of the adc is then fed to the meter's display. With higher quality meters, better adc are used and so a higher accuracy and a 3½ digit resolution might be offered; a £300 meter might well have an accuracy of 0.05% and 4½ digits.

Increasing cost will bring other advantages – more later!

The third 'quick' reason for buying a digital meter is that the adc will have a very high input impedance. Good digital meters have an input impedance of at least 10 megohms – some up to 10 gigohms! This high impedance means that the meter will not, under most circumstances, load the circuit which it is measuring. For accurate measures of voltages this can be very important; placing a low-impedance meter across a component can have the effect of shorting it out! Good analogue meters typically have an impedance of 20k ohms per volt – so on a 3V range a 60k resistor is placed across the circuit under test.

There are circumstances where this value of resistance in parallel with the circuit under test will seriously affect the reading being taken. Take, for example, a simple voltage divider consisting of two 100k resistors in series. The voltage at the mid-point will be half the supply voltage – except when you place the meter in the circuit. Then the voltage read will be just over a quarter of the supply voltage! With a good digital meter the error will only be 0.5%.

TRUE OR AVERAGE?

One major difference between analogue and digital meters is their ability to offer "true rms" or "average" readings – meters seem to come in the two types so it is an important point to get right. But what does it all mean?

The term "average" means that the meter measures the average value of the ac voltage or current. A "true root-mean-square" meter measures the effective heating value of the signal being measured.

In many cases there is little difference. Since wave signals give the correct reading regardless of the type of meter used; slightly distorted sinewaves will give

readings which may be only a few percent in error. However, ac waveforms which are spikey – like current from a rectifier or a voltage controlled by an scr or triac (eg, a light dimmer circuit) – can be wrong by some tens of percent if measured with an averaging meter.

If you need a true-rms meter then there is another choice waiting for you. Because the meter has to respond to rapid spikes in signals, the meter's adc unit has to be designed to cope – and it will only do so up to a certain frequency. Averaging meters and lower priced true-rms meters will give readings accurate to a few percent with signals having frequency components up to 1 or 2kHz. Medium-priced true-rms meters will respond accurately to, say, 30kHz; the better quality meters can be used up to a few hundred kilohertz with only a small percentage error.

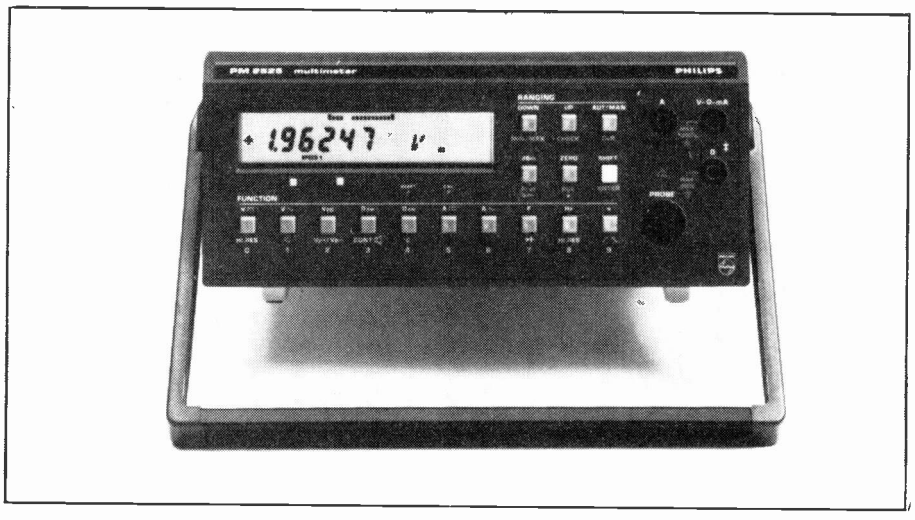
This may seem exotic but if you are trying to measure noise in audio equipment or low frequency digital signals then a response up to 200kHz will ensure that you measure a significant number of the harmonics which the signal is likely to contain.

A manufacturer will also state the crest factor with which the meter can cope. This factor is simply the ratio of the peak voltage to the root-mean-square voltage of the signal; typically a crest factor of three can be accommodated.

MORE AND HIGHER

All meters have their limitations. Perhaps the maximum ac current that can be measured is only 2 amps. This is not enough to test many domestic appliances and certainly not utility or commercial circuits where current up to a few thousand amps can be found.

Current limitations can be overcome by using a shunt for low-current work. The shunt is just an accurate low-value resistance which is placed in parallel with the meter and takes most of the current. These can be used up to around 20 amps. If higher currents are to be measured, a clamp probe should be used. With these probes, you do not have to break the circuit whose current you want to determine; normally a meter has to be placed in series with the circuit under test and requires a break to be made somewhere – with the current off, of course!



With a clamp probe, the probe just snaps round a conductor – which might be a few centimeters in diameter – and uses the magnetic field generated by the current to couple into either a pick-up coil (for ac only use) or a Hall-effect device; Hall effect devices can be used on ac or dc circuits.

Measuring high-frequency circuits is a problem familiar to the amateur. While many amateur radio books have details of build-your-own hf probes, you can also obtain them ready-built with responses up to near 1GHz!

TV service engineers and valve enthusiasts will be aware of the dangers of taking measurements on high voltage circuits – special probes prevent the high voltage leaking up into the unwitting user. Normal meter probes would not be safe at these voltages.

BITS AND PIECES

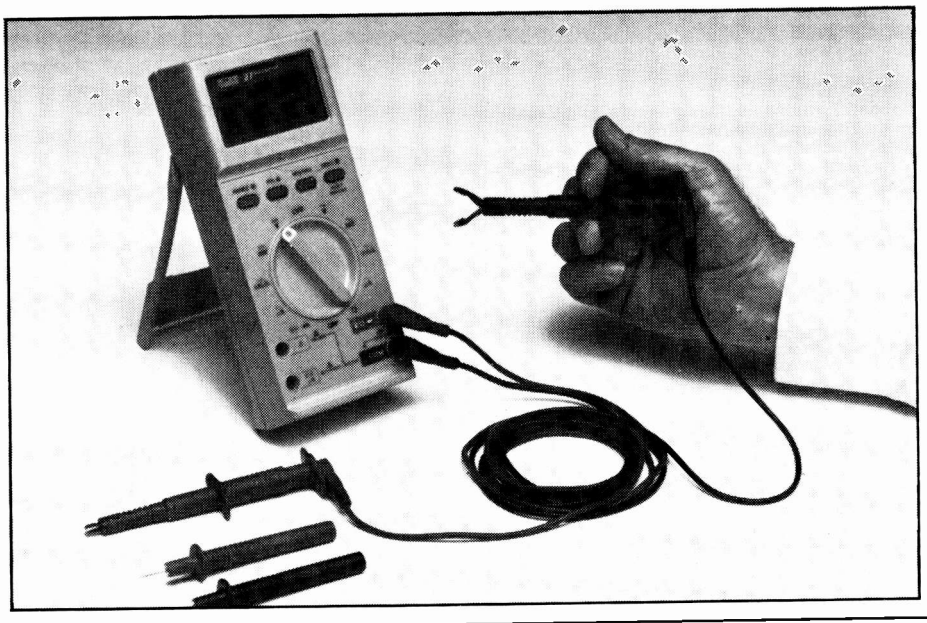
Voltage and current measurements are the main uses to which meters are put. But there is also the need to measure resistance – and digital meters cope well here, too. They also offer a simple diode test facility and a continuity beeper. The extra accuracy can be useful when building audio filters. Often, filter designs call for 1% components – which tend to be expensive. By checking components in stock, items within the tolerance range required can sometimes be found.

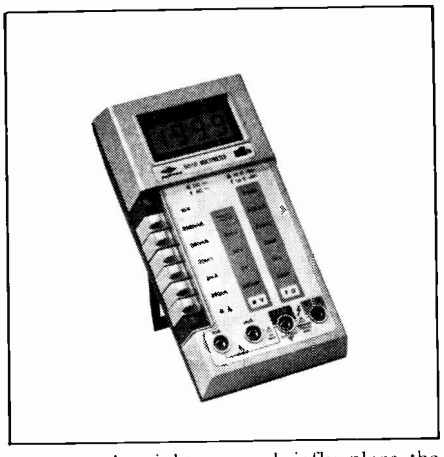
If you find yourself testing cables or circuit continuity often then look in the manufacturer's specification to see if a fast continuity check is offered – some digital meters can take well over a second to signal that continuity is okay.

One completely new field for meters is that of measuring frequency. This was a feature which was never incorporated into analogue meters – but since a lot of digital logic is inside a digital meter it was a little step to make frequency measurements possible. Typical handheld meters can measure up to around 200kHz – very useful if you are testing tone-generating circuits like modems or afsk communications equipment.

Linked with frequency measurement as a new feature is capacitance measurement. This is a rare feature so remember that a resistor and capacitor voltage divider fed with an ac signal of known frequency can help you find the value of a capacitor.

Finally one of the greatest time savers must be the ability to leave the meter watching for the minimum and maximum values that it measures in a circuit – saves waiting for that intermittent fault to happen! So if this is a frequent task, get a meter with a min/max hold facility. Similarly, a touch-hold feature which allows you to set-up the





meter to the right range, briefly place the probes on the circuit, take them off and only then look at the meter to see what the reading was. This is a real boon. How often have you dared a glance a the meter and prayed that the test probes do not slip? PE

METER PHOTOS

We had asked our regular advertisers if they would care to send photos of any meters they stocked. All agreed, but at the time of going to press only Cricklewood Electronics, 40 Cricklewood Broadway, London NW2 3ET, had obliged, to whom our thanks for the photo at top right (model 6010).

The other photos show newly released meters and were received as part of publicity material detailing new products. In order of photo appearance further information can be obtained from:

Philips Test and Measurement, York Street, Cambridge, CB1 2PX (reference Fluke Models 83, 85, 87). Alpha Electronics, Unit 5, Linstock Trading Estate, Wigan Road, Atherton, Manchester M29 0QA (reference Gold Star Model DM 6335).

Electronic Temperature Instruments, PO Box 81, Worthing, Sussex BN13 3PW (reference Model DM 4351). Instrument Rentals, Dorcan House, Meadfield Road, Langley, Berks, SL3 8AL (reference Model PM 2525). Philips Test and Measurement, York Street, Cambridge, CB1 2PX (reference Fluke TL 20 Test lead set and meter model 27).

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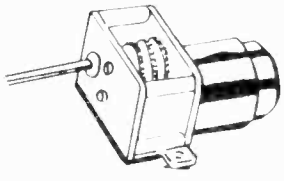

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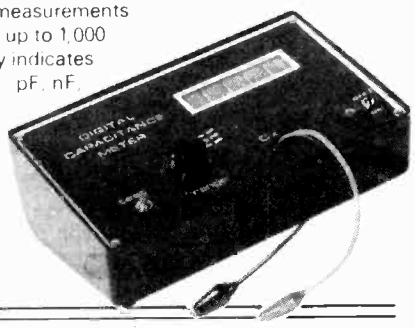

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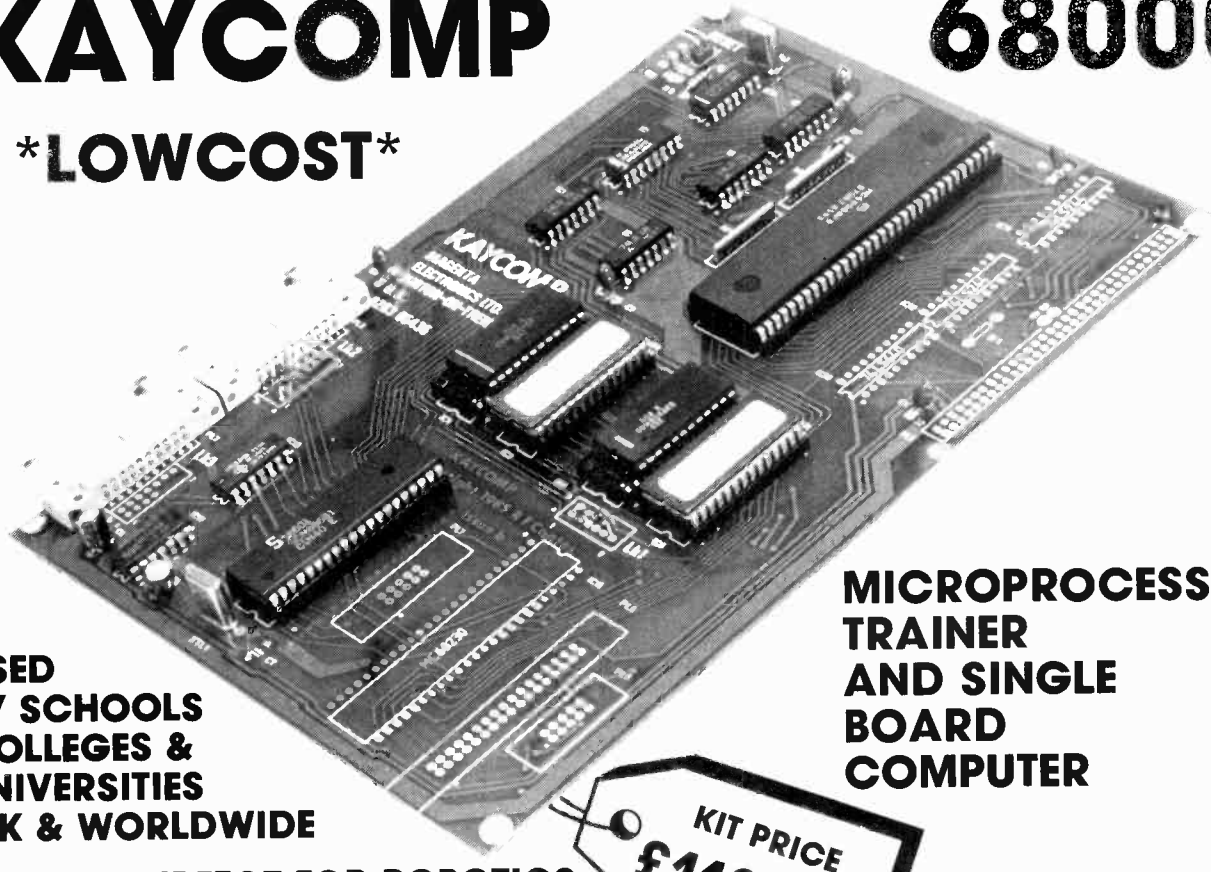

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RUBIDIUM VAPOUR CELL RESONATOR

Like the hydrogen maser, the rubidium vapour cell resonator depends on hyperfine energy changes for its operation. However, the levels of interest are the [F = 1, m_F = 0] and [F = 2, m_F = 0] states which can be abbreviated to F=1 and F=2. The component parts of the rubidium resonator are shown in Fig.8; it employs two isotopes of rubidium, namely Rb85 and Rb87.

Excited atoms in the Rb87 lamp relax down to the F=2 and F=1 hyperfine levels, emitting light energy as they do so. This light is directed through a filter cell containing Rb85 vapour whose quantum energy levels are very similar to those of Rb87. However, there is just sufficient difference for the Rb85 vapour to act as a selective filter to the Rb87 light.

Consequently, the light energy emitted by transitions down to the F=2 level in Rb87 is strongly absorbed by the Rb85 gas, whereas that corresponding to transitions down to the F=1 level passes through unaffected.

Therefore, the light leaving the filter cell and entering the Rb87 absorption cell has the correct range of frequencies to pump atoms from the F=1 level up into excited states, but *not* atoms in the F=2 level (remember, energy is absorbed or emitted according to the formula E=hf.) Naturally, this process results in the F=2 level having far more atoms than F=1, ie, we have a population inversion in the F=2 level.

Now, because all the atoms in the F=1 state have been pumped up to higher levels, the light energy responsible for this excitation is no longer absorbed and passes through with constant intensity.

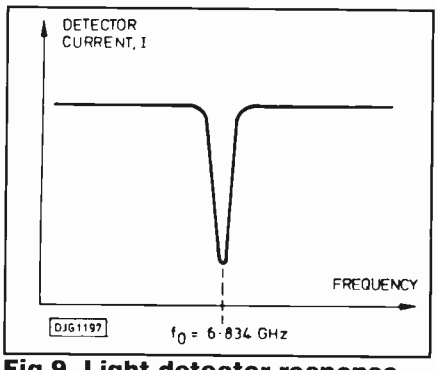


Fig.9. Light detector response

If we now supply microwave energy to the cavity with the right frequency to stimulate transitions from the excess population created in the F=2 level, we effectively re-populate the F=1 state with atoms which immediately begin absorbing light energy again.

The result is that the solar cell detects less light at the F=2 to F=1 transition frequency (about 6.834GHz) than at other frequencies, and a plot of detector current vs frequency (Fig.9) shows a dip at this frequency.

The detector output current is used as a control signal for the vco which acts as a slave oscillator feeding the 6.834GHz microwave energy to the cavity. The actual stability and accuracy of the vco on its own is unimportant, since its output is locked to the F=2 to F=1 transition frequency by means of the closed loop provided by the light detector.

Consequently, the precision of the vco output is essentially that of the atomic transition frequency; an accuracy of 1 in 10^{11}, and a stability of 1 in 10^{11} per month are typical values.

HI-TECH TIMING

PART 2
BY ANTHONY H. SMITH B.Sc.

Following on from last month's look at quantum physics, masers and lasers, we examine the accuracy of caesium resonators and rubidium standards

For most practical purposes, an output frequency much lower than the transition frequency is required, and this can be obtained from a secondary oscillator phase-locked to the vco.

To ensure the rubidium resonator has a high Q-factor, special 'buffer' gases must be added to the filter and absorption cells. However, these gases produce substantial frequency shifts, as does mistuning of the microwave cavity; consequently, the device cannot be used as a primary frequency standard, and must be carefully calibrated at manufacture. Once the cell is adjusted and sealed, however, the frequency remains highly stable and the drift rate is around a hundred times less than the highest quality quartz oscillators.

Another attractive feature of the rubidium oscillator is that, unlike the hydrogen maser and caesium resonator, it re-uses rather than depletes source atoms and so frequent renewal of exhausted parts is unnecessary.

Certain rubidium oscillators do not feature the light detector and vco, but instead take their output directly from the maser energy in the microwave cavity. However, the light source must have higher power, and the cavity tuning and Q-factor become much more critical parameters; thus, systems employing the closed-loop servo mechanism are often preferred, and are known as 'passive'atomic standards.

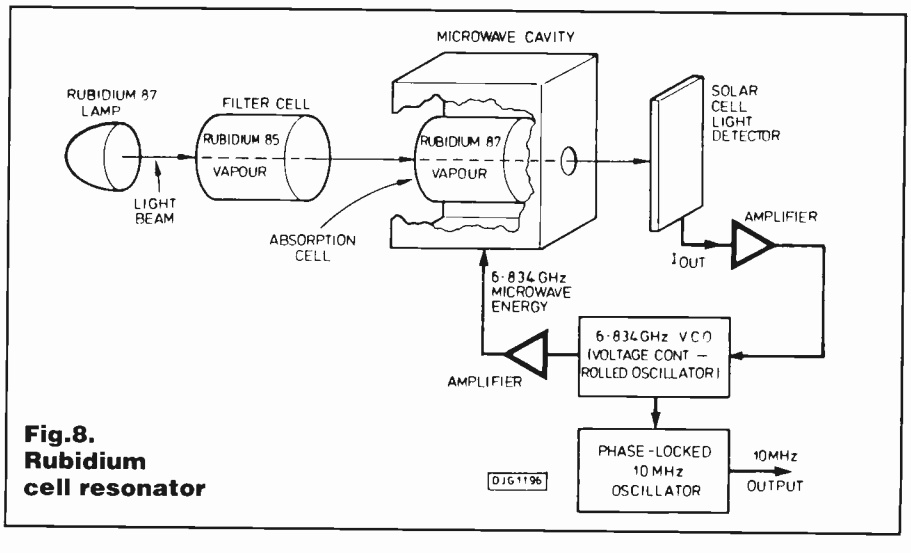


Fig.8. Rubidium cell resonator

THE CAESIUM BEAM RESONATOR

The caesium oscillator shown in Fig.10 is also a passive standard, but in many ways is superior to other atomic references, and advantages such as its excellent long-term stability and relative

insensitivity to magnetic fields make it an ideal choice for the international standard.

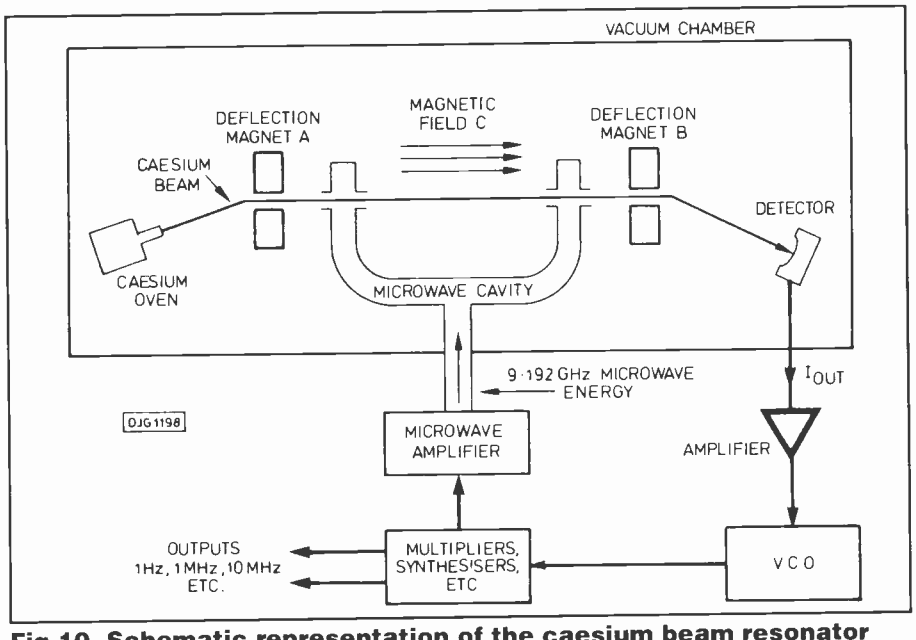


Fig.10. Schematic representation of the caesium beam resonator

Like the hydrogen maser and the rubidium oscillator, the caesium resonator exploits quantum energy transitions to establish the required reference frequency; the transition used occurs between the [F = 4, m_F = 0] and [F = 3, m_F = 0] levels.

Caesium atoms of various energy levels are evaporated from the oven and directed as a beam towards magnet A which deflects each atom through an angle determined by its energy level. Consequently, those atoms in the F=4 states are deflected through the microwave cavity towards magnet B, while those in the F=3 states are deflected away.

Now, the field gradient of magnet B has the same direction as that of magnet A. Thus, if the atoms arriving at magnet B have *not* made a transition in the cavity, they are still in the F=4 state and are deflected *away* from the detector; however, if they *have* made a transition from F=4 to F=3, they will be deflected so as to strike the detector.

The transitions are stimulated by supplying the cavity with microwave power: if the microwave frequency is close to the transition frequency (9,192,631,770 Hz) many atoms will be induced to make the transition. However, if the frequency is not quite right, the transition probability will decrease; thus the detector output current will peak at the exact transition frequency (Fig.11).

By feeding the detector current to the vco, whose output is multiplied to provide the microwave signal, we have again established a closed-loop servo system - similar to that of the rubidium oscillator - such that the vco is locked to the atomic transition frequency. It is then a relatively simple matter to synthesise other output frequencies, also locked to the atomic transition, and having the same accuracy and stability.

From Fig.11, we see that the resonance curve is about 50Hz wide at half intensity, and so the caesium Q-factor is: $Q = f_0/50 = 9{,}192{,}631{,}770/50 = 183$ million!

The [F = 4, m_F = 0] to [F = 3, m_F = 0] transition is chosen because it is the one least affected by external magnetic fields. Nevertheless, some field dependence does exist, and the exact frequency is given by:

$f = (f_0 + 427 \times 10^8 \times B^2) = (9{,}192{,}631{,}770 + 427 \times 10^8 \times B^2)$ Hz.

Although screening can reduce these effects, it is almost impossible to remove all magnetic influences, and so a small magnetic field - the 'C' field is deliberately induced in the cavity. This

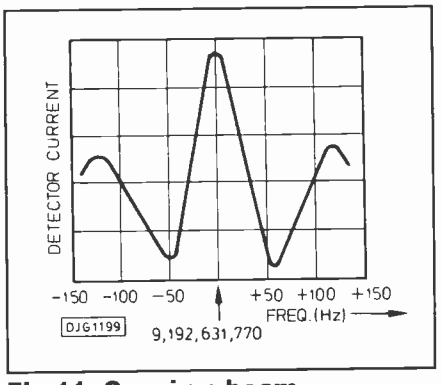


Fig.11. Caesium beam resonance curve

field separates the Zeeman levels, and allows the correct transition to be 'picked out' from those which would otherwise produce unwanted resonant frequencies.

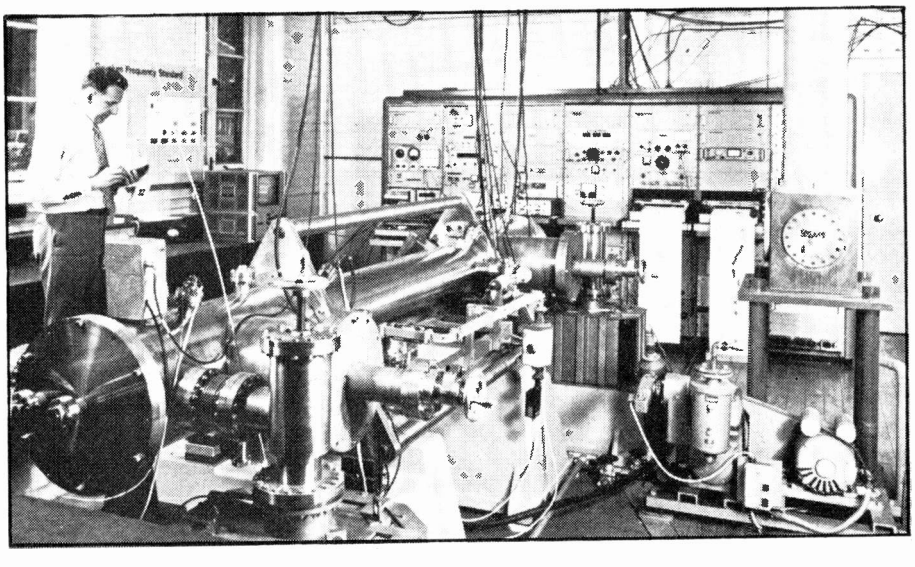
Various other factors can degrade performance. For example, any asymmetry in the microwave cavity will introduce unwanted phase shifts to the microwave field, and the accumulation of caesium deposits on the cavity ends can result in frequency errors as large as 1 part in 10^{11}.

A secure vacuum seal is also important; during development of one of the prototypes at the National Physical Laboratory, Essen and Parry found that the most convenient remedy for small leaks was to bung them with plasticine!

Fig.12 depicts the present caesium resonator at NPL: this formidable mechanism is a third generation machine which boasts an accuracy of 1 part in 10^{13}.

ACCURACY AND AVAILABILITY

When we talk about the accuracy of, say, a tapemeasure, we are concerned with how closely its graduations correspond to those of an accepted standard of length.



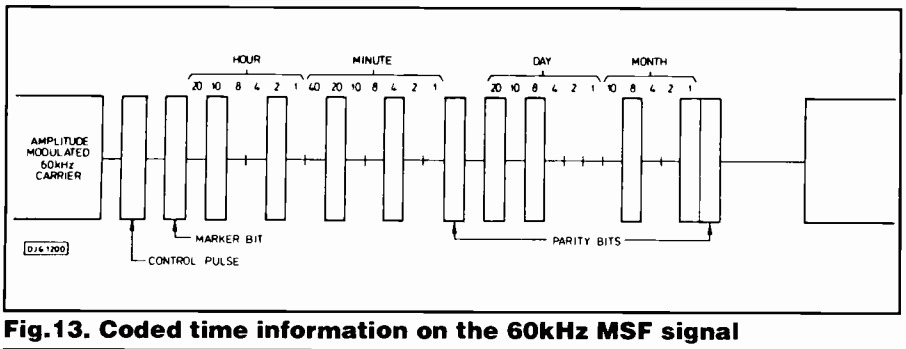


Fig.13. Coded time information on the 60kHz MSF signal

However, when dealing with the caesium standard - which is itself the accepted frequency reference - it is difficult to conceive of its accuracy since we have no superior standard with which to compare it.

Nevertheless, one approach is to measure or estimate the uncertainties of allknown parameters which affect the transition frequency, and to combine these figures in a statistical manner to determine theoretically how far the frequency deviates from the value laid down in the definition.

Alternatively, a more practical method regularly conducted by a collection of international laboratories, involves the comparison of scores of caesium resonators in order to determine the *average* transition frequency: this is then taken as the principal reference value, and each individual resonator can then be 'tweaked' to bring its frequency into line.

Many of these resonators are commercially available, and, indeed, the fundamental purpose in developing any standard is that it can be made available as a reference for accurate measurements.

Hewlett Packard, for example, market the HP5061B caesium beam standard, and the HP5065A rubidium oscillator, both of which can be supplied accurate to a few parts in 10^{12}. However, the price of such accuracy is considerable: the rubidium oscillator costs around £22,500, and the caesium model will set you back a cool £24,000!

Radiocode Clocks of Penryn, Cornwall, supply two rubidium oscillators: one is a compact module measuring just 4 x 4 x 4 inches and accurate to 5 parts in 10^{11}, whereas the RbS 10000 is a microprocessor-controlled instrument for high precision application. Although cheaper than the Hewlett Packard models, these oscillators are still only intended for specialised use, and prices start at around £6000.

Fortunately, for those of us with modest budgets, there is another way to make use of atomic accuracy. For many years now, various authorities throughout the world have broadcast special signals carrying time and frequency information which is locked to an atomic standard.

For example, in Britain, Radio 4 programmes are transmitted from Droitwich, Burghead and Westerglen on a 198kHz carrier wave which is locked to the BBC's rubidium standards which are periodically checked by the NPL. A similar service is transmitted on 162kHz from Allouis, France.

Another popular British service is the MSF 60kHz signal transmitted from Rugby. MSF began experimentally in 1950 with a one-hour broadcast every day, and was extended in 1966 to provide 24-hour coverage.

The signal comprises a 60kHz carrier synchronised with the NPL caesium resonator, and modulated with a comprehensive code providing year, month, day of month, hour and minute information. For example, in Fig.13, the code represents 12:24 on September 28th.

At the transmitter, the accuracy of a broadcast standard like MSF is essentially equal to that of the controlling standard: thus, MSF has a transmitted accuracy of around ±2 parts in 10^{12}.

However, the receiver accuracy will be compromised by the effects of noise and propagation errors. High frequency signals propagate in a complex manner as they reflect from the ionosphere back down to earth. Variations in the ionosphere's profile and height introduce a Doppler frequency shift to the signal, and errors as large as several parts in 10^7 can occur.

Low frequency signals, however, follow the earth's curvature, using the ionosphere more as a boundary than a reflector. Consequently, the Doppler effects are less troublesome to low-frequency transmissions like MSF, although the ionospheric component cannot be ignored, especially during the winter months when it causes maximum disturbance.

A typical arrangement for detecting and decoding the time and frequency information is shown in Fig.14.

The phase-locked-loop is used to lock the high stability crystal vco to the broadcast carrier; thus, the vco output is an exact multiple of the carrier frequency having the same accuracy and stability, and can be used to synthesise other frequencies if desired. In this way, the crystal vco behaves as a 'flywheel' oscillator whose output is constantly corrected by the incoming precision signal; in many cases, the loss of the broadcast signal (for example, due to a break in transmission), need not be catastrophic, since the crystal vco continues to run, albeit with reduced accuracy.

For broadcast signals like MSF which contain time information, suitable decoding logic is also required to generate a 24-hour time display.

Radiocode Clocks market the RFS 1000 which is a portable off-air frequency standard tuned to the 60kHz MSF broadcast, and has decade frequency outputs ranging from 1Hz to 1MHz. The basic model costs around £450 and provides long-term accuracy approaching 1 part in 10^{11}.

The IFS8000, on the other hand, is an 'intelligent' off-air standard which uses a microcomputer-based control system to improve performance and increase long-term precision to 1 part in 10^{12}.

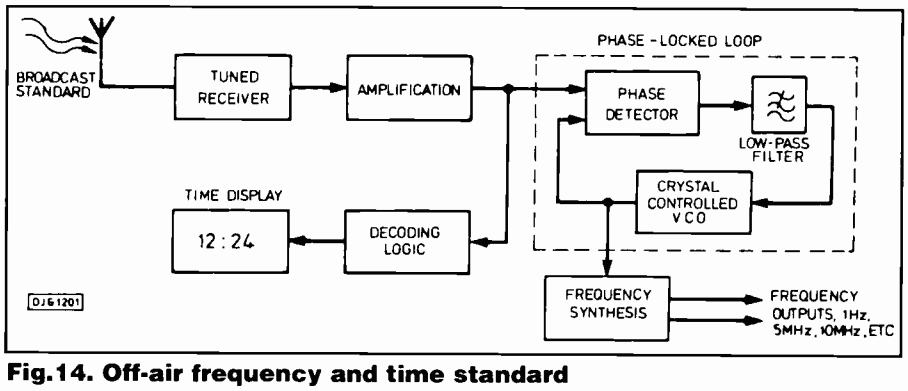


Fig.14. Off-air frequency and time standard

Such off-air standards can be used as the reference oscillator of a universal counter timer (uct), allowing measurements to be made with accuracies far superior to those obtained with a quartz crystal timebase.

Nevertheless, we shall see in a future article that a variety of operational and systematic errors must be considered before the uct measurement accuracy can approach that of the external standard. PE

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BT138-600 12A TO-220 ..... **70p**
NEC TRIAC AC08F 8A 600V TO220 ..... 5/**£2** 100/**£30**
TXAL225 8A 400V 5mA GATE ..... 2/**£1** 100/**£35**
TRAL2230D 30A 400V ISOLATED STUD ..... **£4 each**

CONNECTORS
D25 IDC SOCKET FUJITSU **£2**
34 way card edge IDC CONNECTOR (disk drive type) **£1.25**
CENTRONICS 36 WAY IDC PLUG **£2.50**
CENTRONICS 36 WAY IDC SKT **£4.00**
BBC TO CENTRONICS PRINTER LEAD 1.5M **£3.50**
CENTRONICS 36 WAY PLUG SOLDER TYPE **£4**
USED CENTRONICS 36W PLUG+SKT **£3**

USED D CONNECTORS price per pair
D9 **60p**, D15 **£1.50**, D25 **£2**, D37 **£2**, D50 **£3.50** covers **50p ea.**

WIRE WOUND RESISTORS
W21 or sim 2.5W 10 of one value **£1**
R10 OR15 OR22 2R0 2R7 4R7 5R0 5R6 8R2 10R 12R 15R 18R 20R 22R 27R 33R 47R 56R 62R 91R 120R 180R 390R 430R 470R 680R 820R 910R 1K15 1K2 1K5 1K8 2K4 2K7 3K3 3K0 5K0 R05 (50 milli-ohm) 1% 3w ..... 4 FOR **£1**
W22 or sim 6W 7 OF ONE VALUE **£1**
R47 R62 1R0 1R5 1R8 3R3 6R8 9R1 12R 20R 24R 27R 33R 51R 56R 62R 68R 100R 120R 180R 220R 390R 560R 620R 910R 1K0 1K2 1K5 1K8 2K2 2K7 3K3 3K9 4K7 8K2 10k 15K 16K 20K
W23 or sim 9W 6 of one value **£1**
R22 R47 1R0 1R1 15R 56R 62R 100R 120R 180R 220R 300R 390R 680R 1KO 1K5 5K1 10K
W24 or sim 12W 4 OF ONE VALUE **£1**
R50 2R0 9R1 18R 22R 27R 56R 68R 75R 82R 100R 150R 180R 200R 220R 270R 400R 620R 1K0 6K8 8K2 10K 15K

PHOTO DEVICES
SLOTTED OPTO-SWITCH OPCOA OPB815 ..... **£1.30**
2N5777 ..... **50p**
TIL81 PHOTO TRANSISTOR **£1**
TIL38 INFRA RED LED ..... 5/**£1**
4N25, OP12252 OPTO ISOLATOR **50p**
PHOTO DIODE **50p** ..... 6/**£2**
MEL12 (PHOTO DARLINGTON BASE n/c) **50p**
RPY58A LDR **50p** ORP12 LDR **70p**
LEDs RED 3 or 5mm 12/**£1** ..... 100/**£6**
LEDs GREEN OR YELLOW 10/**£1** ..... 100/**£6.50**
LEDS ASSORTED RD/GN/YW + INFRA/RED ..... 200/**£5**
FLASHING RED **OR GREEN LED** 5mm **50p** ..... 100/**£35**

STC NTC BEAD THERMISTORS
G22 22OR, G13 1K, G23 2K, G24 20K, G54 50K, G25 200K, G16 1M, RES @ 20°C DIRECTLY HEATED TYPE ..... **£1 ea**
FS22BW NTC BEAD INSIDE END OF 1" GLASS PROBE RES @ 20°C 200R ..... **£1 ea**

CERMET MULTI TURN PRESETS ¾"
10R 20R 100R 200R 250R 500R 2K 2K2 2K5 5K 10K 47K 50K 100K 200K 500K 2M2 ..... **50p each**

IC SOCKETS
6 pin 15/**£1** 8 pin 12/**£1** 14/16 pin 10/**£1** 18/20 pin 7/**£1**, 22/24/28 pin 4/**£1** 40 pin **30p**

SOLID STATE RELAYS
40A 250V AC SOLID STATE RELAYS **£18**

POLYESTER/POLYCARB CAPS
100n 63v 5mm ..... 20/**£1** 100/**£3** 1000/**£25**
1n/3n3/5n6/8n2/10n 1% 63v 10mm ..... 100/**£6**
10n/15n/22n/33n/47n/68n 10mm rad ..... 100/**£3.50**
100n 250v radial 10mm ..... 100/**£3**
100n 600v sprague axial 10/**£1** ..... 100/**£6 (£1)**
2u2 160v rad 22mm ..... 100/**£10**
10n/33n/47n 250v ac x rated 15mm ..... 10/**£1**
470n 250v ac x rated rad ..... 4/**£1**
1U 600V MIXED DIELECTRIC ..... **50p ea.**

RF BITS
12 volt CO-AXIAL relays sim. RS 349-686 ..... **£6**
Ex-equipment, with BNC tails
TRIMMER CAPS ALL 4/**50p**
SMALL 5pf 2 pin mounting 5mm centres
SMALL MULLARD 2 to 22pF 4/**50p**
SMALL MULLARD 5 to 50pF 4/**50p**
grey larger type 2 to 25pF
TRANSISTORS 2N4427 ..... **60p**
FEED THRU CERAMIC CAPS 1000pF ..... 10/**£1**

MINIATURE RELAYS Suitable for RF
5 volt coil 1 pole changeover **£1**
5 volt coil 2 pole changeover **£1**
12 volt coil 1 pole changeover **£1**

MONOLITHIC CERAMIC CAPICITORS
10n 50v 2.5mm ..... 100/**£4.50**
100n 50v 2.5mm or 5mm ..... 100/**£6**
100n ax short leads ..... 100/**£3**

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MIN CASH ORDER £3.00 OFFICIAL ORDERS WELCOME
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65p OTHERWISE (LIGHT ITEMS)
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BOUGHT FOR CASH

Access

READERS' SURVEY!

HELP US PLAN THE FUTURE!

£100, £50 AND £25 TO BE WON PLUS REDUCED PRICE SUBSCRIPTIONS OFFER

WE'RE NEARLY 25 YEARS OLD AND ARE PLANNING FOR THE NEXT 25!

WE ASK FOR YOUR HELP.

The future Editorial policy of PE is in your hands - it will be determined by your replies to this questionnaire. The opinions of every single one of you are of great importance to us. Whether you read PE regularly, or this issue is the first one you've seen, we want to hear from you. Not only will you play a vital part, but each of you who replies will be sent A VOUCHER WORTH £2 off your next subscription.

Not only that, there are THREE CASH PRIZES to be won. The person who most closely estimates the number of questionnaires received back will be sent £100. The next nearest will be sent £50 and the third nearest will be sent £25. £5 each will go to the next five. The questionnaires must be received back by 31st May 1989.

PE TAKES YOU FURTHER ON THE HI-TECH ROAD - WITH YOUR HELP WE'LL TAKE YOU FURTHER STILL. BE PART OF US!

YOUR ANSWERS TO THE QUESTIONS WILL REMAIN TOTALLY CONFIDENTIAL

YOU MAY SEND A PHOTOCOPY OF THIS FORM

PLEASE TICK THE APPROPRIATE BOX!

1. How long have you been interested in electronics?

Less than a year	❑
Between 1 and 5 years	❑
Between 6 and 10 years	❑
More than 10 years	❑

2. What is your present involvement in electronics? (you may tick more than one box)

As a hobby	❑
As a profession/trade	❑
Research and development	❑
Servicing and installation	❑
As a student	❑
As a teacher	❑

3. Below is a list of topics which have been covered in various issues of PE. We should like to know how interested you are in reading constructional articles on each subject.

	Very	Quite	Not very	Not at all
Astronomy projects	❑	❑	❑	❑
Audio/hif	❑	❑	❑	❑
Boating/sailing electronics	❑	❑	❑	❑
Car electronics	❑	❑	❑	❑
Computers	❑	❑	❑	❑
Computer add-ons	❑	❑	❑	❑
Environmental projects	❑	❑	❑	❑
Household projects	❑	❑	❑	❑
Ingenuity Unlimited	❑	❑	❑	❑
Logic	❑	❑	❑	❑
Metal detectors	❑	❑	❑	❑
Microprocessors	❑	❑	❑	❑
Musical projects	❑	❑	❑	❑
Photographic accessories	❑	❑	❑	❑
Radio	❑	❑	❑	❑
Radio control (of models)	❑	❑	❑	❑
Robots	❑	❑	❑	❑
Security systems	❑	❑	❑	❑
Sound effects	❑	❑	❑	❑
Test equipment	❑	❑	❑	❑
Toys and games	❑	❑	❑	❑
Train-set control	❑	❑	❑	❑
TV/video	❑	❑	❑	❑

4. We'd also like to know how interested you are in each of the following articles in PE:

	Very	Quite	Not very	Not at all
Advertisements	❑	❑	❑	❑
Commercial equipment	❑	❑	❑	❑
Consumer equipment	❑	❑	❑	❑
Environment technology	❑	❑	❑	❑
Future developments	❑	❑	❑	❑
Historical information	❑	❑	❑	❑
Home automation	❑	❑	❑	❑
Medical electronics	❑	❑	❑	❑
Military electronics	❑	❑	❑	❑
New products	❑	❑	❑	❑
News from industry	❑	❑	❑	❑
Readers' letters	❑	❑	❑	❑
Space and astronomy	❑	❑	❑	❑
Sports (electronics in)	❑	❑	❑	❑
Theory of electronics	❑	❑	❑	❑
Transport technology	❑	❑	❑	❑

5. How would you describe your expertise in electronics?

Beginner	❑
Average	❑
Advanced	❑
Very advanced	❑

6. On the whole, do you find that the constructional projects in PE are:

Much too simple	❑
A little too simple	❑
Just about right	❑
A little too difficult	❑
Much too difficult	❑

7. How would you rate the information given to you for constructing projects?

Excellent	Good	Adequate	Poor
❑	❑	❑	❑

8.On the whole, how expensive do you find the constructional projects in PE?

Much too expensive to complete	❑
A little too expensive to complete	❑
Not too expensive to complete	❑

please turn over

9. When you build a constructional project published in PE, do you:

Always complete it	❑
Nearly always complete it	❑
Sometime complete it	❑
Never complete it	❑

10. Are the constructional projects published in PE interesting because you want to:

	Always	Usually	Sometimes	Never
Build the exact project shown	❑	❑	❑	❑
Modify the project to suit your own needs	❑	❑	❑	❑
Use parts of the circuit for other purposes	❑	❑	❑	❑
Just read how the circuit works	❑	❑	❑	❑

11. Which other topics, projects or articles, if any, would you like to see covered in PE?

12. How many electronics projects (from any source) have you constructed in the last year?

None	1-2	3-5	6-10	over 10
❑	❑	❑	❑	❑

13. Please list the projects (from any source) you have constructed in the last year (even if you didn't complete them).

14. How much money do you estimate that you have spent in the last 12 months on components, kits, materials, etc.

15. Do you have difficulty obtaining the components for the projects you construct?

Very	Quite	Rarely	Never
❑	❑	❑	❑

16. When obtaining components for the projects you build, do you prefer to:

Shop around for the best prices	❑
Buy from a regular supplier you have come to know	❑
Buy as a kit from a single source	❑

17. How often do you use each of the following sources for obtaining the components you need?

	Very	Quite	Rarely	Never
Mail order through catalogues	❑	❑	❑	❑
Mail order through magazines	❑	❑	❑	❑
Personally through a retail outlet	❑	❑	❑	❑
Some other source (state which)	❑	❑	❑	❑

18. Do you make your own printed circuit boards?

Always	Sometimes	Never
❑	❑	❑

19. How long have you been reading PE?

under 1 year, 1-2 years, 3-5 years, 6-10 years, over 10 years.
❑ ❑ ❑ ❑ ❑

20. How often, if at all, do you read each of the following magazines?

	Most/all copies		Sometimes	Never
Practical Electronics	❑	❑	❑	❑
Electronics (Maplin)	❑	❑	❑	❑
Electronics and Wireless World	❑	❑	❑	❑
Electronics Today International	❑	❑	❑	❑
Elektor	❑	❑	❑	❑
Everyday Electronics	❑	❑	❑	❑
Practical Wireless	❑	❑	❑	❑
Television	❑	❑	❑	❑
Other magazines (say which)	❑	❑	❑	❑

21. How do you usually see the copies of PE that you read?

Buy my own copies	❑
Read someone else's copy	❑
Read copies taken by my school	❑
Read copies taken by my firm/organisation	❑

22. What do you usually do with the copies of PE that you see?

Throw them away after I have read them	❑
Keep them for future reference	❑
Pass them on to someone else	❑

23. Which daily newspaper, if any, do you read?

24. Please tick which age group you are in:

Under 16,	16-24,	25-34,	35-44,	45-54,	55-64,	65+
❑	❑	❑	❑	❑	❑	❑

25. Please say whether you are:

Studying	employed	Self-employed	Between jobs	Retired
❑	❑	❑	❑	❑

26. If you are a student or teacher, how important is electronics on the school/college timetable:

Very	Quite a lot	Not very	Not at all
❑	❑	❑	❑

27. Please say in which hobbies or other leisure activities you are most active or interested:

NAME AND ADDRESS (IN BLOCK LETTERS):

.....

.....

.....

.....

MY ESTIMATE OF THE TOTAL NUMBER OF QUESTIONNAIRES RETURNED TO PE IS : .....

ALL YOUR ANSWERS WILL REMAIN TOTALLY CONFIDENTIAL!

SEND THIS FORM (OR A PHOTOCOPY) TO:

Practical Electronics, Survey Dept,
193 Uxbridge Road,
London W12 9RA

Write to us if you have further opinions to express!

NEW THIS MONTH

32 page **SPRING SUPPLEMENT** featuring Calculators, Disco Gear, Speaker Cabs, Metex Meters, + lots of surplus! FREE with Cat, or send large SAE.

WIN a top of the range Metex Meter! Enter our Competition – full details in the Spring Supplement!

FREE Headphones + Speakers – Full details in the Spring Supplement.

VIDEOTAPES – Top quality VHS E180 tapes by Videolab at unbelievable prices! £2.50ea; 10/£20; 40/£64.

13A TEST PLUG – 2 neons illuminate to show any faults on line Only 99p

HALOGEN SPOTLIGHT
ML328 Incredible 50,000 candle power given out by this high power spotlight. Operates from 12V DC – plugs into car cigarette lighter socket. Rated 55 watts. Coiled cord extends to 3.6m. On/off switch and plastic hanger are two further features. Robustly made in high impact black plastic with glass lens. £6.95

SOLDER BARGAIN
Shipping error to our supplier means you benefit! 500gm reel of 16SWG resin cored solder at a low, low price. **ONLY £3.95; 10 reels £33.00; 50 reels £150.00**

POWER SUPPLY
Z4170 Plug in power supply. Built in 13A plug. Output 6V DC 300mA on 2m long lead terminated in a 3mm power plug. British Made to BS415 **£1.50**

JUST ARRIVED
60,000 Miniature toggle & other switches. Ring or write for full listing. Prices from 5p!!

EPSON SERIAL INTERFACES

Model 8143	£15
Model 8143 with 2k buffer	£25

Just arrived – full details on next list

HALF PRICE KITS!!
Range of 'OK' Kits at half price! 5 diff. top quality kits containing all parts, inc. PCB, plastic case and comprehensive instructions!

EK1	Quick Reaction	£2.90
EK2	Electronic Organ	£3.34
EK3	Digital Roulette	£4.29
EK4	Electronic Dice	£3.98
EK5	Morse Code Oscillator	£1.99

CURRAH MICROSPEECH
We've bought up remaining stocks of this popular add-on to re-sell at a fraction of the original cost!

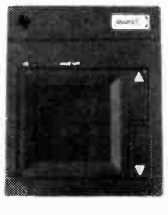
Z4136 New complete and boxed set for the ZX Spectrum **£8.95**

Z4140 As above but unboxed – these were bulk packed **£7.95**

Z4142 Speech 64 for the C64. No software needed! New and working, but no case. With full instructions. **£6.00**

Z4138 Microslot 'T' connector allowing peripherals to be connected to the Spectrum. New & boxed **£2.00**

Also a quantity of 'returns' available – see Bargain List 43 for details



Z811 Cumana touch pad for the BBC B computer. Enables you to draw on the screen using the stylus with the touch sensitive pad. Supplied with 2 stylii, power/connecting leads and demo tape with 4 progs. Originally sold at £79.95.
Our price: £19.95

1989 CATALOGUE

★ 100 BIG pages of components and equipment
★ Low, low prices
★ Fast "by return" service
★ 28 pages of Surplus Bargains
★ Only £1 – send for yours now!

LCD display:
Z4115 8 digit 12.7mm high LCD by Data Image. 14 segment, so letters as well as digits can be formed. List £15+
Our price **£4.50**

Z4148 6 Digit LCD, 50 pins DIL 12.7mm digit height, with ?????? **£3.00**

SPEECH SYNTHESIZER KIT
Z315 All parts inc. PCB to make a speech synth for the BBC micro **£4.99**

Z316 De-luxe version – also includes V215 case, 1m 20W cable plus connector **£7.99**

MICRO PANELS
Z620 68000 Panel. PCB 190 x 45 believed to be from ICL's 'One per Desk' computer containing MC68008P8 (8MHz 16/8 bit microprocessor, + 4 ROM's all in skts; TMP5220CNL, 74HCT245, 138, LS08, 38 etc. **£5.00**

Z625 32k Memory Boad, PCB 170 x 170 with 16 2k x 8 6116 static RAM's. Also 3.6V 100mA memopack nicad, 13 other HC/LS devices, 96w edge plug, 8 way DIL switch, R's, C's etc. **£4.80**

JIMMY
the electronic football game of skill

Z817 Exciting electronic football game – Waddingtons' 'JIMMY'. Brand new models in full working order, but without plastic peripherals, stickers etc. **£5.00**

DIL SOCKETS
Must clear excess stocks – 1/4 million low profile top quality IC sockets to dispose of!

Pins	10	100	1000
8	40p	£3.00	£20
14	68p	£5.10	£34
16	72p	£5.40	£36
18	76p	£5.70	£38
20	80p	£6.00	£40
22	84p	£6.30	£42
24	88p	£6.60	£44
28	92p	£6.90	£46
40	96p	£7.20	£48

'D' CONNECTORS

	15W	25W	37W
R/A plugs	40p	50p	60p
R/A skts	50p	60p	70p
W/W plugs	40p	50p	60p
W/W skts	50p	60p	70p
S/P plugs	40p	50p	60p
S/P skts	50p	60p	70p

All top quality gold plated

Z345 OPTICAL SHAFT ENCODER. Similar to RS631-632, but 80% cheaper! **£8.50**

SEMICONDUCTORS
Hundreds in Cat – look at these sample prices:
LM317K £1.00; 68008L8 £3; 27C256-25 £5; 68A00 £1.20; LM223K £3; DL1416 £7; RBG1000 £1.20; DL3416 £8; 555 20p; 741 20p; 74LS240 25p

COMPONENT PACKS

K560 Semiconductors – Over the years we have purchased many transistors, diodes, ICs etc. which for one reason or another have accumulated in one of our stock rooms. Rather than spend weeks sorting and listing them, we have decided to make them into packs. All components are full spec marked devices. Some may be coded. We believe this to be one of the best value packs ever offered, as many high value components are included. Packs are made up by weight; this means contents are very approximate – if there are several bulky power devices, there will be considerably fewer parts than those packs containing all small signal items.
Pack of approx 100 £5.50
Pack of approx 250 £12.00
Pack of approx 1000 £40.00

K539 Led Pack – not only round but many shaped leds in this pack in red, yellow, green, orange and clear. Fantastic mix.
100 £5.95 250 £13.50

K547 Zener Diodes – Glass and plastic, 250mW to 5W ranging from 3V to 180V. All readily identifiable. **100 for £4.50**

K546 Polystyrene/mica/ceramic caps – Lots of useful small value caps up to about .01µF in voltages up to 8kV. Good variety.
100 £2.75

K528 Electrolytic Pack – All ready cropped for PCB mounting, this pack offers excellent value for money. Good range of values and voltages from 0.47µF to 1000µF. 6V to 100V
100 £3.95 250 £8.95 1000 £32

K518 200 Disc Ceramic Caps – Big variety of values and voltages from a few pF to 2.2µF; 3V to 3kV **£1.00**

K530 100 Assorted Polyester Caps – All new modern components, radial and axial leads. All values from 0.01 to 1uf at voltages from 63 to 1000!!
Super value at £3.95

K520 Switch Pack – 20 different assorted switches – rocker, slide, push, rotary, toggle, micro etc.
Amazing value at only £2.00

K569 Reed Switch Pack. A selection of about 15 types of reed switch from submin 12mm long to 5A rated 50mm long, mostly form A (make), few form C (Change-over).
Pack of 30 £2.75

K540 Resistor Pack – mostly 1/8, 1/4 and 1/2W, also some 1 and 2W in carbon, film, oxide etc. All have full length leads. Tolerances from 5 to 20%. Excellent range of values. **500 £2.50 2500 £11.00**

K503 100 Wirewound Resistors – From 1W to 12W, with a good range of values. **£2.00**

JOYSTICKS

Z004 Skeleton Joystick, switch type. Good quality, made by AB. Brass spindle has 44mm long black plastic handle attached. Body has 4 mounting holes. These really are a fantastic bargain! **Only £1.00**

Z8831 Dragon Joystick. Made by Dragon Data. Hand-held with fire button. 2m lead with 5 pin DIN plug. Uses 2 x 100k pots. **£3.00**

Z615 BBC Joystick. Internal resistors give the required voltage levels. 2 fire buttons. Rubber suction feet. 120 x 110 x 155 **£3.00**

POWER SUPPLIES

Z975 Cased PSU 92x57x45mm with built-in 13A mains plug. Output 14V ac @ 600mA. **£3.00**

Siliconix mains PSU 62x46x35mm with built-in cont. 2 pin plug. Output 4.5V DC 100mA to 3.5mm plug **ONLY £1.00**

Z4113 BBC Computer PSU (early models). Steel case 158 x 72 x 55mm, 2m long mains lead, rocker switch, fused. Outputs: +5V at 2.5A; -5V at 100mA **£3.95**

KEYBOARDS

Z8852 Keyboard: Superb brand new keyboard 392x181 with LCD displaying 1 line of 10 characters & a further line with various symbols. 100 keys, inc separate numeric keypad. Chips on board are 2x74HC05, 80C48. **£15.00**

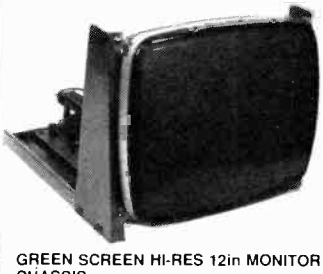
Z8848 Alphanumeric plus separate numeric keyboard. 104 keys plus 11 chips. 442x175mm. **£12.00**

Z4116 24 way (8 x 3) membrane keypad. Large (200 x 90mm) area – they were used in a teaching aid. Overlay template and pinout supplied. **£3.00**

Z810 KEYBOARD Really smart alpha numeric standard qwerty keyboard with separate numeric keypad, from ICL's 'One Per Desk'. Nicely laid out keys with good tactile feel. Not encoded – matrix output from PCB taken to 20 way ribbon cable. Made by Alps. Size 333x106mm. 73 keys **£8.95**

COMPUTER KEYBOARD **£4.00**
Yes, only £4 for this Cherry keyboard – 67 full travel keys inc. function keys. Size 340x130mm. Pale/dark brown **£4.00**

Z8863 KEYBOARD – High quality by Microswitch. 69 keys, 6 LED's, 15 various LS chips + socketed D8048 by Intel. Output via 7 way plug. Size 317x170mm **£12.00**



GREEN SCREEN HI-RES 12in MONITOR CHASSIS
Brand new and complete except for case, the super high definition (1000 lines at centre) makes this monitor ideal for computer applications. Operates from 12V d.c. at 1.1A. Supplied complete with circuit diagram and 2 pots for brilliance/contrast, plus connecting instructions. Standard input from IBM machines, slight mod (details included) for other computers **Only £24.95+£3 carr.**

MONITOR INTERFACE KIT
Enables our hi-res monitor (above) and most others to be used with virtually any computer, PCB **£3.00**
Complete set of on-board components plus regulator and heatsink **£9.95**
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Investigation 4

The DIY memory

Breadboarding the memory circuit is a challenge for those who like finishing up with a bird's nest of connecting wires. This investigation is strictly for the enthusiastic. If you are feeling faint-hearted at the prospect, the next investigation is much less demanding!

The circuit requires more room than usual (Fig. 17). It is best to begin by wiring up the buffers and their control gates – the three ics on the right of Fig. 17. Check that these operate properly before completing the circuit with the NOR gates and latch ic. This version of the circuit has two leds to indicate the state of data input or output.

To read and store data, follow the steps listed in the previous section. When you are reading data, do not have the D_0 and D_1 leads plugged in, as this over-rides the true data output.

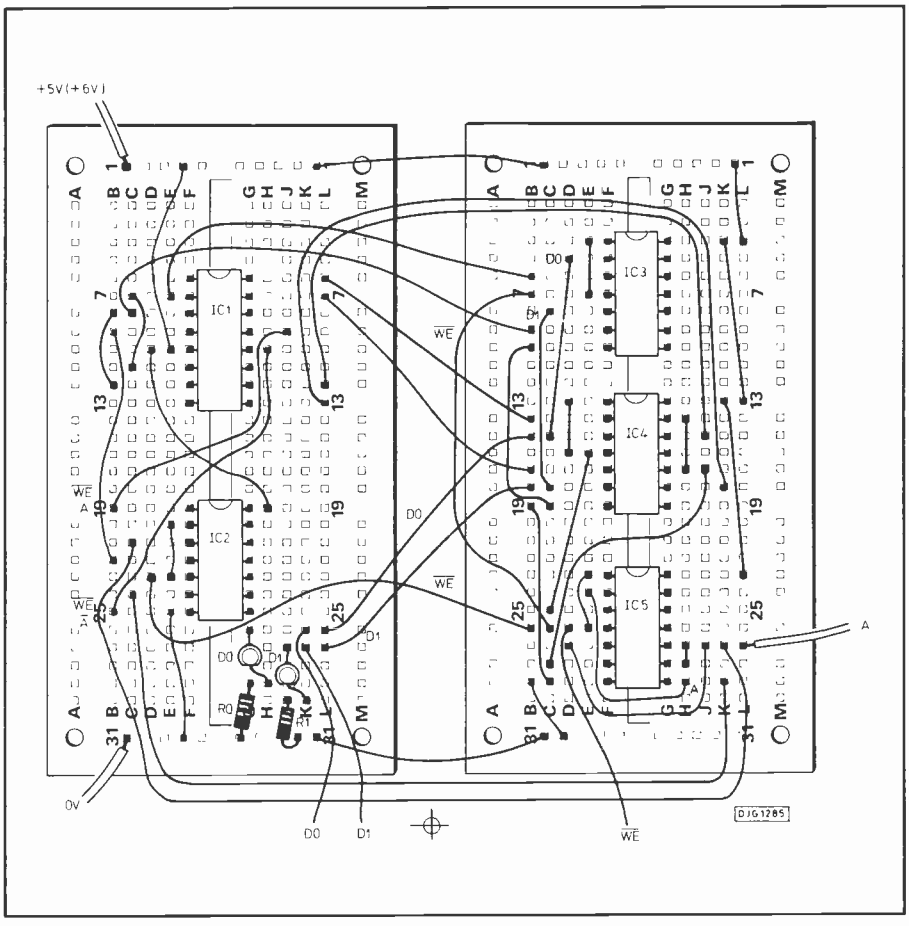


Fig.17. Breadboard version of the DIY memory

Investigation 5

The 2114 memory chip

This ic (Fig. 18) contains all the circuit elements of Fig. 17 and a lot more beside. Instead of storing four bits, the 2114 stores 4096 bits. Its addressing system provides for 1024 words, of four bits each. It is a good example of the power of large scale integration.

DIGITAL ELECTRONICS

BY OWEN BISHOP

PART 8 – MORE COMPUTER LOGIC

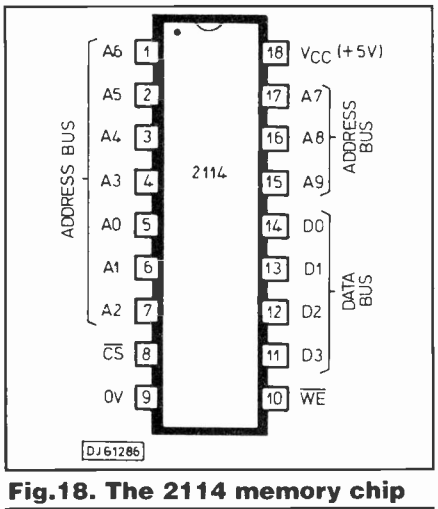


Fig.18. The 2114 memory chip

In order to write or read to 1024 different addresses we need ten address bits. Addresses range from 00 0000 0000 to 11 1111 1111 (0 to 1027 in decimal or 0 to 3FF in hexadecimal). There are four data input/output terminals. The WE input has the same function as in our diy memory. There is an extra control input, CS. This is the *chip select* input. A computer needs more than just one 2114, so this input is used to bring this particular ic into action when required. When CS is high, the chip is, in effect, disconnected from system. When it is low, data may be written or read.

Owen shows more practical ways in which you can learn the basics of computer hardware, concluding with simple circuits for a 2-bit adder, awd, frost alarm and weighted dice.

Wire up Fig. 19 to see how the memory works. CS is connected permanently to 0V so that the chip is enabled. To write data:

- plug WE into the +5V line (read)
- set up an address by plugging A_0 (lsb) to A_9 into the +5V or 0V lines. You have 1024 addresses to choose from. To prevent yourself from becoming too tangled in a maze of wires, it is best to connect A_3 to A_9 permanently to 0V. Just work with A_0 to A_2. These give you eight addresses, which is ample.
- set up the data by plugging D_0 to D_3 into the +5V or 0V lines. You can set up any value from 0000 to 1111. The data you are writing is displayed on the leds.
- Make WR low. Then make it high again. The data is now written into the latches in the chip.
- You are now in read mode. Remove the data leads from the supply lines. The leds now show what data is being read.

Store several different values at different addresses. You can then read the data from these addresses. Try not to disturb the wiring more than necessary. You may generate 'spikes' on the supply line, which could cause stored data to be lost or altered. Normally, the data remains at each address until it is altered by you, or the power is deliberately switched off.

Keep this ic wired up, as we shall use it again later.

OTHER MEMORIES

The memory chip that we have just been working with is known as *random access memory*, or ram. There are two types of ram. The 2114 is one of the type known as *static* memory. Static memory, once written to, holds its contents until they are altered or the power is switched off. The other type of ram is known as *dynamic* memory. This does not hold the data indefinitely. This is because the data is not stored in flip-flops but in tiny capacitors. The capacitors are either charged or not charged, depending on whether they have been written with 1 to 0. But the charge leaks away from the capacitors in two or three milliseconds unless it is *refreshed*. This operation has to be done repeatedly by circuits in the computer. When the chip is refreshed, every capacitor is tested before the charge has had time to leak away completely. Uncharged capacitors are left uncharged. Capacitors that have some charge remaining on them are recharged. All this has to be done in between the times allocated to the microprocessor for writing and reading.

Obviously dynamic ram is a lot more trouble to use. Its chief advantage is that, since capacitors are less complicated than flip-flops, it is possible to fit many more of them on to a chip. They cost less too. For about the same price as the 2114, storing 4096 bits, you can buy the 41256 dynamic ram which stores 262144 bits.

RAM is intended for temporary data storage such as programs loaded into the computer and later replaced by other programs, and data such as the results or calculations made while the program is running.

The other main type of memory is *read only memory*. This is intended for permanent data storage. It may store the programs of a computer's operating system, for example, or its built-in language. Or it may store frequently used programs such as a word-processors. The data in a rom is put into it when the computer is being manufactured. Or perhaps the owner buys a rom chip or a cartridge containing such a chip, and plugs it into a socket in the computer. There are several types of rom, differing in the way the data is stored:

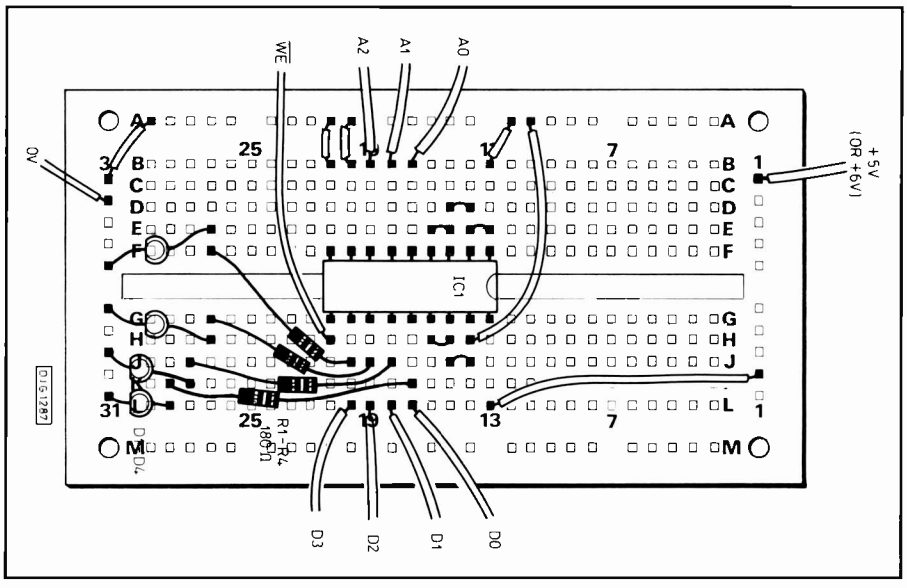


Fig.19. Breadboarding the 2114 memory chip

Mask-programmed:

This type is manufactured with the data already part of the chip design. The data can not be changed once the chip is made. It has to be specially made and is therefore expensive, except in large quantities.

Fusible link:

The chip is manufactured with all the bits set '1'. To set a bit to '0' it is addressed and then a high current is passed through the chip. This 'fuses' the addressed circuit units, converting the bit to '0'. Once this has been done the only change you can make is to turn more '1's into '0's, but not '0's into '1's. This type of rom is cheap to make. The only extra cost is the original programming.

Eprom:

The Erasable Programmable ROM is the most frequently used type of rom. The data is held in small capacitors, charged by applying a high-voltage pulse. Unlike static ram, the charge does *not* leak away rapidly as the capacitors are not electrically connected to the outside world. They retain their charge (and therefore the data) for hundreds of years. The charge is detected by the effect of its electric field, but this does not remove any of the charge itself. These chips are cheap to make and easy to program. Their other advantage is that they can be altered. If you make a mistake when programming them, you can erase the program and start again. Erasing is easily done by shining strong ultra-violet radiation on the chip for about half an hour. This is why eproms have a quartz window (Fig. 20). The uv produces ions which discharge the capacitors.

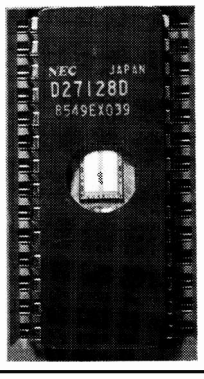
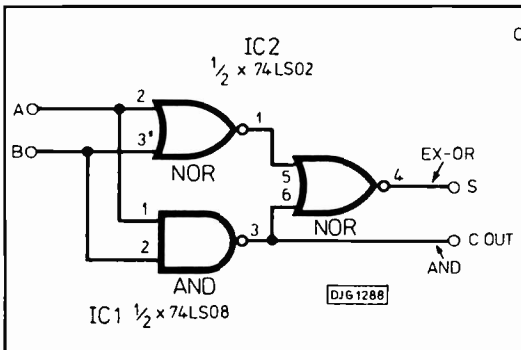


Fig.20. Typical Eprom device, showing window.

E²rom or Eerom:

The Electrically Erasable rom, or Electrically Alterable rom (earom), like the eprom, can be erased and reprogrammed as required. E²roms are much quicker than eproms to erase but are much more expensive.



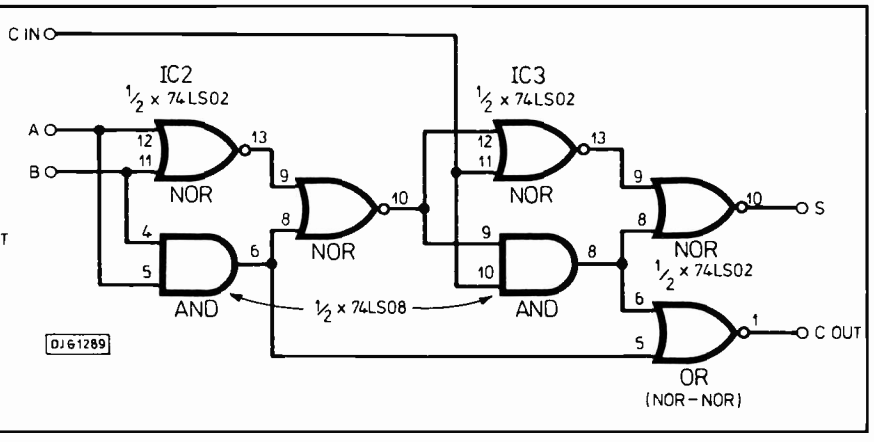


Fig.21. (above) Half adder
Fig.22. (right) Full adder

Cd-rom:

Digital recording techniques need not be restricted to audio. A cd disc can also store large quantities of data and programs in binary form. It takes longer to read the data, since it is not possible to pick out any particular byte instantly, simply by calling up its address. But a cd player does not take more than a few seconds to find the required track and, once it is in position, can read a continuous block of data quickly.

MORE ELECTRONIC MATHS

We have seen how multiplication can be done. Now let's look at addition. In binary arithmetic there are only four possible addition sums:

Numbers to be added		Result	
		Carry	Sum
A	B	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Two single-bit numbers, A and B are added to give a single-bit sum S. When A=1 and B=1, the sum is 10 or '0, carry 1'. The table above looks like a truth table. What truth-table is it? It is really two truth tables in one. One is the truth table for A, B and S. S-0 when A and B are equal; S=1 when A and B are different. Those readers who were with us for Part 2 (PE Oct. 88) will recall that this operation is known as exclusive-OR. The other truth table is the table for A, B and C. This is the AND operation. The logic of binary addition can be done with just two gates, an EXOR and an AND. However, since we need the AND gate to get C, we can get the EXOR function from two NOR gates and the AND as in Fig. 21. (Work out the truth tables for yourself, to prove it!) This circuit adds two 1-bit numbers and produces the sum bit and the carry bit.

When we are adding numbers of 2 or more bits we need to allow for the carry-over from one stage to the next, as this example shows:

```
  01
+ 11

 100
```

Step 1:

Add the two least significant bits:
1 + 1 = 0, carry 1

Step 2:

Add the next two bits:
0 + 1 + 1 (carried over) = 0, carry 1

Fig. 21 can do step 1, but not step 2. It has no input for a bit carried over from a previous step. Fig. 22 shows a circuit that accepts a *carry-in* bit. Fig. 22 is called a *full-adder*, while Fig. 21 is only a *half-adder*. The full adder consists of two half adders: the first adds A and B, producing a sum and a carry; the second adds C_{IN} to the two half-adders are ORed to give C_{OUT}.

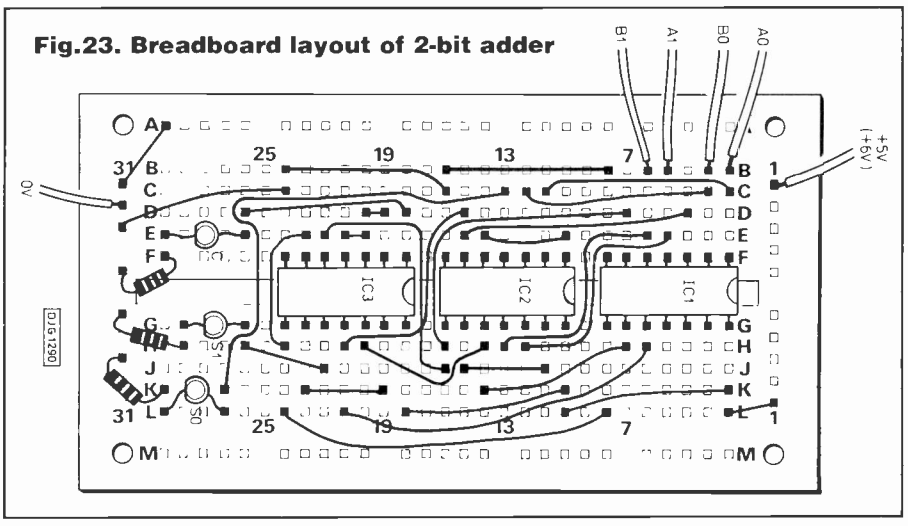


Fig.23. Breadboard layout of 2-bit adder

If we connect the C_{OUT} of Fig. 21 to the C_{IN} of Fig. 22, we have a circuit that adds two 2-bit numbers.

INVESTIGATION 6

A 2-bit adder

Fig. 23 shows a breadboarded version of Figs. 21 and 22. Instead of the single OR gate we make use of two NOR gates, since these are to spare in IC3. This circuit (with some of the gates swapped to simplify the wiring) is also featured as Module 11 this month. If you prefer, build the module and use it in this investigation.

The adder accepts two numbers A and B. A_0 and A_1 are the lsb and msb of a respectively, and similarly for B. The outputs appears as two sum digits, S_0 (lsr) and S_1 (msr), and a carry-out digit. Build the adder and try adding various pairs of numbers. What is the largest answer that it can produce? (Answer at end.)

You can extend the adder by connecting another full adder to it. The C_{OUT} output of this circuit becomes the C_{IN} of the extra adder. Now you can add two 3-bit numbers.

MICROPROCESSORS

Last, but no means least, we come to the logic device that is at the centre of all microcomputers, the microprocessor. Microprocessors are also to be found in many other pieces of equipment that perform complicated operations, such as washing machines, computer printers, robots, video players etc.

The key section of the microprocessor (Fig. 24) is the *arithmetic and logical unit*, the *ALU*. Here is the logic that performs arithmetic operations such as adding and subtracting, and logical operations such as ANDing, and ORing. The alu operates on data stored in a special register called the *accumulator*. This is equivalent to a small pad of paper that you might use to jot down the various stages of a calculation that you are doing in your head. The alu corresponds to your head! You can think of the

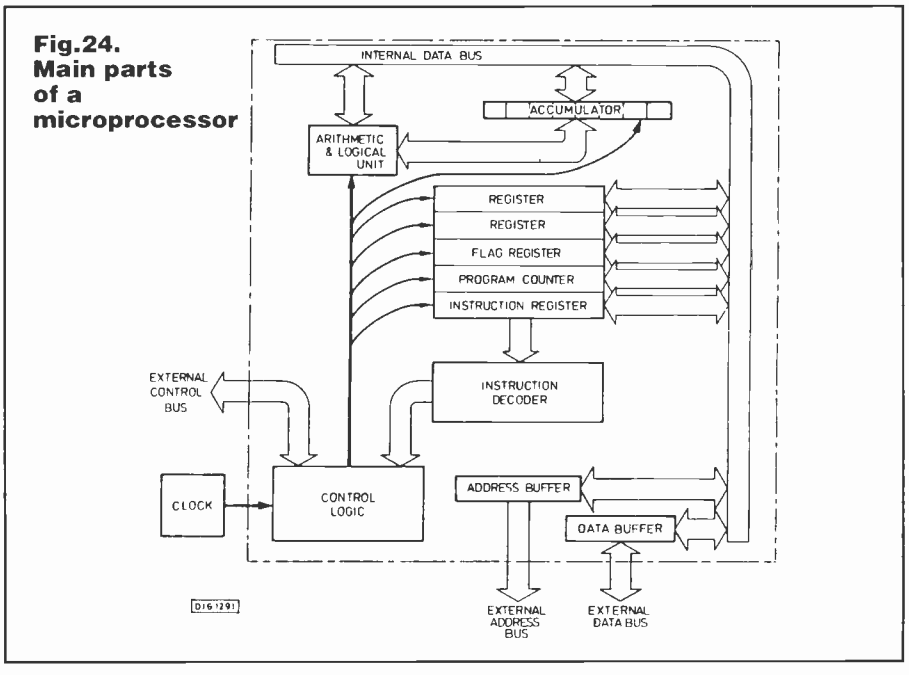


Fig.24. Main parts of a microprocessor

accumulator as a register rather like the shift register of Fig. 7 last month but with parallel loading and unloading. Its shifting facility is used for operations such as multiplication – though this is not the only way multiplication can be done. The accumulator is often an 8-bit register, though many microprocessors may have 16 bits or more in the accumulator and in other registers. Data from the accumulator may be taken to the alu, operated on and then returned to the accumulator. Data from the accumulator may also be taken along the internal data bus to the other registers. There are usually several general-purpose registers used for holding numbers that will be needed later. Data is stored in these until it is needed again. The other registers are:

Flag register:

This is used not for storing an 8-bit byte, but for single bits, each of which has a special meaning. For example, one flag bit is used to hold the carry bit from an addition. Another is set to 1 if the result of a calculation step is negative.

Program counter:

This tells the microprocessor at which address in memory the next instruction of the program is stored.

Instruction register:

The current instruction is stored here (more about instructions next month), and goes to a decoder to find out what has to be done.

The instruction decoder passes on the decoder instruction to the *control logic*. It is this section that sends data around inside the microprocessor from one register to another, tells the alu what to do with it, and calls up the next instruction when it is ready to proceed. It has connections to other parts of the microcomputer through a set of lines known as the *control bus*. Data is sent from one part of the microprocessor to another along an *internal data bus*.

At bottom left in Fig. 24 is the *clock*, an astable which produces pulses at a high rate (several megahertz). This times the operations of the microprocessor and ensures that its action is synchronised both internally and externally (for example, so that the microprocessor does not try to read or write to dynamic memory while it is being refreshed). The clock is usually a separate ic, not part of the microprocessor.

Data is sent to other parts of the computer along the *data bus* (more about this next month). There are tri-state buffers between the external data bus and the internal data bus. There is also a buffer for the address bus, another topic for next month's discussion.

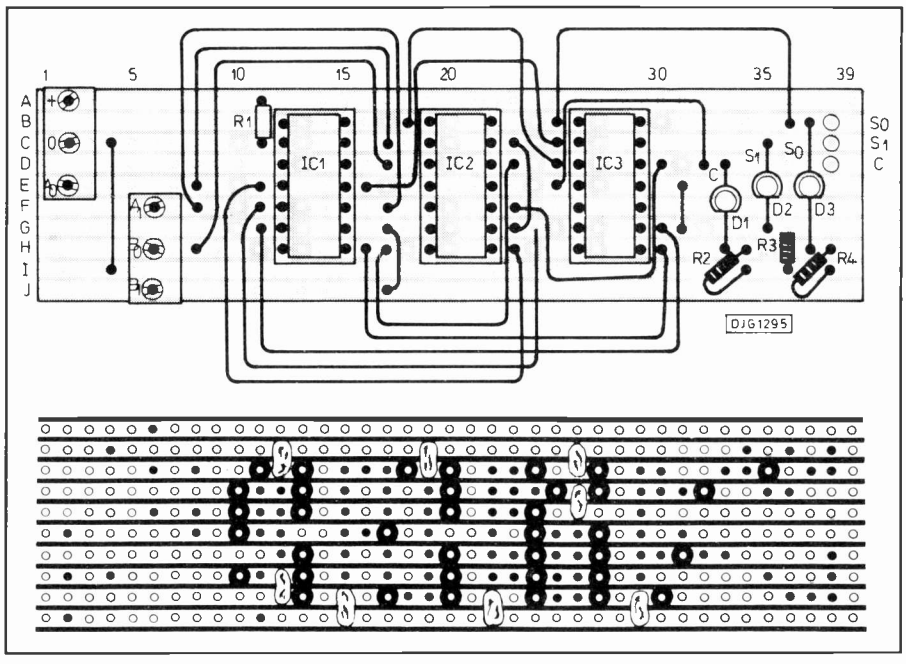


Fig.25. Module 11. 2-bit adder

SELF-TESTING

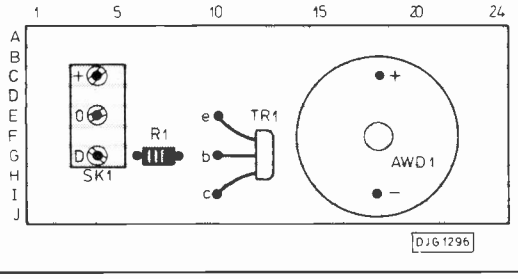
1. Name three logical circuits that can be built up from D-type flip-flops.
2. What input is needed to make a D-type flip-flop change state?
3. What is the difference between a siso shift register and a sipo shift register?
4. What types of shift register would you use for sending data along a transmission line?
5. How many shifts are needed to multiply 7 by 16? What do the bits look like before and after shifting.
6. What is the difference between a register and a latch?
7. What are the three output states of a tri-state buffer?
8. What does WE mean?
9. What factors can alter the data stored at a memory address?
10. What is the difference between ram and rom?
11. How is data held in an eprom?
12. How is data erased from an eprom?
13. What logic gate is used to calculate the 1-bit sum (S) of two 1-bit binary numbers? What logic gate calculates the carry bit?
14. Why is a half-adder so-called?
15. Which part of a microprocessor does the arithmetic?
16. Which is the main register used for calculations?
17. What is the purpose of the internal data bus of a microprocessor?
18. Which register keeps a note of how far the microprocessor has got in its program?
19. Where in a microprocessor would you look to find the bit carried over from an addition.
20. What does the instruction register do?

The answers are on the next page.

MODULES OF THE MONTH

A 2-bit adder

This is based on Fig. 23, though the pin connections are different, so as to adapt the wiring for stripboard (Fig. 25). The two 2-bit numbers added are A_1A_0 and B_1B_0. Their sum (S_1S_0) and carry (C) are indicated by three leds. There are three terminal pins on the right, for connecting to other circuits (see the second System of the Month). The module requires a maximum current of 30mA.



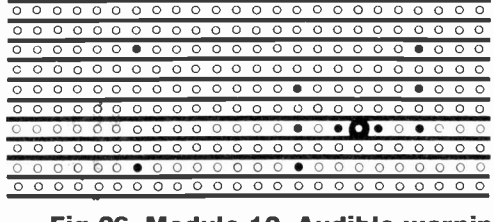


Fig.26. Module 12. Audible warning device

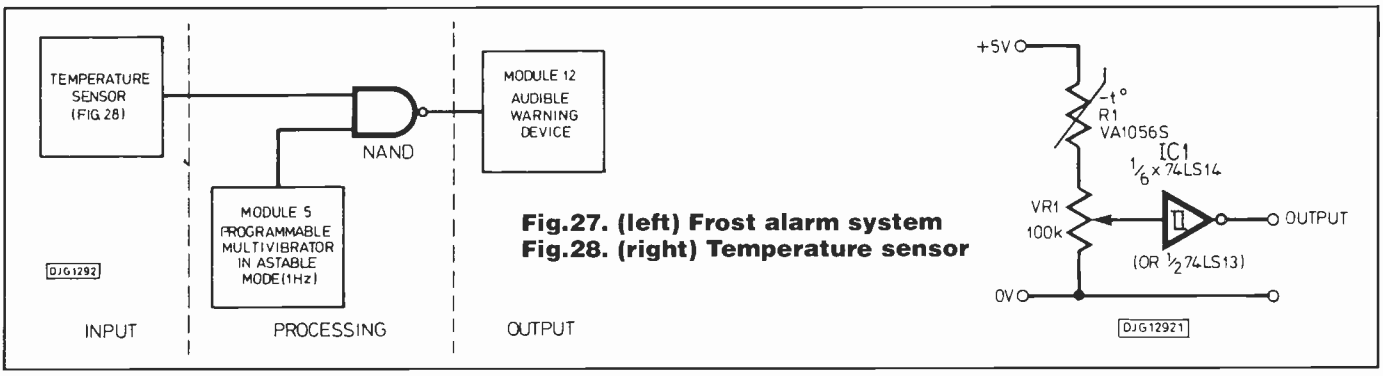


Fig.27. (left) Frost alarm system
Fig.28. (right) Temperature sensor

Parts required:

R1 1k carbon 5%
R2-R4 180 ohm carbon 5% (3 off)
IC1 74LS08 quadruple 2-input AND gates
IC2,IC3 74LS02 quadruple 2-input NOR gate (2-off)
D1-D3 TIL209 or similar leds, 2 red (sum), 1 yellow (carry)
1mm terminal pins (3 off)
SK2,SK2 pc terminal 3-way (2 off)
14-pin dil socket (3 off)
Stripboard 10 strips by 39 holes

Audible Warning Device

A useful output interface (Fig. 26) for alarm systems, warning of circuit malfunction etc. The awd is any of the solid-state devices or buzzers that produce a tone when a current is passed through them (Note: NOT the piezo transducers, which require an astable to generate the tone). Operating voltage should be in the range 3-12V. Although many of these devices can be driven directly from a logic gate we use a transistor switch here. This reduces the drain on the logic to only a few microamps. High input activates the awd. The module requires 2mA when activated.

Parts required

R1 47k carbon 5%
TR1 ZTX300 npn transistor
AWD1 audible warning device (see above)
ST1 pc terminal 3-way
Stripboard Vero 14345

SYSTEMS OF THE MONTH

Frost Alarm

This sounds an audible alarm when the temperature falls below a given level (Fig. 27). The sensor consists of the thermistor and variable resistor connected as a potential divider (Fig. 28). The input to the Schmitt trigger gate falls as temperature falls. Eventually the gate output changes from low to high. When the gate output is high, the pulses from the astables pass through the NAND gate, and invert and activate the awd. An intermittent warning tone is produced.

Weighted Dice

This is an electronic dice system for use in games (Fig. 29). It is weighted, but that does not mean it is unfair. If you shake a pair of ordinary 6-sided dice, you will rarely score 2 (double 1) or 12 (double 6). Score 7 is the easiest to obtain because you can get it from 1+6, 2+5, 3+4, 4+3, 5+2 and 6+1. In this system the counter output is used as if it is two 4-sided dice. It is hardest to score 0 (double 0) or 6 (double 3), and easiest to score 3 (0+3, 1+2, 2+1 and 3+0). This is what we mean by saying it is weighted. The astable runs fast, running the counter through from 0 to 15 too quickly for anyone to see the score. When you press the button, the stream of pulses from the astable is interrupted. The counter halts. Its upper two bits are taken to represent a score of 0 to 3 on one die. The lower two bits represent 0 to 3 on the other die. The adder totals these two scores and presents you with the answer – 0 to 6. An optional extension to the system sounds an awd if you score double-3.

DID YOU KNOW?
Owen Bishop is the author of numerous books on electronics and allied subjects and has been a frequent contributor to the monthly magazines in the field for many years.

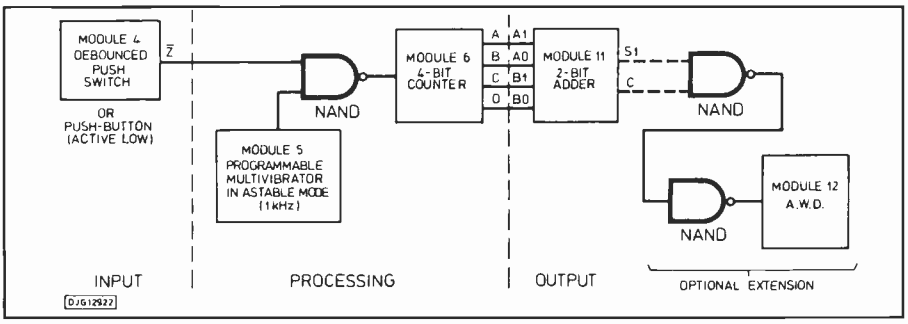


Fig.29. Weighted dice system

ANSWERS TO QUESTIONS

Investigation 6:

The largest answer produced is 110, the sum of 11 and 11.

Self-testing

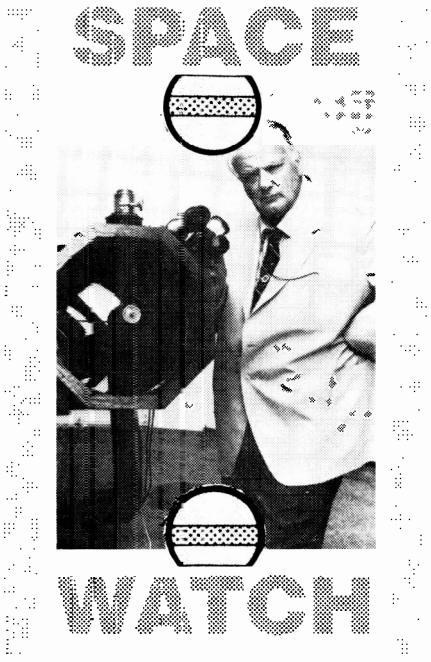
1. Counter, storage register, shift register.
2. A positive-going (rising) edge triggers the 7474 D-type flip-flop.
3. SISO has only serial input and output. SIPO has parallel output as well.
4. PISO at the transmitting end SIPO at the receiving end.
5. Four shifts, starts as 00000111 (=7), finishes as 01110000 (=112).
6. The output of a register is fixed until the clock goes from low to high. Then the output changes to the new data. The output of a latch follows the input data (the latch is *transparent*) as long as the clock input is high. When the clock goes low, data present at the output is held latched until the clock goes high again.
7. High (1), low (0) and high-impedance (in effect, disconnected).
8. Write enable. Writing is enabled when this line is low.
9. New data being stored there; 'spikes' on the supply line; power being switched off.
10. RAM is temporary data storage that can be freely written to, and read. ROM has data stored in it before it is installed in the computer.
11. In capacitors that are charged or not charged.
12. By exposing the chip to strong ultra-violet radiation.
13. Exclusive-OR; AND.
14. It does not allow for a carry-in bit.
15. The alu, arithmetic and logical unit.
16. The accumulator.
17. Carrying data from one register to another, or to the alu, or to the buffers.
18. Program counter.
19. In the carry bit of the flag register.
20. It holds the instruction that the microprocessor is currently performing. PE

NEXT MONTH:
Owen looks at computer systems, their architecture, input-output functions, and drives a bus!

PROBING SOLAR SYSTEMS

BY DR PATRICK MOORE CBE

In Chile, astronomers are observing an event which is probably unique in our time – a star hatching into a solar system. And the Russians are looking for life on Mars.



Astronomy has been revolutionised by electronic devices, notably the ccd or charge-couple device, developed largely by a British team at Herstmonceux led by Professor Alec Boksenberg. *(We ran a report on them in PE Sep 88. Ed.)* Using a ccd together with the 2.2-metre telescope at La Silla, the Chilean observatory run by the Europeans, three astronomers – H.E. Schwarz, C. Aspin and J.H. Lutz – have made important studies of a faint object which may be unique. It is too far south to be seen from Britain (it lies in the constellation of Centaurus) and has the unexciting designation of He 2-104. It may well be the first object to be observed in a state of transition from one state to another.

There are some pairs of stars, physically associated, which are known as symbiotic stars in which the two components are interacting. Some of these are surrounded by envelopes of gas, others by envelopes of dust. He 2-104 seems to be of the 'dusty' variety, but it has sent out what look like arms and blobs; the blobs are moving away from the small, hot, central star at around 100 kilometres per second. Probably it is about to shed its outer layers, in which case it will turn into an object of the kind known, midleadingly, as a planetary nebula. If this transition stage lasts for only a thousand years or so, we are lucky to have caught He 2-104 "in the act".

One of Russia's leading rocket technicians, Valentin Petrovich Glushko, has died at the age of 80. He was the man behind the creation of the rocket engines which were, in the 1950s, the most powerful in the world, and enabled the Soviets to launch their initial massive payloads. He was associated with Sergei Korolev, probably the most brilliant of all the Russian pioneers of space-flight, and was able to rescue Korolev when he had run foul of the Stalin régime and had been imprisoned. In 1974, Glushko took over Korolev's design team, as General Designer of Manned Space-ships and Space Stations, so that he was deeply involved in the planning and construction of the Mir station now orbiting the Earth.

THE PHOBOS PROBE

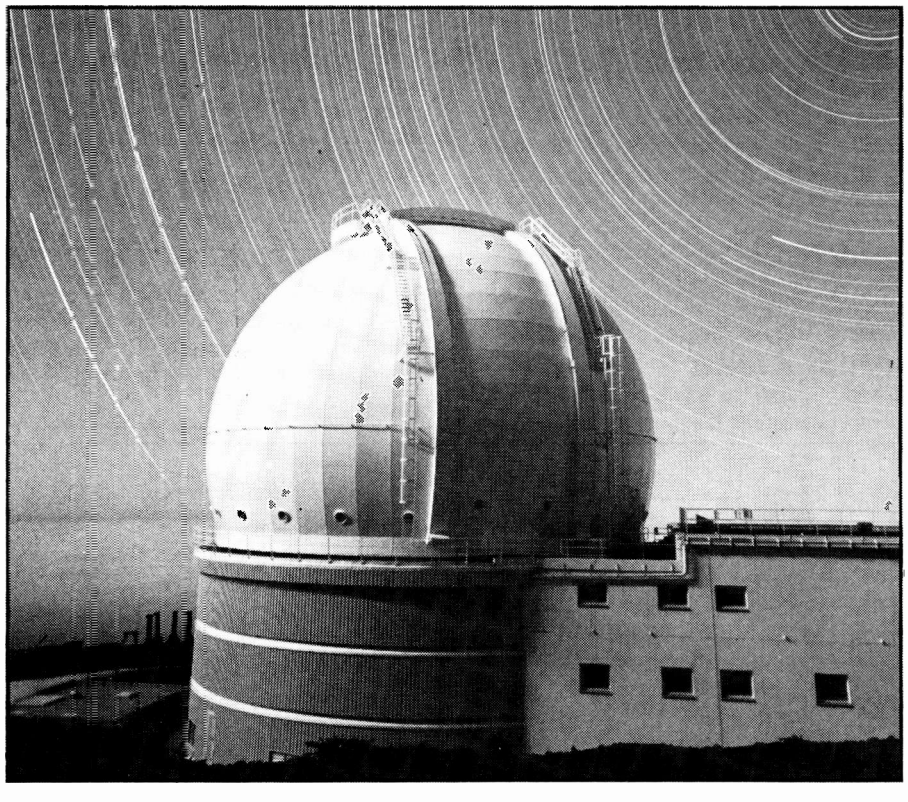
Phobos, the inner satellite of Mars, has come in for a great deal of attention lately. It is a curious little body, irregular in shape and with a longest diameter of less than 30 kilometres, so that it is quite unlike our massive Moon. It also seems to be in an unstable orbit, gradually spiralling down toward Mars, so that it will eventually crash on to the surface even if it is not previously broken up – though the demise of Phobos is by no means imminent! (Deimos, the smaller and outer satellite, seems to be safe.)

Last July the Russians sent two probes to explore Phobos. One of these was lost when it was given a faulty command from the ground station – a case of human error; efforts to locate the probe from the La Sulla Observatory failed, and the chances of finding it again now seems to be virtually nil. This leaves Phobos 2, which will – we hope – hover at a height of no more than 50 metres above the surface of the satellite, making analyses of the soil elements, rock structure and so on.

MAPPING MISSION

By the end of January, Phobos 2 had reached the neighbourhood or Mars, and a braking manoeuvre put it into an orbit round the planet. One of its first tasks has

The William Herschel Telescope at Las Palma. Photo by courtesy of R.G.O.



been to begin making a temperature map of the Martian surface, and study the materials present there: it seems that the Russians have not finally given up all hope of finding some sort of organic material ("life"), though it is clear that even if Mars is not completely sterile, any living organisms there must be very lowly indeed.

However, Phobos is the main target for this particular probe, and one is bound to ask just why the concentration is upon the tiny satellite rather than on Mars itself. The reason is that so far as we can tell, Phobos is typical of the very small members of the Solar System. It may well be a captured asteroid; after all, Mars is much closer to the main asteroid zone than we are. But for the *Challenger* disaster, the Americans should have obtained the first close-range asteroid pictures by now (en route to Jupiter, the Galileo probe was to have imaged the asteroid Amphitrite), but as things are the Russians seem ready to be first in the field.

Small through Phobos is, it could well be of tremendous importance in the future. Manned missions to Mars are being planned, and Phobos seems to be a perfect natural space-station: it is close to Mars – only about as far above the Martian surface as we in Britain are from Aden – and its gravitational pull is so slight that a "landing" there will be more in the nature of a docking. So Phobos, and Deimos too, may have a major rôle to play in our exploration of the Red Planet. PE

THE SKY THIS MONTH

For planetary enthusiasts, the main target this month will be Mercury, which is in the evening sky and should be easily visible with the naked eye. For the second part of April it will set well after the Sun, so that this is the most favourable opportunity for some time to come. At maximum brightness, on the 14th, the magnitude is -1.4, just about the same as that of Sirius, though of course Mercury is never visible against a dark background. Telescopes will not show much – almost all our knowledge about Mercury has been derived from one space-probe, Mariner 10 – but it is always a source of satisfaction to locate this quick-moving, elusive little planet.

Venus is out of view (it passes through superior conjunction on April 4, so that it is on the far side of the Sun). Mars passes from Taurus into Gemini, and is in the evening sky, but has now faded to well below the first magnitude; Jupiter remains brilliant in the west for some time after dark, and Saturn, still in Sagittarius (the Archer) is coming into view well before dawn. The rings are wide open, so that even though the planet is low in the sky even a modest telescope will show the ring-system easily.

The Moon is new on April 6, and full on the 21st. There are no solar or lunar eclipses this month. There is, however, one meteor shower; the Eta Aquarids are active from about April 24 to May 20. They are associated with Halley's Comet, and may have a ZHR of as high as 35 (that is to say, a naked-eye observer with the radiant at the zenith could expect to see 35 Eta Aquarids per hour).

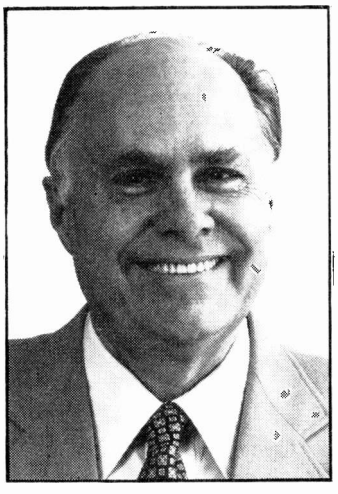
We have now lost the brilliant winter constellations, such as Orion; instead, the southern aspect of the sky is dominated by Leo (the Lion) and Virgo (the Virgin). The Great Bear is high; the "tail" points to the brilliant orange Arcturus, and the curved line joining the Bear with Arcturus will, if continued, lead on to Spica in Virgo. Lower in the south there is a rather blank area; this is filled by Hydra (the Watersnake) which has only one fairly bright star. The W of Cassiopeia is at its lowest, in the north, though over Britain it never sets; Capella is descending in the west, Vega gaining altitude in the east. Deneb, in Cygnus, has also risen, but we have yet to see Altair in Aquila (the Eagle), the third member of the unofficial "Summer Triangle".

LOW ORBIT

A recent survey indicates that the public are likely to be slow in installing satellite tv receiving equipment for Sky and BSB transmissions. Whereas Sky forecast sales of 1 million aerials during 1989, and BSB expect 3 million by 1991, a report by Logica, a software and consultancy company, predicts that the total homes receiving satellite tv by the end of 1991 will only be between 1.6 and 2.2 million.

Looking on the brighter side, the survey suggests that by 1996 more than 7 million homes will be suitably satellite-equipped. Personally, I am waiting for tv manufacturers to produce sets and aerials capable of tuning to all satellite channels before I enter the viewing arena.

STATE SIDE



The January Winter Consumer Electronic Show (CES) in Las Vegas was a frost – not so much in temperature, but in content. The swarms of electronic press reporters were all asking each other if they had seen anything new. Four long days of blah.

To give you an idea of how dead the event was, the biggest news was the Nakamichi, announcement that they were going to start selling a consumer $10,000 dat recorder in the US. Other than some smirks at the concept of the Record Industry Association of America (RIAA) carrying out their threat to haul any firm trying to sell a dat recorder into court, the ripple effect was small.

CANNED LAUGHTER

One wonders how much record company money the RIAA would be willing to spend on such a frivilous suit. Going into court and asserting that a $10,000 dat recorder is going to destroy the record industry might tend to make them even more of a laughing stock than they already are.

TWEEKS RUMBLED

The LP tweeks were there. Yes, there are still a few people who believe that lps sound better than cds. Any cds. Sigh, I twit them, saying, yes, they're probably right, but of course my lp player has a 100-pound turntable with adjustable balance weights around the rim to assure a steady speed – each lp is individually centered to eliminate wow – the table is independently sprung to avoid feedback – driven by belts to avoid rumble – has a vacuum suction to hold the lp tight – a special cushion to reduce the needle bounce – the whole works is in a special class 10 clean cabinet to avoid dust – and so on.

VAGUE GAMBLING AT VEGAS

BY WAYNE GREEN

THE WCES 89 RETORT!

Consumer electronic shows can be a bore. Or they can be a laugh. Or they can be so boring, you *have* to laugh. But no cheap cd? *That's* not funny.

Several members of congress were assembled, where they repeated the message we've had from two previous CES congressional panels; the record industry needn't look to congress for any action until they can prove actual losses. No more yelling wolf.

The Nakamichi entry, in addition to its amusing price, had one other interesting aspect: it will record at the previously verboten 44.1kHz sampling rate, thereby enabling it to make direct digital copies from cds – the ultimate horror for RIAA. Heh, heh.

DAT hasn't made much headway in Europe or Japan, I suspect because the systems have been blocked from the 44.1kHz cd standard.

The early dat systems were priced for people who have to have the latest technology – and can afford to pay for it. But one hears rumours of $300 dats being readied for manufacture, once things get moving.

AUTO-DESTRUCT?

There's a chicken/egg problem with prerecorded digital tapes. Without players, record stores won't stock the tapes. And, many industry insiders believe, without prerecorded dats, it's going to be very difficult to sell dat players – particularly for cars, where they are needed the most. Car cd players are okay, but they do skip on the bumps, and it's difficult to change discs while driving. Yes, I know about the cd car jukeboxes. I also know what they cost.

As I wandered around the enormous halls at CES. I was reduced to numbness by the endless recitations of "exciting" features which the new models of everything sported. The Pitchmen spluttered when I asked them what the benefits of these exciting new features were. Did all these new features mean that serious faults in their earlier products had been discovered and had now finally been surmounted? This confused them.

HI-D BOOMBOXING

There were a few high definition tv demos. Yep, sure looks great! But with so much money at stake, the infighting over standards is going to be fierce and could possibly lead to the industry's self destruction. Would quad sound have lived if there had been one standard format? Would vcrs have been accepted several years sooner if we hadn't had the Beta/VHS war? Something akin to quad sound is sneaking back via surround-sound encoded movies on video tapes.

The high end audio exhibitions were in the Riviera Hotel. There a hundred or so makers of almost identical, expensive, small speakers did their best to convince the attendees that their particular speaker was the best. They did prove that if you put good speakers into small boxes, they'll sound pretty good – as long as you don't have something right there in a larger speaker for comparison. As is obvious from boombox sales, the human ear can get used to almost anything.

I was disappointed that the outfit which promised the laser arm for playing lps showed only a hand-made sample, and announced that they were not going to actually market the players. Darn. My life is so full of disappointments.

The biggest disappointment of the show was the lack of record companies exhibiting. Dozens of people stopped by my CD Review booth to lament records not being there, in years gone by Telarc had done a land office business selling thousands of their cds for $10. CES clamped down on selling at the show, so the record companies dropped out. Might CES go the route of NCC, National Computer Conference, once the biggest of all American computer shows and now defunct? Could be.

TOP POPS

VCRs and compact discs are still top selling consumer electronic products, so that's where most of the CES action was, even if the new products were comparatively boring.

Of course, in Vegas there's always the gambling. Casinos and slot machines are everywhere, The dream of something for nothing dies hard in man and is the secret of Vegas' success. It takes stern moral fibre not to succumb to the beckoning slots. You never win on the first play, which means that from then on you're working just in the hopes of breaking even. The machines are computer controlled to egg you on, always giving back less than you've spent. They will inexorably drain you, as they have millions before you.

You'll notice that no one working the slot machines is smiling. They have nothing to smile about. They are grimly trying to recoup the ever growing deficit their fading hopes have triggered.

The next CES is in June at Chicago. After the excitement at Las Vegas, I can hardly wait.

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DSX 900 Decoder unit for CTX900. Connects to earphone output of receiver to descrambie signal from CTX900 output to headphones. 9-12V operation. Measures 35mm x 50mm **£17.95**

TLX700 Micro size telephone transmitter. Connects onto line at any point and requires no batteries. Clearly transmits both sides of conversations on both incoming and outgoing calls. Undetectable by phone users. Fully tuneable output covering FM band. Range up to 1000. Measures just 20mm x 20mm **£9.95**

ATR2 Micro size telephone recording unit. Connects onto line at any point and connects into ANY normal cassette recorder having MIC and REM sockets. Requires no batteries. Switches recorder on silently when phone is used for incoming or outgoing calls, switches off when phone replaced. Clearly records both sides of conversations. Undetectable by phone user. Measures 10mm x 35mm **£10.95**

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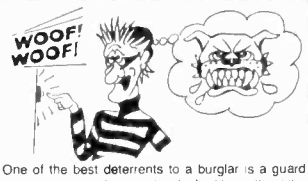
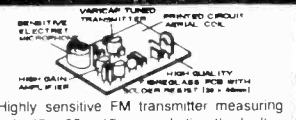


One of the best deterrents to a burglar is a guard dog and this new kit provides the barking without the bite! The kit when assembled can be connected to a doorbell, pressure mat or any other intruder detector and will produce a random series of threatening barks making the would-be intruder think you have a guard dog and try his luck elsewhere. The kit is supplied complete with high quality PCB, mains transformer, all components and instructions. The kit even includes a horn speaker which is essential to produce the loud sound required. The "dog" can be adjusted to produce barks ranging from a Terrier to an Alsatian and contains circuitry to produce a random series of barks giving a more realistic effect. Don't delay, fit one before you go on holiday and let our dog help you guard your home.

XK125 Complete kit of parts **£24.00**

SUPER-SENSITIVE FM MICROBUG



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Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz. this kit also includes circuitry to trigger the light from an external voltage source (eg a loudspeaker) via an opto isolator.

Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply 240V ac. Size 75x50x45.

XK124 Stroboscope Kit **£13.75**

VERSATILE REMOTE CONTROL KIT

This kit includes all components (+ transformer) to make a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (relays, triacs, etc – details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits.

Supply: 240V AC or 15–24V DC at 10mA.

Size (excluding transformer) 9 x 4 x 2 cms.

The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of outputs to be used.

MK12 IR Receiver (incl. transformer) **£16.30**

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The **DL8000K** is an 8-way sequencer kit with built in opto-isolated sound to light input which comes complete with a pre-programmed EPROM containing EIGHTY — YES 80 different sequences including standard flashing and chase routines. The KIT includes full instructions and all components (even the PCB connectors) and requires only a box and a control knob to complete. Other features include manual sequence speed adjustment, zero voltage switching. LED mimic lamps and sound to light LED and a 300W output per channel. And the best thing about it is the price **ONLY £31.50.**

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REMOTE-A-BELL

BY JOHN BECKER

Fancy a quick dabble with the soldering iron? Your Ed's got a new series of quick-chippy circuits that you can put together in little more than the batting of an eyelid. They'll give you pleasure to build, and become useful little gadgets that you know you've always wanted, even if you didn't realise it! Here's this month's offering: a legal telephone monitor. We're sure it's for yoo-hoo!

The problem with telephones is that you're not allowed to connect anything to the lines unless you've obtained official approval. A real shame, this, since there are all sorts of things one can invent that could make direct use of Buzby's wireful-world communications nestwork. It's not allowed though!

Even though British Telecom now have special sockets into which other gear can be plugged, that equipment has to have the approval of Those in Charge. BT have relinquished their authority on this, and it's Oftel who are now responsible. But, try as I might, it seems an impossibility to find out precisely what the situation is about getting approval for home telephone accessories that plug into the lines. However, adding together various statements made by different sources, it appears that even if a particular circuit is in theory suitable for approval, unless it's made by an approved manufacturer it may not qualify. "Too many possibilities for home constructors to get their assembly wrong", is the opinion generally offered. "We don't want poor unsuspecting telecom engineers knocked off their poles by a 250Vac overload if someone mistakes a mains socket for a 9V battery!" Point well taken.

INDICATING INDUCTORS

Still, all is not lost. There are other ways of doing things without direct connection. It's possible to detect the voltage changes in a telephone without plugging anything in. All it needs is an inductor close to the phone line and an amplifier. Surely there's no way that anyone's going to regard this as unofficial connection?

So what can we invent that's useful? Speech detection is really out of the question for a simple circuit since the amount of amplification and consequent noise levels would be too high to accept. We can, though, remotely detect whether the phone bell is ringing, or if someone is dialling out. So let's take that as this month's quicky theme.

CIRCUITOUSLY EXTENDED

We'll build a circuit that will allow you to have an extension buzzer well away from the phone, out in the garden perhaps. It will also let you hear if someone is using the phone while you're off in another room somewhere. With all the recent fuss about Chat-lines, I can see that this might perhaps help cut down on phone bills! "I hear you dialling your friends again - make sure you put the money in the box ..."

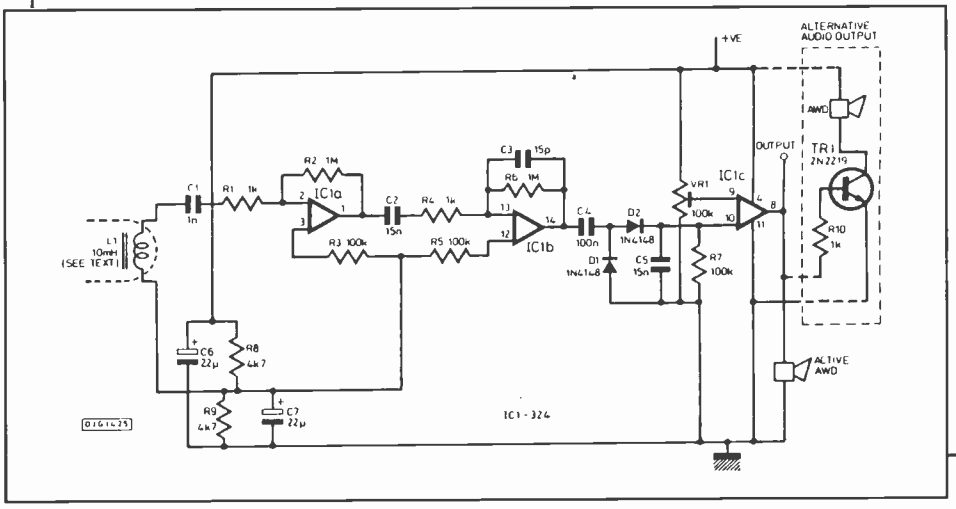
Incredible as it may sound, you can detect whether the phone line is being pulsed simply by taking a single turn of its cable around a simple small inductor. The phone line swings up and down by about 50 volts when you dial out, or someone is ringing you. This change in voltage can induce a small current into the inductor. Looking at Fig.1, L1 represents the inductor and the single turn of cable around it.

The value of L1 has been found experimentally not to be at all critical. Values of between 1 milli-Henry and 100 milli-Henries all produce results. The signal level obtained, though, is extremely small. We need to amplify it. One end of L1 is taken to a mid-voltage reference level, as set by R8 and R9, and the other taken via C1 and R1 to the inverting high-gain amplifier IC1A. C1 is made fairly small so that mains hum from nearby electrical wiring is not unduly picked up and amplified. The gain at IC1A is set by the ratio of R1 to R2, about 1000 times. The output here is a very short pulse of a few millivolts, accompanied by diminishing harmonic peaks caused by the action of the inductor.

C2 isolates the dc output of IC1A so that only the pulse affects the next amplifier, IC1B. The amplification factor here too is around 1000 as set by R4 and R6. This is sufficient to raise the pulse to a respectable level, approaching the maximum allowed by the opamp characteristics. C4 just adds a little bit of damping to lower level noise signals. If on test the gain is found to be a bit high, and random noise still gets through, increase the value of R4, or decrease R6.

We now raise the pulse to full line level by using a comparator, IC1C. The comparator triggers from a low to high output state when incoming signals pass above the threshold level set by VR1, typically around 0.5V above half the battery level. Between them C4, D1, D2, C5 and R7 form a diode pump network. Pulses pass through C4 and D2 to charge up C5. When the charge on C5 exceeds the threshold level set by VR1, the comparator is triggered into a high output state. Once the pulses have ceased, R7 discharges C5, and IC1C reverts to its low output state.

Fig.1. The Remote-A-Bell circuit diagram. Note that the pulse length can be extended by increasing C5 or R7



DETECTIVITY

The output of IC1C is sufficiently powerful to allow a high impedance audible warning device to be connected directly to it. Alternatively, the output can be taken via the transistor TR1 to provide sufficient power for driving a small bell. The type of transistor used for TR1 is unimportant so long as it's an npn type capable of carrying the current through the speaker.

You can use any dc power supply of between about 5V and 15V. A 9V battery will do just fine. If you use a 5V supply, you could use the output of IC1C to send pulses to a computer so that you can do a bit of programmed detection work on the signal. I'm not going to give information about this here since I have a more complex computer-controlled dialling and cost

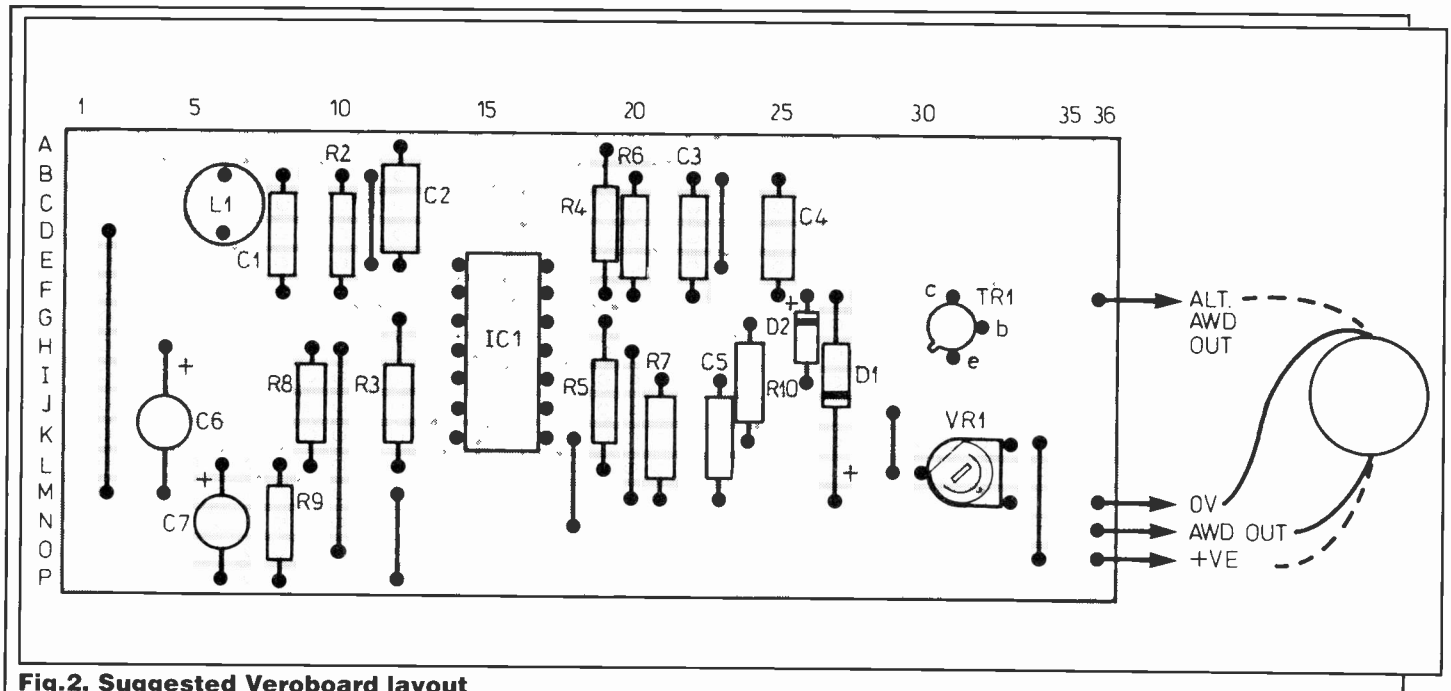


Fig.2. Suggested Veroboard layout

monitoring circuit in mind for some time in the future. But I'll give the hint that both serial and parallel computer ports can be used to detect changes in logic levels, and that Basic is fast enough for monitoring the phone pulses. This should give you something to think about!

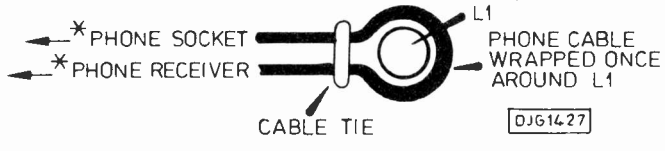
There's hardly anything to the assembly of this circuit, and a small piece of Veroboard or similar is quite acceptable. A suggested layout is shown in Fig.2.

Just make sure that you check all your joins for satisfactory connections without shorts across the tracks. Remember to cut all the track points where shown. Naturally, IC1, TR1, D1, D2 and the electrolytic capacitors must be inserted in the correct way round. There's no real setting up to be done - twiddle VR1 until the buzzer or bell remains silent until you dial out, or someone rings you.

One final point. The circuit, in its simplicity, can be subject to interference from spikes occurring on nearby mains wiring. Such things as fluorescent tubes, fridges and microwave ovens can create these spikes when they are turned on or off. Suppression techniques for such happenings are beyond the scope of this simple project. The occasional "ping" on the extension bell, though, is unlikely to be mistaken for a true phone call or dial-out.

I hope to have another simple quicky for you next month. PE

Fig.4. Looping the phone cable. NB it may produce a stronger signal if the current flow direction is reversed – try it and see by turning over the cable loop.

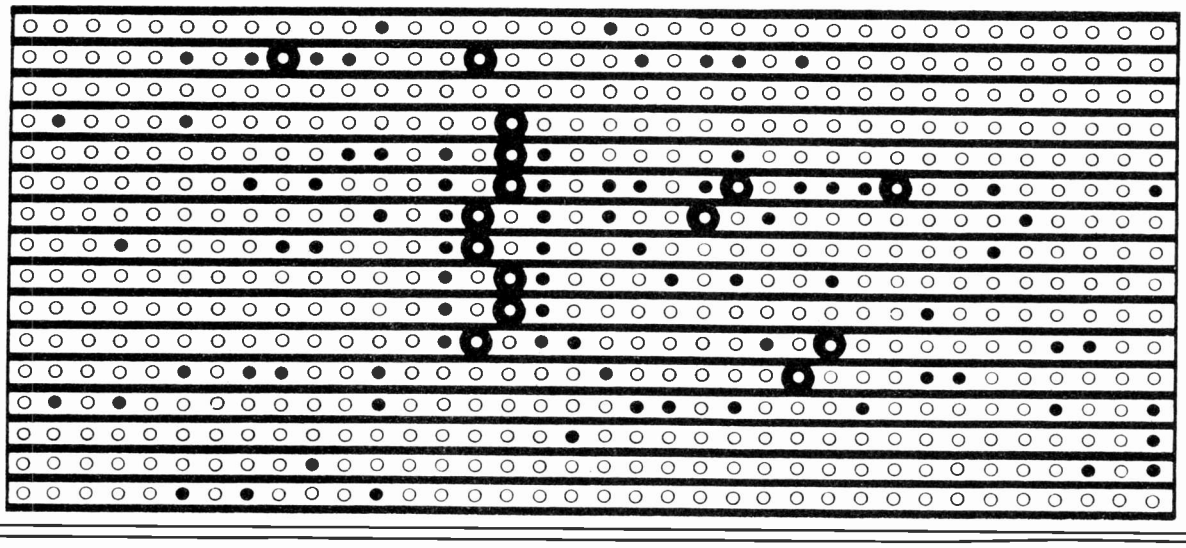


ED-LINES

SPEECH THERAPY

Nasa has introduced a computer controlled method whereby technicians can more accurately monitor the condition of each of the 31,000 heat resistant tiles on the Shuttle. Previously, one technician up a ladder would measure each of the tiles and shout down the results to a colleague on the floor - a system open to errors. Now a single technician speaks the number of each tile into a speech recognition unit and takes measurements with a laser tool, following instructions from a computer. The technique has cut down the total checking time from several months to just eleven days. **Ed.**

Fig.3. Track view of Veroboard layout.



LETTERS

If you have any comments, criticisms or suggestions, write and let us know. We are interested in what you think and say, especially regarding our new style and your views on our role for the 1990s.

MAJOR AND MINOR

Dear Ed,

After reading part one of the Dual Beam Oscilloscope, I decided that, like you lots of years ago, I would make it my first major project. But when looking through the components list it said 'a suitable transformer is available from Barrie Electronics, type Y1' but they don't have a Y1 transformer in their advert. Also, what is a Phonosonics PCB, and what do you mean when something says 'R55 3M3'?

Thank you very much, but before I go, I think PE is great for all ages, and even my brother (8 yrs) has a read sometimes (even though he doesn't understand it).

D.L. Breeze. Bournemouth.

You are obviously someone destined to make electronics your career if you keep up your enthusiasm (and perhaps your brother will too).

Barrie Electronics DO have stocks of the Y1 transformer. Remember that many advertisers have far more items to sell than they have space to publicise in an advert.

A Phonosonics pcb is a printed circuit board sold by Phonosonics, who are one of our advertisers. Where a company name is mentioned in a constructional parts list the company will usually carry an advert in the same issue, so look at their advert for their address, then write for more details of their products, enclosing a stamped addressed envelope for their reply.

A number like R55 is the number given to a component in a circuit or pcb diagram. Each component will have a different number prefixed by, for example, R for resistor, C for capacitor, D for diode etc. The 3M3 means that the value of R55 is 3M3, or in other words has a resistance of 3.3 Megohms, which is the same as saying 3,300,000 ohms.

Best wishes to you and your brother.

Ed.

STAR DRIVE

Dear John

I am a retired electronics engineer and subscribe to PE because I want to stay in touch, mainly through Marketplace, Industry Notebook, Leading Edge, Editorial and Spacewatch.

I write in response to Mr Trice's letter (PE Sept 88) about Astro Electronics and your reply and appeal to readers. I have misgivings about Mr Trice's idea of using a stepper motor to drive a telescope. They are inherently very low torque devices and in view of telescope mass and power losses in the reduction gear wonder if their torque would be sufficient. Also, the fact that the speed must be variable might lead to a complicated and expensive clock control.

A small universal motor, such as a washing machine spinner, might be more appropriate. They have a high torque and are easily controlled by a dedicated chip, like one of the TLE310x series from Seimens, with a tachogenerator in the control loop. This would be less complicated and cheaper. However, before starting on a project like this I need a few questions answered –

What should be the mean tracking speed taking into account Earth's movement round the Sun? Is it true that dedicated amateur astronomers have instruments up to six inches? What speed variation is admissible when taking photographs? How does one calculate the exposure values?

D.Balet, Co Kerry, Eire

I share your misgivings about stepper motors and believe that synchronous motors will achieve more satisfactory results under adequate control.

The Siderial Clock article in PE Feb 89 gives figures for calculating sidereal time which, compared to solar time, gains approximately 3 minutes 56 secs per solar day. Patrick Moore's opinion is that it is pointless to spend money on any refracting telescope with an aperture of less than three inches or a reflector with a main mirror less than six inches diameter. The subject of light intensity and camera exposure values is too complex for a published reply so I refer you to the Astrophotography article in Astronomy Now Apr-Jun 1987, and to the book Astro Physical Quantities by Clayborn Allan (available through a library). As a rough guide, with an f1.8 28mm lens, 30 seconds exposure on 1000 ISO film will probably produce acceptable results without apparent star trailing.

Ed

MICROWAVES

Dear Ed,

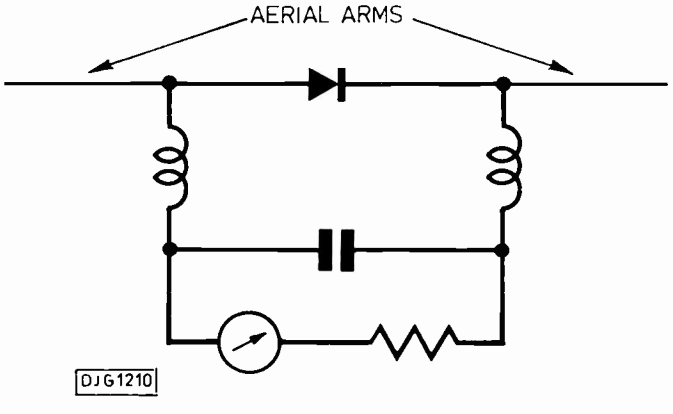
To answer Christopher Law's letter in PE Oct 88, microwave ovens do not emit particles that could be detected by a Geiger counter, rather, they emit electromagnetic waves in the frequency range of around 2.5 GHz. They can readily be detected by a passive receiver similar in essence to a humble crystal set.

I recall that some years ago I saw an article describing such a unit. It consisted of a di-pole aerial some 42mm long and formed as part of a pcb track with an ultra-high frequency diode across a gap in the middle of the aerial. Two inductors were formed as part of the pcb track, coming from each side of the diode, with a small value capacitor across the two inductor ends. A 250µA meter, in series with a limiting resistor, was then connected across the capacitor. It needed no power supply since any microwave leakage would generate sufficient current to drive the meter directly.

C.P. Finn, Beverley

Thanks, I assume you mean something like this

Ed.



ELECTRONIC SMOG

Dear Ed,

Barry Fox's article dealing with 'electronic smog' (PE Sept 88) is timely although the problem is not new. One might also include high voltage ac railway electrification as another offender.

I did not, however, understand the comment that a motor or welder has zero resistance at the moment of switch-on. Surely resistance is a physical property of the conductors and is always present? The in-rush current depends upon the source impedance of the supply and the resistance and reactance of the motor. The latter is complex but is low at standstill, hence the high current, and increases as the motor speed rises. In the case of welders I think the real problem arises from the electromagnetic energy associated with the welding arc.

Finally, let us not forget the effect of mains spikes on components leading to breakdown.

M.W.Burnby, Wirksworth, Derby

Mr Burnby is right of course. I was using shorthand. At the moment of switch-on there is an almost complete short circuit across the supply because resistance is almost zilch - then reactance and inductance take over.

I appreciate helpful comments like this - it keeps journalists like me on our toes.

Barry Fox

SANTA COPS IT

Dear Ed,

I must thank you for the relief you have given to the thousands of electronics enthusiasts who might become professionals. I believe that the most wonderful Christmas present for the people I speak for is your diy oscilloscope - it's a dream come true. We were like trained policemen who were only given pen and paper to take complaints from the public but who were never allowed to go out and investigate.

With your scope we will now be able to build circuits and investigate them, finding out what really goes on inside. You have broken down a barrier on the road towards professionalism. Bless you.

S.Oleghe, Wandsworth.

This is the sort of reaction that I had hoped to provoke - creating greater enthusiasm among less experienced readers by showing them how to gain visual knowledge of circuit responses, but without too much expense.

Ed

Barry Fox, in *Leading Edge* of PE Jan 89, reported on the imminent arrival of the second generation of cordless telephones, the so-called CT2 generation. Keith Clarke of British Telecom Research Laboratories obliquely referred to CT2 in part one of *Home Automation* last month. "The expectation is", he said, "that in the future the customer will have a stylised personal communicator which will operate to any of a large number of receivers and transmitters". The concept of which he spoke, in fact encompasses personalised transceivers not only of the CT2 genus, but also those of CT3 and beyond. CT2, though, has now been officially announced and, by the time this report is published, should be at the mass production stage. It will shortly be available to domestic consumers, and to all potential operators of the telepoint networks which will be installed in the UK during 1989. A powerful advantage of CT2 technology is that base stations can be installed quickly and cheaply in virtually any location, in public places, at the office or at home.

TELEPOINTING THE FORUM WAY

By Michael Strassen

The British are scoring points with CT2, a lighter, simpler access-only version of the poserphone. There are five to win in the PE competition, too.

BACKGROUND

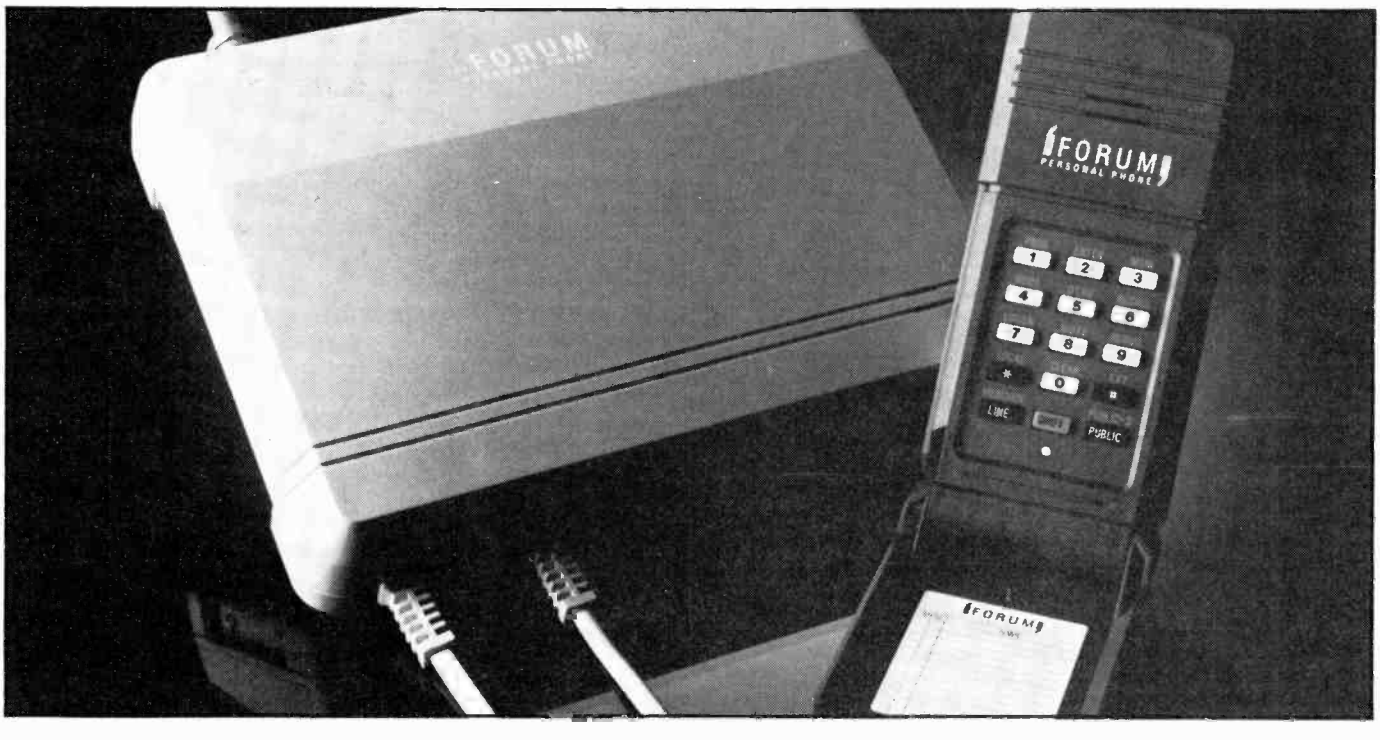
Personal communicators of the cordless telephone variety have been around for some time, falling into two basic categories: those of the conventional type immortalised in the BBC tv series *"Bread"*, and the cellular phone variety. As a quick recap, *"Bread"* phones have a low-power two-way radio in the handset and, using analogue techniques, communicate with a mains powered base station plugged into the user's own telephone line. The range varies from around 50 metres indoors, to at best 1km outside. Cellular phones also use a radio link, but communicate with commercial base stations at which computers handle the call routing to mobile targets throughout most of Britain.

This first generation technology, CT1, is subject to interference and suffers from low speech quality which gradually falls off even further as the user starts to move away from the base station. CT1 also has an inherent lack of security, through operating on a fixed frequency with only eight channels available, and being open to eavesdropping by unauthorised listeners.

CT2 is being implemented under the general name of telepoint and offers an inherently more secure mode of operation, using digitally coded techniques. The telepoint concept consists of a network of public base stations linked into the public switched telephone network. Subscribers will be able to access the network using personal pocket sized cordless phone handsets. The intention is to liberally scatter the base stations at strategic places around the country. Locations may be as diverse as railway stations, shopping centres, restaurants and service stations. It is also possible to purchase one's own station for domestic or office installation.

ROVING ACCESS

Although the system is intended for roving use, it is not a mobile phone as such. The user must remain within the locality of a base station, the public versions of which do not allow handsets to receive incoming calls. Besides which, unlike the cellular phone network, there is no central computing system which can search out the locality of a given receiver. However, because it is basically only an outgoing system, the circuit design is much simpler, and the handsets can be far lighter.



To dial into the national and international telephone network the user simply stands within range of a telepoint, typically around 200 yards, switches on the handset, enters a personal identification number (PIN) and keys in the appropriate telephone number. The telepoint will check that each handset's unique code number corresponds to the user's PIN, so ensuring that no unauthorised use can be made of the system and that calls are correctly allocated for subsequent billing. As an additional safeguard, subscribers will receive fully itemised bills - similar to the use of credit cards in this respect. Calls will be charged at the normal telephone rates. Although there will be additional subscription charges, the tariffs will be considerably lower than those for cellular services.

The technology is totally British, and the UK is the first entrant to this communications field. There are four licence holders in the scheme, consisting of BT/STC, Mercury/Shaye, Ferranti, and a group including Philips, Barclays and Shell. Shaye Communications is the company who have designed and developed the first of the CT2 handsets and base stations for the telepoint network. Shaye grew out of a laboratory set up by Sir Clive Sinclair (whose entrepreneurial endeavours are much admired by PE).

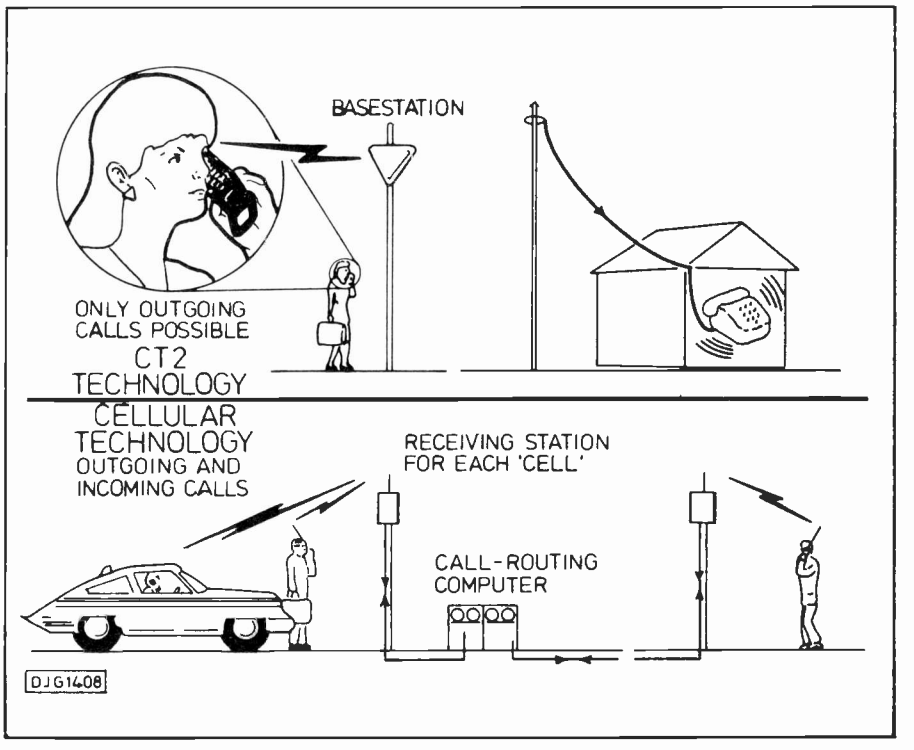
FORUM HANDSETS

Known as the Forum, Shaye's handset weighs just 130 grams, around the same as popular calculators, and contains an integral aerial. It communicates via the telepoint network and complies with the common air interface (CAI) standard for CT2 systems. This standard defines the radio interface between equipment produced by different manufacturers and allows interworking of products.

Operating in the 864 to 868 MHz spectrum, the Forum phone offers excellent speech quality with no degradation as the caller moves toward the speech range extremity. Interference is further limited and security improved by the fact that the phone is frequency-agile and selects the best available channel out of a range of 40 each time a call is made.

The handset fits easily into the pocket and offers up to 50 hours of continuous speech from a replaceable long-life lithium cell. Alternatively, the user may opt for a rechargeable nickel-cadmium battery used in conjunction with the Shaye nicad battery recharger.

To make a call once you are within range of a telepoint station, switch on the handset by opening the flap which conceals the keypad when the phone is not in operation. Select an appropriate telepoint network (customers can subscribe to more than one network) which will ask for your PIN. Enter the number, then key in the telephone numbers, make the call, and on completion, close the flap.



If you have a Forum personal base unit plugged permanently into a standard telecom wall socket at home or the office, calls can be made or received in exactly the same way as existing cordless phones operate. In the office the personal base unit can be connected to either a direct line or pabx exchange line. For outgoing calls the handset is operated in the same way as if you were using a public telepoint station. With the Forum you can also receive incoming calls via the personal base station. If the handset rings, indicating an incoming call, pick up the handset, open the flap and respond as normal.

FORUM HANDSET FACTS

Dimensions	143.5 x 61 x 2mm maximum
Weight incl lithium battery	130gms
Construction	Injection moulded abs
Controls	15-key silicone rubber keypad
	Flap operated on/off switch
	Flap release button
Transducers	Moving coil earpiece
	Electret microphone
Range	Up to 200 metres
Power source	Replaceable lithium cell or rechargeable battery pack
Supply voltage	3.6V nominal
Battery life	Dependent on use pattern, typically 6 months in domestic use using lithium cell, and 6 weeks in business environment

STANDARD FORUM FEATURES

Pushbutton digit dialling.
Memory storage of 12 x 22 digit numbers.
Last number redial.
User selection of loop disconnect of dtmf signalling.
User selection of telephone service provider (BT or Mercury).
User selection of telepoint service provider.
Call transfer.
Intercom through suitably equipped base unit.
Mute.
Memory retention during battery change.
Inbuilt protection against recharging a non-rechargeable battery.
Reverse battery polarity protection.
Low battery indicator.

INFORUMATION

The Forum Personal Phone and the Forum domestic base unit will retail at £150 each, plus vat. Both will be available through multiple retailers and other outlets. For further information please contact Shaye Communications, Capital House, 48-52 Andover Road, Winchester, Hampshire SO23 7BH. Tel: 0962 55925, or Jonathan Simnett/Isabel Robertson, A Plus Public Relations on 0753 686655.

FORUM FOR ALL

Shaye's chief executive, Bill Jeffrey, comments, "For the first time the consumer will be able to have a single telephone that is personal to them, one which they will be able to take with them at all times and use in the home, in the office and when they are out and about."

"The Forum personal phone is", Bill Jeffrey continues, "the smallest, lightest, and most truly portable cordless telephone developed to date, one that will change the face of personal communication in the next decade." PE

WIN YOUR OWN FORUM

Now you've read about the Forum, enter the PE competition and stand the chance to win one of five handsets. You could be one of the first owners of this hi-tech personal communicator. See page 61.

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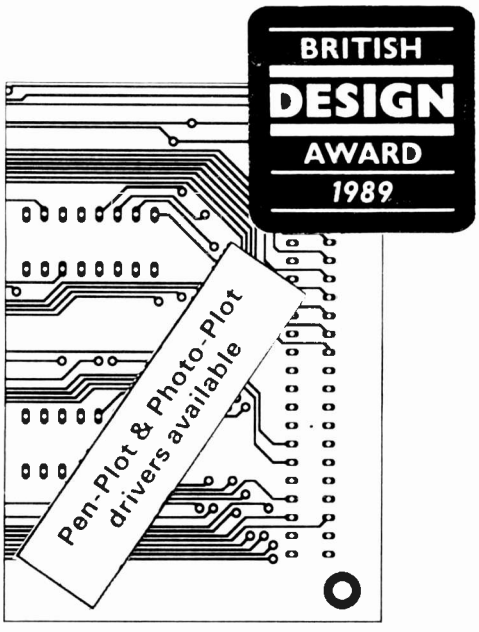

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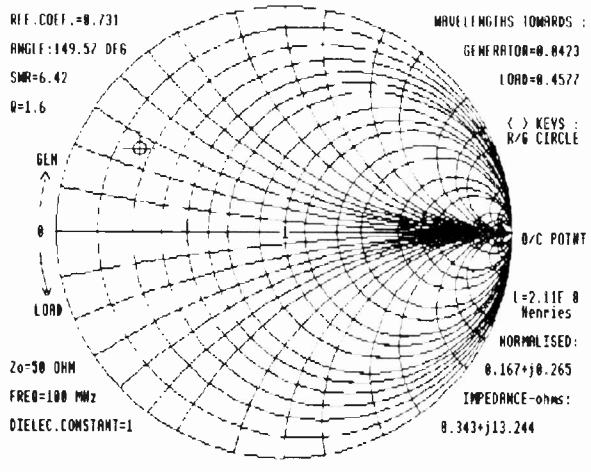

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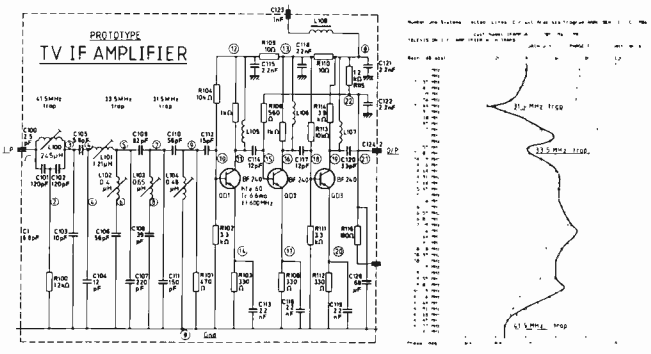

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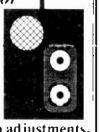

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INDUSTRY NOTEBOOK

MUSICAL CHAIRS

BY TOM IVALL

The frenetic takeover and merger activity among the electronics giants at the moment is not as counter-productive as may at first appear. New pathways to development may open – if it all works out.

By the time you read this the Monopolies and Mergers Commission may have made a decision on whether to allow a proposed takeover of Plessey to go ahead. The 'predators', as the newspapers call them, are GEC and Siemens of West Germany, who would set up a joint company for the purpose.

All this started to happen last November, and you may have been wondering why I haven't mentioned it before, considering that such a massive re-grouping would be highly significant to the whole UK electron-ics industry. Well, I was repeatedly frustrated by a whole series of new devel-opments affecting GEC. Several times, as I was poised with fingers over the keyboard ready to write a report, something else would happen to change the whole picture.

Most important was a 'phantom bid' for GEC itself. This came from a company called Metsun, specially formed for the purpose by an international group of electronics/communications companies and bankers. Relying on certain rumblings of discontent from GEC shareholders, Metsun planned to acquire the group and dismember it into what it saw as a more efficient commercial deployment of operations.

As things turned out, GEC threw a defensive spanner into Metsun's works by announcing a tie-up with the American giant General Electric on several joint ventures to improve the two companies' competitiveness in European markets. Thus GEC became much less vulnerable, wedged supportively as it was between GE and Siemens, respectively the second and fourth biggest electrical/electronic companies in the world. Soon after this, a powerful member of the Metsun consortium, AT&T of America, withdrew from the takeover plan and the whole project collapsed.

You may remember that GEC once tried to take over Plessey on its own (see my report in the March 1986 issue). The main idea of GEC was to make itself bigger in the telecommunications equipment business and thereby achieve a better share of the world market. But this plan was vetoed by the Monopolies and Mergers Commission.

Subsequently, as I reported in February 1988, Plessey and GEC agreed to co-operate just on the manufacture and marketing of telecoms switching equipment, which is now largely electronic. This led to the formation of a joint-venture company called GEC-Plessey Telecommu-nications (GPT), which now has annual sales of over £1 billion and a foot in the US market through its subsidiary Stromberg-Carlson over there.

Well, GPT is now a major factor in the latest proposed takeover of Plessey. Siemens is already a big player in public telecom-munications networks (third largest in the world), switching systems and components, but not, apparently, big enough to go it alone. "The opening up of the telecommunications markets" it said recently "will lead to a world-wide struggle between competitors to force one another out of the market."

Like GEC, Siemens doesn't want to rely on maintaining its world market share in telecoms by internal expansion alone. The R&D costs necessary for keeping abreast of competitors are a very great financial burden for a single company. So collabora-tion with another large concern seems to be the immediate answer. If the Plessey takeover did succeed, Siemens would have a 40% interest in GPT, while still keeping its own telecoms product line. GEC would acquire a 50% interest in Siemens' military electronics business. Thus each partner would get some access into the other's existing markets.

Other businesses in the two groups could well be involved if the takeover succeeded, for example medical equipment (already part of the GE-GEC deal) and semiconduc-tors. And this brings me to another significant change of ownership in the UK electronics industry. In the April 1988 issue I concentrated on the semiconductor field with particular emphasis on the uncertain future of Inmos, the firm responsible for the Transputer. I remarked "It's no secret that Thorn-EMI wants to sell Inmos" and "... this once bright hope of state enterprise will probably fall into foreign hands."

Well, sadly, this has in fact happened – or seems imminent at the present time of writing. Ironically, though, Inmos is probably going back to being a state-controlled business again – not British but French! The present UK government sold off its majority shareholding in Inmos to Thorn-EMI because it is against nationali-sation and believes that the British taxpayer should not be expected to support loss-making concerns. Thorn-EMI did some cost-cutting but was unable to get Inmos into a satisfactory state or profitability. It has now sold the vlsi company to the Thomson group, which is controlled by the French state.

To be more precise, the majority share-holding in Inmos will go to the holding company of SGS-Thomson Microelectron-ics BV, based in the Netherlands. This was formed last year when the Italian chip firm SGS was merged with the semiconductor business of Thomson. It seems that Thorn-EMI will continue to have a shareholding in Inmos but probably a small one.

Obviously there's something of an entente cordiale going on between Thorn-EMI and Thomson. You'll recall that it was Thomson to whom the UK company solid its Ferguson radio and television set making business not long ago.

So what is the reason for all these bids, mergers, takeovers, joint ventures and so on in the electronics industry? Why can't all these firms just settle down and get on with the job of making and selling electronics products without so much fuss about ownership?

The mere facts as outlined above don't explain very much. From a financial viewpoint it's obviously something to do with firms needing to maintain or improve market share and profits, and thereby satisfy their shareholders, in a very competitive environment. But saying this makes it sound like some autonomic process working on its own, a mere collection of blind reflexes. Nor does the financial explanation, which revolves around market value rather than use value, take account of the technology and its development. In a later report I hope to explore these questions more deeply, because conventional explanations only seem to deal with the "how" and not the "why". PE

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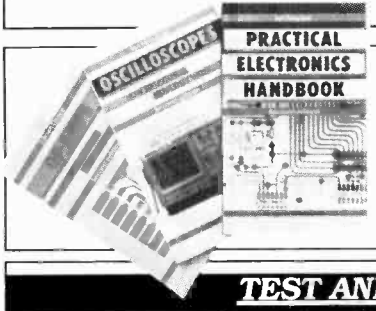

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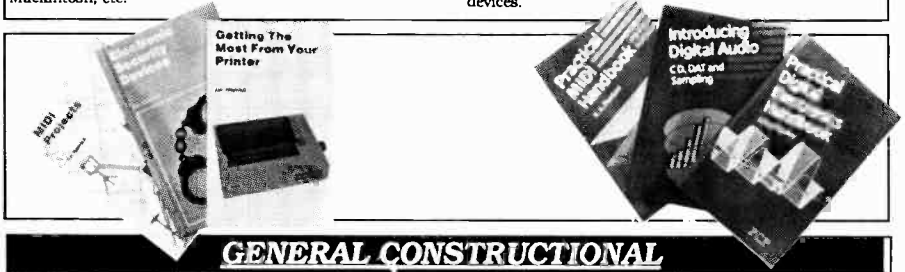

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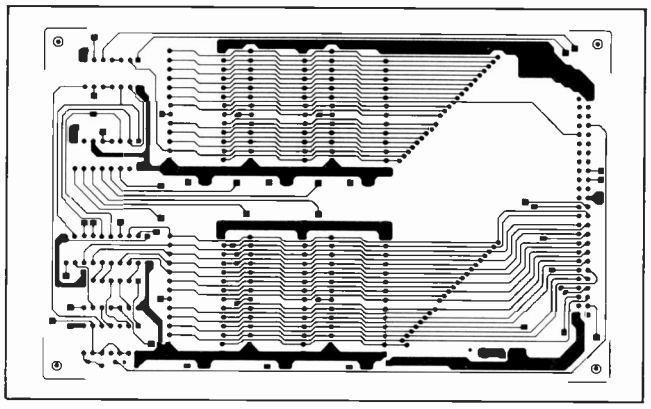

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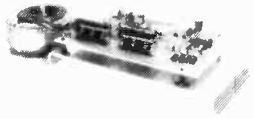

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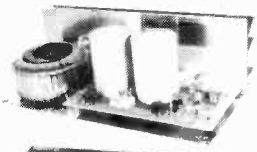

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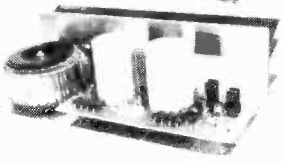

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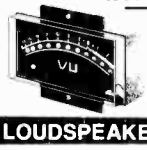

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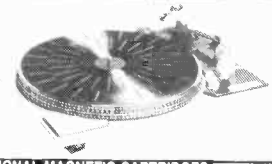

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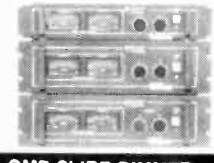

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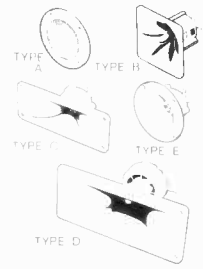

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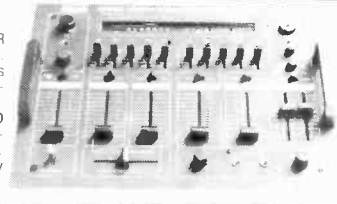

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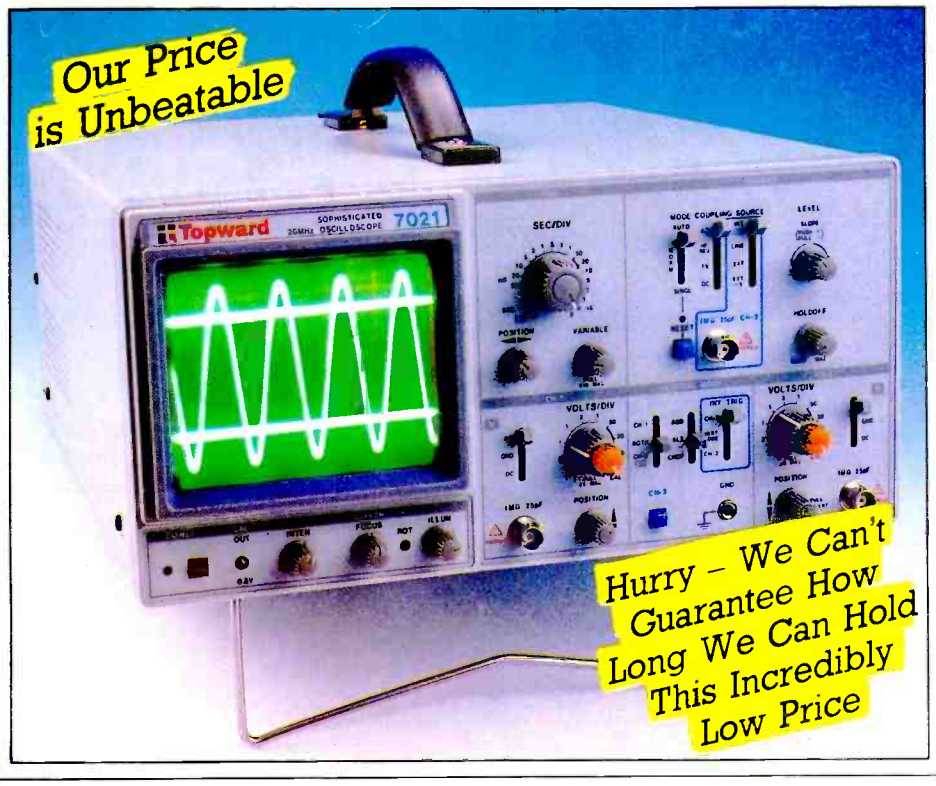
Superb Triple-Trace 20MHz Oscilloscope



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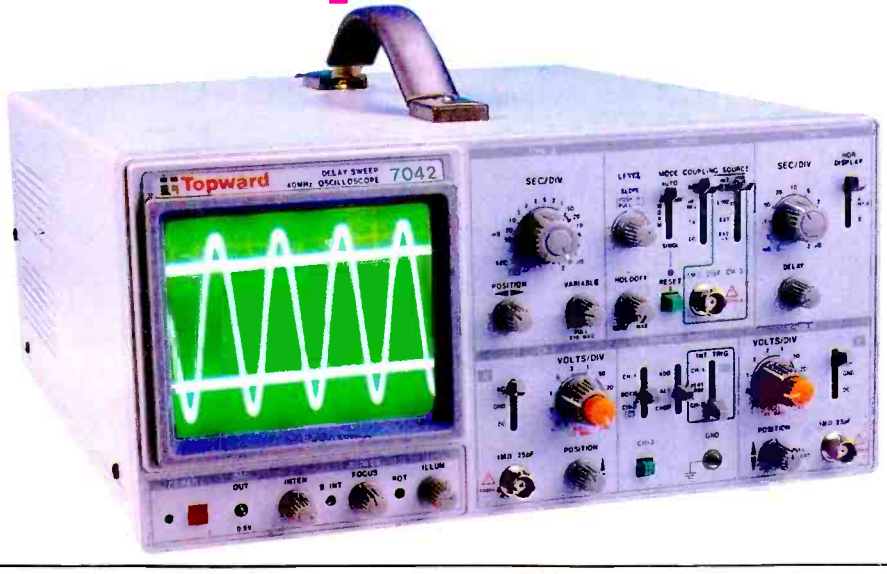

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