THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

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APRIL 1997 NO. 112
Best Value Electronics Monthly
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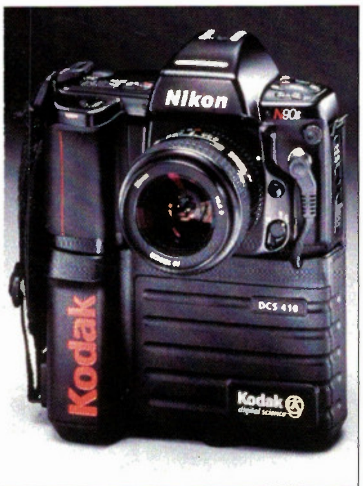
Digital Cameras – an Overview



Synchrolinking Video Recorders

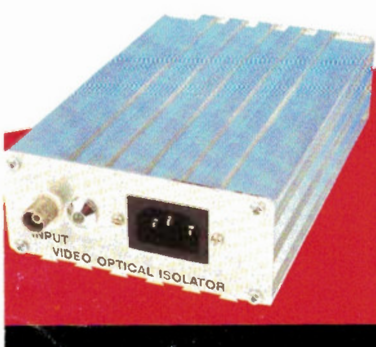
Top 40 Internet Tips – see inside for details

The Rosetta Mission

Chasing the comets

Mobile Data

The current state of play



PROJECTS FOR YOU TO MAKE

I/O Interface Card Video Optical Isolator
Bicycle Alarm Holtek Sound Generator Chip
Temperature Controller for Wine

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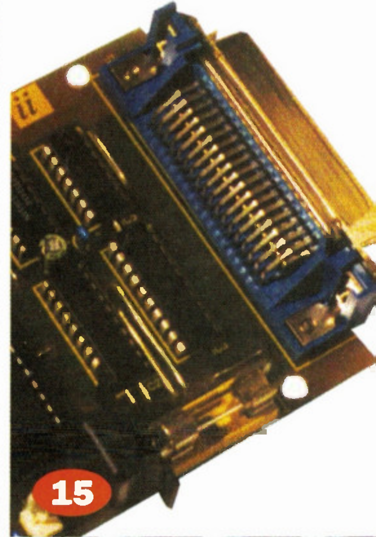
April 1997 Vol. 16 No. 112



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Safeguard your bicycle and its appendages with this inexpensive, easy-to-build and use Loop Alarm.

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ELECTRONICS and Beyond

Despite great advances made in digital camera technology we are not quite at the stage where the general public will turn to buy them as readily as buying a normal camera. Although reproduction quality is nearly there, the price is not acceptable and the infra structure to deal with any print conversion if necessary, is not in place. Professional photographers, particularly those associated with publications are making waves to buy at this point because of the ease of interfacing with Desk Top Publishing technology. This together with direct-to-plate printing technology for magazines and newspapers will eventually see the use of photographic film as 'a thing of the past' in this industry.

To mark the 25th anniversary of Maplin Electronics and the launch of our new Maplin MPS catalogue, out 1st March, we have launched a series of monthly crosswords. In the first one, to be found amongst these pages, we will be offering four prizes of £25 to the first four correct entries opened. You will need a copy of the catalogue to hand in order to answer all the questions. Good Luck!

Paul Freeman-Sear, Publishing Manager

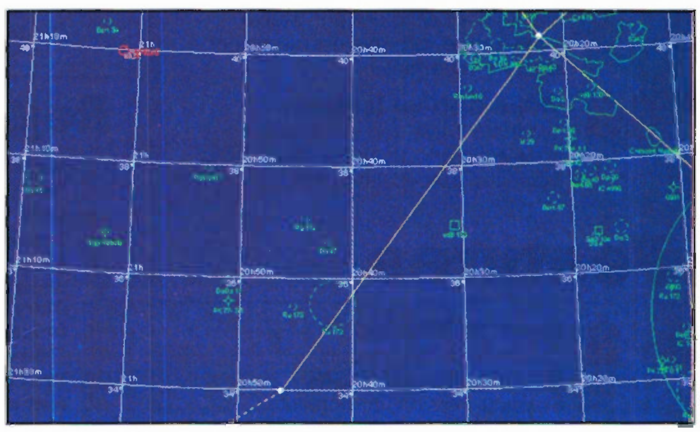
NEWS REPORT

Savacentre Invests £500,000 to Target Customers

Savacentre has installed an IBM RS/6000 SP mainframe at its head office in Wokingham, Berkshire. The RS/6000 system will run online transaction processing (OLTP) software to identify and track consumer purchasing patterns which will be used to develop and run more targeted Savacentre sales promotion activities. The data-warehousing project, which went live in July, will enable Savacentre to react quickly to customer trends.

Bob Jones, business development manager at Savacentre, told *Electronics and Beyond*, "Almost half a million customers visit our twelve UK stores every week. Being able to exploit information on customer purchasing patterns is vital to maintaining our competitive edge. We are already seeing the benefits of more cost-effective direct mail activity because our marketing team can now develop really targeted mail-shots using analysis carried out on the new mainframe." For further details, check: `http://www.ibm.com`.

Contact: IBM, Tel: (0171) 202 3000.



Explore the Sky with SkyMap

SkyMap is a Planetarium for the PC from The Thompson Partnership which allows users to explore the skies. By entering the latitude, longitude and any date from 4000BC to 8000AD, SkyMap will then give a view of the planets and deep space objects in the sky for that date.

Using a mouse, users can quickly change view so that the sky can be observed looking north, south east or west. By zooming into an object, you can get further details including a tracking map annotated with dates to show you where the object will be in the sky at a particular time and its route. For example, you can find Jupiter in the night sky and accurately predict where to observe it in 7, 14 or 21 days time.

SkyMap costs around £35.00 and runs under Windows '95.

For further details and an evaluation copy of SkyMap, check: `http://www.ttp.co.uk/news.htm#skymap`.

Contact: The Thompson Partnership, Tel: (01889) 564601.

Cut-price Portable Add-ons

Portable Add-ons has added two cut-price PC Cards from New Media to its range of portable peripheral solutions. The BASICS SCSI Adapter enables up to seven SCSI devices to a portable PC, while the BASIC Gameport allows the user to connect joysticks, gamepads, steering wheels and paddles to a laptop. The BASICS SCII Adapter and Gameport retails at £99 and £96, respectively.

For further details, check: **http://www.portable.co.uk**.

Contact: Portable Add-ons, Tel: (01483) 24133.

Compaq to Launch Home Super PC

Compaq has revealed plans for a new range of Presario multimedia home PCs that it says will out-perform and out-spec all competitive products. The range is to be launched in the UK in February '97. The new Presario line will include the latest Pentium processors with MMX technology, and a host of enhanced features.

Compaq says that the new PCs with MMX technology will offer 20% more processing power, 15% more memory performance, and one of the fastest CD-ROM speeds in the industry. To optimise Intel's MMX technology, the new Presario range will include Sync DRAM memory, 16x Max CD-ROM drives and Pro Sound.

For further details, check: **http://www.compaq.com**.

Contact: Compaq, Tel: (0181) 332 3000.

Hitachi Leads Single Electron Memory Research Consortium

A new European collaboration aims to push forward the pace of the research and development of single electron semiconductor memories.

A team of researchers from Hitachi Europe's Cambridge Laboratory and the Microelectronics Research Centre at the Cavendish Laboratory, Cambridge, have joined laboratories from France, Germany and Greece. The project is being funded by the European Programme for Collaborative Research (ESPRIT).

The project, 'Fabrication and Architecture of Single Electron Memories', will continue for three years with funding of £2.8million. It will complement the research work which Hitachi is already undertaking into Single Electron Logic under the sponsorship of the Japanese Ministry of International Trade and Industry.

Hitachi believes that participation in the European project will lead to an acceleration of the research towards future memory chips. This could have vast potential for applications in computer, communications and other electronic systems.

For further details, check: http://www.hitachi.com.

Contact: Hitachi, Tel: (01628) 585000.

Quarterdeck Makes CleanSweep

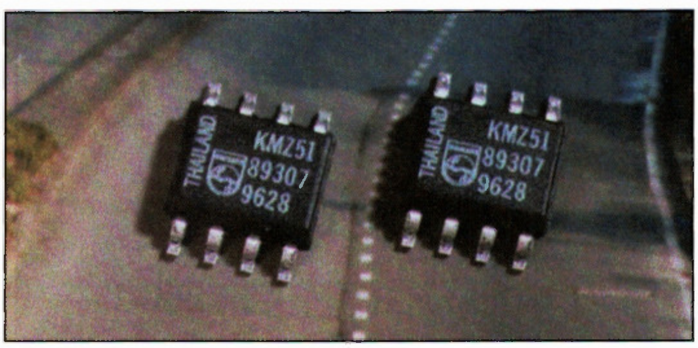
Quarterdeck has launched CleanSweep 3.0, a software application which frees up valuable hard disk space by removing unwanted programs and by quickly finding and removing duplicate files, redundant DLLs, orphaned files and infrequently used files on Windows 3.1, Windows '95 and Windows NT 3.51 and 4.0. Automated wizards determine which files are clogging up the user's system, then guide the user through the cleanup process.

CleanSweep 3.0 also features a new application knowledge base containing the program files and configuration entries for more than 1,000 applications.

CleanSweep 3.0 is now available in all good retail stores at a recommended retail price of £39.99.

For further details, check: **http://www.quarterdeck.com**.

Contact: Quarterdeck, Tel: (0645) 123521.



Sensitive Sensor Simplifies System Design

Philips Semiconductors' latest magneto-resistive sensor with integrated compensation coils is sensitive enough to distinguish different types of vehicle in a traffic detection system. By eliminating the need for external coils, the KMZ51 sensor simplifies system design in applications requiring the measurement of weak magnetic fields, allowing the inherent sensitivity, stability and high accuracy of the magneto-resistive effect to be cost-effectively exploited.

For further details, check: **http://www-eu.philips.com**.

Contact: Philips Semiconductors, Tel: +31 40 272 20 91.

Toshiba Cuts Prices and Launches New Machines

Toshiba has cut notebook prices by up to 10%. The price reductions coincide with the launch of the new Tecra 730XCDT and Tecra 740CDT, which are the first portable PCs to integrate the Intel Pentium Processor with MMX Technology.

Murray McKerlie, product marketing manager at Toshiba, told *Electronics and Beyond*, "Our product strategy is to make leading-edge technology more affordable and accessible to a broader audience. As a volume manufacturer of notebook PCs and components, we are able to pass on the benefits of economies of scale to our customers in the form of an aggressive pricing strategy".

For further details, check: http://www.toshiba.com.

Contact: Toshiba, Tel: (01932) 828828.

Psion Dacom Deals Winning Cards to Nokia

Nokia Mobile Phones and Psion Dacom has announced a co-operation agreement which makes two of Europe's most successful product lines – Psion Dacom's Gold Card Series and the Nokia GSM phones – compatible.

Nokia and Psion Dacom consider this co-operation significant in the further development of GSM data applications. Under the licensing agreement, Psion Dacom's Gold Card multifunction and GSM cards will become compatible with the digital Nokia GSM and PCN handsets.

Nokia digital phone users will, therefore, benefit from access to multifunction cards and existing Psion Dacom Gold Card users can be upgraded via flash memory to support Nokia phones.

For further details, check: **http://www.psiondacom.com**.

Contact: Psion Dacom, Tel: (01908) 261686.

Canterbury Christchurch College Goes Direct to Dan

Canterbury Christchurch College has turned to Dan Technology to equip its new £2 million dedicated computing centre. In an order worth around £150,000, the 8,000-student college has been kitted out with Pentium PCs from the London-based direct PC vendor. Each of the networked machines is loaded with Microsoft Office applications, a web browser, and e-mail client.

For further details, check: http://www.dan.co.uk.

Contact: Dan Technology, Tel: (0181) 830 1100.

Rockwell Licenses ARM

Rockwell Semiconductor Systems has become the seventeenth company to license Advanced RISC Machines' (ARM) RISC microprocessor technology. This partnership will enable Rockwell to incorporate ARM's high-performance, low-system cost, low-power RISC CPU cores into its communications semiconductor systems.

Building on the ARM technology, Rockwell can expedite its expansion into new product areas, including wireless platforms and digital information and entertainment solutions, as well as high-density central site modem systems for Internet access using Rockwell's recently announced K56Plus technology.

Dwight Decker, president of Rockwell Semiconductor Systems, told *Electronics and Beyond*, "Rockwell selected ARM's RISC technology because of its industry leading price, performance and power efficiency. Embedded 32-bit ARM RISC controllers are a key enabler of Rockwell's diversification into new communications areas".

For further details, check: **http://www.arm.com**.

Contact: ARM, Tel: (01223) 400400.

Faster Modem Speeds in a Flash

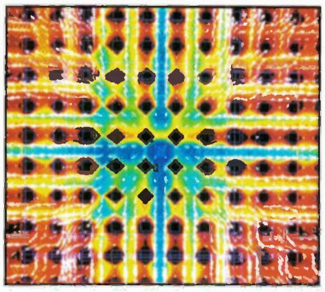
US Robotics, the UK modem market leader has launched the Sportster Flash modem which is flash upgradeable to its high-speed x2 56k-bps technology. x2 enables Internet and online connections at speeds nearly twice as fast as those currently available over standard telephone lines.

The Sportster Flash is the first Sportster modem to have flash memory, which has been a feature of the company's high-end Courier modems for several years. Those buying the new modem can register for an x2 upgrade and receive it free of charge, via a software upgrade from US Robotics' bulletin board in February 1997. The modem's flash memory also enables future firmware upgrades as new technologies become available.

In addition to the flash upgrade capability, the new Sportster has all of the user features of the current Sportster Voice 33.6. These include fax, personal voice mail with multiple mailboxes, hands-free speakerphone, remote voice message and fax retrieval, and fax-on-demand. To use the voice features including the hands-free telephone function, requires the addition of a headset, a powered speaker or a soundcard.

For further details, check: http://www.usr.co.uk.

Contact: US Robotics, Tel: (01734) 228200.



Flotherm Aids Mainframe Development

Sequent Computer Systems has used Flotherm thermal management software from Flomerics in the development of its Intel-based NUMA-Q mainframe to provide early predictions of air distribution and component temperature.

Sequent claim that the use of Flotherm, thermal management software enabled it to develop the new system three months ahead of time without undertaking any type of prototyping or laboratory work.

Sequent used Flotherm to determine the cooling requirements of the system's powerful Quad processor card, which features four Pentium Pro microprocessors with up to 4G-byte memory. A key aspect of the thermal design was the use of impingement cooling, with air jets blowing directly onto pin-fin heat sinks attached to processor devices in places of conventional forced air cooling.

For further details, check: **http://www.flomerics.com**.

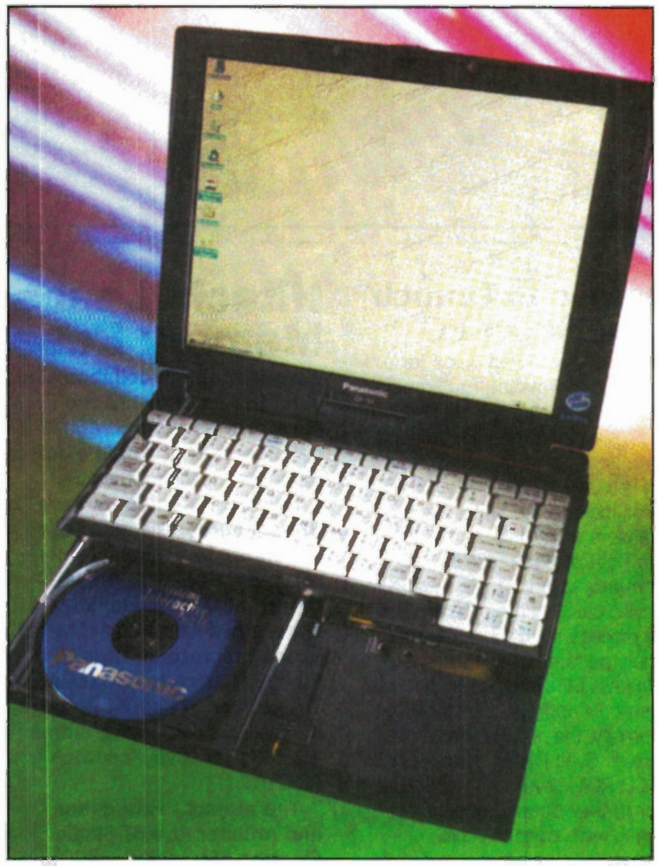
Contact: Flomerics, Tel: (0181) 941 8810.

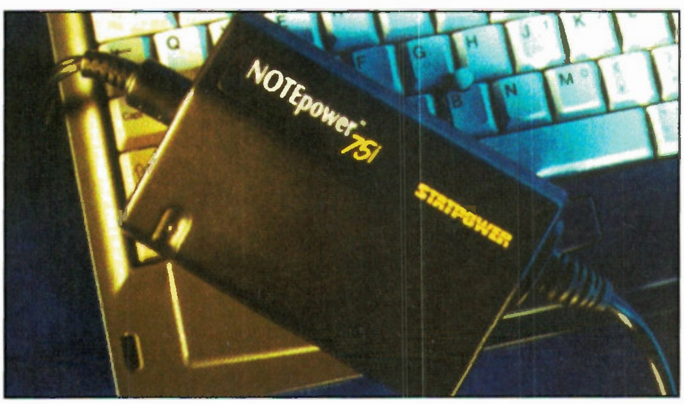
Panasonic Extends Multimedia Range

Panasonic has extended its range of multimedia notebooks with the release of the CF-61. Features include an 8-speed CD-ROM, 12·1in. TFT colour screen, 16M-byte EDO RAM, 1·35G-byte hard disk, built-in 16-bit sound card, 32-bit PCI bus architecture and a high-speed infrared (IrDA) port. The CF-61 is available in 120MHz and 150MHz versions, priced at around £4,200 and £5,200, respectively.

For further details, check: **http://www.panasonic.co.uk**.

Contact: Panasonic, Tel: (01344) 853550.





Portable Power from a Matchbox

Mobile computer users can now recharge the batteries in their PDA or laptop from a car battery using an inverter from Merlin. The NOTEpower 75i allows users to run and recharge mobile computing equipment by silently converting a car's 12V battery power into mains electricity.

NOTEpower is supplied with a cigarette lighter socket plug to enable connection from within a vehicle to the battery supply. The mains equivalent output is fed to the computer's own power supply brick using the standard cable.

Merlin, with its innovative use of rectifier electronics means that NOTEpower is over 90% efficient. The device is expected to retail for approximately £100.

Contact: Merlin, Tel: (01491) 824333.

Apple Announces Dual Operating System Strategy

Apple Computer says that for the next few years, it will pursue a two-pronged strategy, offering machines that run both its existing Macintosh System 7 operating system and its new NeXT-based system, code-named Rhapsody.

Chief technology officer, Ellen Hancock, has promised existing Mac users that support for System 7 will continue for the next several years. The new line of machines is necessary because the NeXT-based system won't run on any of the existing Macs, including those using the popular Motorola 680x0 line of chips. It will, however, run on Intel-based computers now using Windows '95 and Windows.

For further details, check: **http://www.apple.com**.

Contact: Apple, Tel: (0181) 569 1199.

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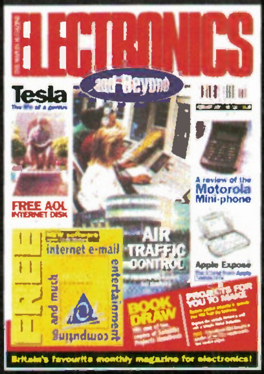

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THURROCK RETAIL PARK

Maplin Electronics PLC require forward thinking, ambitious staff to help us transform the face of Electronic component retailing. Our new Superstore, based on the prestigious Lakeside, Thurrock retail park, opens for business shortly and will need a full complement of motivated staff, trained and ready to provide the highest standards of customer care. Our success is dependant on your ability to promote the quality products and service that have established Maplin at the leading edge of Electronic component supply and we want to hear from people who have the skills and experience to support this exciting concept and can meet the criteria for the following vacancies:

TEAM LEADERS
Technical

Applicants must be able to demonstrate a clear understanding of the elements that are required to manage a fast-moving, profitable specialist department. An electronics qualification, such as an HNC, or two years supervisory experience, preferably in a retail/electronics environment, coupled with good communication skills, cheerful personality and determination are essential ingredients.

There are three distinct specialist areas and your area of interest should be indicated on your application:

Sound and Vision
Specialist Electronics: Components
Computer: Accessories and Networking

SALES ASSISTANTS
Technical/General

We also require people with an interest/qualification in electronics and/or retail experience to undertake duties consistent with the efficient running of a high turnover store. Staff will work in teams with specific areas of responsibility and your ability to satisfy customer needs and promote a welcoming atmosphere is important. Posts are available on a full-time, part-time and weekends only basis.

Applications from experienced non-technical retailers are also welcome.

Successful candidates will receive a period of basic training combined with further opportunities for personal development. We can offer an excellent reward package including staff discount on personal purchases and a uniform is supplied.

Interested applicants should write to:

Elaine Chapman, Human Resources Department,
Maplin House, 274-288 London Road,
Hadleigh, Benfleet, Essex SS7 2DE.

Please specify the post you are applying for.

Applications should contain sufficient information about qualifications, experience, personal qualities, etc. to enable us to short list candidates for interview, to be held at Maplin House, Hadleigh, Essex.

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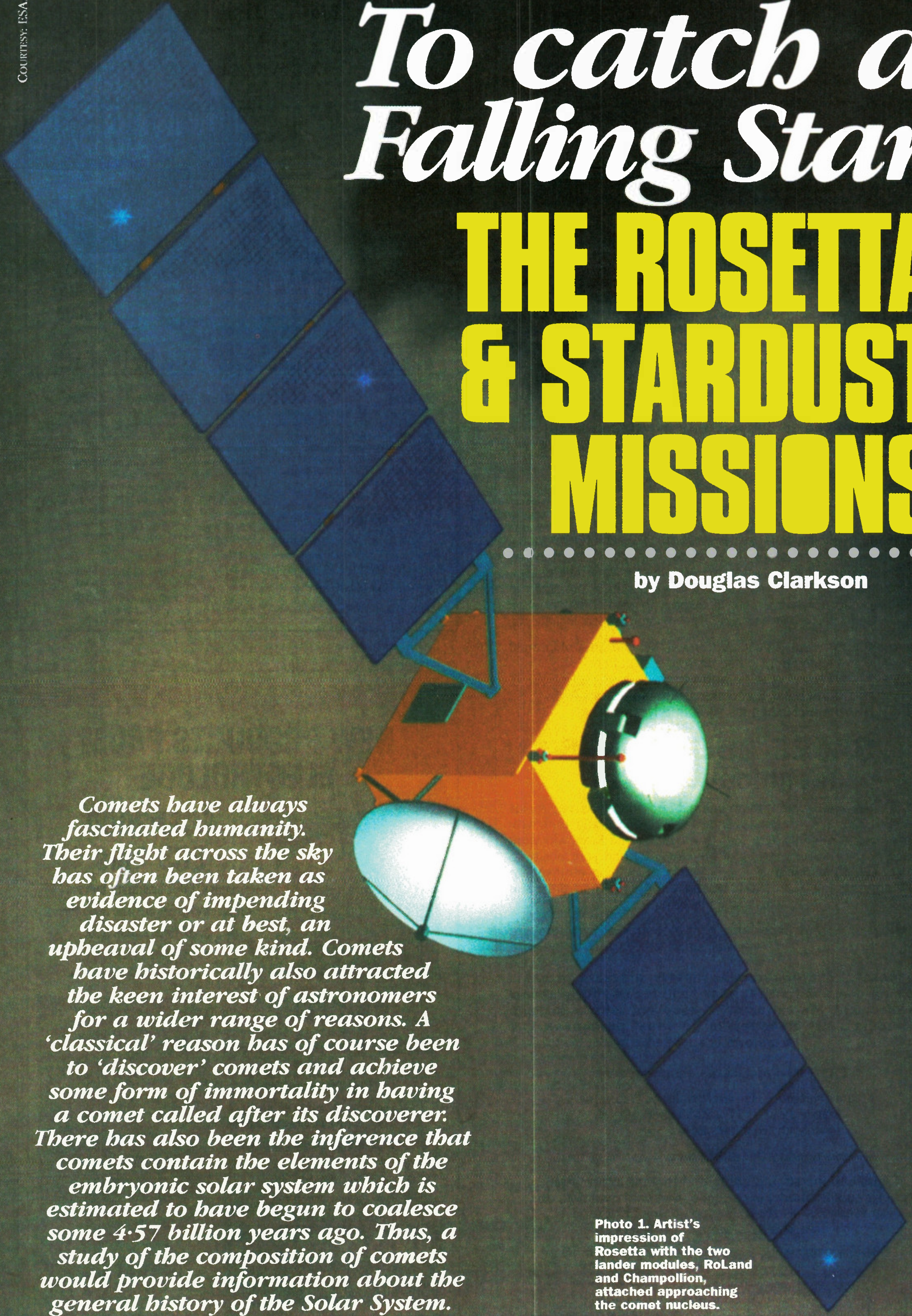
To catch a Falling Star

THE ROSETTA & STARDUST MISSIONS

by Douglas Clarkson



Comets have always fascinated humanity. Their flight across the sky has often been taken as evidence of impending disaster or at best, an upheaval of some kind. Comets have historically also attracted the keen interest of astronomers for a wider range of reasons. A 'classical' reason has of course been to 'discover' comets and achieve some form of immortality in having a comet called after its discoverer. There has also been the inference that comets contain the elements of the embryonic solar system which is estimated to have begun to coalesce some 4·57 billion years ago. Thus, a study of the composition of comets would provide information about the general history of the Solar System.

Photo 1. Artist's impression of Rosetta with the two lander modules, RoLand and Champollion, attached approaching the comet nucleus.

In 1986, the fly-bys of Comet Halley by the Giotto, Vega, Sagigake and Suesi probes added a considerable body of information to the study of comets in general. Also, the Giotto Extended Mission to P/Grigg-Skjellerup in July 1992 provided additional sets of valuable data.

More recently, however, as the emission spectra from these bodies can be extensively analysed by systems such as the Infra Red Space Observatory (ISO), the evidence present of complex organic molecules may indicate that comets play a key role in the development of life on systems generally as they may have the potential to 'seed' vital compounds on planets. Also, the Hubble Space Telescope allows comets to be observed in greater detail and initially at greater distances from the sun.

Space scientists in Europe and the USA have firmly set their sights on missions to unravel the secrets of comets. In this article, the progress of the mainly European Rosetta mission and NASA's Stardust mission will be described in some detail. It is relevant at this point, however, to consider in greater detail some of the possible origins of comets.

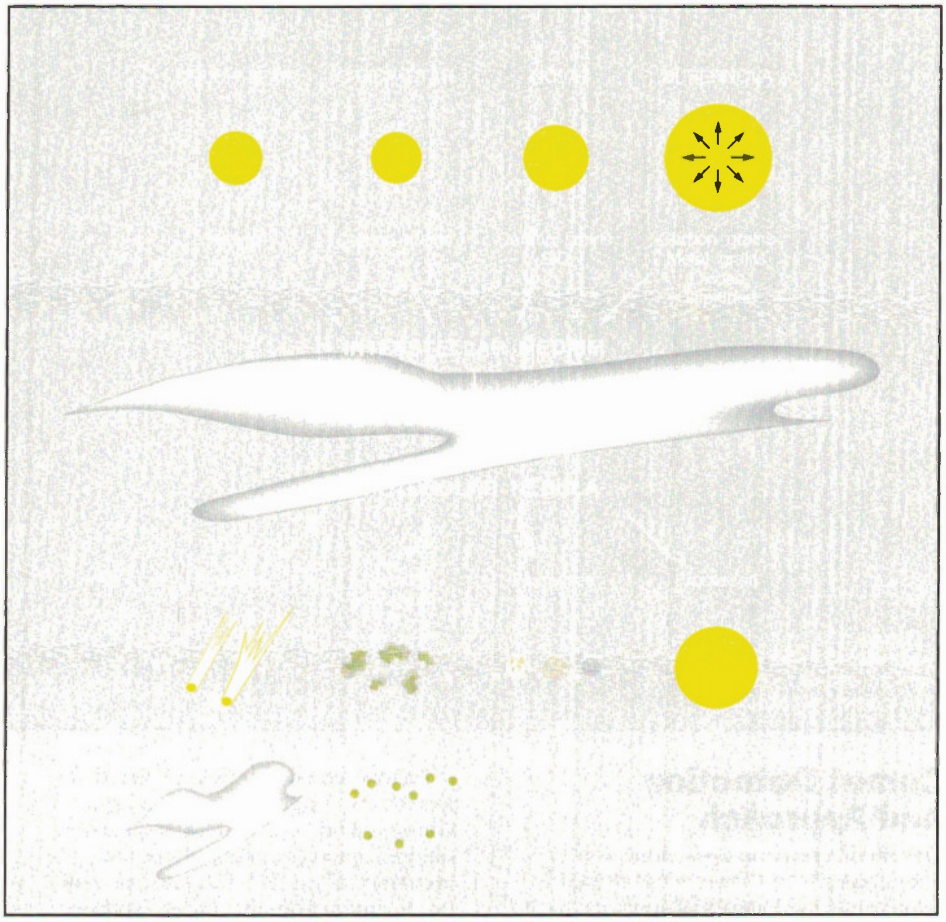
History of Circumstellar Dust Grains

The material which aggregates together to form comets is thought to be at least as old as the material that initially formed the major planets of the Solar System and so a study of their chemical composition is like reading the history of its earliest days. There is particular interest in obtaining data from comets which have suffered minimal cycles of sublimation due to close approach to the sun.

It is thought that the material of comets collects from a range of contributions. Stars can be considered to be stellar 'factories' that during their various evolutionary phases, release matter into the interstellar medium. Thus, oxygen-rich stars can contribute Silicates, Carbon-rich stars can contribute Carbon. Supernova explosions can contribute Carbon grains, metal grains, oxides and sulphides.

Images from the Infra-red Space Observatory (ISO) confirm the outwards distribution of diverse elements at various phases of stellar evolution. Interactions with molecular clouds and protosolar nebula are also active to produce physical elements that can appear in structures which include comets, asteroids, planets and of course, stars. Grains of material created before the birth of our own sun are likely to be found within the core of 'fresh' comets. This 'recycling' of physical matter is summarised in Figure 1. As the Universe becomes older, however, physical matter will increasingly take the form of elements of higher Atomic number.

In some ways, the material forming the planets in our Solar System and presumably, elsewhere, is akin to a fossil remnant of previous phases of stellar evolution. Comets are considered, however, to reflect the representative form of matter before it became subject to the various stages of processing within the Solar System. Cosmic dust is considered to originate from comets as, like a leaking pepper pot, they spread the sublimated particulate material from their tails.



Courtesy: ESA.

Rosetta Takes Shape

The relative degree of success of the fly-by missions such as Giotto occurred at a time when ESA and NASA were studying a 'Comet-Nucleus Sample-Return mission' to land a probe on a comet and recover samples from it to Earth for extensive analysis. The project, subsequently called the Rosetta Mission, would derive benefit from the combined resources of NASA and ESA, both in the development of the probe and in the mission control facilities.

Funding difficulties within NASA, however, forced a re-assessment of the mission objectives. The challenge of capturing cometary nucleus material and recovering it to Earth with the limitations of thermal and mechanical stresses presented a major scientific and technological challenge that exceeded allocated funding. The aspect of 'sample and return' was to become 'sample and report' by direct landing of probes on a comet and telemetry of data to Earth. The project would essentially become an ESA venture but with input from key participating groups in the USA. The various constraints of the mission included the use of solar power, the use of an Ariane launch vehicle and the use of ground stations belonging to ESA member states.

The initial mission scenario had been to investigate the comet Scwassman-Wachman 3 for a rendezvous in June 2008. The increase in the layload of Rosetta, however, indicated a longer mission to utilise an additional Earth gravity assist. As a compensation, however, the scientific data is increased with the fly-by of two asteroids.

From this revised starting point, a range of mission scenarios was identified. Key variables included the use of an Ariane 5 rocket and various planetary gravity assist manoeuvres, such as Mars/Earth or Venus/Earth/Earth. This planning stage indicated that a range of missions was possible which would allow interception of comets of interest or even allow close encounters with more than one object.

Figure 2 indicates the currently favoured mission scenario for Rosetta. Like a 'pinball' gallery, the craft would initially be launched, experience a Mars gravity assist, then an Earth gravity assist, then a second Earth gravity assist to put the craft into an orbit to match that of the Wirtanen comet. As a bonus, a fly-by of the asteroid Mimistrobel would also be achieved before the second Earth gravity assist. Also, a fly-by of the asteroid Rodari or Siwa would be achieved prior to the final rendezvous with the comet. Table 1 summarises the properties of the comet Wirtanen.

Period:	5·5 years
Perihelion:	1·08 AU
Aphelion:	5·13 AU
Eccentricity:	0·6523
Inclination:	11·7
First apparition:	1947
Last apparition:	1991
Next near-Earth passage:	8/9/96

Details of size, mass, density, etc. of the comet are not known to any certain extent.

Table 1. Summary details of Rosetta target: comet Wirtanen.

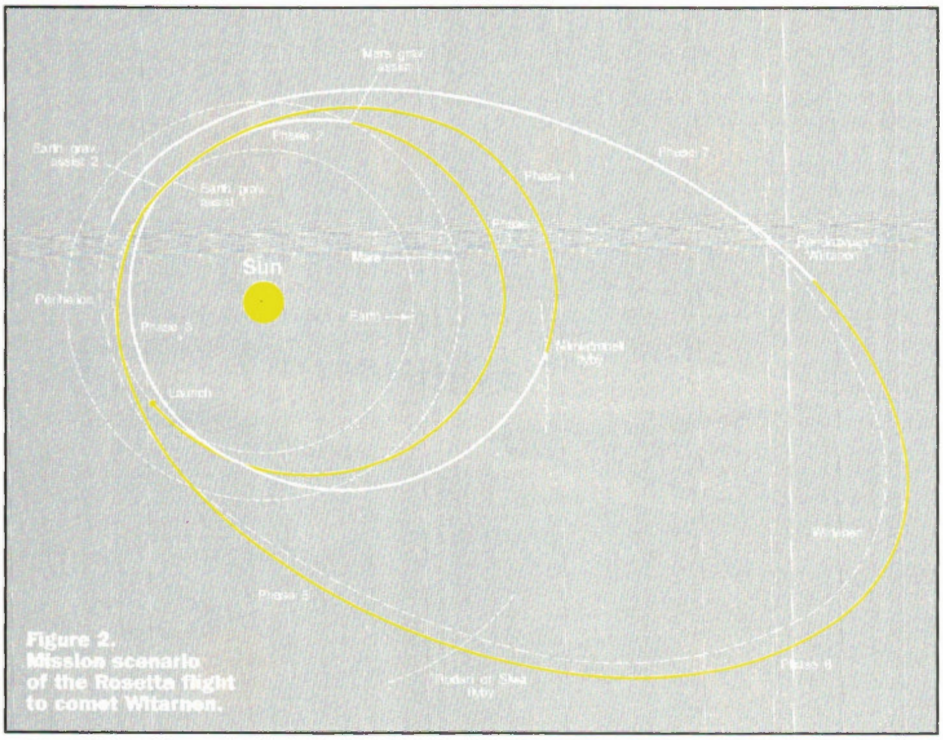


Figure 2. Mission scenario of the Rosetta flight to comet Witarnen.

Courtesy: ESA

Comet Detection and Approach

The alteration of the Rosetta mission to one of sample and observe has altered significantly the logistics of approach to the selected comet. Also, the dependence on purely European facilities places additional limitations on observational windows and does not allow critical near-nucleus operations to be undertaken at distances greater than 3·25AU (Astronomical Units). Also, the planned sizing of the solar array would not allow the payload to be operated at distances greater than 4·4AU.

It is planned that the relative velocity between Rosetta and the selected comet will be around 100m/s at a distance of 500,000km. It will take Rosetta approximately 60 days to approach the comet closely. At an approach distance of around 500km, the relative speed of Rosetta will be progressively reduced and the onboard narrow angle camera with a 3·5 × 3·5° field of view will seek to detect the motion of the comet against the fixed star background.

In addition, a wide angle camera will also be available to track the comet nucleus. An important phase of the observation with the narrow angle camera will be the determination of the possible tumbling and spin rate and phase of the nucleus of the comet. At the end of the observational phase, the comet will extend across 500 × 500 pixels of the narrow angle camera. It will also be possible to identify the spin rate of Rosetta by observing the motion of Rosetta against the fixed star background.

Mapping of Comet Body

It is proposed to essentially 'park' Rosetta in an orbit round the comet nucleus. The final parking orbit has yet to be determined, though it is anticipated that this will vary between 1 and 10km. This will then allow the surface of the comet nucleus to be observed closely for identification of possible sites for impaction of surface probes.

Factors required to be considered include the requirement to maintain constant illumination of the solar arrays, uninterrupted communications and avoidance of gas and dust jets that may be streaming from the nucleus surface.

Unlike Giotto's approach to Halley's comet where the fly past induced relative velocities of around 68km/sec, the relative velocity of particles emitted from the comet nucleus will only be a few metres per second and so Rosetta should not suffer damage from particles emitted from the comet's surface. There is, as ever, the risk of coming into contact with space debris from diverse sources.

Scientific Payloads

After a process of review of proposals for Rosetta payloads, two main modules which are intended to land on the surface have been provisionally approved in addition to the main orbiter payload.

The Champollion module is intended to land on the comet surface to undertake a short-term study (around one week) of the comet surface. This payload is named after Jean-Francois Champollion, who was able to produce the most extensive translation of the complex hieroglyphics of the Rosetta stone which was found in the vicinity of the town of Rosetta near Alexandria in mid-July 1799. After Egypt was invaded by Britain in 1801, the stone fell into British Hands and is currently held by the British Museum in London. The work of Champollion, who lived between 1790 and 1832, drew on original work conducted by the English Egyptologist, Thomas Young. Table 2 outlines the provisionally selected instruments for the Champollion lander. This lander is principally, therefore, a USA/France joint mission.

The key role of the Champollion lander is that of molecular and elemental determinations, since mineralogical and isotope measurements can more adequately be undertaken by the orbiter craft.

The other lander, RoLand (Rosetta Lander), will be designed principally by a range of European Institutes under the leadership of the Max Planck Institute and DLR in Germany and with participation from other centres, including that of Rutherford Appleton Laboratories in the UK. RoLand is intended to be a long-lived device that will be stationed on Rosetta for several months. This will provide data on how the comet behaves during different stages of its orbit round the sun. Table 3 summarises the provisionally selected instruments of the RoLand lander module.

The technology of chemical agent identification has rapidly progressed so that highly complex systems can now be implemented with great economy of space. Also, the upper design limit of 45kg for the mass of each lander and with a maximum scientific payload of 12·5kg is a severe constraint for the project design teams.

Short Name	Function	Main Country
CHAMPAGNE	Gamma ray emission analysis	France
CHARGE	Chemical analysis of released gases	USA
CIRCLE	Infra-red and camera lander experiment	USA
CPPP	Physical properties probe	USA
ISIS	In-situ imaging and spectroscopy	France
CONSERT	Comet nucleus sounding	France

Table 2. Summary of experiments of the short duration Champollion lander.

Short Name	Function	Main Country
APXS	d-p-X-ray spectrometer	Germany
COSAC	Cometary surface and sub-surface sampler and evolved gas analyser	Germany
MODULUS	Evolved gas analyser	UK
ROLIS	Imaging system	Germany
SESAME	Surface electrical, seismic and acoustic monitoring experiment, dust impact monitor	Germany, Finland, Hungary
MUPUS	Multi-purpose sensor for surface and sub-surface science	Germany
ROMAP	Magnetometer and plasma monitor	Germany, Hungary
CONSERT	Comet nucleus sounding	France

Table 3. Provisionally selected instruments of the RoLand lander module.

The Rosetta Orbiter

The Rosetta orbiter carries a more comprehensive set of experimental modules than the two landers RoLand and Champollion. The planned units are outlined in Table 4.

The MIDAS experiment, with its ability to capture and image – at the atomic scale – grains captured from the comet, is surely the first time it is planned to use this technology in space exploration. The change of mission objective certainly is to take the laboratory to the comet rather than take the comet to the laboratory.

One of the key problems of actually landing on a comet nucleus is that of contamination of instruments by the emission of volatile components. In particular, surfaces of optical equipment are likely to be most vulnerable. While some material will be lost due to dust emission, the relatively low density gas outflows should preserve the fragile structure of cometary grains which are intercepted by the orbiter craft.

A further phase of evaluation of experiments will be undertaken during 1997. A team of five senior interdisciplinary scientists has been commissioned over a three year period to support the implementation of the mission.

Figure 3 shows Rosetta in orbital configuration after deployment of the two lander modules.

Photo 1 shows an artist's impression of Rosetta with the two lander modules, RoLand and Champollion, attached approaching the comet nucleus. It is likely, however, that the design of the outer structure of RoLand and Champollion will progress through several design versions. Photo 2 shows the preliminary design of the lander RoLand.

The catch and approach phase of Rosetta comes at the end of a lengthy mission scenario that is summarised in Figure 4. During a significant part of the mission, Rosetta will be operated in hibernation mode.

The Stardust Mission

The Stardust mission is a solely NASA-based mission which is intended to be launched in February 1999 to rendezvous with the comet P/Wild 2 in January 2004 and with return to Earth with comet dust samples in January 2006. The Stardust mission was chosen from one of three contenders for the fourth component of NASA's Discovery class mission. The missions that 'lost out' were the Suess-Urey mission to collect samples of particle matter from the sun and the Venus Multi-Probe to study the circulation and the atmosphere of Venus. Key requirements of such 'Discovery' missions include good value for money, high chance of success and high scientific relevance. In total, Stardust will cost a total of $199.9 million.

The significantly increased interest in the whole question of cometary structures following the analysis of the meteorite ALH840001,0 that was discovered in the Antarctic confirms that the correct Discovery mission was selected. The comet P/Wild 2 was in part selected because it is known to be a 'fresh' comet after having been deflected from a more distant orbit by the gravitational attraction of Jupiter in 1974.

The Stardust mission is also looked upon as a 'dry run' for the Rosetta interception of 2112. The information obtained at the fly-by of Stardust should provide highly relevant data for the final approach of Rosetta some eight years later.

It is planned that Stardust will approach as close as 62 miles to P/Wild's nucleus. Samples of dust will be captured by aerogel surfaces (see Electronics, Issue 103). The capture process will make separate capture of cosmic dust and dust specifically obtained from the P/Wild 2 comet. The samples will be recovered to Earth in January 2006, with the return capsule landing by parachute on a dry Utah lake bed. Will the sample be microbiologically sterile? Table 5 summarises the properties of the Comet P/Wild2.

Short Name	Function	Main Country
ALICE	UV-spectrometry (70 to 205nm)	USA
VIRTIS	Visible and infra-red spectrometry (0·25-5μm)	Italy
MIRO	Microwave spectrometry (1·3 and 0·5mm)	USA
ROSINA	Neutral gas/ion mass spectroscopy	Switzerland
MODULUS	Isotopic ratios of light elements	UK
COSIMA	Dust mass spectrometer	Germany
MIDAS	Grain morphology (atomic force microscope)	Austria
CONSERT	Radio sounding, (Nucleus Tomography)	France
DFA	Dust velocity and impact momentum measurement	France
RPC	Plasma/Solar wind measurements	Sweden, USA, Germany, France

Table 4. Provisionally selected instruments of the Rosetta orbiter craft.

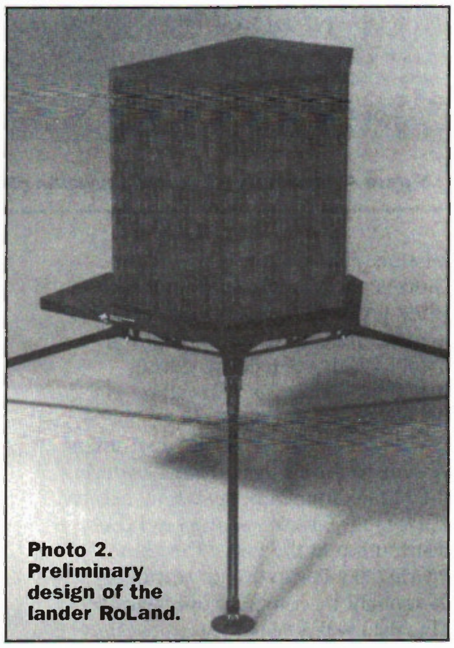


Photo 2. Preliminary design of the lander RoLand.

Courtesy: ESA.

Comets: The ESA Experience

The success of the initial Giotto mission to Halley's comet in March of 1986 was in itself a high point of achievement for the European Space Agency. The experience gained with the development, construction and control of the craft will certainly be of value in the development of the Rosetta

Period:	6·17 years
Perihelion:	1·491 AU
Semi-major axis:	3·44 AU
Eccentricity:	0·54
Inclination:	3·2

Table 5. Summary details of Stardust target: Comet P/Wild 2.

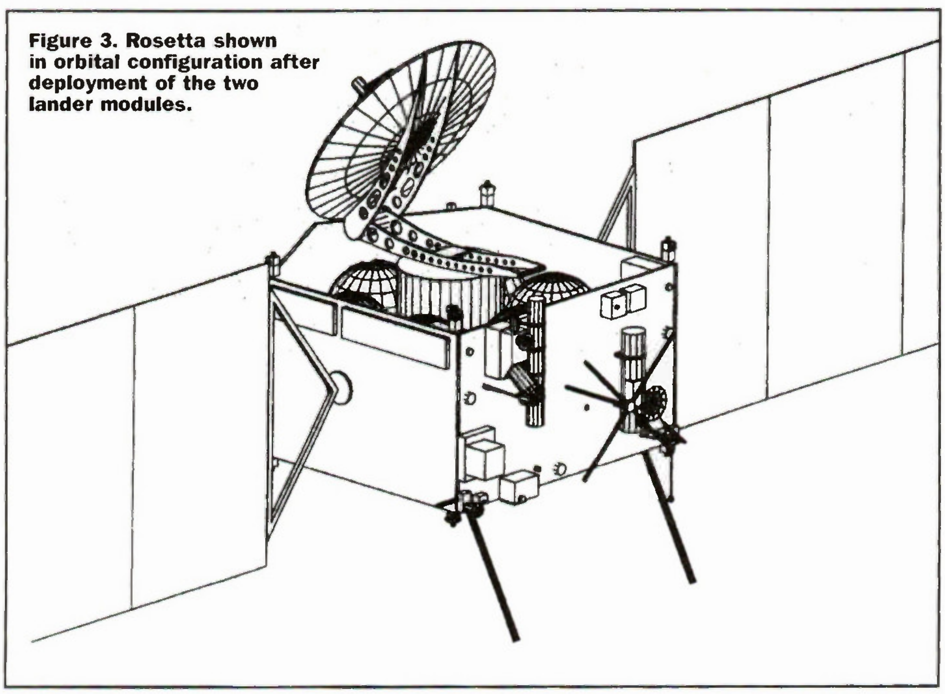
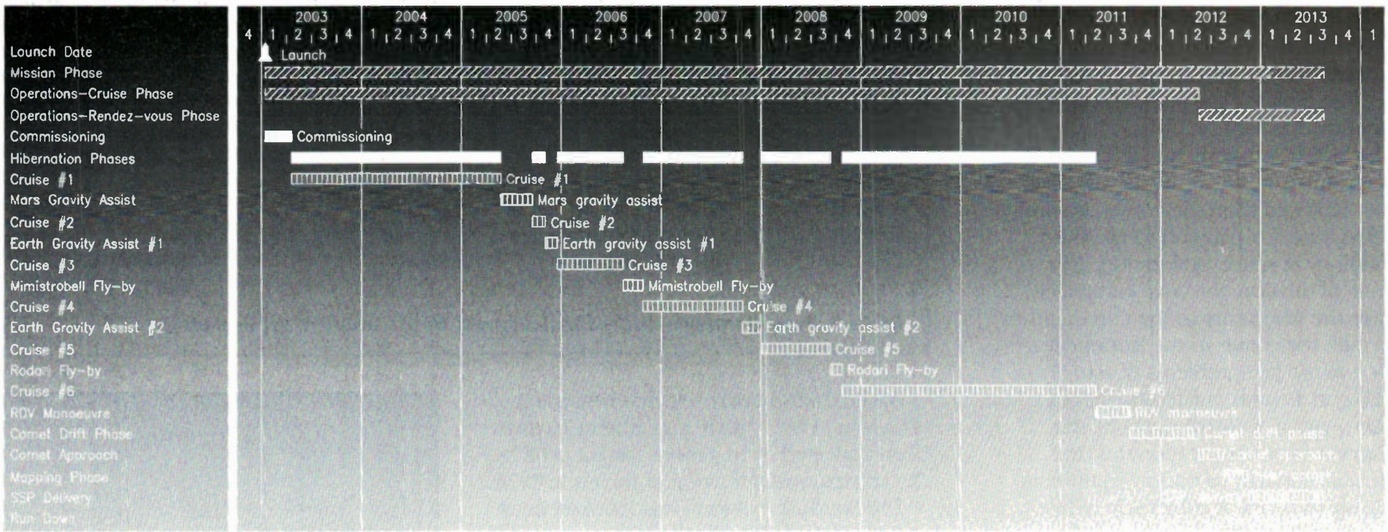


Figure 3. Rosetta shown in orbital configuration after deployment of the two lander modules.

Courtesy: ESA.



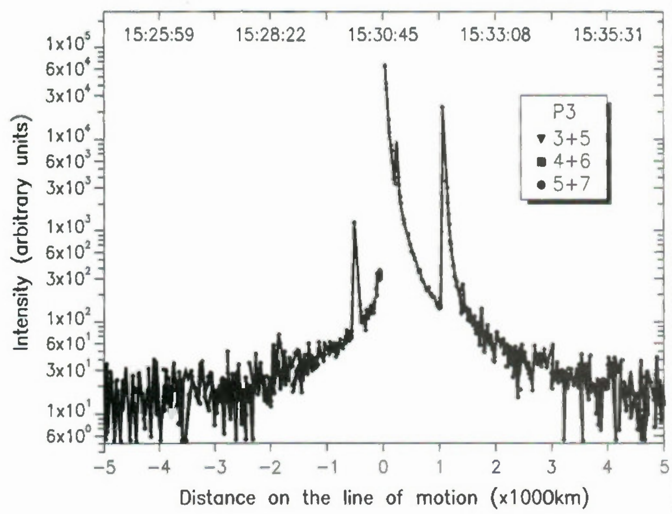
Courtesy: ESA.

Figure 4. Summary of Rosetta mission phases. The craft for a large part of its flight will be maintained in hibernation mode.

mission. Also, the resilience of the Giotto craft was further demonstrated when ground controllers succeeded in directing Giotto to intercept the comet P/Grigg-Skjellerup during July 1992 – some six years after the initial mission highlight.

While around 60% of the instrument systems survived the extreme battering, the Multicolour camera system, alas did not. Figure 5 indicates the brightness distribution in the tail of the comet P/Grigg-Skjellerup due to scattering of sunlight by cometary dust particles. This data was achieved at a closest approach estimated at less than 200km. The data indicates a missing data frame when the spacecraft was hit by a large dust particle.

Figure 5. Brightness distribution in the tail of the comet P/Grigg-Skjellerup due to scattering of sunlight by cometary dust particles, as detected by the Extended Giotto Mission.



Courtesy: ESA.

Options for an Extended Mission

While the immediate target of the Rosetta mission is to achieve the initial goals of landing plus post-landing observation, the planners must also be considering the possible extended phase of exploration. This relates to the orbiter craft and the RoLand lander. Initially after deployment, Rosetta will be approaching closer to the sun. An extended observation time may be possible before it becomes necessary to shut the orbiter and possibly Roland down, before the comet wings out to its Aphelion distance of 5·13 AU from the sun, where it will not be possible to be operated. The experience of the Giotto Extended Mission is, however, an indication of the resilience of such craft. The main difference between missions such as Giotto and Rosetta, however, is that Rosetta is intended to 'dock' with its chosen comet rather than rush past it at high speed of tens of km/sec. The local environment of the comet nucleus, however, may place uncertainty on how long the craft will remain fully operational, especially when it draws closer to the sun and becomes more unstable.

Summary

Comets probably exist in their various forms for countless millions of years. The experience of comet Wirtanen, however, is likely to be somewhat different as it is intercepted, probed, listened to and scanned in great detail. Missions such as Rosetta indicate how increasingly complex scientific tasks can be undertaken using intelligent analytical systems. The large sets of information which missions such as Rosetta and Stardust will hopefully provide scientists with new insights of the origin and development of the solar system.

Also, the function of the onboard instrumentation is likely to be reviewed in the light of the discovery of the Martian meteorite, ALH840001. Thus, while in the past in astronomy, decades might occur between the development of theory and the verification by experiment, in the 1990s, the pace of scientific unfoldment in astronomy is now significantly faster. In order to communicate this new stream of information to the world at large, it is just as important that adequate resources are put in place to achieve this goal also.

Further Information

ESA's Report to the 31st COSPAR Meeting, Birmingham, United Kingdom. The International Rosetta Mission, pp. 137-146.

ESA's Report to the 30th COSPAR Meeting, Hamburg, Germany. The Giotto Extended Mission, pp. 37-46.

Internet

Champollion Home Page via NASA (search Rosetta)
Discovery Program – Stardust Page via NASA (search Stardust)

Points of Contact

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Tel: 001 301 441 4197
(Contact David Williams for data on planetary science.)

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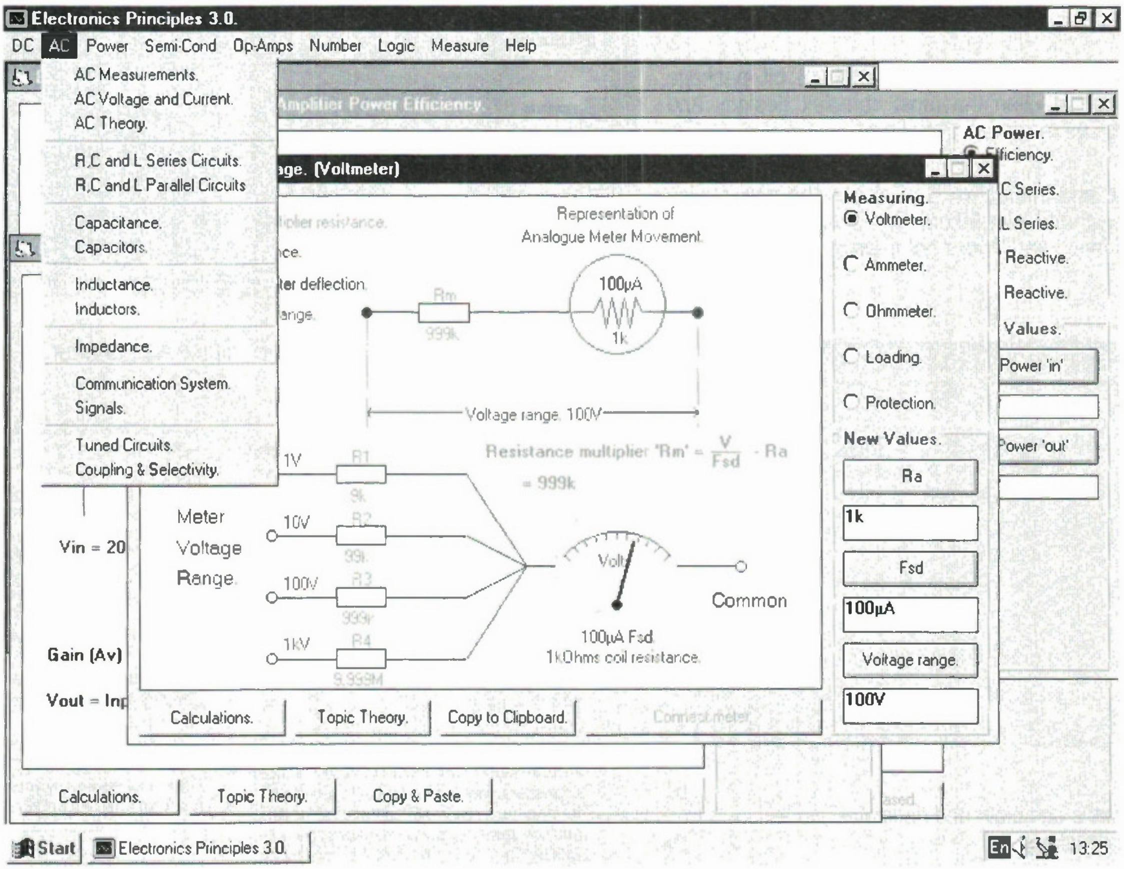

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PROJECT

Programmable CENTRONIC 24-LINE INPUT/OUTPUT CARD

PART 2

by Dr. Pei An

Dr. Pei An concludes this article, which describes a general-purpose programmable I/O card for computers. Part 1 of this project can be found in Issue 111.

Operation of the Card

The schematic of the card is given in Figure 6A and 6B. The DATA port of the Centronic port sends data from the Centronic port to the I/O card. The STATUS port reads data from the card. The CONTROL port controls reading and writing operations of the 8255 PPI.

Data transfer is facilitated by IC2 and IC3 (74LS241 and 74LS244 tri-state buffers). The control of the 8255 PPI is made by IC4 and IC5 (74LS365 tri-stage buffers and 74LS02 NOR IC). It can be seen from Figure 6 that two lines of the CONTROL port (Pins 31 and 36) are connected to the address lines A0 and A1 of the 8255 PPI via IC4, which is a tri-state Hex buffer IC.

The other two lines of the CONTROL port (Pins 1 and 14) are connected to –RD and –WR of the 8255 via IC4. The two inputs of the 74LS02 NOR gate (Pins 2 and 3) are connected to the two control lines from the Centronic port (Pins 1 and 14) and its output is connected to the ENABLE of IC4 (Pins 1 and 15 of the 74LS365 IC). When the two lines from the Control port are both low, the output of the NOR gate will go high. This will disable all the buffers on the 74LS365 IC and set all the outputs at high impedance state and the two resistors R1 and R2 pull up the –RD and –WR lines high.

To write data to an 8255 register, firstly the required data is written to the Data port and an address to the Control port, then a high-to-low-then-high pulse is issued from -WR line of the Control port. This will enable buffers on IC3 and the data on the inputs of IC3 will be transferred to the 8255 data bus. The –WR low-going pulse will also write the data into the selected register.

Reading data from the 8255 is slightly complicated, since the Centronic port only has five input lines and in order to read an 8-bit data into the computer, the computer has to read at least twice. This is accomplished by IC2 (74LS241). 74LS241 is a tri-state octal buffer IC and its pin-out function is shown in Figure 5(b).

It can be seen that when pin 1 (the 1st enable) is low, the 4 left hand side buffers work (i.e. the outputs follow the inputs). When pin 19 (the 2nd enable) goes high, the 4 right hand

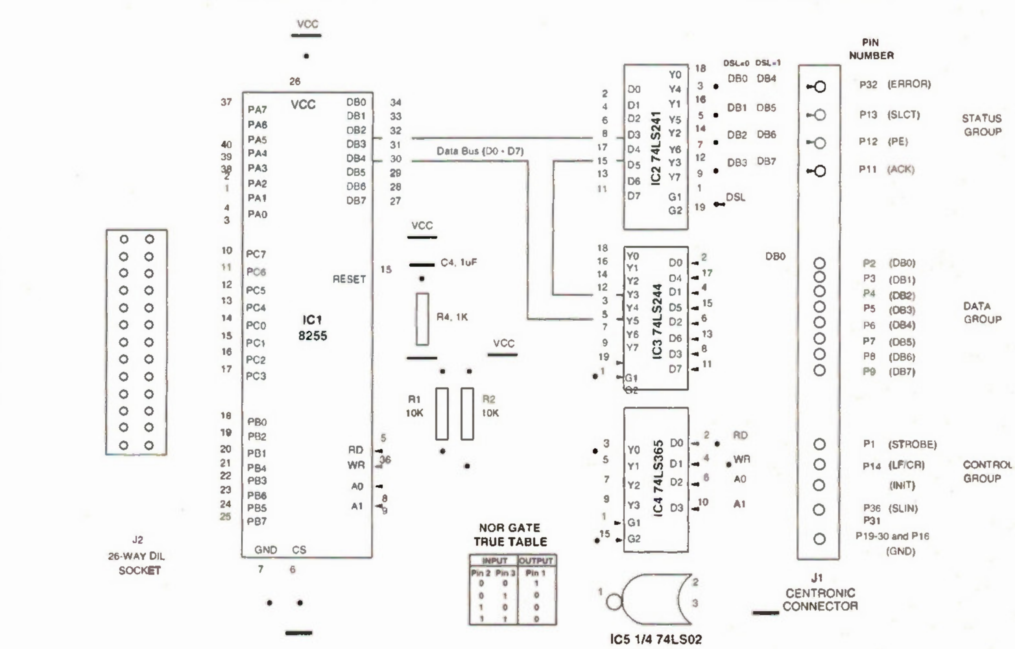
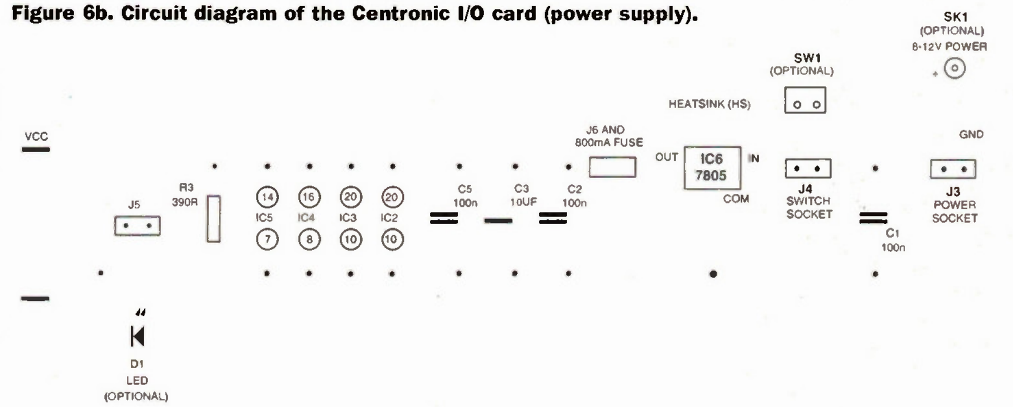


Figure 6a. Circuit diagram of the Centronic I/O card (main circuit).

Figure 6b. Circuit diagram of the Centronic I/O card (power supply).



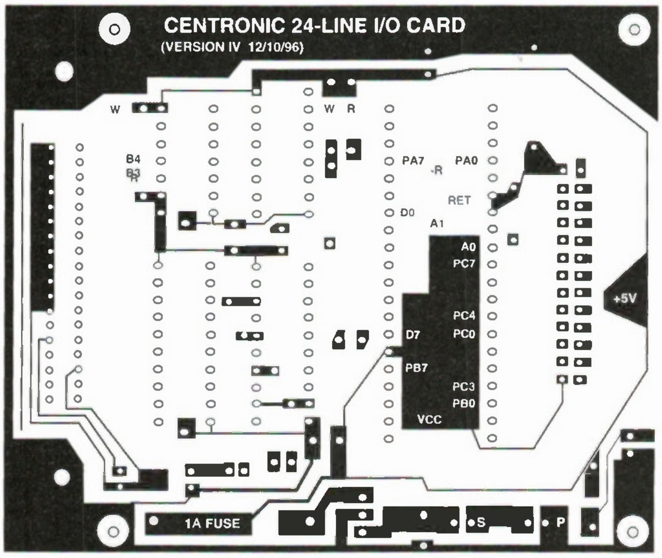


Figure 7. PCB track.

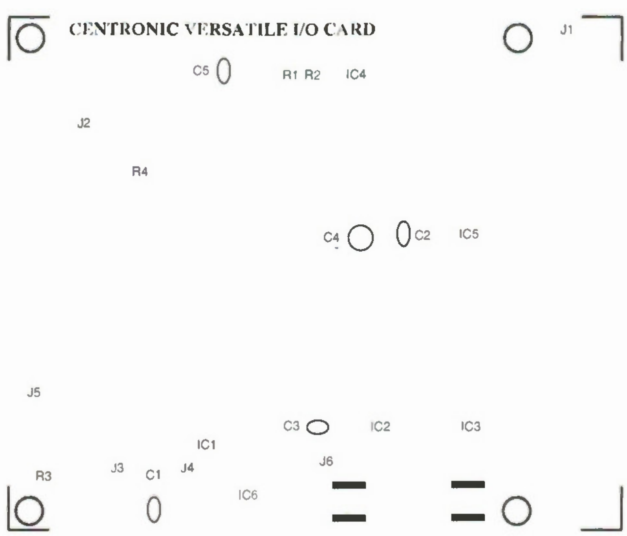


Figure 8. PCB legend.

side buffers will work. If Pin 1 and Pin 19 are connected together to form a Data Selection Line (DSL) and by putting the line low and then high, the Status port can read the 4 bits connected to the left hand buffers and the other 4 bits connected to the right hand buffers, in turn.

These two readings are then bit-manipulated and combined to form a single 8-bit byte. Operating in such a manner, the 8-bit data appearing on the input lines of IC1 can be read into the Centronic port. Referring to Figure 6A, the DSL line is controlled by the first (LSB) bit of the Data port of the Centronic port (DB0). When reading data from an 8255 register, firstly an address (A0 and A1) is written to the Control port and -RD line is held low. This will make the 8255 PPI output data onto its data bus, DB0 to DB7. Then the DSL line is set low and the Status port reads the first reading. The Status port reads the second reading with the DSL line held high. Those two readings are then combined to reproduce the original data.

The card consumes about 100mA and incorporates a 7805 1A 5V regulator. An external 8-12V DC supply is required. The regulated 5V power supply is also supplied to the expansion socket which can be used by other external circuits. An 800mA onboard fuse is used to limit the total consumed current. If 74HCT series chips are used, the current consumed by the card can be reduced. The schematic of the power supply circuit is shown in Figure 6B.

Construction

This I/O card is constructed on a single-sided PCB. The artwork of the PCB is given in Figure 7 and the component layout is shown in Figure 8. Components may be mounted on the board in the following order: links, resistors, DIL IC sockets, capacitors, electrolytic capacitors, PCB connectors, voltage regulators, Centronix female connector, fuse holders, 26-way DIL sockets and finally, the ICs. It is suggested that IC sockets are used for all the ICs.

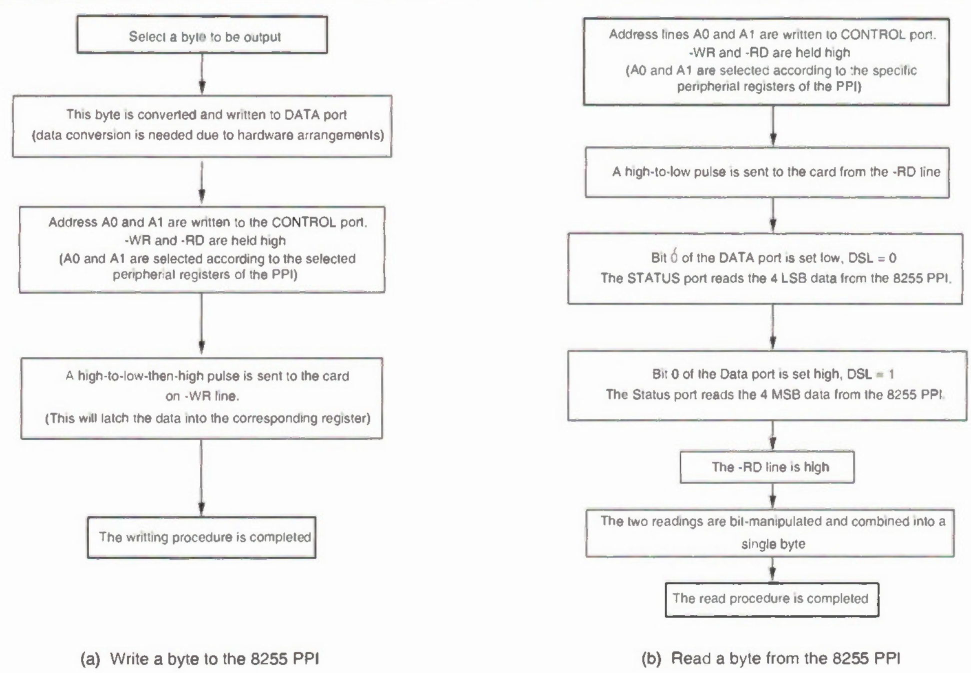
Testing

After soldering, check all the joints and connections to make sure there are no shorts due to excess solder. Only connect the power supply once you have made sure that the board is properly constructed. Since the card is simple to construct and involves no adjustment at all, it should work straight away if all the ICs are OK and properly located in position. To test the output of the ports, connect the card to the Centronic port via the printer cable and run the Demo program (which will configure all the 24 lines as outputs). A logic tester described in Application 5 (Integrated driver ICs) can be used for testing the logic level of the outputs. If a logic generator is at hand, the input function of the ports can be tested as well. However, in this case, the program needs a slight change. When testing the card, readers should be familiar with the pin functions of the 26-way expansion socket (see Figure 1) and know the configuration of the ports. It should be pointed out that connecting a logic output to an output of the 8255 may cause permanent damage to the PPI chip.

Programming

A demonstration program of the card is written in Turbo Pascal 6. The program consists of two operations: writing data and reading data from the card. The flow charts of the two operations are shown in Figures 9(a) and 9(b).

To use the card, first of all, the 8255 PPI should be initialised by writing a suitable control word to the control register. After this, data can be written to or read from peripheral registers. The procedures of writing and reading are discussed in detail below.



(a) Write a byte to the 8255 PPI

(b) Read a byte from the 8255 PPI

Figure 9. Procedures for writing data to and reading data from the I/O card.

When writing data to an 8255 register, the required data is firstly written to the Data port, then the address is written to the Control port to specify a particular register with the other two lines of the Control port set high. Next, a high-to-low-then-high pulse is sent to the 8255 via –WR line of the Control port. This will write the data into the register. It should be noted that we can only write data to the control register and peripheral registers with their corresponding ports configured as output ports. Due to the fact that the data lines of the Centronic port are not connected to that of the 8255 PPI in the same order (Figure 6A), the actual data sent to the 8255 PPI must be converted before output from the Centronic port.

To read data from the card, the following procedure is required (see Figure 9(b)). Firstly, an address (A0 & A1) is written to the Control port with the other two lines of the Control port (–WR and –RD) set high, then a high-to-low pulse is supplied to –RD line. This makes the 8255 to put data to its data bus. Next, the DB0 of the Data port is set low (DSL = 0) and the Status port of the LPT1 reads the first time. Then the DB0 of the Data port is set high (the DSL = 1) and the Status port reads the second time. Finally, the two readings are bit-manipulated and combined into a single 8-bit word and the reading procedure is completed.

Two program tools are supplied with the kit. One is the Turbo Pascal 6 include files, which control the writing and reading operations. When users develop their own Turbo Pascal program, these files can be included in the program. The other tool is the Windows™ DLL files. The DLLs are written in Turbo Pascal for Windows™. When users develop software using Turbo Pascal for Windows™, Visual C or Visual Basic, these DLLs can be called.

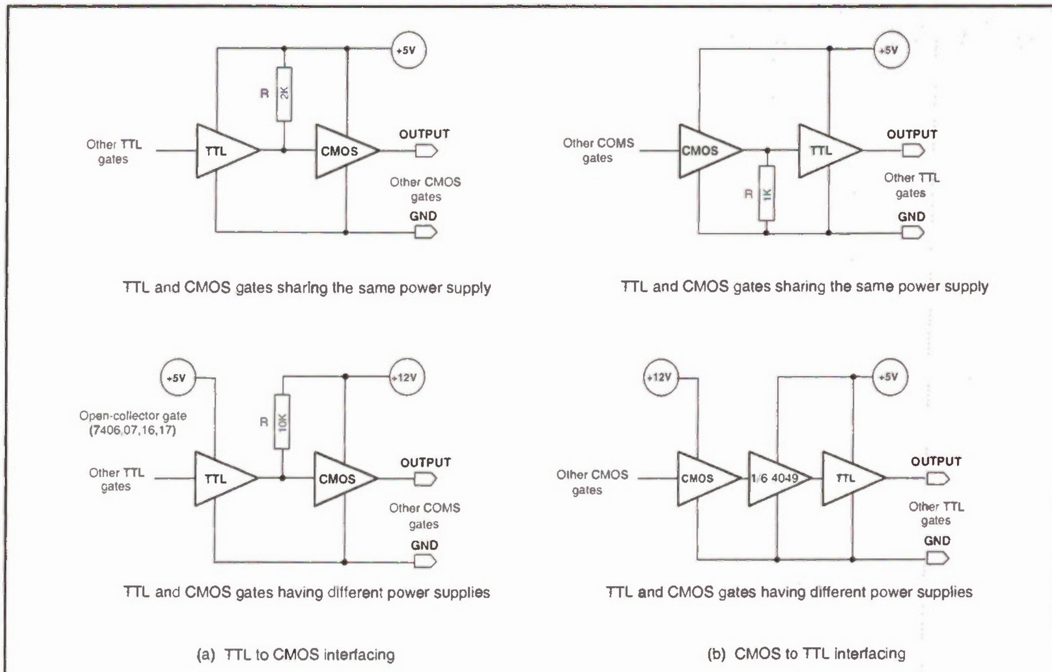


Figure 10. Interfacing between TTL and CMOS gates.

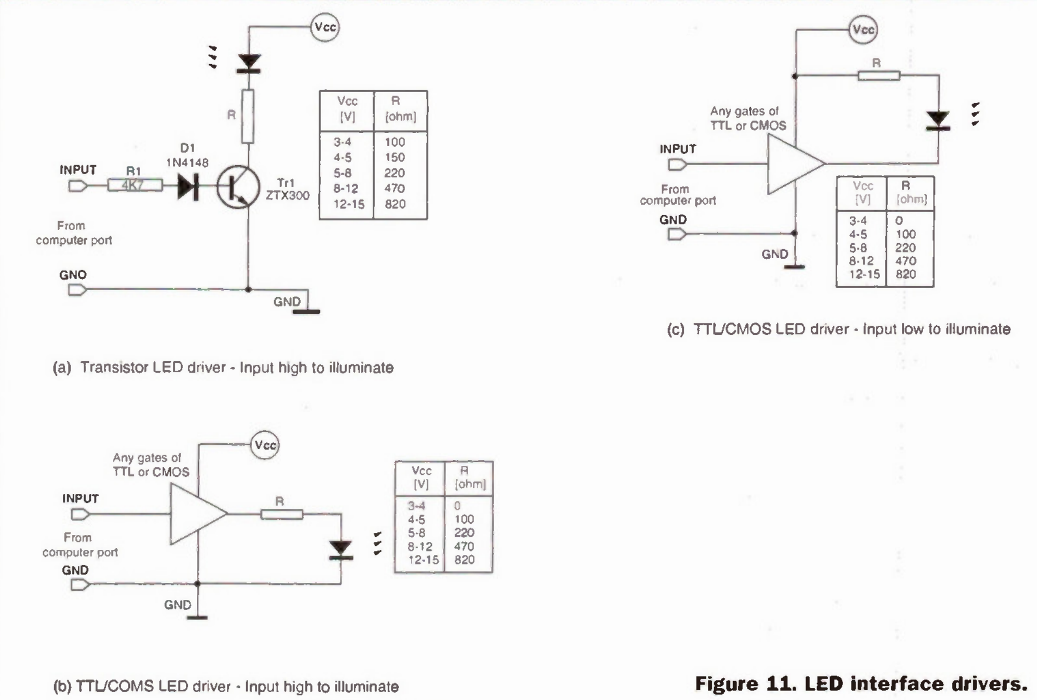


Figure 11. LED interface drivers.

Applications

Building this I/O card is only half of the story of computer interfacing. The other half is to do the actual interfacing with external devices. There are mainly two interfacing schemes. The first is to use the I/O card as an output device to control external devices. The other is to use it as an input device to obtain information from the external world. In this section, various ways in which external devices can be interfaced to the I/O card are discussed.

Before this, a brief description is given to show the relationship between logic levels (0 or 1) and voltage levels of a TTL output and input. A TTL output has two status, Logic 0 and Logic 1. At logic 0 state, the output voltage will be any voltage between 0-0·8V. At logic 1, the voltage will be between 2-5V. A TTL input will interpret any incoming voltage between 0-0·8V as 'Logic 0' and interprets any incoming voltage between 2-5V as 'Logic 1'.

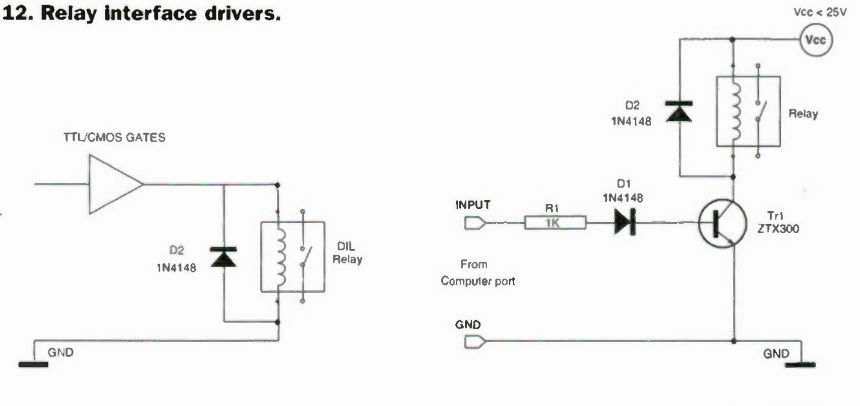
Interfacing between TTL and CMOS

Often, a TTL gate and a CMOS gate have to be connected together. Figure 10(a) shows how this is achieved. The upper figure is the case where the two gates share the same power supply and the lower one is where the two gates have different power supplies. Figures 10(b) shows how a CMOS gate is connected to a TTL gate.

LED drivers

Using computers to control LEDs is very common in interfacing projects. LEDs are low-power light-emitting devices which require only about 5mA at 2V potential to illuminate. Several LED drivers are shown in Figure 11. Figure 11(a) shows a LED driver using a transistor, ZTX300. In this circuit, a resistor R has to be used in series with the LED and its value should be chosen according to the voltage applied. LEDs can also be driven by TTL or CMOS gates directly, as shown in Figures 11(b) and 11(c). In Figure 11(b), a logic 1 at the gate output will illuminate the LED. In Figure 11(c), a logic 0 will make the LED to illuminate. For TTL gates, the voltage of the power supply is 5V, the serial resistor R is thus about 100Ω. For CMOS gates, R should be chosen according to the voltage of the power supply.

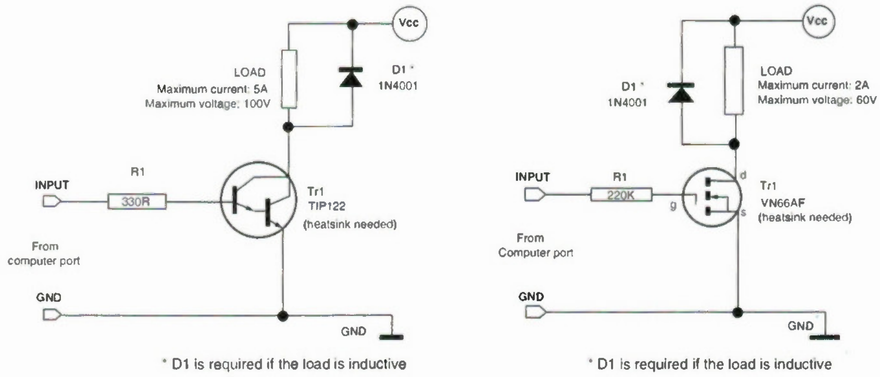
Figure 12. Relay interface drivers.



Relay required: Maximum operation voltage: 25V
Maximum operating current: 500 mA

(a) Relays driven directly by the TTL gates

(b) Relay driver using a transistor



(a) Darlington transistor high power driver

(b) VMOS transistor high power driver

Figure 13. Darlington and VMOS transistor high power drivers.

Relay drivers

Low power reed relays, some of which are housed in tall DIL plastic packages, will operate with a coil voltage of about 3·7V and a current of 7·4mA. These can be driven directly from TTL gates. A suppressor diode must be used to protect the TTL output against the reverse voltage generated as the relay switches off. However convenient, the contact rating of this type of relay is rather low. The maximum voltage is usually below 100V and the maximum power is in the range from 3 to 10W. This only enables loads such as low voltage filament bulbs and small electric motors to be controlled, but is inadequate for the majority of applications.

Medium and high power relays require higher coil voltage and current, hence, relay drivers have to be used. Figure 12 shows a relay driver using a transistor ZTX300. The driver will operate for a maximum supply voltage of 25V and a maximum current of 0·5A. This is adequate for most relay applications. The actual voltage of the power supply should be chosen according to the specification of the relay applied. In all cases, the suppressor diode must be used. Other medium power transistors such as BC108C and BC548 can also be used for such an application.

Drivers for high-current loads

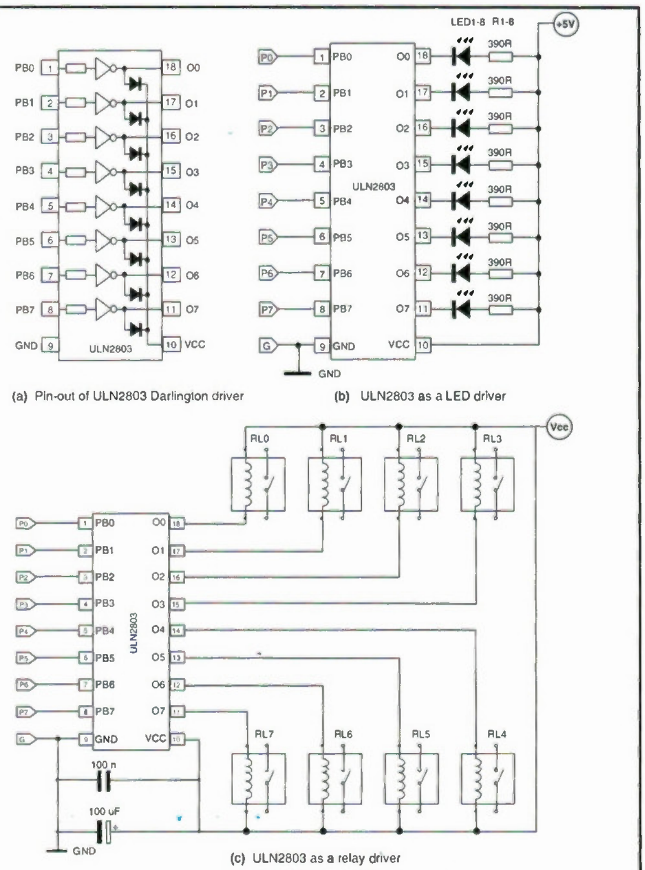
Figure 13 shows two driver circuits. The first one uses a Darlington power transistor, TIP122, which can be used with a maximum supply potential of 100V and a maximum current of 5A. Darlington transistors start to conduct for a base voltage of 1·2V and have a typical current gain of 5,000, therefore, a base voltage slightly higher than 1·2V will cause the transistor to saturate in conduction. It can, therefore, be interfaced directly to TTL gates. The second one uses a VMOS transistor, VN66AF, which can handle a maximum voltage of 60V and a current of 2A. A VMOS transistor requires an input voltage between 0·8 to 2V to conduct, thus it is possible to directly drive a VMOS transistor from a TTL output. In both cases, the suppressor diode must be used for highly inductive loads such as relays or electric motors and is not necessary if the load is non-inductive such as bulbs or electronic circuits.

Integrated driver ICs

In cases where a number of LEDs, relays or loads are needed, an integrated driver IC such as ULN2803 (or ULN2003) is recommended. This IC has 8 Darlington pair transistor drivers (ULN2003 has 7 pairs) and the pinout is shown in Figure 14(a). In use, pin 9 is connected to the GND and pin 10 is connected to the positive power supply. The maximum voltage is 50V and each driver can handle up to 0·5mA current. For currents above 0·1A, heatsinks should be used. Figures 14(b) and 14(c) give the circuit diagrams in which 8 LEDs and 8 relays are controlled by the IC, respectively. The former can be used as a simple logic level indicator for checking the operation of the present I/O card (see section 'Testing').

Opto-isolator

Opto-isolators are used to electrically isolate the computer from the external devices. This is useful to ensure that any fault or mistake in the device side will not lead to the damage to the computer. A typical opto-isolator consists of an infra-red LED and a photo-transistor (see Figure 15). In use, the LED is driven from a TTL



(a) Pin-out of ULN2803 Darlington driver

(b) ULN2803 as a LED driver

(c) ULN2803 as a relay driver

Figure 14. ULN2803 Darlington driver IC and its applications; (a) Pinout, (b) LED driver, (c) Relay driver.

gate in the normal way. For the photo-transistor, there are two configurations, i.e., inverting and non-inverting. In the first case, a logic 1 at the input will result in the output going low (Figure 15(a)). In the second one, a logic 1 at the input will make the output high (Figure 15(b)).

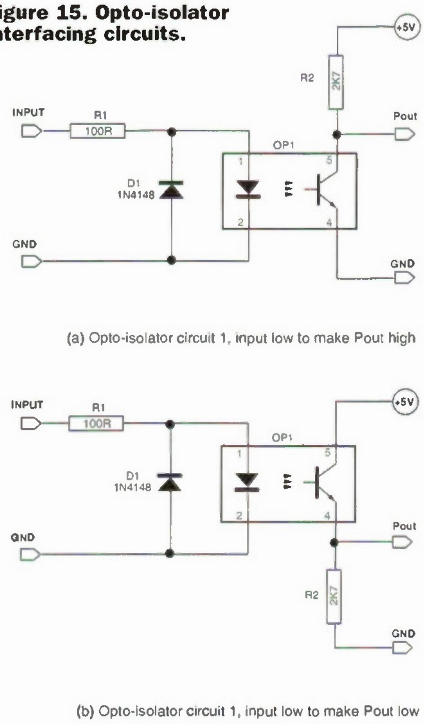
Opto zero-crossing Triac isolator

This device (e.g. MOC3041) is mainly used for controlling the mains (see Figure 16). It incorporates an infra-red LED a zero-crossing unit and a Triac. The Triac has a 400V rating and can handle a maximum current of 100mA. Sometimes, this is inadequate and more powerful opto triacs are used. **When dealing with the mains supply, extreme care must be taken.**

Input conditioning interface for TTL gates.

In some applications, the signals from certain sensors to be sensed by a TTL input are not TTL compatible. It is necessary to incorporate additional interfacing circuitry between the sensor and the input port. Figure 17(a) shows how a switch is interfaced to the TTL input. This circuit is known as the 'debounced' switch. Figure 17(b) shows how temperature can be sensed using a temperature sensor. The arrangement generates a logic 0 input whenever the temperature level exceeds the threshold setting and vice-versa. Figure 17(c) shows how light level is sensed using a photodiode sensor. This circuit generates a logic 0 input whenever the light level exceeds the threshold setting and vice-versa. Figure 17(d) shows how sound can be sensed using a crystal microphone. In the absence of sound, the output from the amplifier is about 2·5V. When sound is detected, the output oscillates above and below this level and the low-going voltage change can be detected. ELECTRONICS

Figure 15. Opto-isolator interfacing circuits.



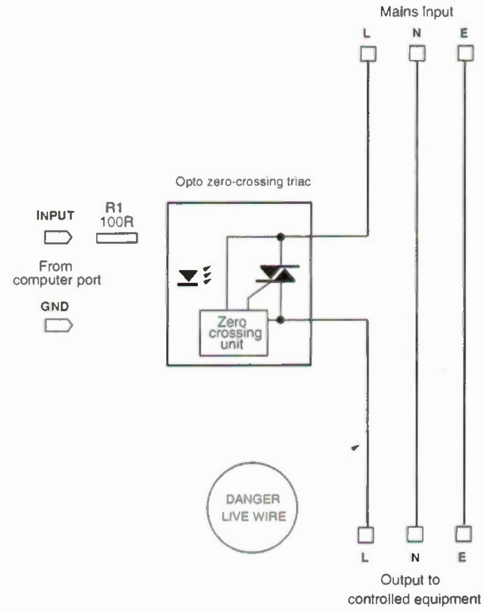


Figure 16. Opto zero-crossing triac for mains control applications.

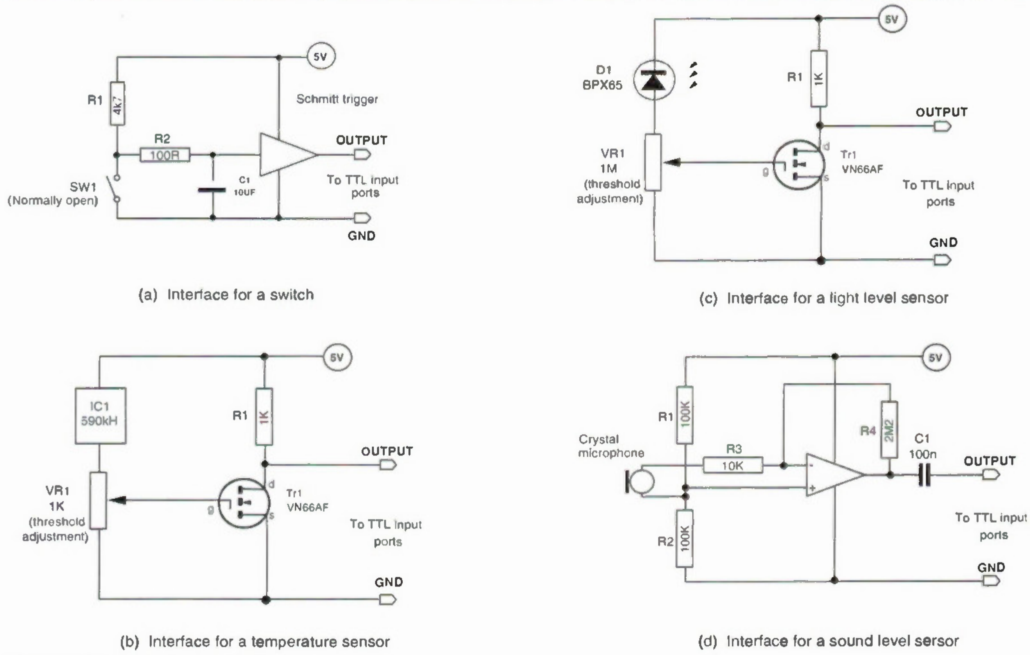


Figure 17. Interface circuits for various sensors.

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1,R2	20k	2	(M20K)
R3	390Ω	1	(M390R)
R4	1k	1	(M1K)

CAPACITORS

C1,2,5	100nF Ceramic disc	3	(YR75S)
C3	10μF 63V Radial Electrolytic	1	(AT77J)
C4	1μF 63V Radial Electrolytic	1	(AT74R)

SEMICONDUCTORS

IC1	8255 PPI	1	(YH50E)
IC2	74LS241 Octal Tri-state Buffer (or 74HCT241)	1	
IC3	74LS244 Octal Tri-state Buffer (or 74HCT244)	1	(QQ56L)
IC4	74LS365 Hex Tri-state Buffer (or 74HCT365)	1	(YH11M)
IC5	74LS02 NOR Gates (or 74HCT02)	1	(YF02C)
IC6	7805 5V Regulator (1A rating)	1	(CH35Q)

MISCELLANEOUS

J1	36-pin Female Centronix-type Connector	1	
J2	26-way DIL Male Socket	1	
J3-5	2-way PCB Connectors	3	
J6	Fuse Holder	1	
F1	800mA Fuse	1	
LK1-10	0·6mm Diameter Copper Wire	As Req.	
	6BA Spacers for PCB Mounting	4	
	Heatsinks for 7805 Power Regulator	1	

OPTIONAL

SK1	2·5mm Power Socket	1	
SW1	Toggle Switch	1	
D1	5mm LED	1	(WL27E)

The Maplin 'Get-You-Working' Service is not available for this project.
The CEN8255 Kit is available from the author at a price of £37.00. They include all the components for the board. Windows Visual Basic and Turbo Pascal 6 software drivers (both EXE files and source codes) are provided with the kit. Assembled and tested cards are also available at £45.00. Please add £3.50 for postage and packing and send your order and cheque to Pei An, 11 Sandpiper Drive, Stockport, Cheshire SK3 8UL, United Kingdom.

PROJECT

Bicycle ALARM

Design by Alan Bradley
Text by Alan Bradley and Maurice Hunt

The statistics for the theft of bicycles is alarming, amounting to many thousands a year in the UK alone. With the replacement cost of even a used bike being rather steep, it makes sense to take precautions to safeguard the one you have. The obvious priority is to lock it securely whenever and wherever you leave it, even if you are only popping into a shop for a moment (which is all it takes for a thief to leap on and pedal off, never to be seen again. Another worthwhile measure is to add a suitable alarm to your two-wheeled transport, so that it alerts attention if tampered with, hopefully making a thief look elsewhere instead for an easier target.

The Bicycle Alarm described in this article is based on the Loop Alarm project previously featured in Issue 70 of *Electronics*. This makes for easier construction, since a ready-made PCB is available. However, the original design is adapted to fit into a more compact casing suitable for attaching to a bike frame or for storing in a saddlebag, handlebar bag pocket or pannier.

The alarm will also protect the wheels and other valuable components of a bicycle (the saddle for instance!) if the loop is made of sufficient length to be threaded through these parts. The alarm can also be used as a normal Loop Alarm, to protect items in shops, rooms, sheds, garages, etc.

Circuit Description

Refer to Figure 1, showing the circuit diagram. The project is based around the Loop Alarm circuit, which utilises half the gates of a 4001 CMOS quad 2-input NOR IC, connected to form a latch. The output of the latch goes high when the input is triggered by breaking the loop, and can only be reset by switching off the circuit via the keyswitch.

The loop must have a total resistance of no more than 90kΩ, which allows for a very long loop indeed, using normal low-resistance wire.

Capacitor C3 is included to prevent false triggering of the alarm that could otherwise be caused by the loop picking up stray RF bursts from nearby CB/taxi radio transmitters, etc.

Transistor TR1 drives the piezo sounder, which gives out a piercing 90dB wail when the alarm is set off. A single 9V PP3 battery is used to power the alarm, and the circuit's low power consumption in standby state will ensure a long life.

For additional security, an optional anti-tamper microswitch can be installed within the casing (details provided), so that if the lid is removed with the alarm armed and the loop intact, the alarm will sound.

SPECIFICATION

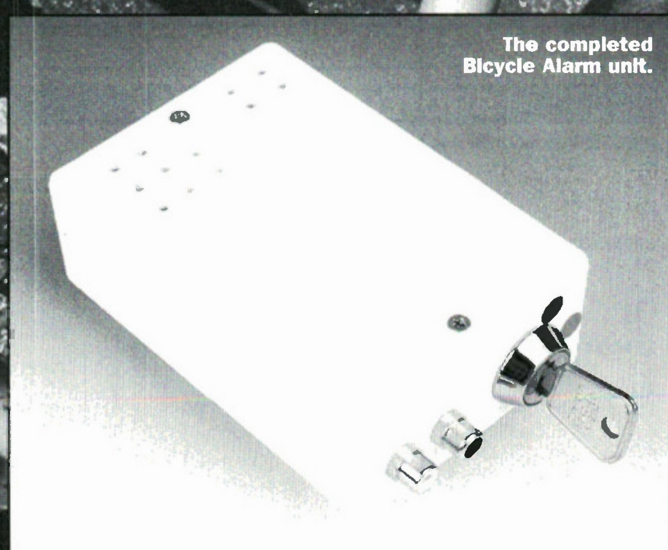
Operating voltage:	4-12V DC (9V nominal (single PP3 battery)
Operating current:	70(A (standby)
	60mA (triggered)
Sounder output:	90dB approximately
PCB dimensions:	27 × 93mm
Case dimensions:	114 × 76 × 38mm

FEATURES

- Low cost
- Low standby power consumption
- Compact
- Easy to build and use
- Optional anti-tamper switch

APPLICATIONS

- Protecting bicycles and motorcycles
- Loop alarm for shops, rooms, sheds and garages



The completed Bicycle Alarm unit.

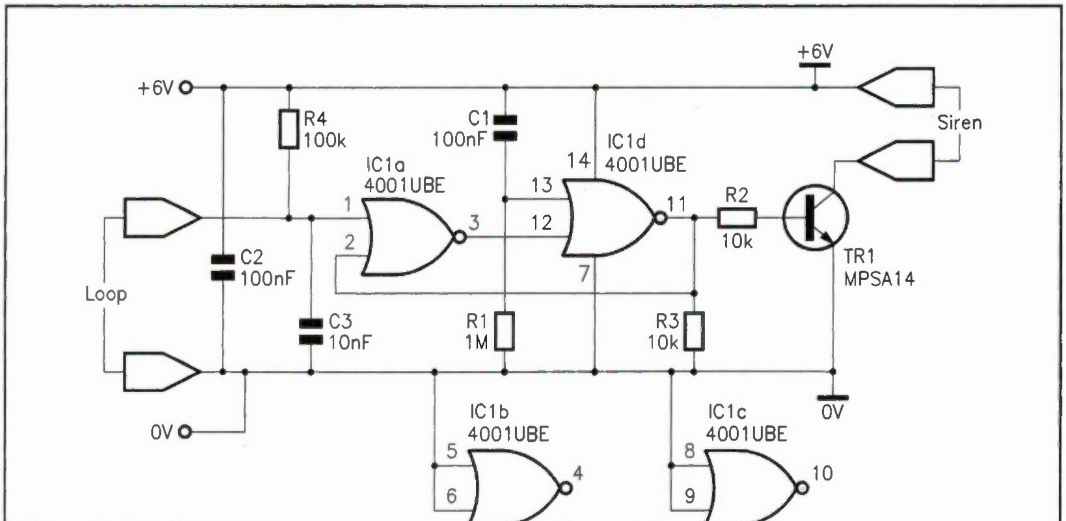


Figure 1. Circuit diagram of the Bicycle Alarm.

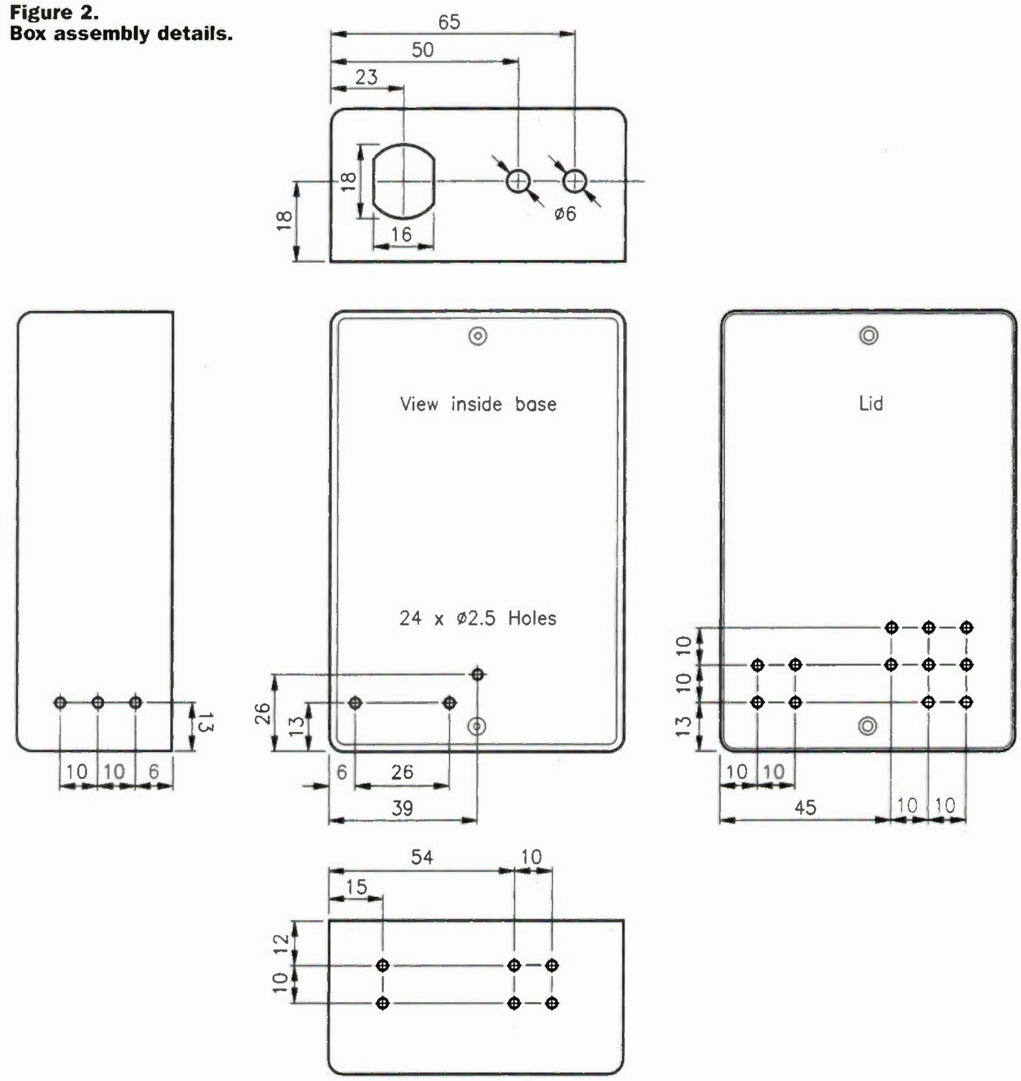


Figure 2. Box assembly details.

Construction Details

The specified PB1-type box should be drilled as shown in Figure 2. The sounder is attached to the case using M3 bolts, while self-adhesiveVelcro pads are recommended for fixing the battery holder and PCB in place. If fitted, the optional anti-tamper microswitch should be bolted in position such that its operating lever is held shut with the lid on the box.

The PCB should be assembled in the usual order of ascending component size/height, ensuring that polarised components are orientated correctly. If required, refer to the Loop Alarm project article or its construction leaflet for further details. A DIL-holder allows for easy replacement of IC1, should it be necessary. On completion, check carefully for mistakes, solder whiskers, bridges and dry joints, then

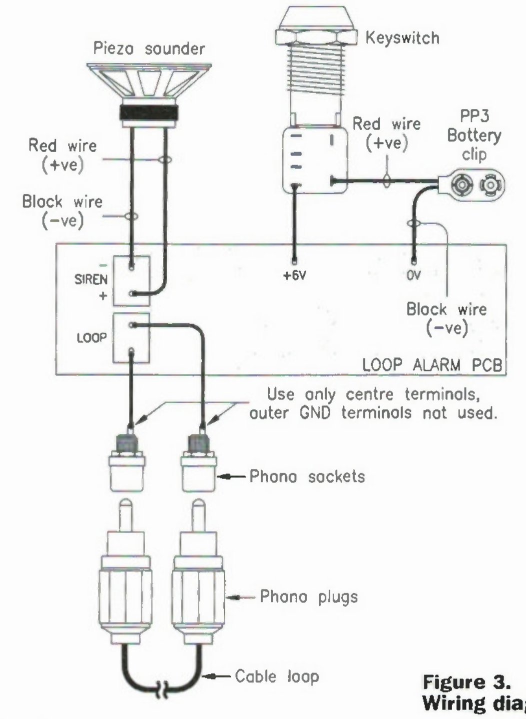


Figure 3. Wiring diagram.

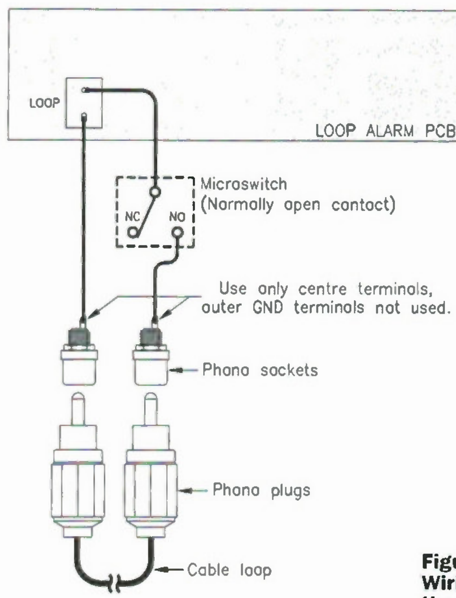


Figure 4. Wiring for the optional anti-tamper microswitch.

clean excess flux off the board using a suitable solvent.

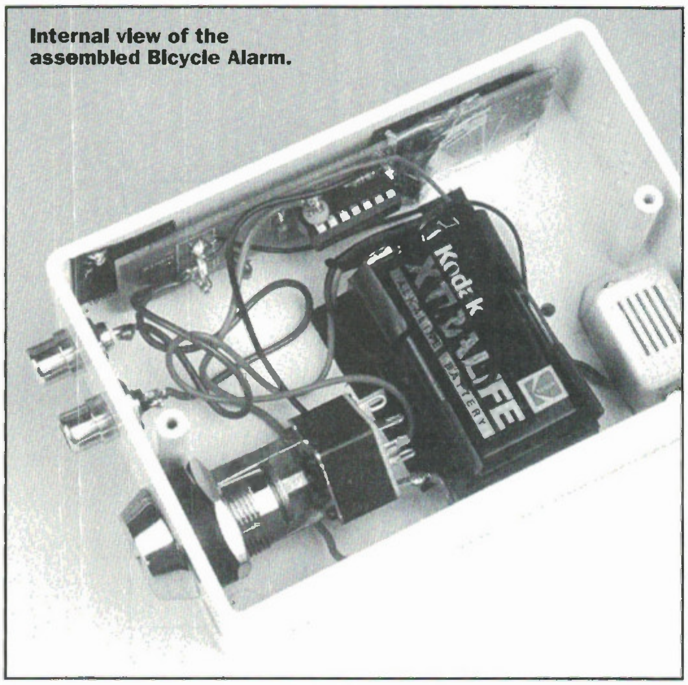
Wire up the completed board in accordance with the wiring diagram shown in Figure 3. Figure 4 shows how to connect the optional anti-tamper microswitch.

Testing and Use

With the kewswitch in the OFF position, and the loop made, install a fresh PP3 battery (observing polarity). The casing lid will then need to be shut if the optional anti-tamper switch is fitted. Arm the alarm by turning the keyswitch to the ON position, and the alarm should remain quiet. However, breaking the loop or removing the lid (if the microswitch is installed) should set off the sounder. Remaking the loop and/or shutting the box lid should not have any effect – the only way to turn off the alarm once triggered (other than disconnecting the battery or subjecting the unit to a severe beating!) will be to turn the keyswitch back to the OFF position.

Note that the specified casing is NOT waterproof. The alarm should therefore be mounted so as to protect it from moisture ingress. If a degree of water-resistance is required, the assembled circuit board can be protected by spraying it with lacquer/varnish or encapsulating it in resin – the latter measure would also improve its tamper-resistance considerably.

The battery should be checked and replaced periodically, say once a year, preferably using an alkaline type for long life and leak resistance.



Internal view of the assembled Bicycle Alarm.

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless Stated)			
R1	1M	1	(M1M)
R2,3	10k	2	(M10K)
R4	100k	1	(M100K)
CAPACITORS			
C1,2	100nF 16V Ceramic Disc	2	(YR75S)
C3	10nF 50V Ceramic Disc	1	(BX00A)
SEMICONDUCTORS			
IC1	4001UBE	1	(QL03D)
TR1	MPSA14	1	(QH60Q)
MISCELLANEOUS			
	DC Piezo Buzzer	1	(CR34M)
	Box Type PB1 (Black)	1	(LH14Q)
OR	Box Type PB1 (White)	1	(LF01B)
	Keyswitch (Round Key)	1	(CJ92A)
OR	Keyswitch (Flat Key)	1	(CJ98G)
	14-pin DIL Socket	1	(BL18U)
	PP3 Battery Clip	1	(HF28F)
	PP3 Battery Box	1	(CK65V)
	2-way 5mm PCB-mounting Terminal Block	1	(JY92A)
	Chassis-mounting Phono Socket	2	(YW06G)
	Screw-cap Phono Plug Black	2	(HQ54J)
	Single-core Cable Grey	As Req.	(XR13P)
	7/0·2 Wire Red	10m	(BL07H)
	1mm Single-ended PCB Pins	1 Pkt	(FL24B)
	M3 16mm Bolts	1 Pkt	(JY24B)
	M3 Nuts	1 Pkt	(JD61R)
	Loop Alarm PCB	1	(GH46A)
	Loop Alarm Instruction Leaflet		(XU32K)
	Constructors' Guide	1	(XH79L)
	Alkaline PP3 9V Battery	1	(AR46A)
OPTIONAL			
	Microswitch	1	(FP44X)

The Maplin 'Get-You-Working' Service is not available for this project.
The above items are not available as a kit.

COMMENT

by Keith Brindley

As an ex-sufferer of carpel tunnel syndrome myself, I'm acutely aware of the pain which can be caused by incorrect posture and unergonomic human/machine interfaces when using computer equipment. There are many thousands more computer users around the world in a similar predicament who will, no doubt, be interested in a recent award for damages against a US computer manufacturer for injuries caused by computer keyboards. It's the first time such a huge award ($6m) has been given against computer makers, and marks something of a turning point for them all, I'm sure. The company in question in this dispute is Digital Equipment, although exactly *who* the company is is largely irrelevant to the issue. Every computer has a keyboard, of course, and anyone who uses a keyboard to a large extent may suffer from such a work-related repetitive strain syndrome. In my case, my painful problem was caused by constant use of a computer mouse – not a keyboard – fortunately relieved by changing my working environment around and obtaining a trackball. The different posture the new setup provides has proved more comfortable and my pain has disappeared. If I don't use the mouse, I have no trouble. As a result, I've discovered the other benefits of a trackball (superior performance, greater manoeuvrability – although there's a wide variance between trackballs, too) and could recommend one to any computer user. My point here, though, is that it is perhaps not so much the computer equipment which is at fault, more the way it is used by the user. Yes, the keyboard and the mouse are factors in any damage or strain which may be caused by repetitive use, but are they the sole factors? I don't think so.

No doubt, other US computer manufacturers are wondering where this is all going to lead. There are, after all, several thousand other computer users in the US who have suffered similar complaints, and this precedent may be all they have been waiting for to claim for similar damages.

Smile for Big Brother

Among strong (unconfirmed) rumours that many police spy cameras positioned at many road junctions throughout the country are not taking pictures (some, apparently don't even have film in them), due to cost reasons, rumours just as strong abound that the nation's analogue cameras are about to be replaced by digital cameras linked by network to the Driver & Vehicle Licensing Agency database. One estimate puts up to 90% of cameras as non-functional – possibly making them the biggest set of technological ornaments in the world.

It seems that many police forces, after commissioning analogue cameras to photograph speeding motorists, simply can't afford the backup costs of following up the processing and administration requirements, taking the drivers to court and providing the photographic evidence required. (Obviously, they haven't arranged a quantity discounted deal with their local Boots.) As a result, not all motorists speeding through junctions have their cars photographed, and those that do aren't always brought to book in the courts anyway.

The Home Office is currently finalising specifications for a digital camera network which will link the police camera system directly to the DVLA database, and provide details of the vehicle's owner immediately. Don't expect to see digital cameras in use at all rapidly though, as no budget has yet been allocated for their purchase and maintenance.

This Way, No, This Way

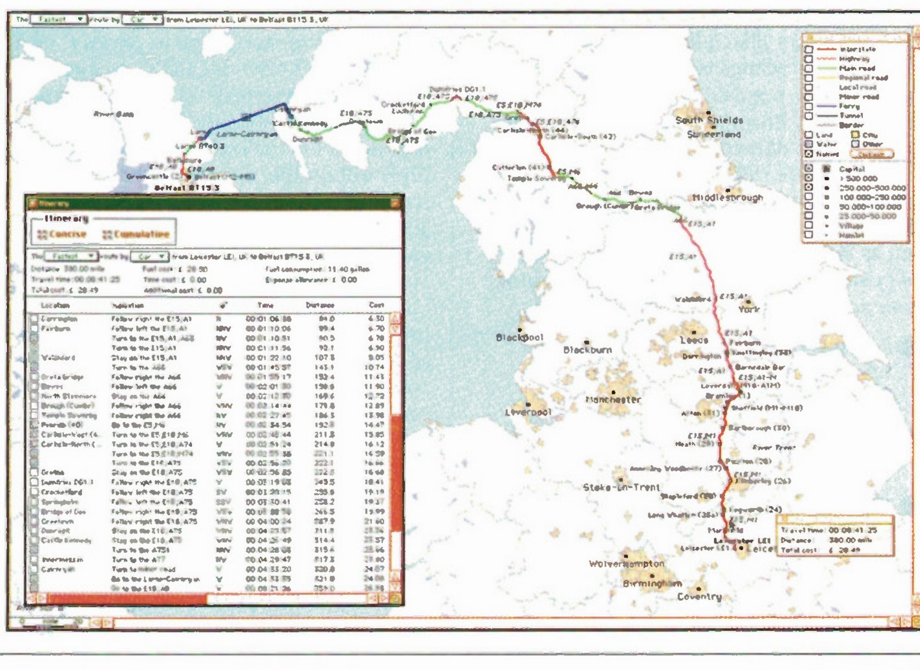
Back seat drivers, beware. Route planning software is getting decidedly more easy to use and with the advent of laptop computers may soon form the death knell of that most dreaded of Sunday antics – map reading. One of the latest route planners is Route 66. The version considered here is the Ultimate Traveller Bundle, a CD-ROM based program which shows the best route, travel times and route descriptions rapidly and conveniently for (in alphabetical order) Austria, Benelux, Eastern Europe, France, Germany, Greece, Ireland, Italy, North America, Portugal, Scandinavia, Spain, Switzerland, Turkey, and also the United Kingdom. There are other versions available which feature just a local country map together with the base application. Operation is simple. You choose your current position and your destination from a list of locations, after which, the program calculates your route within seconds. You can specify that the route should be fastest, shortest, or cheapest, and you can also specify whether you're going by car or bike. You can also set other variables such as the speed you expect to travel on varying road types (such as motorways, and local roads), together with fuel consumption and fuel prices, so that you can have a full description of costs associated with your journey.

Once the program has done its stuff and displayed your route, you can click on any part of the map to zoom in to several levels to check your progress as you go. Another window gives you your itinerary, listing all the junctions you need to traverse and the directions you need to take. It's a nice program, well-developed by a Netherlands-based company (Route 66 Geographic Information Systems BV, PO Box 1135, NL-3900 BC Veenendal, The Netherlands +31 318 554724; `http://www,route66.nl`). It is easy to use, and the single CD-ROM of the Ultimate Traveller Bundle is a hybrid, allowing it to run on both Windows and Mac platforms. Priced at £99 for the Ultimate Traveller Bundle, £39 for the route planner with a single country map, or £29 each individual map, it's well worth a look if you travel at all frequently by road.

Remember the Good Old Days?

Yes, I predicted it months ago, and finally, it's about to happen. Computer memory prices look set to rise – if they haven't already as you read this – following rumours that South Korea (one of the world's biggest manufacturer and exporter of RAM) is cutting back on production in an effort to avoid long-term damage to the Korean economy.

Computer memory represents a massive 14% of the country's export trade, and the low prices which have overtaken the industry over the last few months is already doing damage. By cutting back on production in Korea, worldwide prices will naturally become inflated. Initially, this will occur as a panic measure (with some cowboy distributors making money out of old stocks, presumably), but should settle down before too long at a higher, nevertheless once again, steady price. ELECTRONICS



Close Encounters of THE BILLING KIND

by Alan Simpson

Billing has become a buzzword in the telecommunications industry, whether in association with customer care or as a 'stand alone' subject. In fact, it has become a major factor in the telecom world, with one of the main driving forces being the increased competition that the operators are facing, putting pressures on tariffs as well as services offered. That is where billing comes into account, as flexible tariff management (part of the billing function) is a necessity to respond to new offerings of competitors. To survive in a competitive environment, operators have to attract new customers and to maintain their current client base. Tariffs and discount schemes are used (for example, Friends and Family), often in combination with innovative services (call divert, call waiting, conference calling, etc.) and a better customer service.

There can be no doubt that the world of Billing is in high growth mode, especially with over 400 delegates being attracted to the recent CommEd Conference Billings Conference and exhibition in Paris. With 46 telephone companies already operating in the UK, and with the international world opening their telecoms frontiers with a keen zeal never before encountered, the Billing market is certainly expanding in a fast rate of bauds.

While we consumers take it for granted that our call triggered on a Cellnet GSM network within Europe is seamlessly handled, or the cost of a call routed via Mercury, Cable & Wireless, MCI, France Telecoms and Andorra PTT, is smoothly compiled, industry regulators seek reassurance that related billing activities are being accurately accessed. That is where The Billings Conference comes in. Speakers and exhibitors alike take the opportunity to confirm that billings is a growing concern to operators, regulators and users alike.

Of course, Billings is not about billings only. It is about measurement, analysis and what the trade calls 'call behaviour'. This, for the uninformed, is not about shouting abuse down the line to the local gas board, but as Hewlett Packard insists, is a matter of positive advantage for the PTT operator, covering such matters as:

- Analysis of call data – calling patterns, effectiveness of advertisements, customer segmentation based data.
- Geographical analysis – using maps wherever possible.
- Choice of user interfaces – with graphs, bar charts and other presentation methods.
- Open extraction of data – allowing different front-end tools, e.g., Oracle Forms, Business Objects, Excel.

Bob Connell, an HP Business consultant, believes that essential business decisions increasingly rely on Call Behaviour Analysis. Operating influences, meanwhile, embrace such areas as usage trends, advertising campaigns, close monitoring of competitor activities plus much 'what if' analysis. Apparently, every morning (at 8.30am to be precise), senior BT executives can be provided with a complete picture of what took place the previous day on their networks, even to the level of revenues earned. "Informed guesses in today's telecoms environment are just not good enough".

This year saw the European Billing '96 Conference event moving to Paris, where a record number of delegates, exhibitors and sponsors gathered together to hear the latest developments in the supercharged world of telecommunications billing and customer care. According to James F. Orr, President and CEO of CBIS (Cincinnati Bell Information Systems), "At the end of the day, it will be our customers who choose the winners in the communications business. They will decide, if we the carriers, are meeting the competitive challenge or not. Technology, pricing and increasingly, service and support, will determine the winners. How effectively could I compete with a company offering the kind of service that today's global roamer, one who makes use of a laptop, wireless Internet, video, voice and e-mail messaging, is seeking? And how do I provide for that level of service?"

"Changes", James told his audience, "are happening now which the regulatory environment in the European Union and the United States is driving forward in the competitive landscape. By the year 2000, most of the PTT monopolies that now exist in Europe, will be facing significantly more intense competition. This will range from new national carriers and service providers to the expanding reach and growing range of services offered by international carriers and joint ventures such as Concert, Unisource and Global One".

Borders Coming Down

"Borders are coming down within technology itself. Until recently, the borders between wireline, cable TV, wireless and online services and service providers were clearly marked. Now, companies are working to break down these barriers, planning to compete for and win market share in non-traditional territories. Cable TV companies are offering telephone services, telephone companies are offering Internet access and planning on providing video services, and more or less everyone, including online service providers and broadcasters, have moved onto the Internet. The stakes are high. There will be both winners and losers. The investments are large; time is short and the choices are critical".

Helping to meet those challenges and opportunities is Frank Owen, managing director of Sema Group Telecoms Mobile Division, who took the opportunity to launch a new module of the CABS 2000 billing system for mobile network operators. The latest version now has a Graphical User Interface (GUI) option, which allows even faster and easier system access by customer service staff. Using a dedicated single entry screen with customised defaults, customer details can be quickly captured. As Frank comments, "System Integration is the name of today's comms game".

Comprehensive Billing Systems

Similarly coming to the assistance of the carriers, was John Gear of the Cambridge UK company, Generic Technology, who took the opportunity of the Conference to launch the much anticipated GENEVA event-based billing system. This, as John made clear, offers multi-service providers with a means of reducing costs through billing services and products, from any source and in any combination onto one single document.

Other event highlights included a new Directory of customer care and billing software in electronic format. This fully comprehensive database on software packages provides full supplier profiles. Meanwhile, a further new Billing verification system allows operators to send text calls over their network and analyse the results to ensure the calls are not being under or over-metered.

Every Second Counts

With BT alone clocking up over 140 million calls a day, every second counts. There is an urgent need for hardware and software packages which can measure the accuracy of a telephone operator's network and billing systems. In fact, already available in the market place are packages which claim to determine call duration down to 100ms and in trial, users have been consistently achieving levels of resolution better than 10ms.

Warning Shots

However, warning Billing shots are already being fired. The collection and maintenance of data for the operation of billing systems has, on the one hand, certain privacy implications for those about whom data are held and on the other hand, freedom of information and economic implications for those who wish to hold it. Of relevance to billing systems is the issue of the purchase of personal data by third parties for use in direct marketing. In the UK, such activities are covered by the Data Protection Act 1984, but already, an EU Directive on Data protection has been adopted which will require certain amendments to be made to the UK statute. This covers the production of such matters as itemised bills and related personal data.

This debate between the interests of privacy and freedom of information is set to continue well into the next century. However, the question may not be one of legislation at all. It may be that new modes of communication, for example, via the Internet, will prove unregulatable.

Two characteristics above all others are being emphasised at every stage covered in the work of billing system requirements. The first essential is to have flexibility and adaptability, to allow the business to evolve freely, without being constantly confined by the restrictions of a billing system.

The second demand is operational: the billing system must always be able to prove the integrity of its processes, and it must maintain audit trails so that it can demonstrate that any aspect of its data – be it value, count, balance, total, control summary, statistic or analysis – can always be clearly reconciled with any other.

Historically, the requirements of a billing system were restricted to producing bills and maintaining sales ledger accounts. Whether due to time or cost restraints, or to simple misjudgment, the failure to enhance a billing system to reflect the requirements of the business as a whole often resulted in systems which were inefficient to begin with, grew more so, and which – sometimes surprisingly quickly – became a threat to the viability of the business itself.

The new breed of software packages will take Billing to the next dimension, that of providing cascading measures of data for all users, carriers and the regulatory industry.

AIR YOUR VIEWS

E-mail your views and comments to:
AYV@maplin.demon.co.uk

Write to:
***Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU**

Feeling the Heat

Dear Sir,

You no doubt feel that, with the letters in issue 109 from Ray Marston and R. Simpson, the subject of the hot-cold resistance ratio of filament lamps has been fully aired, but the editorial footnote to R. Simpson's letter ". . . attempting to measure the working temperature of a lamp filament could prove to be easier said than done!" warrants a reply. The standard non-contact method of measuring surface temperature is to measure the radiated energy from the source by means of a pyrometer. The 'total radiation' type is the simplest to use, being a true 'point and read' instrument; however, a version covering the lower end (–18° to +540°C) temperature range costs over £700 – a bit costly for DIY use! For temperature measurement of a small-area source emitting visible light such as a filament lamp, an optical type pyrometer is more suitable. This contains a calibrated reference filament bulb with a variable filament current control; the calibration chart relates to filament temperature. A lens system enables the reference unknown filament changes to be superimposed; the reference filament current is adjusted for equal brightness of the two images and therefore, equal temperature. A final small point concerning the hot-cold resistance ratio of car bulbs. For adequate life, '12V' car bulbs are in fact designed for an operating voltage of 13·2V (12V +10%). Hence, we should use 13·2V, not 12V, when calculating a car bulb's hot resistance from the R=E²/W equation; the true hot resistance figure is thus 21% higher (from $1{\cdot}1^2 = 1{\cdot}21$) than the 12V figure, with a corresponding 21% increase in the estimated hot-cold resistance ratio.

D. Becker, St. Albans, Herts.

Thank you for reminding us of the pyrometer method of determining filament working temperature. Since most vehicle electrical systems normally operate at slightly above 13V when the battery and charging system are in good condition, perhaps the bulbs should be designed to operate at 10% above that figure, i.e., 13·2V + 10% = 14·5V? Obviously though, dim lights would be a downside effect if the vehicle's battery/charging system weren't operating at their best. As an aside, the increasing use of LEDs for vehicle lamps (particularly stop lamps) should lead to reduced lamp failure and even a slight reduction in rear-end collisions – LED lamps come on a few milliseconds before a filament lamp can light, making a crucial difference in reaction time for a following driver travelling at speed, and they aren't as affected by vibration.

Out of (Camc)order!

Dear Editor,

I have only recently become a reader of *Electronics and Beyond*, and I think it is a marvellous magazine. However, I think that your educational circuits pages would be better if you gave a stripboard layout. I tried to construct the doorbell from the January magazine, and had to come up with the layout myself because you only supplied the circuit diagram. This was difficult and makes your projects less appealing. On a different note, how about running a series about repairing broken appliances; my grandfather was quoted £168+VAT by a local firm, to have a couple of capacitors changed on the boards in his Canon camcorder!

Philip Frampton, Broadstairs, Kent.

The seemingly exorbitant price for the camcorder repairs is not unusual for a professional repair quote that takes into account the disassembly, troubleshooting (of a fault or faults that may not be at all obvious), repair and reassembly of the appliance. Most of the cost will be in the labour charge, and the repair shop naturally have to cover their overheads and make a reasonable profit. Many modern electronic appliances simply aren't designed to be repairable, after all!

In this issue, J. G. Wilkinson of Coxford, Southampton wins the Star Letter Award for his letter describing the design of a home-made electronic water de-scaler.

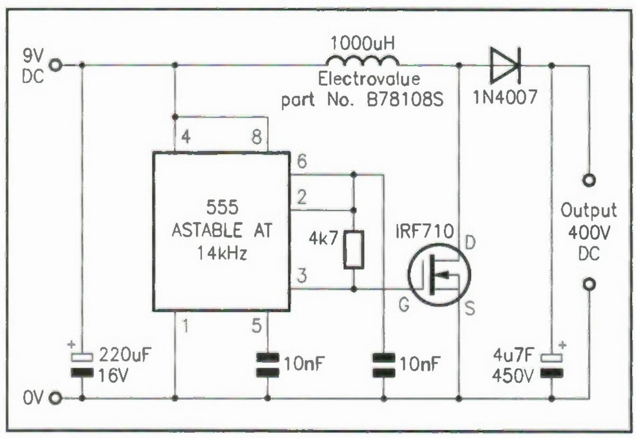
£5 MAPLIN GIFT VOUCHER

Star Letter

Dear Sir,

I have just received my copy of the March issue. I have read in the letters page, the sad story of Mr Sadler of Somerset, regarding electric water de-scalers. I designed this circuit myself to de-scale my water supply efficiently. I am pleased to state that it works well, and the people I have made them for are more than delighted with its performance. The circuit produces about 400-425V DC, at several milliamps. It is installed by first insulating about 10-12in. of mains water pipe with waterproof tape. Two strips of self-adhesive copper foil, which can be purchased from craft shops, are then wrapped around the insulated pipe (NOT TOUCHING, of course). The output of the circuit is attached to the strips and the whole area is then covered with another layer or two of insulating tape so that no-one can touch the live strips of copper. For a standard 0·5in. pipe, the two strips of tape need to be about 10mm wide, so that about 33% of the circumference is covered. The circuit produces a strong electrical field in one direction only. This has the same effect as placing strong magnets around the pipe. The field alters the molecular structure of the insoluble chemicals in the water and renders them soluble again. The MOSFET transistor is available from Greenweld of Southampton for 80p at the moment. The 555 is a common enough component. The inductor is a 1mH axial type from Electrovalue, and is very critical. The part number is B78108S. The maximum voltage the circuit will work at is 9V. I would recommend an 8V 100mA regulator. The circuit consumes around 80-90mA when operating.

Thank you for sending in your water de-scaler design, which will be of considerable interest to many of our recent correspondents.



Orderly Q

Dear Editor,

I was dismayed by your answer to Richard Rider (Issue 110), regarding charges for customers. Are you really saying that you don't want the people who don't spend large sums of money to shop with you? Surely, these must be the majority of the customers who have helped make you the large concern you are today. I can remember over twenty years ago, when you had only the one shop, and advertised in *Practical Wireless* and other similar journals, then you were pleased to sell anything to all and sundry. There must be many people like me who have been electronic enthusiasts for many years, who are now housebound or have no shop locally who sell such items; these people have to buy by mail order even for the smallest item. This new system will not be at all helpful for these people and I am most disappointed with this new attitude by Maplin.

J. Nichols, Kendal.

We welcome and greatly appreciate all custom, no matter how small. However, the handling charge for orders of less than £30 is necessary to cover overheads, else the delivery cost could in many cases exceed the order value and losses would be incurred.

Black and Blue

Dear Editor,

Just a few points to keep you on your toes, young Sir. Pity about the 1996/97 Catalogue, which should have been issued with a magnifying glass to read the prices printed as small black characters on a blue background, a point which has been raised before in respect of magazine articles. Last year, I bought an Antex A545 24V 50W temperature controlled soldering iron from Maplin at no mean price, but it does not appear in the current catalogue. Does this mean that it will now be impossible to obtain spares such as the element which appears unique to this iron? Lastly, your correspondent Ron Cook (Air Your Views, Issue 109) may be interested to know that way after the 1930s, the split-beam double-beam oscilloscope is still alive and well. In 1966, I purchased a surplus Cossor Model 1035 MkIII which had been in recent use and serviced by the R.A.F.. It uses a −2kV CRT supply and has a +2kV post deflection anode supply, giving good focus with little intermodulation, despite the use of only one Y deflection plate per trace. The best Y frequency response is only 5Hz to 5MHz, but is still useful for audio and lower RF, has expandable triggered or repetitive timebase with variable time delay, trace bight-up, direct access to the X and Y plates and Z modulation if required, plus a good service manual. Its substantial PSU and valves also keep the shack warm in winter, although I must admit to having a Maplin 20MHz D/B scope for RF and more precise work.

N. L. Smith, Stoke-on-Trent, Staffordshire.

Most feedback we have received concerning the new MPS Catalogue has been complimentary towards the revised layout and presentation/printing – the text within the highlighted blue boxes, in my opinion at least, is easily readable in reasonable lighting conditions from a distance of about 3 feet away! (I conducted a quick test as I wrote this reply.) The 45W Antex A545 soldering iron (YZ70M) uses bit type 1106, which is available as Stock Code FR30H. In fact, any of the (type 1100-1109) bits suitable for the Antex CS/CX/TCS/XSD/XSTC/A soldering irons will fit the A545. Unfortunately, the A545 element is no longer stocked by Maplin.

Wind-up Merchant!

Dear Sir,

Trevor Baylis has developed a radio receiver powered by handwound clockwork for use especially in under-developed countries where batteries are difficult to obtain and expensive. He was inspired by a humanitarian desire to spread health information on AIDS to Africans. From the beginning in 1992, he encountered disbelief, discouragement and downright abuse for his idea of a clockwork powered radio, from all electronic manufacturers as well as an extensive series of critical letters in *The Times*. Then the BBC produced two QED programmes on his radio a year apart – the update being September 1996. He started manufacturing Bay Gen radios in South Africa with 100 people (many with disabilities), producing 20,000 radios per month. Nelson Mandela described the radio as a "fantastic achievement", and Baylis was given BBC Designer of the Year award. Surprisingly, the radio for under-developed countries proved to be very attractive to purchasers in Britain through a *Radio Times* offer and several other outlets. It was sold at a much greater price than the rock-bottom non-profit price to Africans. All this is well-known history, but demonstrates that old methods, heavy, cumbersome and inefficient, can be revived to serve new ends by taking advantage of new materials where more power can be packed into less weight and space. This trend covers the whole of science, from the modern use of leeches and maggots in medicine to Clive Sinclair's battery assisted bicycle – a fine example of the progress in magnetic materials in the motor. The Bay radio does not charge a battery, but recently on the market has appeared a solar cell/clockwork wind battery charger built into a radio. Also to be found are low power solar cell battery chargers and larger solar power supply units. It seems to me that the logical requirement is a clockwork battery charger which is adaptable to all sizes and types of rechargeable battery. All the basic technology is feasible and the keen experimenters who read *Electronics and Beyond* are just the people to develop the idea. Just think of the many thousands of batteries in camcorders, personal stereos and disc players, mobile phones and laptop computers, where a spare recharging at a distance would prevent frustration. I don't think solar cells are the complete answer; clockwork manually wound is more reliable.

Alastair Knight, Edinburgh.

The simple ideas are often the best! Maplin stock the Solar/Dynamo Powered Radio, Stock Code BS58N, which has a built-in Ni-Cd battery to store the charge generated, allowing some 20 minutes of use in between windings, and of course, the Sinclair Zeta (Zero Emission Transport Accessory) is available as DZ90X. No doubt, 'green' energy sources will be used to power all manner of appliances to satisfy growing environmental concerns.

Add Salt to Taste

Dear Editor,

Having installed an ion exchange domestic water softener about three years ago for my 4-bedroomed house and finding the rising cost of the bags of salt unwelcome, I installed one of the electronic gadgets four months ago, so I can now make some practical comment. Basically, the bulky ion exchange container requires £50 of salt per annum and has to be topped up weekly. Installation and maintenance costs are very high in comparison with the relatively cheap electronic type which is quickly fixed in position on the water supply pipe. I found that the conventional type requiring salt, exchanged the calcium salts for sodium, which in the family's opinion, made the water not so acceptable for drinking. It did remove scale from the system which was a real problem before, so the bath water felt really soft, using less soap and no scum. The 'computerised' electronic package which it replaced consisted of a small box with a mains input, which was reported to produce a signal "consisting of a modulated waveform within a calculated frequency bandwidth, with frequencies consisting of some 160 computer-calculated changes within a four-minute timeframe. The 2 to 4 micron crystals produced become repellent and will not coagulate or precipitate and form scale in the same way as untreated calcium carbonate would". In practice, there is a fine white • powdery deposit in the electric kettle used for making the tea, which does not build up as the scale did. The old limescale is also being gradually removed over some weeks. The bath water does not feel as soft as before and there is some scum. On balance, the new gadgetry is preferred as the extra 'softness' with the old system was not considered to be worth the extra costs and trouble of regular maintenance. I would support Mr Sawyer's request for more information on the practical circuitry involved and how the electronics operate. One other related topic engrosses me at the moment. I purchased two electronic woodworm repellers which emit ultrasonic sound waves at around 24kHz. Are they effective and do they work? Being ultrasonic, we cannot hear them operating. But wait, I found a way. By connecting up the pair close together, at first, nothing happened. Then, after about a week, I heard a high-pitched noise coming from them – obviously a beat frequency. This varied and disappeared, only to return a few days later. So, the circuitry used must produce a waveform that varies over time. As for the water softening gadget, could someone be found who could prepare an article for the magazine on the related circuitry and how ultrasonic frequencies may be measured or charted?

John Aston, Dorchester, Dorset.

Ultrasonic devices claimed to scare off cats and dogs have been around now for several years, but we weren't aware of the woodworm repellers until now! An alternative method of 'listening in' on ultrasonic sound emitters is to place a sheet of polystyrene packing foam nearby the sound source; the (constructive) interference of the sound waves within the foam causes an audible frequency to be heard in many cases. A way of measuring the frequency of ultrasound is to connect an ultrasonic receiver transducer (e.g. HY12N) to the input of either a digital frequency meter (DFM) or an oscilloscope. Simply read off the frequency on the DFM display or calculate it from the 'scope trace, using the equation: Frequency = 1/Period (time for one complete cycle). A pre-amplifier may be required to boost the signal from the transducer, depending on how sensitive the measuring equipment's 'front end' is. See this month's Star Letter for a DIY electronic water de-scaler circuit.

Long-lived Clock

Dear Sir,

Twenty years ago, I bought a Maplin digital alarm clock kit. I built the printed circuit boards and fitted everything into a custom-made wooden box. It worked very well then, and amazingly, it is still working today – 7,300 days non-stop! The alarm has woken me regularly and nothing has gone wrong. What is of additional interest is that soon after I completed the project, the gurus were predicting that the 'new fangled' LED displays would fade and be unreadable in a few years. They got it wrong – I am sure my clock display is little different to the day it first brightened my bedroom.

Edwards, East Grinstead, West Sussex.

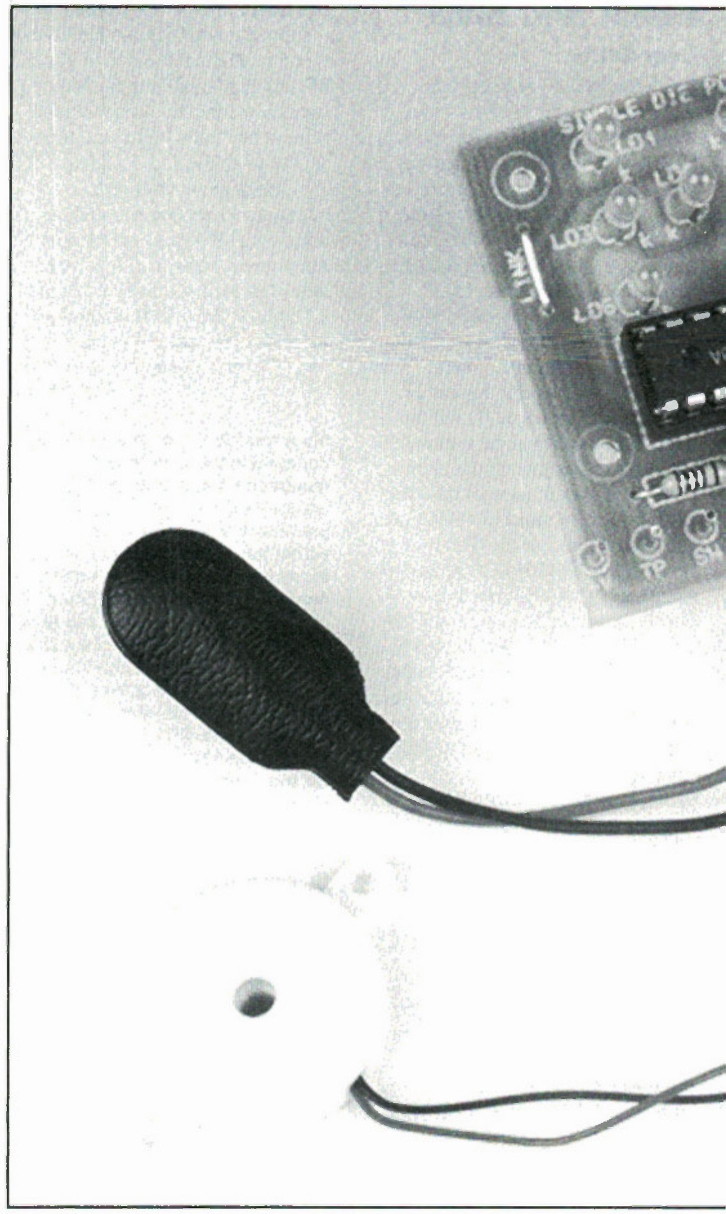
Good to hear that your Maplin clock kit has been giving good service for so long. LED displays tend to last indefinitely – usually a very long time – unless their operating current limit is being exceeded. However, liquid-crystal displays (LCDs) do have a limited life expectancy – 50,000 hours being a typical figure quoted, which equates to 5·71 years of continuous use. Many modern LCDs will however exceed this by a large margin, but this wasn't the case with many early versions, which tended to become unreadable after a few years as the segments merged and spread, until eventually the whole display went black.

PROJECT

Simple DICE KIT

Design and Text by Tony Bricknell

Most board games that involve the random element of chance normally use a cheap, wooden or plastic dice. However, one sweep through any child's bedroom will inevitably turn up numerous board games with . . . you guessed it, the dice missing! But its not just the children who are to blame – so many people get carried away with board games and throw the dice almost to the other side of the room. I'm sure I've spent more time looking for that lost dice than actually playing the board game!



Well, the days of that impromptu game 'hunt the die' are numbered – build this Simple Die kit and wave goodbye to all that frustration caused by crawling around under the table, looking under the sofa, etc. for a 12mm square cube!

The Holtek HT2070A is a low power CMOS LSI containing all of the necessary circuitry to simulate the action of a die. Its seven outputs directly drive LED's arranged in a 'H' pattern. In addition, an output is provided to directly drive a piezo buzzer. The HT2070A is also equipped with an 'auto-power-off' mode, returning the unit to a low-current stand-by mode a few seconds after the dice has been 'thrown'. This article also contains instructions of how to link two or more PCB's together to produce a dual die (triple die? quadruple die? Yahtzee here we come . . .)

Circuit Description

Referring to the circuit diagram in Figure 1, it can be seen that the barest number of components are required to produce a complete working dice project.

The DC supply entering the project must have the correct polarity, otherwise damage will occur to the semiconductors. The maximum operating voltage that can be applied to the HT2070A, IC1, is 3·3 volts (optimised for use with 2 × 1·5V cells). If using supply voltages in excess of this, a suitable voltage regulator should be employed. As the unit is both small and designed for battery powered use only, no smoothing capacitors are required. IC1 is brought out of stand-by mode by pulling its KEY input (pin 12) down to

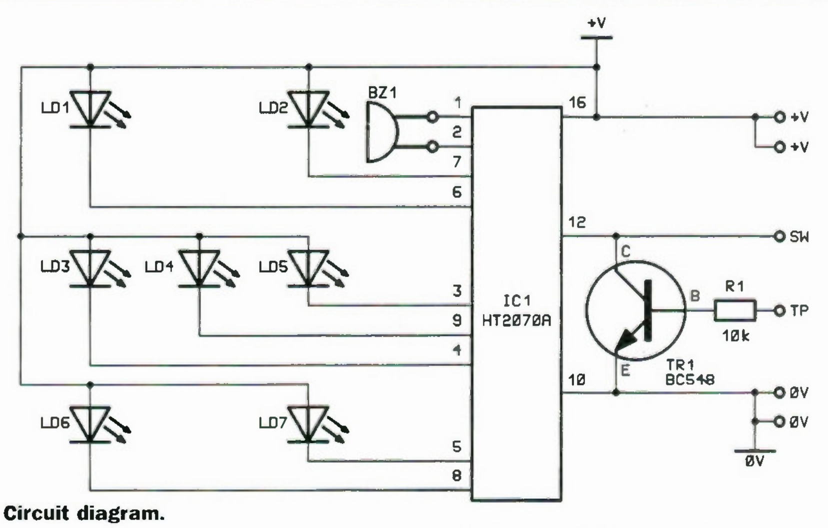
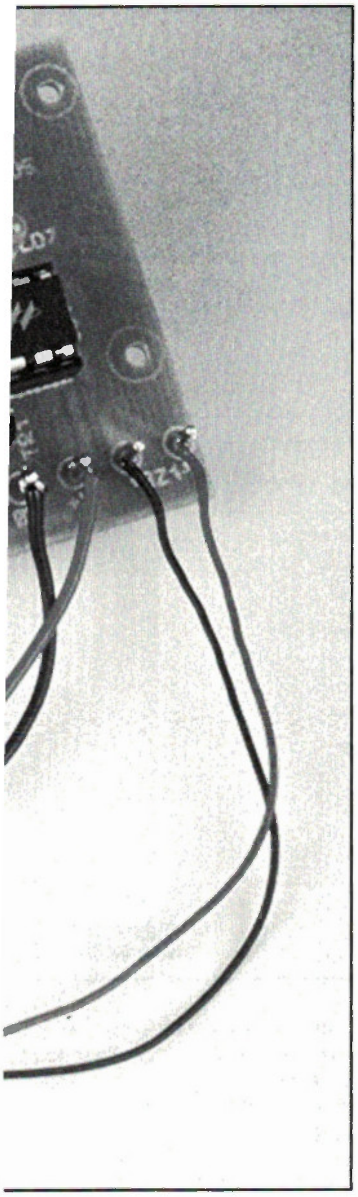


Figure 1. Circuit diagram.



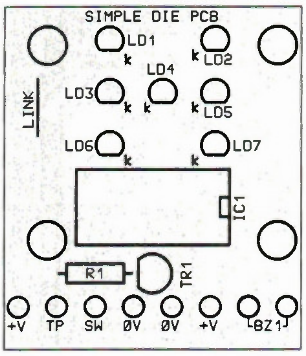


Figure 2. PCB legend and ghost track.

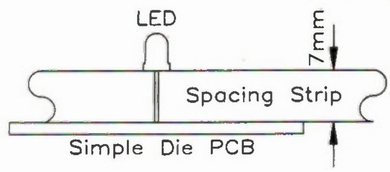


Figure 3. Mounting the LED's at the correct height.

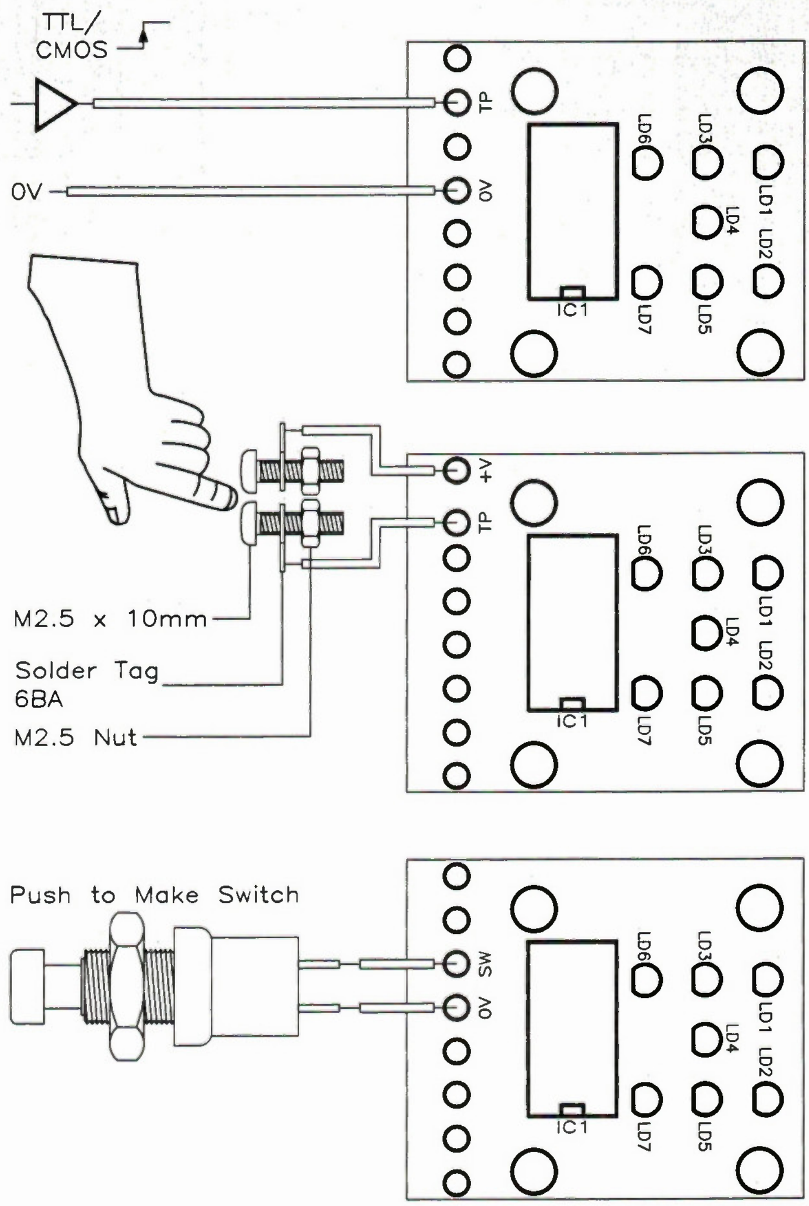


Figure 4. Various trigger configurations of the Simple Dice kit.

FEATURES

- Small PCB
- Easy to build
- Minimum of tools required
- No setting-up required
- Auto power-off
- Low stand-by current (typically $1\mu A$)
- Low cost

APPLICATIONS

Playing dice based games in limited spaces, or on the move

PROJECT RATING 1

Kit Available
Order as LU78K
Price £7.99

0 volts. However, the unit may be triggered by a positive pulse by fitting R1 and TR1 – this also allows the die to be activated by 'touch-pads'. IC1 incorporates current-limited drive for the seven LEDs, allowing them to be directly connected to the IC and, with a stand-by current consumption of only $1\mu A$, no on/off switch is necessary. In addition, by connecting a piezo buzzer across pins 1 & 2 of IC1, a 'beeping' noise is produced whilst the dice is 'rolling'.

PCB Construction

The Simple Dice kit is easy to construct and requires no special tools, setting up or adjustment. The circuit is constructed on a high quality fibreglass PCB which has a printed legend to facilitate component positioning. If you are new to project building, refer to the Constructors' Guide included with the kit for further information on component identification and soldering techniques.

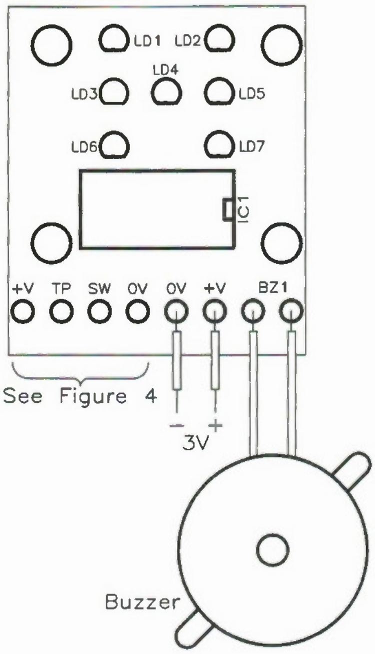


Figure 5. Wiring diagram.

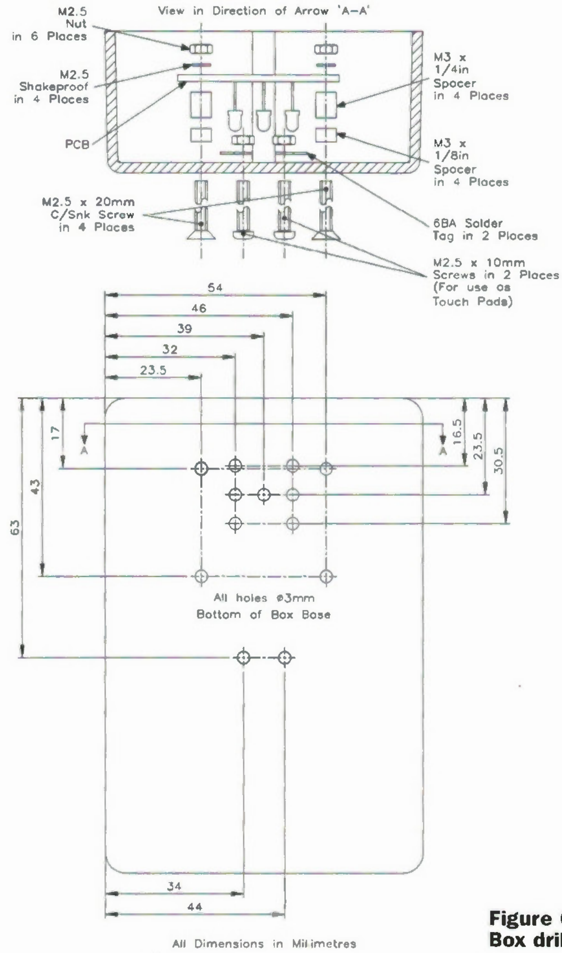


Figure 6. Box drilling.

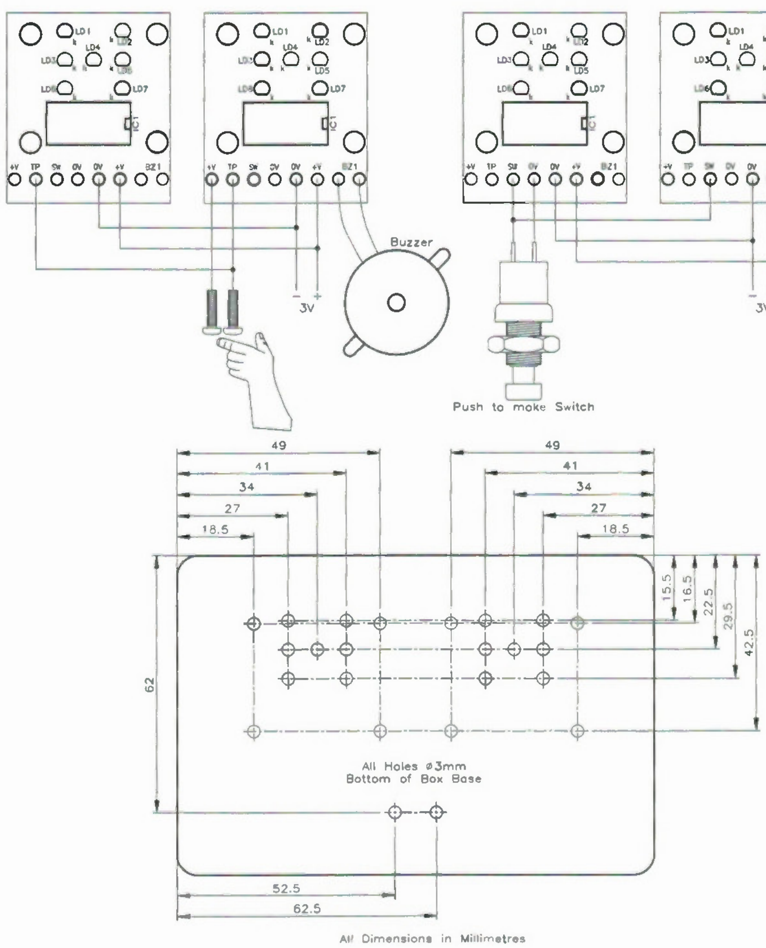


Figure 7. Linking multiple Dice kits together.

Insert and solder the components onto the PCB referring to Figure 2. Start by inserting the eight PCB pins, and press them into position using a hot soldering iron. When the pins are heated in this way very little pressure is required to push them in place. Once the pins are in position they can be soldered. Now fit the resistor, link (made from an off-cut resistor leg), IC socket (taking care to match the notch in the end of the socket with the block on the legend), and transistor (matching the shape of its case to the outline on the legend). All component leads should be kept as short as possible and the height of the components above the component side of the PCB must be kept to a minimum to avoid problems when housing the project.

With reference to Figure 3, the LED's require mounting at a height of 7mm above the PCB. The best way to do this is to cut a thin strip of card 7mm wide and place this between the legs of the LED's and the PCB whilst they are soldered in place. Note that the cathode wire, which is the shorter of the two, must correspond with the 'flat' side of the LED symbol printed on the PCB legend Take care not to overheat the LEDs as they can be very easily damaged.

Now check your work very carefully, ensuring that all solder joints are sound. It is also very important that the bottom, track side of the circuit board does not have any trimmed component leads standing proud by more than 1mm.

Wiring and Boxing

Figures 4 and 5 detail the various wiring configurations of a single Simple Dice kit. When using the 'touch-pads' it is suggested that two M2·5 × 10mm screws with 6BA solder tags and M2·5 washers and nuts are used; To ensure proper operation, these should be mounted on a 10mm pitch as detailed in Figure 6. Those who do not wish to hear the 'beeps' when the dice is 'rolling' need not fit the buzzer, BZ1.

Figure 6 gives drilling information for fitting the Simple Dice Project into a black plastic box, LH14Q. Note that the PCB is mounted from the *front* using M2·5 nuts/bolts and M3 spacers. Drilling is also given for positioning two M2·5 screws for use as touch-pads. The buzzer and battery box can be fixed in place using 'Quick stick' pads, HB22Y.

More Than One?

Multiple Simple Dice projects may be connected together, enabling one switch/touch-pad to control several dice. The wiring for such an arrangement is shown in Figure 7. Figure 7 also gives drilling information for fitting two Simple Dice kits in the black plastic box, LH14Q.

Rolling The Die

The Simple Dice kit can be used in the majority of situations where an ordinary die would normally be employed, for example, in games such as snakes and ladders or ludo. When the brightness of the LED's fade significantly it is recommended that the batteries are replaced to preserve correct operation of the unit. Two alkaline AA batteries should power the unit for months of typical use and, with a stand-by current consumption of only 1μA you need not worry about forgetting to turn the unit off!

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal film (Unless specified)			
R1	Min Res 10k	1.00	(M10K)
SEMICONDUCTORS			
IC1	HT2070A	1.00	(AE16S)
TR1	BC548	1.00	(QB73Q)
LD1-7	Lo I 3mm Green LED	7.00	(CJ56L)
MISCELLANEOUS			
BZ1	Low Profile Sounder	1.00	(KU57M)
	DIL Socket 16-pin	1.00	(BL19V)
	Pin 2145	0.08	(FL24B)★
	Simple Die Kit PCB	1.00	(GJ82D)
	Simple Die Kit Leaflet	1.00	(XZ43W)
	Constructor Guide	1.00	(XH79L)
OPTIONAL (Not in Kit)			
	AA Battery Box	1.00	(YR60Q)
	PP3 Battery Clip	1.00	(HF28F)
	Duracall AA	2.00	(JY48C)
	Box PB1 Black	1.00	(LH14Q)
	M2·5 × 10mm Steel Screw	As Req.	(JY30H)
	M2·5 Steel Nut	As Req.	(JD62S)
	6BA Solder Tag	As Req.	(BF29G)
	M2·5 × 20mm C/Snk Screw	As Req.	(JC69A)
	M2·5 Isoshake	As Req.	(BF45Y)
	M3 Spacer ¼in	As Req.	(FG33L)
	M3 Spacer ½in	As Req.	(FG34M)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.
The above items (excluding optional) are available as a kit, which offers a saving over buying the parts separately.
Order As LU78K (Simple Dice Kit) Price £7.99

Please Note: Items in the Parts List marked with a ★ are supplied in 'package' quantities (e.g., packet, strip, reel, etc.), see current Maplin Catalogue for full ordering information.

The following new item (which is included in the kit) is also available separately, but is not shown in the 1997 Maplin Catalogue.
Simple Dice PCB **Order As GJ82D Price £3.49**

Synchro Linking MULTIPLE PANASONIC RECORDERS

by Roger Silvester

It is well known that a pair of Panasonic video recorders, linked with a Synchro Connection Cord, can produce excellent, frame-accurate edits. The recorder, with the edit master loaded, is set in record/pause mode at the exact point where the next scene is to be added and the player is set in play/pause exactly at the start of the chosen scene. Releasing pause on the recorder causes both machines to backwind then roll forwards in synchronisation, performing the edit in exactly the right place.

When we at Copthorne Camcorder Club edit club videos, we pool our equipment so that we can use two or three machines as players, all connected to the same recorder. This allows us to work from two or three master tapes without frequent rewinding. The Panasonic system allows only one player and one recorder to be used at a time, so it is necessary to plug the Synchro Connection Cord into whichever player is in use or disconnect it completely in order to control the player independently. This isn't very good for the sockets nor, when we forget to plug the lead into the right machine, is it very good for our sanity.

To overcome this, I made up a switch box that allows us to have up to three players linked to a recorder and to switch the synchro control to any one, or none, of the players at will. The switch box has four 2·5mm jack sockets that match the Sync/Edit socket on a Panasonic deck and a rotary switch that points at any one of the three player sockets or either of the two NC (not connected) positions.

Using mainly Maplin components, the switch box cost me about £5 and a few hours work but has saved endless frustration and has, no doubt, prolonged the life of our video recorders. You will, of course, need extra Synchro Connection Cords which can be made up very easily using a couple of 2·5mm stereo jack plugs and an appropriate length of twin coaxial cable. If you don't want to make up your own, these can be obtained from Panasonic stockists (Panasonic part no. VW-K1E) or from Lectropacks.

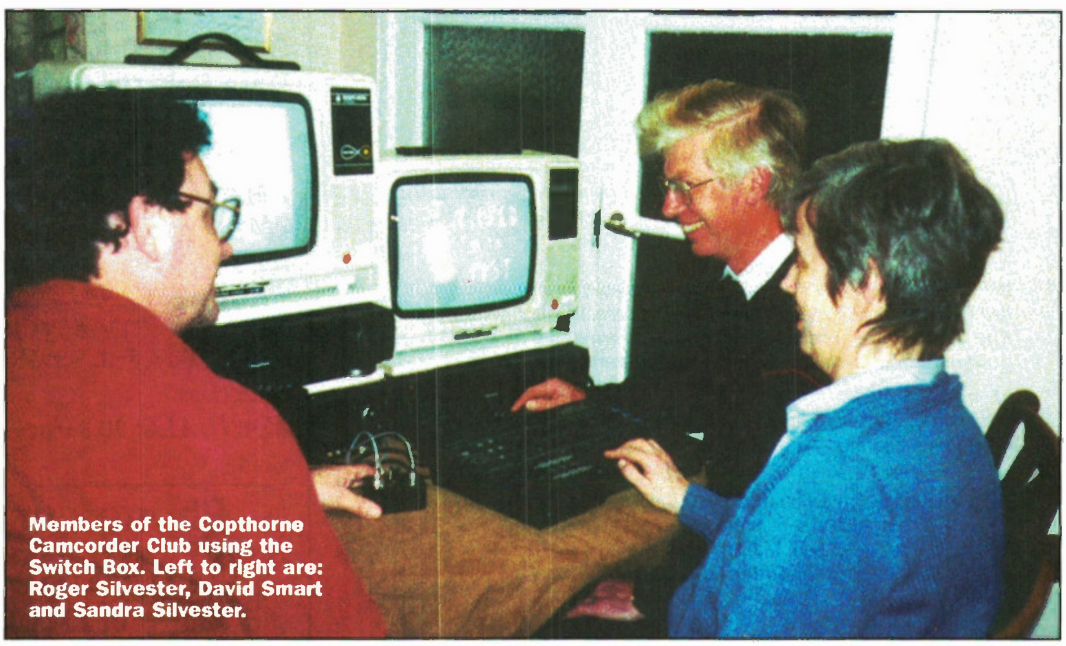
Box Drilling

For the sake of neatness, I chose to build the components into the box, but you might find it easier to build them onto the lid. The hardest part of the construction is marking out and drilling the holes. This isn't critical and can be done with a hand drill, but the nearer you get to the dimensions shown in Figure 1, the neater the job and the easier it is to assemble the components. If the box is more than 2mm thick, it will be necessary to counterbore the four 6mm holes slightly so that the thread on the end of the socket reaches through far enough for the locking ring to engage. The other bit of surgery that will be necessary is to shorten the spindle of the rotary switch to about 11mm. If using a vice, grip the spindle, not the body of the switch while sawing.

While it isn't necessary to label the box at all, it is useful to label at least the three player sockets and the two off positions. Use 2·5mm white letters. Having applied the lettering, it is a good idea to give it a coat of protective lacquer. Most art shops supply a suitable aerosol spray.

Component Assembly

Assemble the four sockets into the box with the cable grips towards the sides and then splay the cable grips outwards so that the solder tags can be seen easily. It makes wiring easier if you ensure that all the solder tags lie on a circle around the rotary switch. The switch has a series of holes numbered 2 to 11 on its top surface. The tongue of the stop washer should be inserted into hole number 5 and then the



Members of the Copthorne Camcorder Club using the Switch Box. Left to right are: Roger Silvester, David Smart and Sandra Silvester.

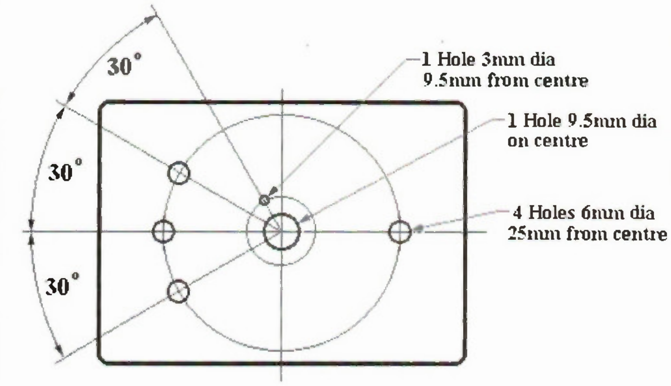


Figure 1. Box drilling details.

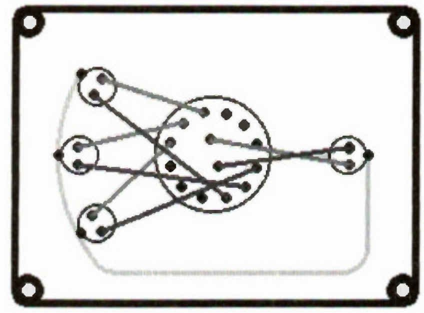


Figure 2. Wiring diagram.

switch can be assembled into the box, taking care that the locating lug goes into the 3mm hole in the box.

The solder tags on the sockets are coloured differently for easy identification; the silver one connects to the jack plug's ring contact and the copper one connects to its tip contact. The tip contact solder tags on the player sockets A, B and C are wired to switch contacts 10, 9 and 8 respectively, while the ring contact solder tags are wired to 4, 3 and 2. Note that the recorder socket wires must be crossed so that the tip solder tag is wired to switch contact C and the ring solder tag wired to switch contact A. The four jack socket cable clamps carry the earth and are wired together. Sounds complicated, but a glance at Figure 2 will make everything clear.

Testing

Before plugging in to your expensive video recorders, I recommend that you test the switch for correct polarity. Plug a Synchro Connection Cord into the recorder socket and another into player socket A. Switch to position A and check that the body, ring and tip of one jack plug are connected to the corresponding parts of the other. Check also that there are no short circuits between body, ring and tip. Now repeat this for positions B and C.

If all works well, you are on your way to your next movie competition winner.

Hints

Marking out can be made easier by sticking a large self-adhesive label to the box and drawing on it with a sharp pencil. After drilling the holes, the label can be removed with paraffin. Don't use a solvent that will damage the plastic box.

A neat way to connect the earth points is to form a piece of stiff copper wire into the required shape and solder it to the four socket cable clamps.

Any 2·5mm white dry transfer letters can be used, however, Letraset sheet L154 has both upper and lower case on the same sheet. Neat white lines can be obtained by rubbing down parts of the transfer sheet heading box.

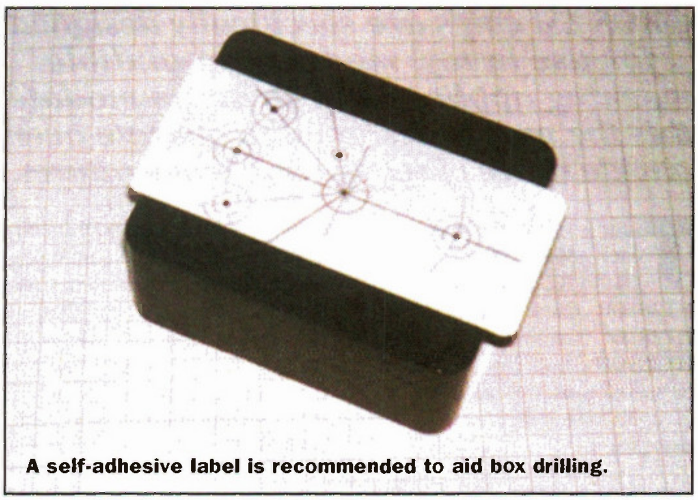
Points of Contact

Maplin Electronics PLC.,
P.O. Box 777, Rayleigh,
Essex SS6 8LU.
Tel: (01702) 554000.

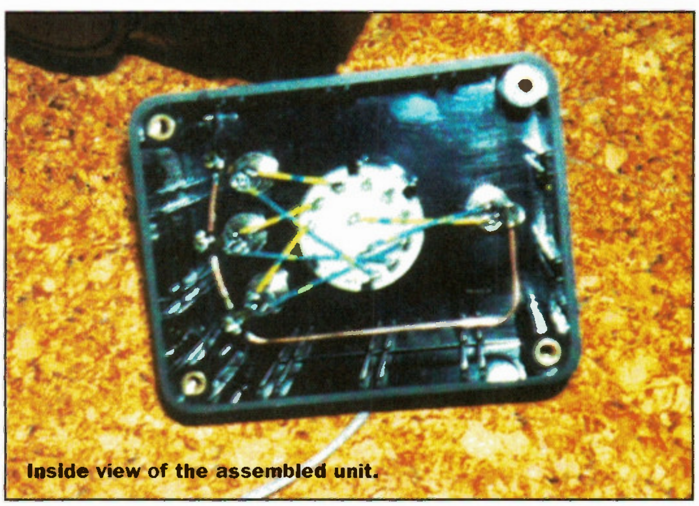
Lectropacks, Windsor House,
141 Bath Road, Hounslow,
Middlesex TW3 3BT.
Tel: (0181) 572 9737.

Panasonic Electronics UK,
Willoughby, Bracknell,
Berkshire RG12 4FP.
Tel: (01344) 853943.

The completed unit.



A self-adhesive label is recommended to aid box drilling.



Inside view of the assembled unit.

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless stated)		
MB1 Plastic Box	1	(LH20W)
2·5mm Stereo Chassis Socket	4	(FT94C)
2-pole 6-way Break-before-make Rotary Switch	1	(FF74R)
Knob	1	(RW87U)
Red Hook-up Wire	1 Pkt	(BL07H)
Blue Hook-up Wire	1 Pkt	(BL01B)
Green Hook-up Wire	1 Pkt	(BL03D)
Synchro Connection Cord (one cord needed for each VCR in use)		
2·5mm Stereo Jack Plug	2	(FE67X)
Twin Screened Cable	As Req.	(XR20W)

The Maplin 'Get-You-Working' Service is not available for this project.
The above items are not available as a kit.

PROJECT

HT2810x Series SOUND GENERATORS

Design and Text by Tony Bricknell

The Holtek HT2810x series of low-power CMOS LSI chips are specifically designed for use in toy, model, and audible warning applications. To accommodate this the unit is designed to operate over a wide range of voltage and temperatures.

Three kits are available, each with a different siren sound IC, as follows:

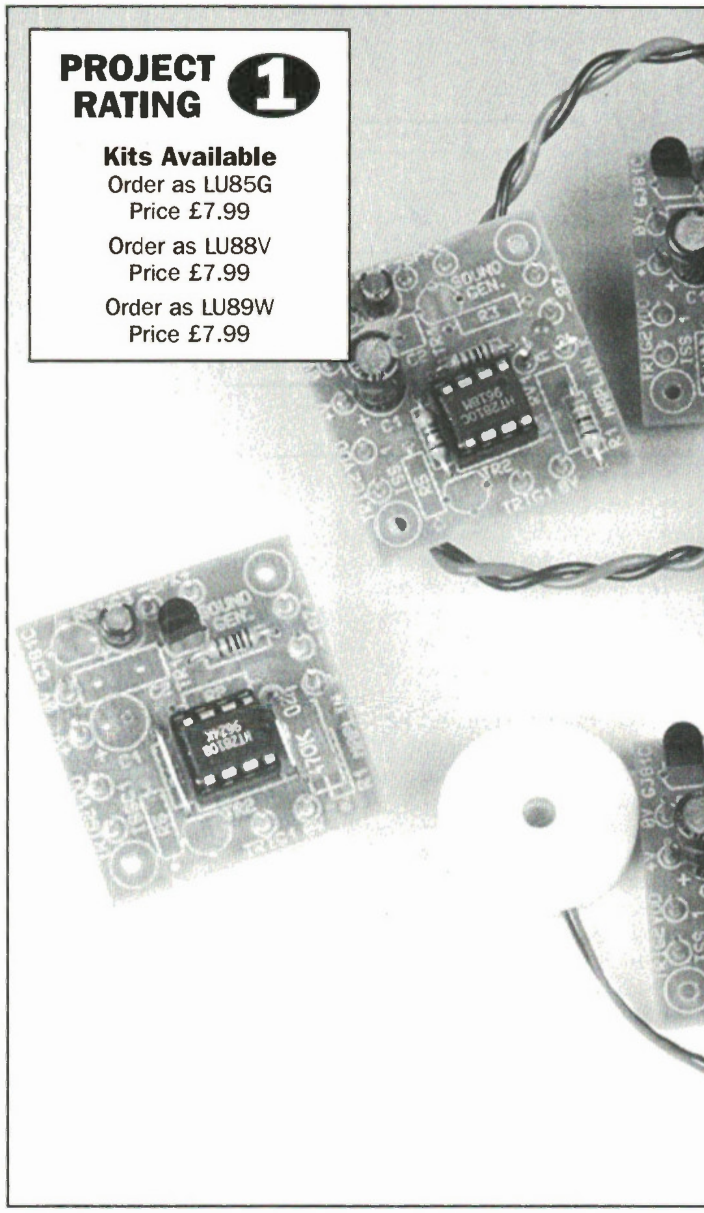
HT2810B Car siren 1 Kit LU85G
HT2810C Car siren 2 Kit LU88V
HT2810H Police car Kit LU89W

Be sure to order the correct kit code for the desired siren sound.

The HT2810 siren sound chip is a compact module containing a logic controlled tone generator, key input logic, LED and Output drivers, see Figure 1. The oscillator runs at a nominal frequency of 64kHz, although this may be varied to speed-up or slow-down the siren tone.

PROJECT RATING 1

Kits Available
Order as LU85G
Price £7.99
Order as LU88V
Price £7.99
Order as LU89W
Price £7.99



SPECIFICATION

Single power supply: 2·4V~24V
Low stand-by current: 1μA typically at V_{DD}=3V
Auto power-off
Speaker or buzzer drive
Pulsed LED output
Minimal external components

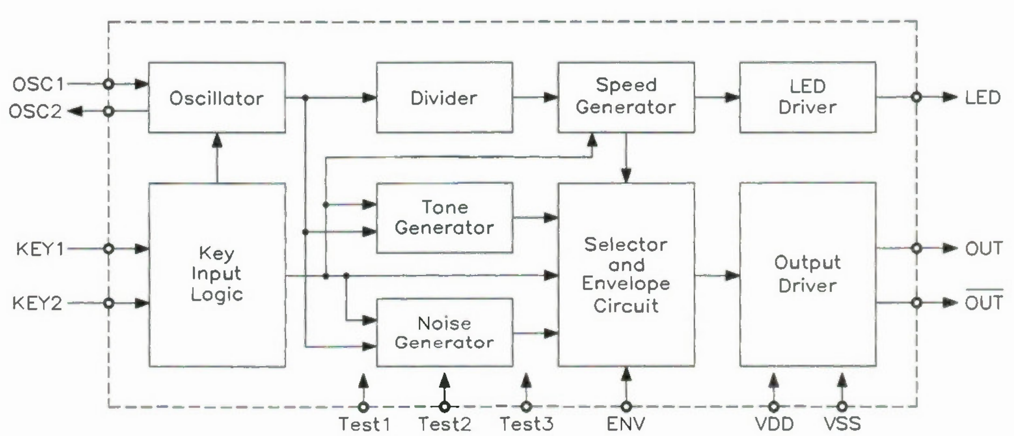


Figure 1. HT2810 Block Diagram.

FEATURES

Easy to build

Minimum of tools and test gear required

No setting-up required

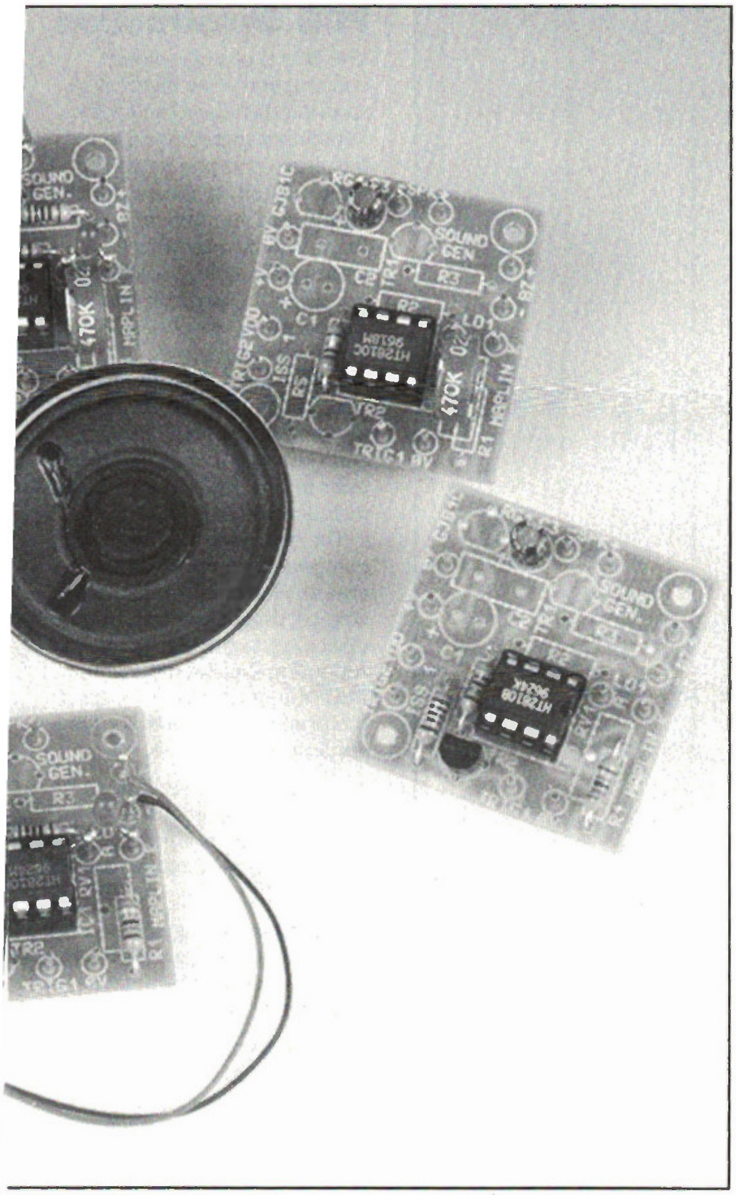
Low power consumption

Three different versions

APPLICATIONS

Children's toys

Audible warning devices



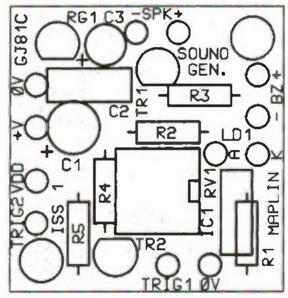
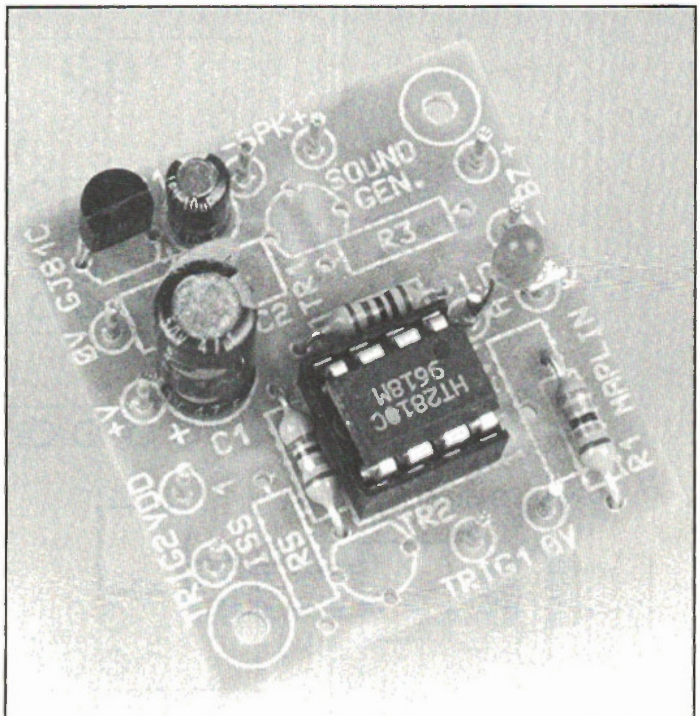


Figure 3. PCB legend and ghost track.

mode by pulling its KEY input (pin 6) down to 0 volts. However, the unit may be triggered by a positive pulse by fitting R5 and TR2 – these also allow the unit to be activated by a 'hand-touch', see Figure 4. The oscillator frequency of IC1 is set by R1/RV1, with a value of 330kΩ producing a nominal oscillator frequency of 64kHz. Finally, R2 provides a current limit to the LED drive produced on pin 4 of IC1.



The assemble PCB.

Circuit Description

As can be seen from Figure 2, few additional components are required to complete the project. The DC supply entering the project must have the correct polarity, otherwise damage will occur to the semiconductors. The maximum operating voltage that can be applied to the HT2810, IC1, is 3·3 volts. If using supply voltages in excess of this, the voltage regulator RG1 should be fitted, allowing supply voltages of up to 24 volts to be utilised. Capacitors C1, C2, and C3 provide supply decoupling, while R4 limits the current supplied to IC1 when directly driving a high-impedance piezo sounder. To allow the unit to operate a low-impedance loudspeaker, R3 and TR1 are used to increase the drive capability of the IC. IC1 is brought out of stand-by

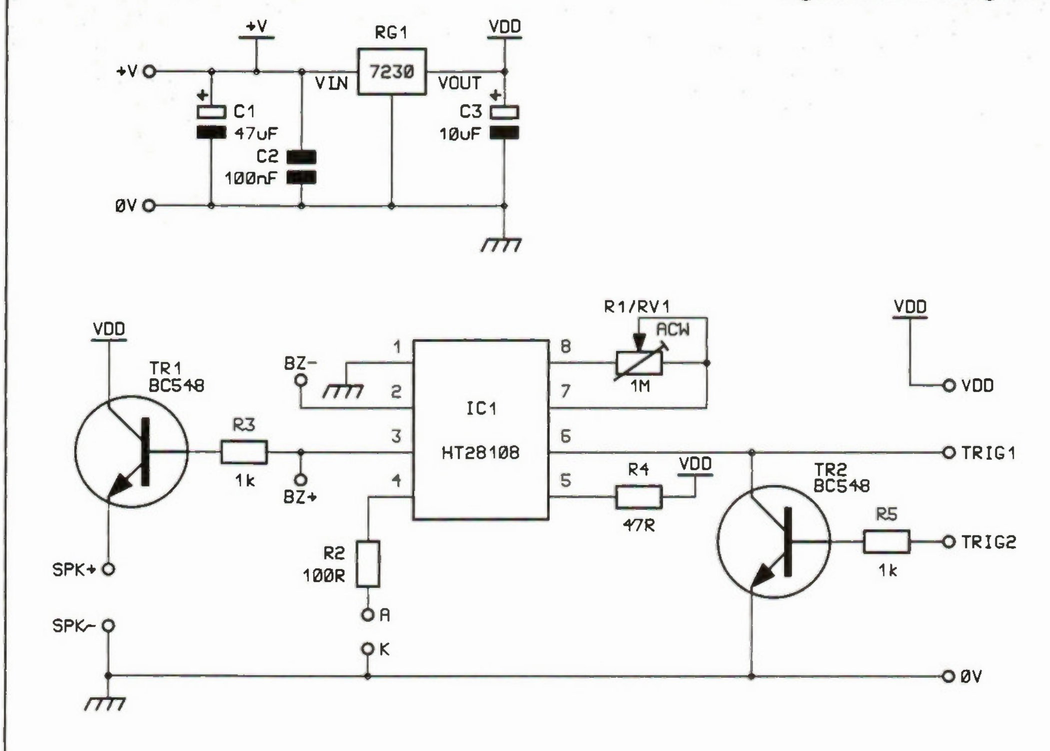


Figure 2. Circuit diagram.

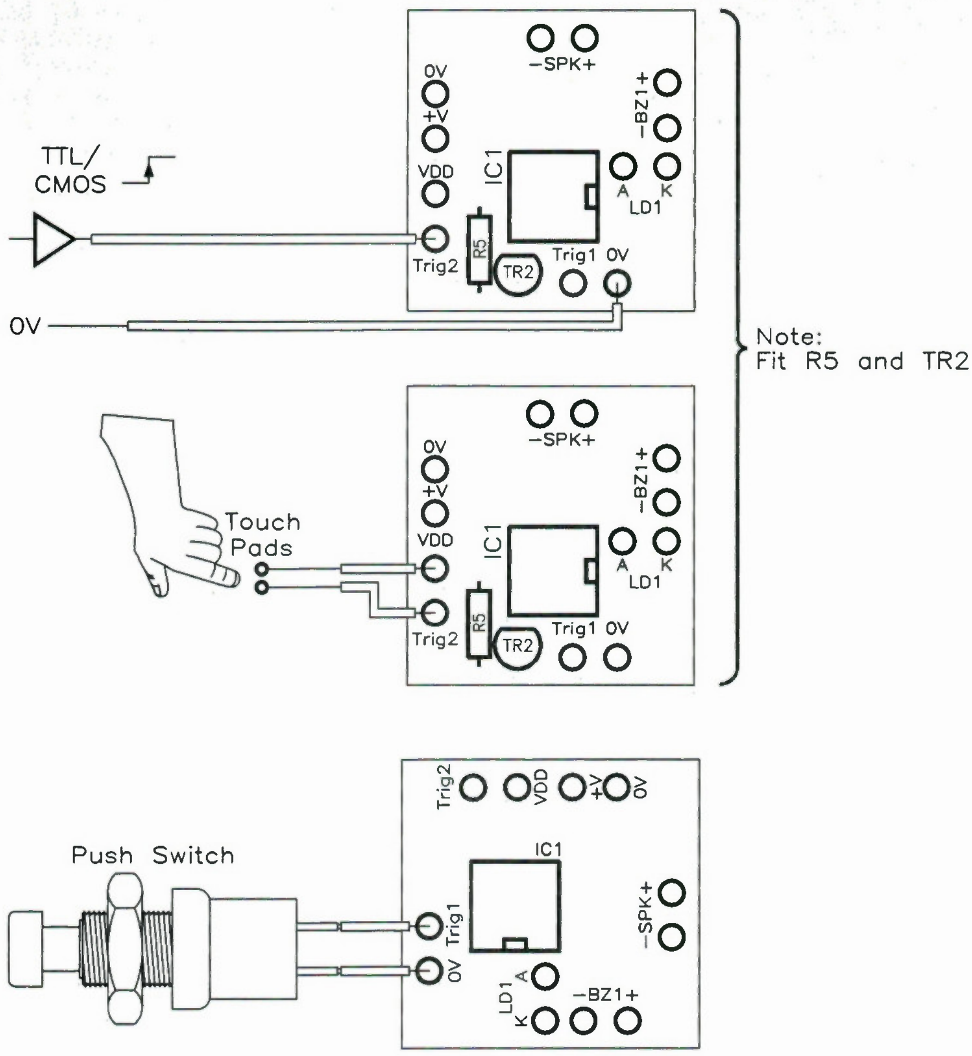


Figure 4. Various trigger configurations of the Siren Sound kit.

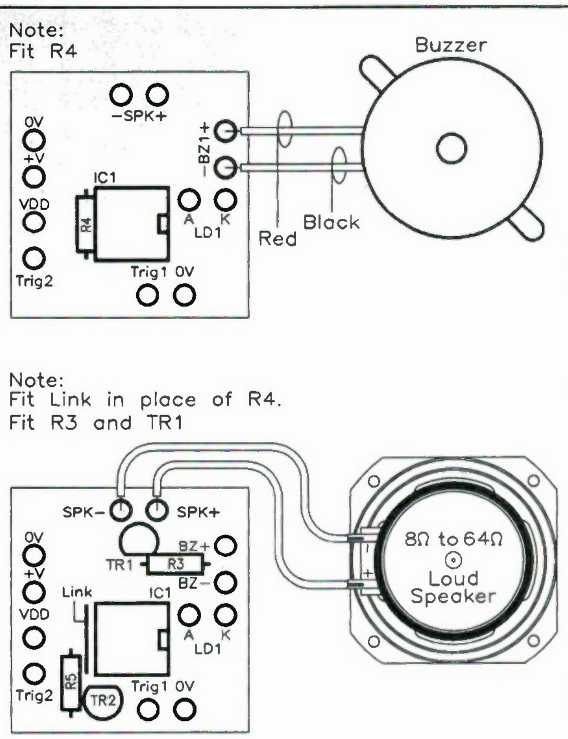


Figure 5. Output configurations available.

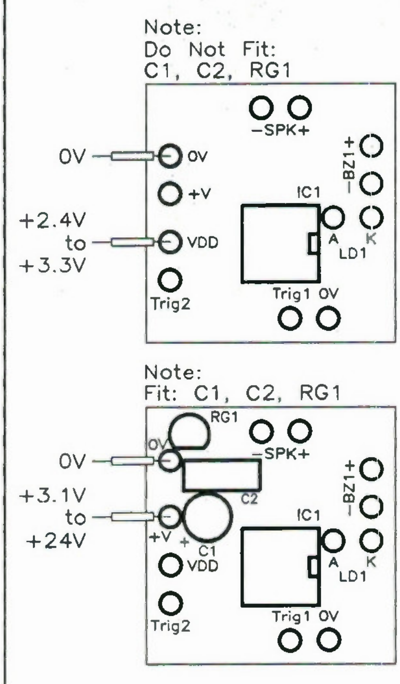


Figure 6. Power supply requirements of the Siren Sound kit.

PCB Construction

The PCB is of single-sided construction – see Figure 3, showing the legend and track. Remember that removal of a misplaced component can be quite difficult, so please double-check each component type, value, and polarity where appropriate, before soldering! Be careful to correctly orientate the polarised devices, i.e. electrolytic capacitors, transistors, regulator, IC and socket. For further information on component identification and soldering techniques please refer to the Constructors' Guide included with the kit.

The sequence in which the components are fitted is not critical. However, the operating voltage, trigger method, output device, and stand-by current are set during the assembly of the PCB. You must therefore select the option most suited for your application, as follows:

1. Operating voltage 2·4V to 3·3V and low stand-by current. Do not fit C1, C2, or RG1. Apply operating voltage between pins V_{DD} and 0V.
2. Operating voltage 3·1V to 24V. Fit C1, C2, and RG1. Apply operating voltage between +V and 0V.
3. When using a piezo sounder (connected to pins BZ+ and BZ–), R4 should be fitted. R3 and TR1 need not be fitted.
4. When using a loudspeaker (connected to pins SPK+ and SPK–), R4 should be replaced with a wire-link, and R3 and TR1 should be fitted.
5. For a fixed siren sweep rate fit R1. To enable the siren sweep rate to be varied, fit RV1. DO NOT fit *both* R1 and RV1.
6. If not using the LED, R2 need not be fitted.
7. When using 'touch-pads' or active-high logic to activate the unit, R5 and TR2 should be fitted.
8. ALL options require that C3 and IC1 are fitted.

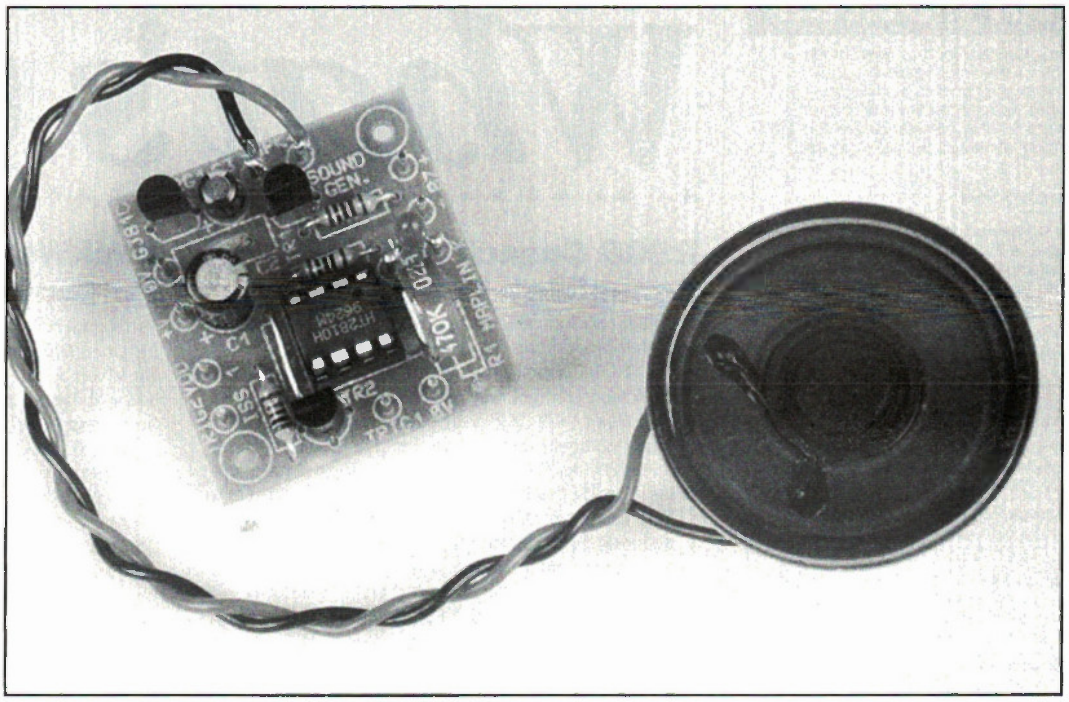
Now check your work very carefully, ensuring that all solder joints are sound. It is also very important that the bottom, track side of the circuit board does not have any trimmed component leads standing proud by more than 1mm.

Wiring

Figures 4, 5 and 6 detail the various wiring configurations of the Siren Sound kit. It is important to note that, to comply with EC regulations regarding Electro-Magnetic Compatibility, the leads from the PCB to the speaker/buzzer should not be extended beyond a length of two metres.

Using The Siren Sound Generators

The unit can now be installed into your toy, model or security/siren housing. If you have the available space the sound level from the unit can be increased by using a low impedance loudspeaker, such as the 8Ω 388 type (WB04E). When used as an audio warning signal, a high efficiency horn speaker (XQ73Q) will give a further increase in sound level from the basic unit. However, if greater volume levels are required then a power amplifier can be used to achieve the desired sound level. ELECTRONICS



PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless Stated)

R1	330k	1	(M330K)
R2	100Ω	1	(M100R)
R3	1k	1	(M1K)
R4	47Ω	1	(M47R)
R5	10k	1	(M10K)
RV1	470k Vertical Enclosed Preset Potentiometer	1	(UH21X)

CAPACITORS

C1	47μF 50V Radial Electrolytic	1	(AT67X)
C2	100nF 50V Ceramic Disc	1	(BX03D)
C3	10μF 16V Radial Electrolytic	1	(AT98G)

SEMICONDUCTORS

IC1 depending on kit ordered:			
	HT2810B	1	(AZ32K)
	HT2810C	1	(AZ33L)
	HT2810H	1	(AZ34M)
TR1,2	BC548	2	(QB73Q)
RG1	3·0V Regulator	1	(LE77J)
LD1	3mm Low Current Red LED	1	(CJ55K)

MISCELLANEOUS

BZ1	Low Profile Sounder	1	(KU57M)
	8-pin DIL Socket	1	(BL17T)
	1mm Single-ended PCB Pin	1 Pkt	(FL24B)★
	PCB	1	(GJ81C)
	Instruction Leaflet	1	(XZ42V)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

8Ω Loudspeaker Type 388	1	(WB04E)
Plastic 5in. Horn Speaker	1	(XQ73Q)
Triangular Touch Pad	2	(HY01B)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.
The above items (excluding Optional) are available as kits, which offers a saving over buying the parts separately.
Order As LU85G (Car Siren 1 Generator) Price £7.99
Order As LU88V (Car Siren 2 Generator) Price £7.99
Order As LU89W (Police Car Siren Generator) Price £7.99
Please Note: Items in the Parts List marked with a ★ are supplied in 'package' quantities (e.g., packet, strip, reel, etc.), see current Maplin Catalogue for full ordering information.

The following new item (which is include in the kit) is also available separately.
Holtek 2810 Sound Generator PCB **Order As GH81C**

Diary Dates

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

March 1997

4 to 6 March. ICAT '97 – Computer Integrated Technology Design & Manufacturing Automation Event, NEC Birmingham. Tel: (0171) 388 2430.

6 to 9 March. Innovation and Inventions Fair, Barbican Exhibition Centre, London, Tel: (01202) 762252.

8 to 9 March. London Amateur Radio and Computer Show, Picketts Lock, Edmonton. Tel (01707) 659015.

10 March. Antennas, Stratford-upon-Avon & District Radio Society, Stratford-upon-Avon. Tel: (01789) 740073.

11 March. Night on the Air/Construction, Bromsgrove Amateur Radio Society, Tel: (01527) 542266.

12 to 14 March. The Television Show – The Film and Video Production, Business Design Centre, London. Tel: (0171) 344 3888.

16 March. Radio Rally, Norbreck, Blackpool. Tel: (01707) 659015.

18 to 20 March. NEPCON Electronics Exhibition, NEC, Birmingham. Tel: (0181) 910 7910.

18 to 20 March. Semiconductor Solutions Exhibition, NEC, Birmingham. Tel: (0181) 910 7910.

23 to 25 March. Electrical Retailing Show, NEC, Birmingham. Tel: (01737) 768611.

24 to 27 March. 1997 Power System Protection and Exhibition, University of Nottingham. Tel: (0171) 344 5477.

24 March. Surplus Equipment Sale, Stratford-upon-Avon & District Radio Society, Stratford-upon-Avon. Tel: (01789) 740073.

25 March. Talk – C. M. Howes Communications Kits by Dave Howes G4 KQH, Bromsgrove Amateur Radio Society, Tel: (01527) 542266.

25 to 27 March. Institute of Physics' Annual Congress, University of Leeds, Tel: (0171) 470 4500.

25 to 27 March. Sixth International Developments in Power System Protection Conference, University of Nottingham, Nottingham. Tel: (0171) 344 5478.

April 1997

8 April. Construction/Night on the Air, Bromsgrove Amateur Radio Society. Tel: (01527) 542266.

8 to 10 April. Environmental Technology, NEC, Birmingham. Tel: (0181) 910 7910.

14 April. Annual General Meeting, Stratford-upon-Avon & District Radio Society, Stratford-upon-Avon. Tel: (01789) 740073.

14 to 17 April. Tenth International Conference on Antennas and Propagation, Heriot-Watt University, Edinburgh. Tel: (0171) 344 5478.

22 to 25 April. COMDEX – Information Technology Trade Show, Earls Court, London. Tel: (0181) 741 8899.

25 April. Top Band Direction Finding Competition, Stratford-upon-Avon & District Radio Society, Stratford-upon-Avon. Tel: (01789) 740073.

May 1997

12 May. Visit to the Technical Operations Centre, BBC Transmissions, Warwick, Stratford-upon-Avon & District Radio Society, Stratford-upon-Avon. Tel: (01789) 740073.

13 to 14 May. Property Computer Show North, Royal Armouries, Leeds. Tel: (01273) 857800.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, Electronics and Beyond, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.

What's On?

RSGB Council and Committee News

The Radio Society of Great Britain's(RSGB) new executive vice-president is John Greenwell, G3AEZ. He was elected by the RSGB Council at its meeting on 11th January 1997. The following changes were also announced by the Council:

- Paul Essery, GW3KFE is the new chairman of the Membership Liaison committee. He fills the vacancy created by Ian Kyle, GI8AYZ, who was elected president.
- Ian Cornes, G4OUT, has been appointed as the new VHF manager. David Butler, G4ASR, had earlier resigned from the position and was thanked for his work in representing UK interests internationally.

The meeting also declared that the Repeater Management Group of the RSGB is now to be called the Repeater Management Committee (RMC) to bring its title into line with the other committees. Chris Goadby, G8HVV is the new chairman of the RMC. The previous incumbent, Geoff Dover, G4AFJ was recently elected to the RSGB Council.

For further details, check: **http://www.rgsb.org**. Contact: RSGB, Tel: (01707) 659015.

The BackWeb Channel

By establishing a BackWeb Channel, companies of all types and sizes can create and deliver a wide variety of content to support a range of business models, including direct marketing, electronic commerce, subscriptions and sponsorships.

Customised content can be delivered using a variety of presentation formats, including interactive animations, screen savers and wallpapers, called BackWeb InfoPaks. Using BackWeb InfoPaks, companies have the flexibility to broadcast to a wide audience, narrowcast to an audience segment or personalcast to an individual end user.

Customers will receive the BackWeb client free when they subscribe to a company's BackWeb Channel. Customers can select the type of information they want to receive and when they want InfoPaks displayed on their desktops. Once they subscribe, customers will automatically receive the information they want without having to waste time searching for it.

InfoPaks are transmitted in background downloads during a user's idle Internet connection time. Utilising User Datagram Protocol (UDP), BackWeb's Polite Agent technology senses available bandwidth and downloads files incrementally when the user is not actively using an online connection, in effect 'doubling' bandwidth.

The Polite Agent gives priority to the user's foreground activities by stopping the download and making the full bandwidth available as soon as the user becomes active. If the user logs off before a download is completed, the Polite Agent notes where it left off and continues from that exact point the next time the user logs on. As a result, BackWeb's Polite Agent makes downloading even large, multimedia-rich files painless for the user. By the time they alert that the information they want is available, it is already resident on their PC.

Statistics regarding the user's interaction with each presentation are aggregated from the client to the server, allowing companies to measure the effectiveness of their InfoPak presentations.

Companies that are BackWeb Channel owners have begun developing customised content and include, InfoSeek Corporation, Ziff-Davis Publishing Company's ZDNet, The Wall Street Journal Interactive Edition, iWorld (Mecklermedia's daily Internet electronic newspaper), General Motors and EarthWeb's Gamelan Java Directory. European Channel providers are expected to sign-up to BackWeb over the next six months.

For further details, check: **http://www.backweb.com**. Contact: BackWeb, Tel: +1 408 437 0200.

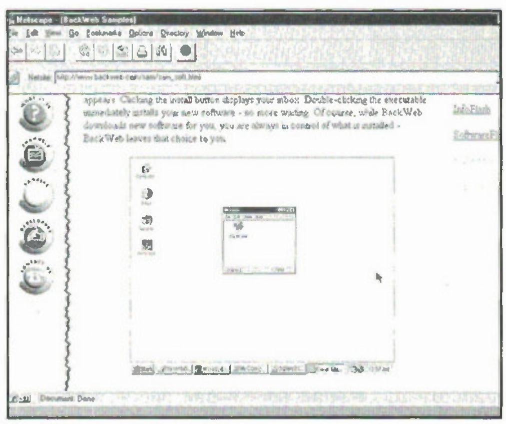
BackWeb Personalises Web

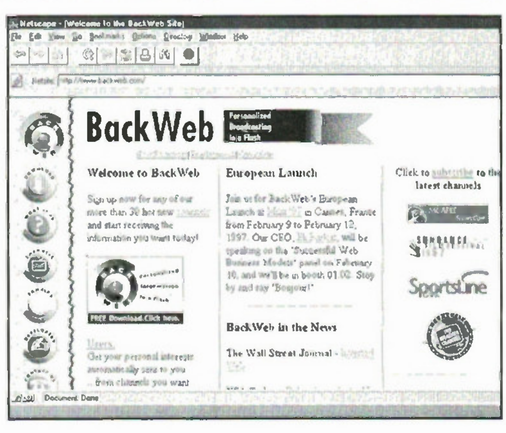
Setting its sites on establishing a new medium for proactive, 'one-to-one' online communication, BackWeb Technologies launched its breakthrough technology in Europe at Milia '97 in Italy at the beginning of February.

BackWeb is designed to fundamentally change the way companies do business and the way customers interact via the Internet. The new client/server system will enable companies to build direct, continuous relationships with customers and provide customised content based on their specific areas of interest.

Unlike centralised, online information services which aggregate content from numerous sources, the BackWeb system offers companies easy-to-use tools to create their own Internet channels. With BackWeb, companies can broadcast a wide range of customer-requested information, including entertainment, software downloads, news and information, and deliver it directly to targeted users based on their pre-selected areas of interest. Companies have complete control over the branding, editorial and 'look and feel' of the content being delivered, utilising a variety of compelling, multimedia formats.

Eli Barkat, CEO and president of BackWeb Technologies told *Electronics and Beyond*, "Companies on the Internet's World Wide Web are learning that posting information on their sites and hoping users will eventually stumble across it is not an effective way to market. With BackWeb, companies will know their message is reaching a very qualified audience because the user will have specifically requested the information".





Digital CAMERAS

by Reg Miles

At the big Photokina show held in Cologne last September, most of the major photographic companies showed digital still cameras. Some were already available, but most were either launched or announced there, adding to those from some of the computer and electronics companies. However, no one seriously expects them to replace conventional cameras in the near future – the other big launch at Photokina was the Advanced Photo System with its new film cartridge and cameras.

Even the cheapest digital camera is many times the price of a reasonable conventional camera. Most also require a computer to view the results, and printed hard copies from 'cheap' models are noticeably inferior to photographic prints. However, the results do look reasonable on a smallish monitor and the cameras provide a simple means of including illustrations in E-mail, web sites, home-made greetings cards, mailshots, and such like. Above that there are models costing up to £1,000 that give reasonable quality hard copies and quite good images on-screen – ideal for sales and promotions by small and medium size companies. Once over £1,000 mark, the quality improves noticeably, making them suitable for producing catalogues and CD-ROMs, news gathering, desktop publishing, etc., while the very expensive specialised models have virtually no limits. All the images can be transmitted over phone lines; although the better the quality, the longer it takes.

Analogue to Digital

Like almost everything digital, its roots lie in the analogue domain. In August 1981, Sony announced its prototype Mavica (magnetic video camera), which had a CCD image sensor and a reusable 50mm floppy magnetic disk called Mavipak that could record 50 analogue colour images. As Figure 1 shows, the still video (SV) camera was similar to a conventional single lens reflex model, but with a CCD in the focal plane and the Mavipak slotting into place behind it. The horizontal resolution was 350 lines (VHS is 260); and it could be switched between single image recording and continuous recording of ten per second. A complete system of accessories was also proposed, see Figure 2.

Sony's purpose in developing Mavica was twofold: firstly, to demonstrate that it could be done; and secondly, to interest others in agreeing a joint SV standard. Sharp showed a prototype that same year – but under glass. Then, in 1983, the Electronic Still Camera Standardisation Committee was formed by electronics and photographic companies, and in the following year, they agreed an SV standard based on the original Mavica.

Here, the video floppy (VF) disk was 47mm diameter, with a magnetic coating of metal particles. Again, 50 tracks could be recorded, plus a cue track to provide functions such as controlling the playback sequence and duration. The video was recorded in component form with an FM luminance carrier frequency of 7·5MHz at peak white and a frequency deviation of 1·5MHz, and there were two FM chrominance carriers at 1·2MHz for R-Y and 1·3MHz for B-Y, producing a horizontal resolution of about 360 lines. The rotational speed was 3,600rpm for NTSC and 3,000rpm for PAL/SECAM; thus, one field was recorded per revolution. The standard allowed for either one or two fields to be recorded at a time (the former would then be played back twice to give a complete interlaced TV frame). Obviously, frame recording using a double-gap head would give twice the vertical resolution, but cut the number of shots to 25, and whether fields or frames could be recorded would depend on the charge transfer and read-out characteristics of the CCD used. Provision was also made for the camera to select the first unused track on a disk by momentarily switching to play and for the erasure of individual tracks or the whole disk either in the camera or in a player, depending on the design.

Almost immediately, prototype SV models from Canon and Sony were loaned to a couple of Japanese newspapers to cover the Los Angeles Olympic Games. This convincingly demonstrated the advantages of instant read-out and remote transmission, but also highlighted the quality differences between SV and film images. Three prototypes were shown at the 1984 Photokina, from Copal, Fuji and Panasonic.

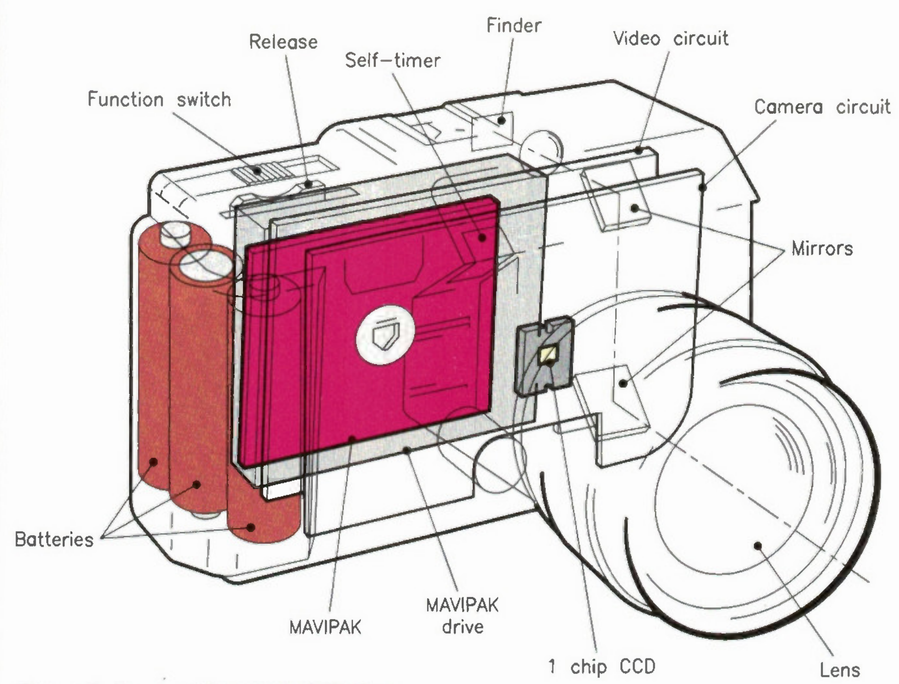


Figure 1. Perspective view of Mavica.

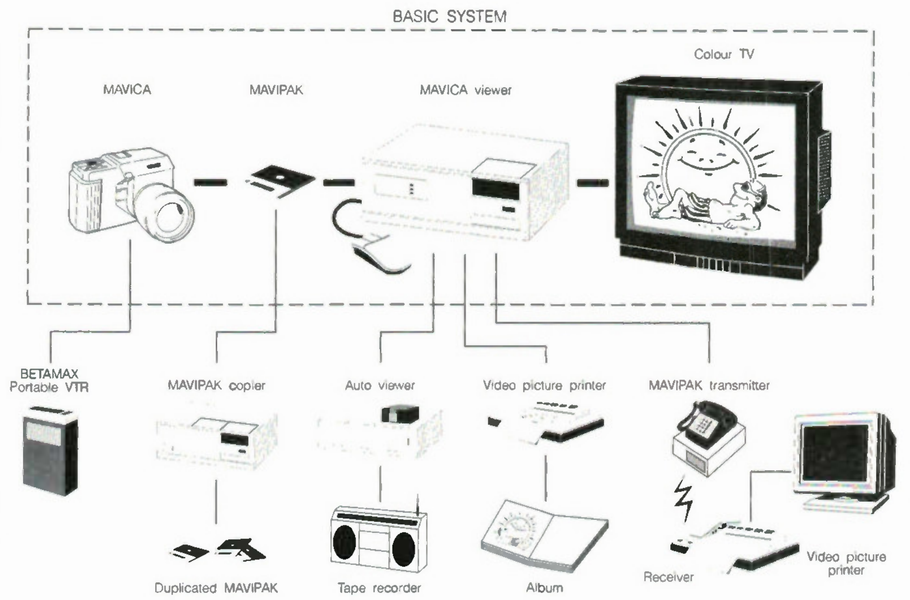


Figure 2. Mavica system.

Sound Move

Apart from a Konica prototype, nothing more of significance happened before 1986. Then, the Standardisation Committee announced an upgrade allowing mono audio to be recorded on blank video tracks. The audio was recorded in FM, with information to denote which audio track went with which video track. Three quality standards were provided for: 10kHz with 5 seconds duration, 5kHz with 10 seconds duration, and 2·5kHz with 20 seconds duration, the intention being to allow comments or ambient sounds to be recorded.

The first SVC to be launched, in 1986, was the Canon RC-701 – a limited production version of the prototype that had been used in Los Angeles. Although it was NTSC, it was also launched in the UK (for professional use, the video system is largely irrelevant; changing it to PAL would have meant a different CCD had to be used). It was an SLR type, with a single CCD, and recorded in field mode. Some more prototypes were shown, including a consumer model from Panasonic and an SV back for 35mm SLRs from Minolta, while Kodak announced it had developed a B&W camera incorporating a CCD with 1·4 megapixels (without colour filtering, the full resolution was usable).

Casio launched the first consumer model the following year. The VS-101 was also the first to have integral disk playback with video output to a TV, but it was confined to the Japanese market, as was Sony's professional Mavica.

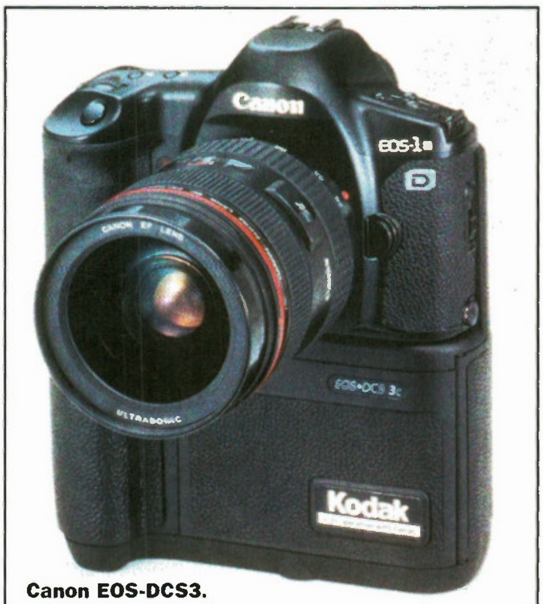
In 1988, a new high-band recording standard was announced in response to the Hi8 and S-VHS formats. This HiVF standard had a higher luminance frequency of 9·7MHz peak white and a frequency deviation of 2·0MHz, which pushed up the horizontal resolution to 500 lines (25% greater than Hi8/S-VHS). However, the actual resolution would depend on the number of pixels in the CCD and the output to the monitor – RF, composite or YC.

Canon launched a second SLR model, RC-760, that had a 600,000-pixel CCD, and could record in both field and frame modes. Again, this found its way to the UK, although in NTSC form. The same applied to Nikon's QV-1000C SLR and associated SV transmitter. Unlike the Canon cameras, though, this was a B&W model. It too could shoot in frame or field modes, although the latter was confined to the 20 images/second speed with shutter on $^1/_{1,000}$th second and mirror locked up. More consumer models were launched, with most conforming to the new HiVF standard. These included a restyled Sony Mavica, now a simple, horizontal model with a fixed lens, built-in flash and audio recording, and equally simple models from Canon and Konica. Fuji's offering was a little more upmarket, with a 400,000-pixel CCD and a 2× power zoom lens – plus audio recording. Fuji also showed a prototype high resolution SV camera with an 800,000-pixel CCD and a 500-line horizontal resolution.

A Spanner in the Works

But 1988 is best remembered as the year in which Fuji threw a spanner into the SV works by showing the DS-1P digital still camera prototype. The same 400,000-pixel CCD was used, but here, the signals were digitised with each of the red, green and blue pixels quantised to 8 bits, giving 256 density levels for each colour. The images were stored on a removable 2M-byte Static RAM card developed jointly with Toshiba – up to ten images in field mode and five in frame mode. The advantage of digital storage is well known: it is rugged and resistant to degradation, the signal is independent of video standards, and it obviously mates very well with computers. However, the SRAM card cost very much more than the disk, and it required a battery to retain memory, although it had no moving parts and required no motor. The camera was a basic model that belied its revolutionary nature. Apart, that is, from using an electronic shutter rather than a mechanical one: this operated within the CCD itself by dumping the charge that was building up and then finally holding it for the required duration – $^1/_{30}$-$^1/_{2000}$th second.

In 1989, Fuji and Toshiba were working closely together to develop the digital technology. Fuji had a second prototype, again, with the 400,000-pixel CCD. The camera was part of a complete system comprising a



Canon EOS-DCS3.

Epson PhotoPC 500.

card player, a remote commander with full keyboard, and a picture filing system for transferring images onto Digital Audio Tape (DAT). Toshiba showed a prototype with a 2·5M-byte card that could store 13 images with some degree of compression.

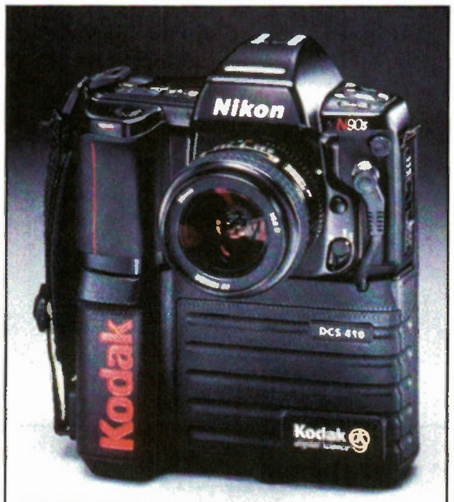
The Canon SV consumer model, which had been launched in Japan the previous year, was launched here as the ION RC-251 – the first model to be converted to PAL. It recorded in field mode, incorporated internal playback, and had a 300-line horizontal resolution. Canon also launched the RC-470 industrial camera with SV player in the UK (although NTSC); a HiVF model with field and frame modes with up to 20 images/second speed in the latter. Kodak continued with CCD development, announcing one that had 4 megapixels.

Prototypes Only

Production forecasts by some of the companies of a million units or more each within a year or two sounded extravagant even then, given that the models that had been launched were not selling in the numbers anticipated and that most of the companies were showing prototypes while waiting for the market to develop.

This trend continued in 1990. One of the prototypes was from Olympus, who also showed an SV processor to permit digital playback for editing and special effects. There were also three SV cameras launched. Sony's MVC-5000 SLR had two CCDs, one for luminance, the other for chrominance, sending their signals separately to the HiVF disk, enabling a horizontal luminance resolution of 500 lines. Other features included audio recording and interchangeable lenses. Sony also launched its Digital Information Handler for sending images, sound, text and data over analogue and digital lines. Both would be launched in the UK in 1991 – the camera in PAL. Another new model that would be launched in a PAL version the following year was an upgraded version of the Canon ION, the RC-260. This was demonstrated with computers, via a digitiser, as well as with TVs. Kyocera (Yashica) launched an SV model that looked like a small camcorder, with a 3× zoom lens.

A prototype that also looked like a small camcorder with a 3× zoom lens was Fuji's third digital model – an SLR this time. It used a 1M-byte SRAM card that could store 5, 10 or 20 images at 4:1, 8:1 or 16:1 switchable compression ratios. The compression used was of the Discrete Cosine Transform (DCT) type which operates by first dividing each image into discrete blocks of pixels and transforming those into a numerical series of coefficients describing the amplitude of the various frequency components. Statistically, most of the picture information will be concentrated in the lower frequencies, allowing the highest frequencies to be largely ignored. Run length coding is then performed so that repetitive values are recorded as codes specifying the number of times they are repeated; and then variable length coding that assigns short codes to the most commonly occurring sequences and longer codes to the least common. Accessories included a simple card player, which could output to either a monitor or a digital signal processor interfaced to a computer, and a transmitter for ISDN.



Kodak DCS-410.

Toshiba also had an upgraded camera that could store 12 frames at 4:1 compression using Adaptive Differential Pulse Code Modulation (ADPCM). This improves on Differential PCM, which records the differences in value between samples, by varying the basic step size to suit the rate at which the signal is changing, and by recording only the differences from a continually modified prediction of the signal. The Chinon prototype (another one looking like a camcorder) also used ADPCM, in this case, with a choice of 1 and 3M-byte cards; the latter accepting 30 compressed or 15 uncompressed fields. The Olympus prototype used a 700k-byte card, and employed Adaptive DCT to give a 10:1 compression ratio, enabling 36 fields or 18 frames to be stored. Konica's digital prototype recorded without compression, storing 10 fields on a 2M-byte card. Minolta approached things differently, taking the NTSC output from a modified SV back to a digitiser and card recorder fitted beneath the SLR camera where one uncompressed frame was stored on a 512k-byte card.

A Lack of Standards

No one seemed ready to agree a standard for the cards as they had done for VF disks. It was not only the number of pins that differed, but also how the data were distributed on the cards, the clock rates, etc., so that both writing and reading were affected.

Fuji further destandardised things by showing a prototype Ultrahigh Resolution Digital Camera. The HC-1 had three 800,000-pixel CCDs for red, green and blue behind a beam-splitting prism, giving an effective resolution of 1,280×960 pixels. Each of the colour pixels was quantised to 10 bits, giving 1,024 density levels. No SRAM card could store this amount of data, so it was output directly to a computer. The camera also had analogue outputs.

Rollei took a different approach: it launched a digital back for its medium format roll film SLR with a linear array CCD instead of the normal area array. This had a line of 5,000 pixels that was moved down in 6,000 steps to produce B&W in one pass and colour in three passes via red, green and blue filters, giving a 30-megapixel resolution at 10 bits. Output from the CCD went to a digitising board in a computer. Of course, it could only be used for static subjects and copying. The area covered by the scan was 35×41mm by comparison with the 6×6cm film frame, so the effective focal length of lenses was increased (a problem that does not affect dedicated cameras because their focal length is matched to the size of the CCD).

In 1991, Kodak launched its Digital Camera System (DCS) consisting of a digital back attached to a Nikon F3 35mm SLR and a digital storage unit (DSU) shoulder pack containing a 200M-byte Winchester hard drive. It had a 1·4-megapixel CCD; with the 6·8μm square pixels contiguous rather than separated as normal, to provide more even coverage (incidentally, pixels are normally rectangular, but square pixels match those of a computer monitor). The CCD measured 21×16mm, roughly 40% of the normal 36×24mm film frame, so the effective focal length was more than doubled. There were versions for B&W and colour. An 8M-byte Dynamic RAM buffer was capable of storing rapid bursts of up to six images, and this could be increased to 32M-byte. The DSU had a 4in. B&W LCD for previewing images, and could store up to 158 uncompressed images and up to 600 in compressed form using the Joint Photographic Experts Group (JPEG) system. This is DCT based, but incorporates a number of options to allow various compression ratios and levels of picture quality. Having a digital back on a conventional camera allowed photographers to change to a film back.

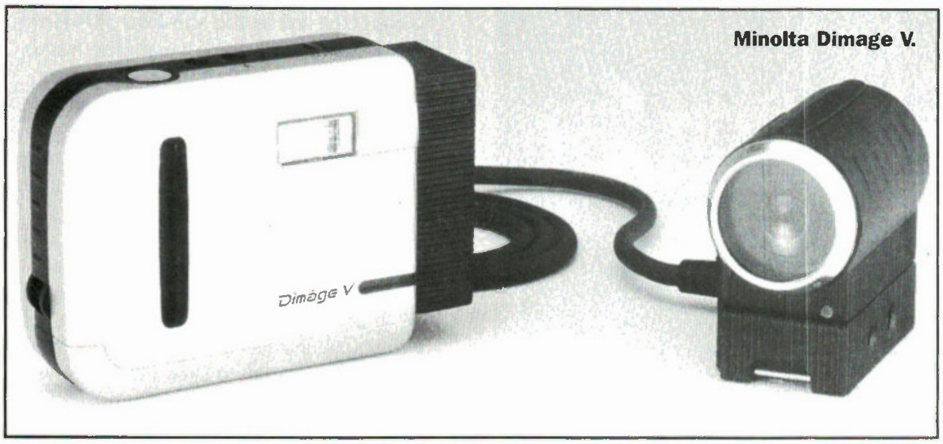
Fuji finally launched a digital camera. The DS-100 had what was claimed to be the world's first Adaptive DCT LSI compression chip, using a Bit Rate Control algorithm to fit each image into the same amount of memory, thus allowing data to be transferred to a computer at a standard rate from the card processor. The camera also had a built-in RF modulator for (NTSC) TV viewing.

Firing off Shots

Canon announced plans to set up facilities for people to have prints made from SV ION images in over 1,000 Hi-Fi, video and camera shops across Europe by the end of 1992 using a Canon video printer and Amiga 500 computer.

1991 was also the year that a digital camera was first taken up into space, aboard the Discovery space shuttle. It comprised a converted Nikon F4 with a 1-megapixel CCD. The B&W images were quantised to 8 bits and stored on a removable hard disk; they were then viewed and enhanced on a laptop computer before being transmitted back to Earth.

1992 proved to be the end of the analogue SV format, with the last launch being that of the Canon ION RC-560 – although Canon was bullish about it at the time. It was launched as a tool for use with computers and had an optional ION-Mac digitiser board (which inadvertently made the point that an all-digital system was more practical). Business users thought so, while consumers had largely rejected both analogue and digital systems. Minolta did launch a variation of its SV back, now with the CCD permanently built into a Dynax SLR, but with a separate DAT-type recorder to store 2,000 images in digital form.



Minolta Dimage V.

Logitech launched the Fotoman B&W digital camera, a basic device that could store up to 32 images in its internal memory. At the opposite extreme, Kodak launched the DCS-200 after field testing it at the Barcelona Olympic Games. This was a self-contained model based on the Nikon 901 autofocus SLR with a 1·54-megapixel CCD. Again, B&W and colour versions were available; each with either a 2M-byte DRAM for storing one image or an internal hard disk storing up to 50 JPEG images.

Built-in Flash

A useful development was the introduction of flash memory cards that required no battery to maintain memory. Fuji launched the basic DS-H2 to take both those and SRAM cards, while Ricoh showed a prototype that could also use the new card.

But the main developments in 1992 occurred in the specialist markets. Kodak launched the Megaplus B&W camera for medical, scientific and pre-press uses. This had a 1·4-megapixel CCD, with each image output to a frame-grabber in a computer. A colour version combined three successive exposures made through a red, green and blue filter wheel. A number of manufacturers launched digital backs that could be fitted onto medium format roll film cameras and/or large format sheet film cameras, with the output going to a digitising board in a computer. The backs were of two types: area array CCD and linear array CCD. Of the former, Arca-Swiss had a 1·13 megapixel CCD for one-shot B&W and triple-exposure colour, Sinar had a one-shot colour back with a 1·2 megapixel CCD, and Leaf had versions for one-shot B&W, triple-exposure colour and one-shot colour. The Leaf had the largest CCD at that time, measuring 30·5×30·5mm, with 4·2 million 15μm pixels. Its 14-bit quantisation gave 16,384 density levels. Incidentally, although large, the Leaf CCD was still smaller than the film area. Arca-Swiss also had a linear array back with 4,900 pixels stepping through 7,350 positions to produce 36 million pixels over an area of 36×47mm. 12-bit quantisation gave 4,096 density levels, which is greater than transparency film can achieve.

Fuji launched a production version of its Ultrahigh Resolution Digital Camera as the HC-1000, while Sony launched the SEPS-1000, based on a three-CCD video camera. This had an RGB output fed to a Digital Video Interface, where it was quantised to 8 bits per colour and interpolated to give a 1,536×576 pixel resolution.

Slow to Take Off

Despite the growing availability of equipment, there was still no great rush by professionals to embrace digital cameras. The equipment was seen as too expensive in a time of economic recession; and computers then had comparatively slow processors and small amounts of memory so that everything took a long time to achieve – instant results were still a dream. It was left to a minority of companies to set up digital departments alongside film and reap the benefits of both worlds.

The upmarket tone continued in 1993, although at a rather more subdued level.

JVC showed how to make a comparatively few pixels go a long way with the TK-F7300 multiple scanning camera. Each pixel has only a small area in its centre that is actually sensitive to light, so a lot of detail is missed.

Nikon Coolpix 100.

To overcome this, the TK-F7300 employed a motorised prism between the lens and square pixel CCD to fractionally shift the image and thus place each part of it on the sensitive area of each red, green and blue pixel, with the separate exposures then fused into one image in a computer. The basic resolution of 736×576 pixels thus required 3 movements for colour while the maximum required 108 movements to produce 36 RGB exposures for a 4,416×3456 resolution. Kontron's ProgRes achieved the same effect, but by microstepping the CCD to give resolutions of 500×380-4,490×3,480.

Canon showed a prototype high definition digital SLR with a 1·3-megapixel Base Stored Image Sensor (BASIS) – a development of the line sensor used for focus detection in its 35mm SLR cameras. This differs from a CCD in using a switched readout rather than charge transfer, and having an amplifier at the base of each pixel rather than after readout to increase the S/N ratio. Storage was on a hard disk or IC packs, with a SCSI interface.

There was also a new version of the 'space camera', with a 4-megapixel CCD.

Further Developments

Kodak began 1994 by demonstrating a prototype 6-megapixel CCD, measuring 27·6×18·4mm. Apple launched its QuickTake 100, a basic design with a flash EPROM that could store 8 or 32 images, depending on resolution. Kodak was back in the news mid-year with the DCS-420, based on the Nikon F90 and with a 1·5-megapixel CCD. Three versions were launched, for infrared, B&W and colour. Images were stored on removable PCMCIA hard disk or memory cards at 12 bits, and audio could be recorded. A variation on this, the NC-2000, was developed for use by Associated Press journalists; it had a 1·3-megapixel CCD with larger pixels to increase light sensitivity. Then Kodak launched two models with the 6-megapixel CCD: the DCS-460, which was otherwise the same as the DCS-420; and the DCS-465 back for medium format cameras, which shared the main features. Fuji and Nikon collaborated to produce the DS-505/DS-515 and E2/E2s respectively, based on a Nikon F4 SLR. This had a condenser lens that refocused the image onto the CCD to finally achieve full image coverage (see Figure 3).

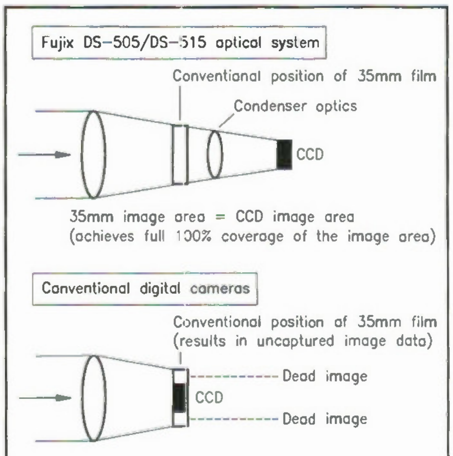


Figure 3. Fuji/Nikon optical system.

It had a 1·3-megapixel CCD, and used 8-bit quantisation, with images stored in uncompressed or JPEG form on PCMCIA cards. It also had a PAL or NTSC output. The DS-515 and E2s could shoot 3 images/second up to 7 frames. There were also a number of medium and large format backs launched together with some self-contained models, including those from Dicomed, Leaf and Phase One with tri-linear CCDs having three rows of RGB pixels to make colour scans in one pass.

Canon made a reappearance in 1995 with a digital model using the EOS 1n SLR with a Kodak back. The EOS-DCS3 had a 1·3-megapixel CCD; capturing 12-bit images and storing them at 8-bit on PCMCIA flash or hard disk cards, plus audio. Kodak launched an almost identical model, EOS-DCS5, but with a 1·5-megapixel CCD. Both versions were available in colour, B&W and infrared. Minolta launched the RD-175 SLR. This had three CCDs, two for green and one for red/blue CCD – which was said to improve the subjective resolution because the eye is more sensitive to green. Each CCD was arranged so as to cover gaps in the pixel array, giving a total of 1,528×1,146 pixels from the 380,000-pixel CCDs. The images were stored at 8-bits for G, G, R/B on a PCMCIA card. Agfa launched the same model under the name of ActionCam, and accompanied it with the StudioCam, featuring a tri-linear CCD. A few more top-range models were also launched.

At the opposite extreme, Casio launched the basic QV-10 incorporating the first 1·8in. colour LCD screen for use as a viewfinder and playback monitor, and with video output. Apple launched the upgraded QuickTake 150, which was capable of giving higher resolution images. Meanwhile, Chinon launched the ES-3000 which could store images using both lossless and lossy compression – internally and on a PCMCIA card. Kodak launched its first automatic camera, the DC40, for light business use. Lastly, Logitech launched the Fotoman Pixtura, with colour reproduction and improved resolution.

Last Year's Models

And so to the watershed(?) year of '96. There are now 31 companies offering over 60 models, with more announced for a 1997 launch. Those new and of particular interest are listed below.

Agfa has added a consumer model to its range, the ePhoto 307, with 2M-byte of internal flash memory to store 36 or 72 images. Canon has added the PowerShot 600 with an internal 1M-byte memory, and a PCMCIA card slot for storing up to 900 images; and the EOS-DCS1 with a 6-megapixel CCD. Casio has added the QV-100 with improved resolution. Colour Crisp's Carnival 2000 is a single-shot colour back for medium and large format that can also move the 31×31mm 4·1-megapixel CCD in three steps to increase resolution. The Dicomed BigShot 4000 has the largest CCD at 6×6cm with 16·7-megapixels in a 4,096×4,096 array; this is a one-shot colour back for medium format cameras. The EPixPRO has a built-in Intel 486 processor for advanced image management and will accept PCMCIA flash, hard drive, modem and Ethernet cards. Epson's PhotoPC 500 is the first to have an optional colour LCD screen, and it can store 60 images in internal memory, upgradeable to 200. Fuji has added the DS-7 having a square pixel CCD; it also has a 1·8in. colour LCD screen; images are stored on a 2M-byte Solid State Floppy Disk Card (SSFDC) in the new Exchangeable Image File (EXIF) format that is expected to become a standard for removable card storage.

Kodak has the largest range thus far, with four basic to business models (three of them new: the basic DC20, DC25 with LCD screen accepting the new CompactFlash card, and DC50 with a zoom lens), six SLRs based on Canon and Nikon bodies (again, three of them new: DCS-410, and EOS-DCS1 and DCS3), and the DCS-465 back. Nikon has added the Coolpix 100, which can be directly inserted into a computer's PCMCIA slot, enabling JPEG images to be directly downloaded – it also has a square pixel CCD. Olympus has launched three Camedia models: the top C800L has the highest resolution in its class with an 810,000-pixel CCD, and the cameras can output images directly to a printer as well as via a computer.

Polaroid's PDC-2000 is the first digital camera to combine high quality, uncompressed, images from a 1-megapixel CCD with the simplicity of an automatic camera. The Ricoh DC-2 is another model with a 1·8in. colour LCD screen, plus a built-in speaker for playing audio clips. Sanyo's VPC-G1 has upgradeable internal flash memory, and allows continuous preview of images on a computer monitor – if you are indoors or use a portable. Finally, Sony with two models – DKC-ID1 and DKC-5000: the former has a colour LCD monitor, and 12× zoom lens; the DKC-5000 consists of a camera with 3 CCDs, and a separate digital processor that stores the images and interfaces with the computer.

Winding On a Frame

There have been three models announced for an early 1997 launch. Konica's Q-EZ will be the first to use Intel's Miniature Card for storage with a 2M-byte capacity. Minolta has added the Dimage V – the first camera to have a detachable lens/CCD assembly, with viewing done on a 1·8in. LCD colour monitor; the CCD has square pixels, and images are stored on a 2M-byte SSFDC using the EXIF format. The Samsung SSC-410N also has a 1·8in. colour LCD screen, and accepts a CompactFlash card. Finally, the Vivitar ViviCam 2000 can store 10 or 21 images in a 512k-byte flash EEPROM and has the additional facility to output continuous video in real time, enabling it to be used as a video camera connected to a TV or a VCR.

Hitachi has taken that concept one stage further with its Digital Video Camera: this can record 20 minutes of MPEG-1 (Motion Picture Experts Group) compressed digital full motion video or 2,880 JPEG compressed digital still images on a 260M-byte PCMCIA hard disk card (MPEG-1 is used for full motion video on CD-ROM, and is DCT based). The camera is the first such device to use a single CODEC LSI chip to handle all the operations, and this has been developed by Hitachi. It will also record MPEG audio. Other features include a 1·8in. LCD screen, a 3× optical zoom and 2× electronic zoom.

Most new consumer and business models have standardised on 640×480 pixels as their maximum, minimum or middling resolution to conform to the VGA standard. All models come with software to interface with a computer. Many also provide some facility for enhancing and altering the images and to integrate them into other software, such as word processors. The more advanced models have image management software and can generally be integrated into a greater range of software. They may also include interpolation software to artificially bolster the resolution. The studio cameras have software enabling them to be operated more or less entirely from the computer. This will generally be a Mac; lower down the professional scale, it will usually be a choice of a Mac or a PC running Windows 3.1 or '95, while at the lower end, it swings in favour of the PC. Most cameras can interface directly with a computer to download images from internal memory; many cameras accepting cards can also act as card readers, while others will require a separate reader if the computer does not possess a card slot. A number also have a video output.

Olympus Camedia.

Summary

Prices of digital cameras are falling, particularly at the lower end, where the prices are being revised downwards even as they are launched. Already, there is talk of not getting enough return on investments (Logitech has withdrawn from the market due to insufficient sales at the price). However, professionals, semi-professionals and consumers with computers are coming to accept digital cameras for the convenience they can bring to image-making.

REVIEW

Mobile Data
THE CURRENT STATE OF PLAY

by Martin Pipe BSc (Hons) AMISTC

In last month's issue, we examined the GSM (Global System for Mobile communications) digital cellular standard, and put a state-of-the-art Motorola phone through its paces. One of the advantages of GSM, which has been adopted by cellular networks in a wide range of countries (including Cellnet and Vodafone in the UK), is that it is optimised for carrying data. The same is also true of the PCN (Personal Communications Network), which has taken off in the UK as consumer mobile phone networks (One2One and Orange). In normal use, that data would be digitised processed speech. But that data could also be from a computer, fax machine or hand-held data terminal. Because GSM and PCN were designed to work with digits from the outset, uncompressed data rates of 9,600bps can be achieved.

Packet-based Data Services

9,600bps without wires isn't new. Packet-based X.25 mobile data systems that operate at this speed, such as Paknet, have been around for years. This system, operated by Vodafone, is really intended for professional use. Paknet, which works over 14 VHF (160MHz) channels each with a 12·5kHz bandwidth, is normally associated with non-moving applications such as telemetry and the remote administration of security systems. Subscribers are given a small box, known as a Radio PAD (packet assembler/dissassembler), for connection via RS232 to their hardware. DC-powered PADs are available for mobile (e.g., lorry cab) installation.

The Paknet PADs communicate to base stations connected to the Paknet X.25 backbone. PADs can connect with other Paknet subscribers if authorised, or to services or other networks connected to the Paknet backbone via a leased or dial-up line. Paknet was, if you're interested, the subject of an article in *Electronics* (Issue 78, June 1994). A similar mobile data network, this time operating on 30 12·5kHz channels located at a frequency of around 450MHz, is operated by a company by the name of RAM Mobile Data.

But it's the volume business markets that are the most lucrative as far as mobile data is concerned. Being able to receive your e-mail, or send a fax to Head Office just after a meeting from the comfort of your car, is a powerful concept. Increasingly, businesses rely on communications to give them a competitive edge. Mobile data is simply an extension of this. The system could also be used by GPs to access patient records, or service engineers wishing to access their employer's parts database or repair records. Mobile data could also be valuable in situations where data needs to be sent from areas not immediately served by a phone-line, such as a cattle shed at a farm (in the case of a veterinary surgeon). For the same reasons, mobile data could prove valuable to police officers at the scene of a crime, or to scientists logging data 'in the field'.

Paknet and RAM are both dedicated to transmitting data, and not voice. They tend to be used from fixed locations, and for highly specialised and mission-critical applications such as credit-card ordering systems and security. Pricing tends to be high. Their main advantage is that calls are quickly set up, and don't have to adhere to the dial-up vagaries of public telephone systems. For example, Chubb marries a Paknet PAD, with an indoor aerial, to its alarm systems. It's used to alert the authorities in the event of a break-in – the speed of connection is obviously critical here. Burglars may cut the telephone line outside the building – many alarm systems use the public telephone network to send a pre-recorded 'help' message to the local police station. In this case, such sabotage won't have any effect. By the time the criminal has forced an entry, the Old Bill could be at the premises.

The majority of businesses, however, have different needs. A mobile data system must also handle voice, and its users should be contactable from an ordinary telephone or fax machine. It must also have a wide coverage – or at least, coverage that accommodates the needs of its users. The hardware should also be readily available, and this – as well as running costs – should be affordable. In most respects, cellular is ideal – the networks have been established for over a decade and have built up good coverage, subscription costs are reasonable, and it's possible to buy the hardware from a bewildering variety of retail outlets and mail-order companies. It's only comparatively recently that data transmission over cellular has been made a practical possibility in this country – most of which stems from its widespread adoption.

9,600bps doesn't sound like much, but it is sufficiently fast to acquire text e-mails for off-line reading. You can also surf the Web, although you're advised to turn off the 'auto load images' on your browser. I know of a journalist who roams around Europe in a RV (recreational vehicle), transmitting copy to his editor in the form of e-mails sent from his GSM phone and laptop. The new generation of briefcase-sized satellite phones, which will work with systems like Inmarsat, Iridium and Globalstar, also offer data compatibility at 9,600bps. These systems, which rely on globally-spanning clusters of satellites in low (900km) or intermediate (10,400km) orbits, really do (or will – most aren't due for a 1998 start) offer worldwide coverage. This is because the satellites offer much greater coverage than those Earth-based cellular repeaters with their limited range. Provided you have a clear view of the sky, you're just as likely to make a successful call from a mountain as you are from Clapham!

Analogue Cellular Data – The Beginnings

9,600bps, although it sounds limited when compared to today's PSTN (land-line) modem speeds, is still a dramatic improvement on what the earliest adopters of cellular data had to put up with. The first steps at transmitting data over mobile phones was done over analogue networks, four or so years ago. These could only muster 2,400bps as an uncompressed maximum, and even then, overall transmission times were adversely affected – inevitably, traditional analogue problems such as noise were a problem, and the chunks of data affected had to be re-transmitted (modern modem error-correction protocols handle this).

The first analogue cellular modems took the form of PCMCIA cards – indeed, they were among the first uses of this technology. The credit card-sized peripherals, a technological marvel made possible through the use of surface-mounted components and densely-packed ASICs, are inserted into a corresponding slot in your computer (for more details on PCMCIA, refer to *Electronics* Issue 94, October 1995). PCMCIA slots can be found on most of the notebooks and PDAs produced since 1993. Apple's PowerBooks and Newton PDAs have them, as do PC notebooks from IBM, Toshiba, Compaq *et al*, and PDAs from Sharp (such as the ZR5000). Unfortunately, an ideal candidate for mobile data – the Psion 3a – doesn't have PCMCIA (it's too small to accommodate the slot).

Analogue cellular modems weren't much different from regular PCMCIA land-line modems – except that they could instigate dialling on an attached mobile phone – and were much more expensive, reflecting their niche appeal. The cards relied on exactly the same transmission protocols (e.g., MNP5, v.42bis, etc.) that regular land-line modems used. Indeed, in telecommunications terms, these modems treated the cellular transmission line as a land-line. Hardly surprisingly, they were also supplied with cables that allowed them to be used as land-line modems. Perhaps just as well; the cost of the mobile call required in sending a couple of hundred k-bytes at 2,400bps (if you were lucky) was significant, and the land-line was always the best option if a BT phone socket was to hand. Over these, you could utilise the full performance of the modem – at that time, the 14,400bps afforded by the v.32bis CCITT standard. Transmitting data on the move was a no-no – you had to do it from a stationary vehicle, or whatever. Switching between cells is normally inaudible when talking on a cellphone. Unfortunately, cell-switching could adversely affect data transmission.

Fortunately, this issue has been solved – indeed, it had to – for GSM and PCN. Transmitting GSM or PCN data while moving – which is normally voice – is generally reliable. Transmitting data over analogue cellular links – which, remember, use unscrambled sub-GHz narrowband FM – also makes it vulnerable to interception by scanner-equipped hackers. If the entire transmission is from a stationary point to preserve integrity, then only one cell would be used. This would allow a nearby hacker to intercept the complete transmission, including modem-to-modem handshakes and any files transmitted from one end to the link to the other. Such security issues do not – yet, anyway – affect GSM voice or data services.

GSM Cellular Data

GSM data, the current de rigeur choice, has been with us since 1995. It offers all of the mobile benefits of the old analogue systems, together with more reliable communication, faster data throughput and international working. Public telephone connectors vary from country to country, and if a land-line connection is to be established, the traveller needs to ascertain the connectors used, and purchase the relevant adaptors in advance. A company by the name of Teledapt specialises in these adaptors. If you're in a country that has a GSM – specifically, a GSM network that has a roaming agreement with the UK service to which you subscribe – you won't need to worry about adaptors, or finding that your hotel doesn't have phone sockets at all.

Again, the hardware takes the form of a PCMCIA card. This handles conversion of the computer's datastream (in PCMCIA, it's 16-bit parallel, akin to ISA) into a form compatible with the digital phone – the phone's voice codec is bypassed. A Hayes 'AT...' command-set control interface is also included, together with support for modem-type error correction protocols. Manufacturers and resellers of GSM data cards include Grey Cell, Nokia, Ericsson, Portable Add-ons, Psion Dacom, Dancall and Motorola/Communicate. Prices range from between 300 and 500. In most cases, each card is designed for use with a specific GSM phone, or manufacturer's range. Such ranges could encompass both GSM and PCN phones. Suitable data-compatible phones can be identified by a logo, 'MC2', which can often be seen in the battery compartment. The manufacturer/phone dependency can be a real pain if you replace your phone with a more recent model, or your phone breaks down or is stolen.

Some GSM data cards also offer v.34 (28,800bps) analogue modem facilities, and it is rumoured that some companies are working on multi-function cards that offer GSM data, regular modem capability and Ethernet connectivity. Some of the lower-priced cards will only transmit uncompressed data at 9,600bps. This is known as 'non-transparent' mode, and relies on the network to error-correct the data. Non-transparent mode is designed for maximum reliability. The more expensive and recent models, such as the Communicate Cellect-2, can operate in 'transparent' mode, which offers compatibility with compression systems for higher throughput when radio conditions are good. The Cellect 2 has a special real-time compression system known as DDF (Digital Data Fast). It's modelled on v.42bis, and indeed, will talk to analogue PSTN modems, at the other end of the chain, in this mode. Handy for talking to BBSs and Internet service providers! If you're sending or receiving files that have already been compressed (such as .zip files in the case of the PC, or .hqx files if you're Mac-allegiant), then the benefits of DDF become much less apparent.

PCMCIA cards are automatically recognised by Windows '95 and MacOS; from then, it's a case of configuring the communications set-up from Control Panel, or whatever. In the case of PCs, I have found that it's possible to configure the PCMCIA modem as COM3: COM1 is normally occupied 'internally' by the trackball or other pointing device, while COM2 is normally reserved by the serial port. Although Windows 3.1(1) isn't directly compatible with PCMCIA, most PCMCIA-equipped notebooks of that vintage are supplied with PCMCIA Card and Socket drivers, normally from the company Cardsoft.

This company, incidentally, wrote the PCMCIA module of Windows '95 for Microsoft. Cardsoft's Win 3.x drivers were supplied with my trusty old 486DX33 notebook, which is running Windows 3.11 and has been used to test a range of PCMCIA communications products. Most data cards are supplied with modem enablers for DOS, so that you can use it with terminal emulation packages such as Telix and Odyssey. It's a simple matter to write a batch file that calls up the modem enabler before running your DOS comms package. Some cards are also supplied with phone-specific programs that allow you to edit and send SMS (Short Message Service) text messages, or edit the handset's phonebook memories.

Non-PCMCIA Cellular Data Solutions

At least one GSM phone dispenses with the need for a PCMCIA card at all. The unusual 580 (without airtime agreement) Siemens M1 doesn't have the usual cellular accoutrements of a display, keypad, microphone or earpiece – you can't make voice calls from this unit. Vodafone, interestingly, offers a 'data-only' tariff – which complements the M1 nicely. The hardware takes the form of a small black box designed for semi-permanent installation – in a car, for example. All it has is a receptacle for the GSM SIM (Subscriber Identity Module) smart card, an aerial socket and a serial port. That's right – good ol' RS232. This means that the M1 can be partnered with older computers, computer terminals and PDAs that don't have PCMCIA interfaces (such as the popular Psion 3a). In theory, the unit could also be interfaced to other intelligent systems – it doesn't end with PCs. This could include vehicle electronics – we live in an age when the average new car has more computing power than a PC of relatively recent vintage.

Siemens already sell a GPS (Global Positioning System) add-on that would allow a stolen vehicle to be tracked – just the thing for your classic and desirable Lamborghini. OK, the M1 cannot handle voice, but the trans-phone portability of GSM – you can simply transfer the SIM from the M1 to your handset for normal duties – means that this isn't really an issue. The current generation of satellite phones also have serial ports for connection to computers, instead of PCMCIA cards. Future models will look more like regular handsets, though, and will – more likely than not – rely on PCMCIA to make the connection to the computer. On another front, Nokia's 900 Communicator GSM phone includes a Psion-type PDA built in. From here, you can send/receive faxes and e-mail, or even access the Web. It's bulky as phones go – it has to incorporate a usable QWERTY keyboard – but it's considerably more portable than lugging a computer around with you. At the moment, the Communicator is a totally unique product. Nokia is considering a PCN version.

Cellular Network Issues

But what of the cellular end itself? All of the UK's current digital cellular operators – Cellnet, Vodafone, One2One and Orange – now offer data compatibility. One2One is the most recent entrant – and it sparked off some controversy when it did take the data plunge. When its original service started in 1993, it offered free local calls at off-peak times, such as weekends and evenings, to gain acceptance with consumers. More recently, it has stopped offering free off-peak evening calls to new subscribers – the original 'Personal Call' tariff has since been discontinued.

If you're an existing subscriber who wants to add data compatibility to his phone, it means changing your contract to a newer one (there are three, referred to as Gold, Silver and Simple, which are chosen according to predicted phone usage) and losing your right to make those free evening calls. This is denied by One2One, which states that it's possible to 'data enable' a Personal Call subscription. I know at least one individual who has tried to do this, but has been told that one of the new packages, with restricted off-peak free calls, has to be adopted.

A lot of long-time One2One subscribers are apparently annoyed about this, and have gone elsewhere for their cellular requirements. What's more, One2One data calls – even off-peak ones – are charged at the peak call rate of the particular tariff chosen. This is presumably to discourage users from surfing the Internet freely for hours at a time. One2One can be quite cost-effective if data services are to be extensively used at peak times. Otherwise, there are cheaper alternatives – some do offer special off-peak rates.

Indeed, the sending of cellular data can be an expensive business, with more expensive calls if data is being sent, and dearer standing charges. There are some concessions, though – Orange, for example, offers subscribers special cut-price access numbers to the Demon and Pipex Dial internet service providers. All well and good if you already subscribe, or plan to subscribe, to one of these services. Orange is also helpful in offering subscribers 'all-in' Talk Plans that include airtime in their monthly charges – although calls that fall outside these specified airtime limits can be expensive. If you travel overseas a lot and need to be contacted, though, neither Orange or One2One will be of much interest to you.

When you add data compatibility to your subscription, you normally get additional numbers which are dedicated to receiving incoming faxes or data, thus saving you the embarrassment of getting an earful of disharmonious bleeping noises. It does depend on you notifying the fax sender when to send the document to your PC; for most of the time, the handset won't be connected up to the computer and the sender could be wasting his time. Sending and receiving faxes occurs at the full Group 3 rate; in other words, it normally takes exactly the same time as it would from a normal fax machine or fax/modem.

How Well Does GSM Data Perform?

To answer this, we examined the 528 GSM Prima from Communicate – a Motorola-owned company that's been involved with cellular data since the very beginning. This unit is designed with Motorola's own digital phones – we tried it with the ultra-expensive StarTAC (reviewed last month) and the rather more affordable d460, both GSM models. Interestingly, we found that GSM data throughput was identical on both phones! The network used was Vodafone, while the PC was a Trust 486DX33 with 8M-byte RAM, 1G-byte hard disk and Windows 3.11. The card also offers v.34 analogue capabilities – there are cheaper models (410 and 328) which offer v.32bis (a mere 14,400bps) and no analogue capability, respectively. Very useful – you get faster and cheaper on-line working if you are within reach of a telephone line.

The hardware takes the form of a standard Type II (intermediate-sized) PCMCIA card. Two cables are supplied. The first connects up to the GSM phone of your choice, and is terminated in a connector specific to the model of phone with which it will be used. The second cable terminates in a standard BT phone jack. It has a bulge in it, which presumably contains the BABT-requirement line interface hardware that's simply too bulky to fit onto the slim PCMCIA card. Switching between the two systems is automatic, and depends on the type of lead plugged in. Prima comes with some software – the modem 'enabler', together with Delrina WinFax 4.0Lite, CompuServe starter disks, and a phone bracket for your notebook. SMS and phonebook editors are not included, which is a pity, considering how expensive the card is.

The Prima's major advantage is that it can work in transparent mode – in other words, data compression is built in. With uncompressed files, such as ASCII text, throughput can be as high as 36,000bps. On heavily compressed files (.zip, for example) though, you'll get the original 9,600bps. The compression system used is the DDF (Digital Data Fast) mentioned elsewhere in this article. The compression doesn't benefit fax transmission, which works at the standard Group 9,600bps anyway.

Performance is good, as Table 1 shows. Computer-generated faxes indeed take the same time to send as their paper-based equivalents take over a landline. Thanks to DDF, the unit is much faster than some of the competition (notably, current Nokia and Ericsson models) when transferring uncompressed files. As an added bonus, Prima is quick to initialise too. Our only problem occurs what happens the first time the computer and Windows are booted up. Trying to connect via the cellphone to anything – be it CIX, Pipex Dial (an Internet service provider) or a remote fax machine, and the phone switches off.

The second – and subsequent – times tried, no further problems are encountered. The problem only recurs, along the same lines, the next time you boot up. Interestingly, there's no trouble of this type when landline connections occur. Since the problem occurred with both phones, it's unlikely to be a phone issue. There's a distinct possibility that this is a bug peculiar to the review model – which was an early sample. When contacted, Communicate didn't deny that there was a problem, and one can only assume that they are working on it.

	Mean transfer time, v.34 (s)	Mean transfer time, GSM (s)
Large Text File (388k-byte)	55	105
Medium Text File (194k-byte)	28	54
Compressed (149k-byte)	52	149
Executable (51k-byte)	19	62

Table 1. Communicate GSM Prima test results.

Points of Contact

Siemens M1: TDC (Telecom Design Communications), Stroudley Road, Basingstoke, Hants. Tel: (01256) 332800.

Communicate GSM Prima: The Technology Transfer Centre, Imperial College, Silwood Park, Ascot, Berks SL5 7PW. Tel: (01344) 291284.

Nokia: Headland House, London Road, Godmanchester, Huntingdon, Cambs PE18 8NX. Tel: (0990) 002110. Web: http://www.nokia.com.

Cellnet: 1 Brunel Way, Slough, Berks SL1 1XL. Tel: (01753) 504000. Web: http://www.cellnet.chc.co.uk.

Vodafone: The Courtyard, 2-4 London Road, Newbury, Berks RG13 1EA. Tel: (01635) 33251. Web: http://www.vodafone.co.uk.

One2One: 2 Imperial Place, Maxwell Road, Borehamwood, Herts WD6 1JN. Tel: (0181) 214 2121. Web: http://www.one2one.co.uk/one2one/.

Orange: St. James Court, Great Park Road, Almondsbury, Bristol BS12 4QJ. Tel: (01454) 618500. Web: http://www.orange.co.uk.

Paknet: Coombe House, Coombe Square, Thatcham, Newbury, Berks RG13 4FJ. Tel: (01635) 72311. Web: http://www.paknet.co.uk.

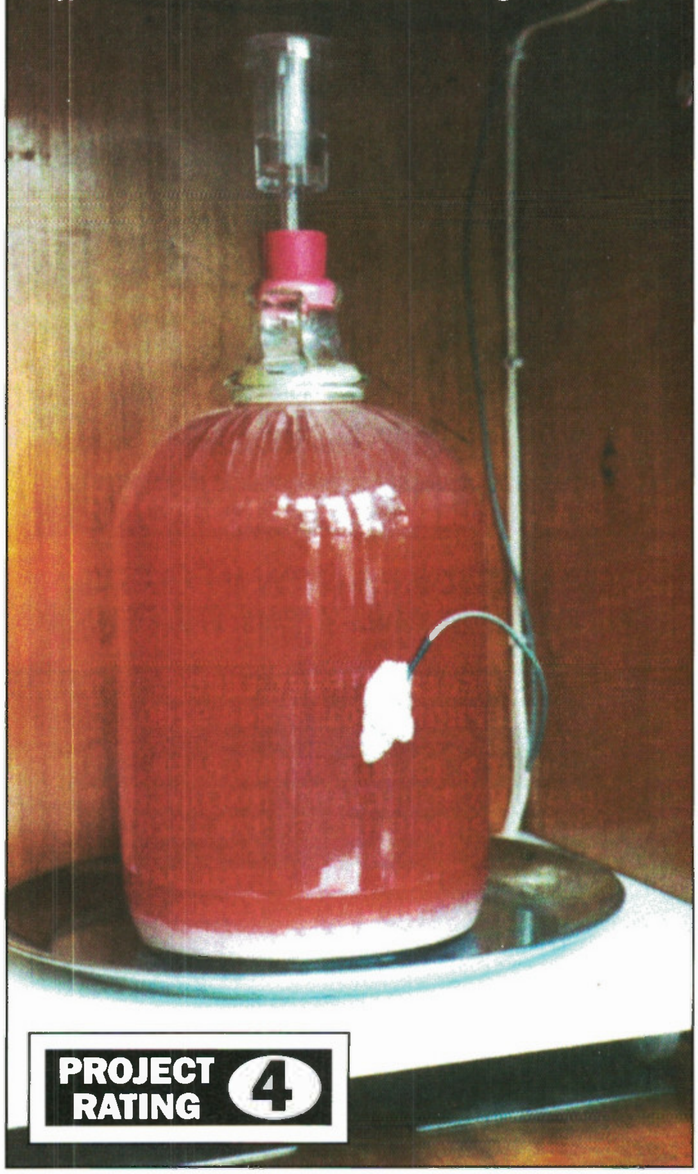
Internet telecoms search engine: http://www.inter-com.co.uk.

PROJECT

Heater TEMPERATURE CONTROLLER

by Raymond Lee BSc (Hons.)

The motivation for this project came from having been given some wine making equipment as a Christmas gift. In order that fermentation proceeds properly, the liquid needs to be maintained at a temperature of 20 to 25°C. Traditionally, many people use airing cupboards, but ours is small and often filled with clothes, and there is no certainty of temperature stability. The rest of the house in winter months is generally much cooler than the ideal range.



A typical fermentation cabinet for wine making.

PROJECT RATING 4

As I enjoy woodwork as well as electronics, I built a cabinet large enough to hold a 2-gallon bucket, or 2 demijohns with airlocks side by side, on a shelf. Beneath the shelf is a space large enough to fit two batten lampholders with a pair of candle lamps which act as the heat source. I then required some control electronics to control the power to the lamps. This is the circuit that I devised to do the job.

The first prototype was built on stripboard mainly with components I had in stock, but I have subsequently designed a PCB layout, and the parts list includes all Maplin stock codes.

How it Works

Referring to the circuit diagram shown in Figure 1, IC1, a quad op-amp, provides the heart of the circuit, with IC1c driving the opto triac IC2, effectively acting

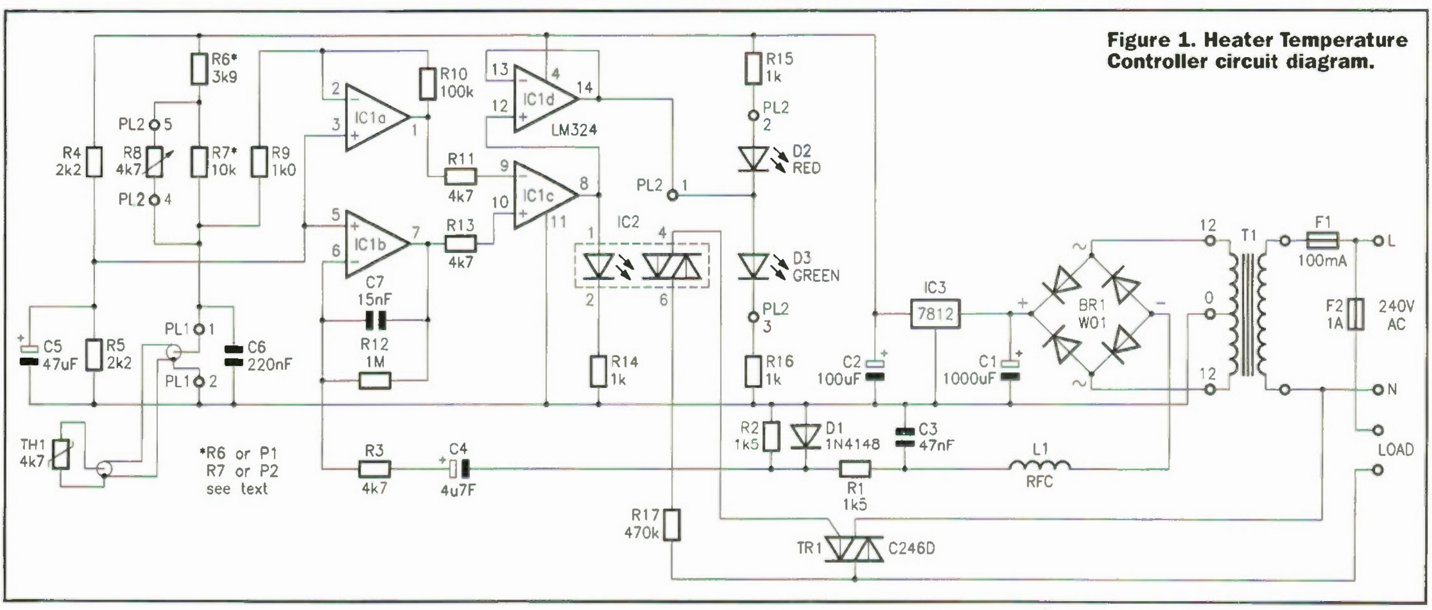


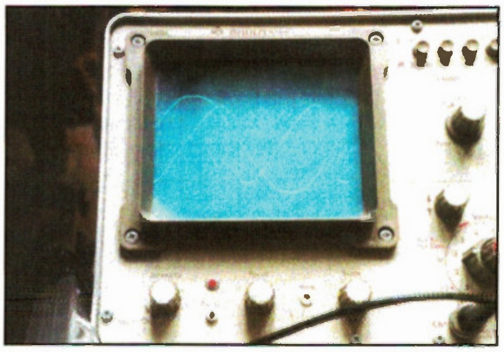
Figure 1. Heater Temperature Controller circuit diagram.

as a phase control lamp dimmer depending on temperature.

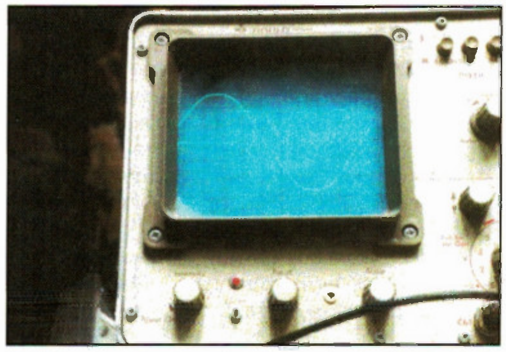
The transformer T1 feeds a conventional bridge rectifier but only the positive side is used to provide a DC supply, via the 12V regulator IC3. The negative side provides full-wave rectified sine waves, which pass first through an RF filter (L1 & C3) to remove any spikes and RF, then through a clipping circuit comprising R1, R2 and D1. The resulting waveform is a short duration positive-going pulse around the zero-crossing point of mains.

This pulse is passed via C4 to IC1b, which is arranged as an integrator, resistor R12 being present to provide a DC path so that the output waveform sits at mid rail. Resistors R4 & R5 and capacitor C5 provide a mid-rail reference for IC1a & 1b. IC1a is used as a bridge balance comparator. R6-8 form the upper arm of the bridge, TH1 the lower arm.

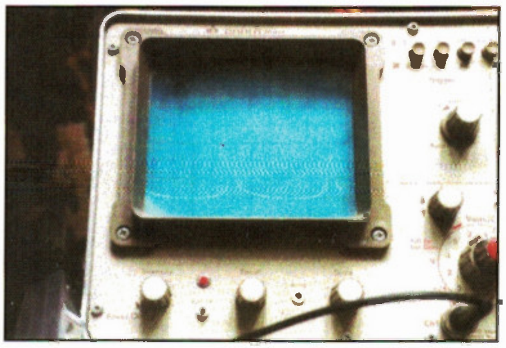
When the bridge is balanced, the output of IC1a is also at mid-rail. A very small increase in temperature will cause the output to go positive, IC1a having a voltage gain of 100. IC1c acts as a comparator, one input being fed with the 4V sawtooth waveform, the other with the DC level from the bridge amplifier. As the thermistor decreases in value (rise in temperature), so the point at which IC1c switches gets higher up the sawtooth, i.e., later in the mains waveform. If it gets too high, the output never changes so there is no drive to the opto triac. Conversely, if the temperature falls, the switching point gets earlier and if too cold, stays high giving a permanent drive to the opto triac. IC1d is a buffer to drive a visual indication of the state of balance, with a Green LED indicating on state and red indicating off state. In the control range, the relative brightness of the LEDs give an idea of the switching point, and hence, the amount of power being delivered.



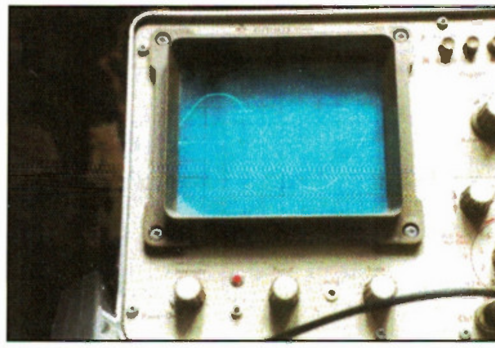
Oscilloscope traces showing output of IC1 pin 7, with mains reference waveform via 24V transformer, to show phase relationship (Y-scale=1V/cm, X-scale=2ms/cm).



Oscilloscope traces showing output of IC1 pin 8 – opto-isolator drive with load light bulbs glowing dimly, with mains reference waveform via 24V transformer (Y-scale=5V/cm, X-scale=2ms/cm).



Oscilloscope traces showing junction of R1, D1, R2, C4 (Y-scale=0·2V/cm), X-scale=2ms/cm).



Oscilloscope traces showing junction of L1, C3, R1 (Y-scale=5V/cm), X-scale=2ms/cm).

Temperature Range Calculation and Setting

The bridge circuit has an upper arm maximum with the values shown of 7k1, and a lower limit of 3k9 (4k7 in parallel with 10k = 3k2). The thermistor value is quoted at a temperature of 25°C (which is 298K), the value at other temperatures being given by the formula:

$$Rt_1 = Rt_2 \times e^{\left(\frac{B}{T_1} - \frac{B}{T_2}\right)}$$

Where B is the temperature coefficient, T1 and T2 the temperatures in Kelvin, and Rt1 and Rt2 the resistance of the thermistor at those temperatures.

Rearranging gives:
B for the 4k7 bead thermistor is 3,977, so:

$$\left(\frac{1}{T_1} - \frac{1}{T_2}\right) = \frac{\log_e\left(\frac{Rt_1}{Rt_2}\right)}{B}$$

Gives a minimum temperature of 16·1°C using the equation:

$$\frac{1}{T_{min}} = \frac{\log_e\left(\frac{7 \cdot 1}{4 \cdot 7}\right)}{3{,}977} + \frac{1}{298}$$

and a maximum temperature of 29·2°C using the equation:

$$\frac{1}{T_{max}} = \frac{\log_e\left(\frac{3 \cdot 9}{4 \cdot 7}\right)}{3{,}977} + \frac{1}{298}$$

The minimum and maximum as measured with the wine thermometer when calibrating were 17°C and 31°C respectively, which is quite close to the theoretical values. The difference is probably due to component tolerances.

Different temperature ranges could be obtained by altering the resistor values in the upper arm, although care should be exercised if the maximum is more than 30°C, due to internal dissipation in the thermistor, as at balance, it will always have 6V across it, and the power dissipated will rise in proportion to the square of the voltage. It may be preferable to use a higher value thermistor, e.g. 15k, if the circuit is to control to a higher temperature. The potentiometer and resistors around it would need to be altered accordingly.

A side effect of a resistor in parallel with a potentiometer is to make the scale non-linear, so ideally, choose a potentiometer closest to the value required to give the range needed, and then trim with a higher value resistor in parallel. If it was required to set the end limits to specific values to cover a precise temperature range, R6 & R7 could be replaced with trim potentiometers (P1 & P2). If only a single fixed temperature was required, the next lowest preferred value to the calculated value with a small trim potentiometer in series could be used in place of R6-8.

Construction

Figure 2 shows the PCB legend and track details. The prototype was constructed on a piece of stripboard cut to a suitable size to fit the plastic box, this being held in place by the plastic PC carrier strips supplied with the box. After drilling holes for the transformer such that it fitted at one end of the box, all the smaller components were fitted and wire links where required. N.B., all the strips around the opto triac were broken over two holes to provide adequate mains isolation. Warning: Mains electricity can be lethal, so double-check that there is no continuity to any other part of the circuit!

If using the optional box to house the controller, the corners of the circuit board will need to be carefully cut away to allow it to fit around the pillars which hold the lid. The circuit board is held in place in the box by PCB adaptors which clip to the board near the transformer, and slot into the box guides. The adaptors will need trimming to length so that the lid holds it all in place. Otherwise, mounting holes can be drilled in the corners to mount it in an enclosure of your choice. If mounting in a metal enclosure, this will need adequate insulation from the live end of the circuit board and should be earthed.

All the small components should be fitted to the circuit board first. Start with the resistors, then add the choke, diode D1, fuse holders and capacitors, taking care to note the polarity of the electrolytic capacitors. Then add ICs, bridge rectifier and triac, again observing orientation. Finally, fit the plug headers, terminal blocks and transformer.

The PCB layout includes pads to fit the vertical type trim potentiometers. Suitable values for the original design temperature range would be 4k7 for P1 and 22k for P2. In this case, R6 & R7 would be omitted.

The control potentiometer and two LEDs were fitted to the lid of the box and wired through short pieces of hook-up wire back to the stripboard. The thermistor was wired to a length of screened cable (to prevent pickup of stray signals), with heatshrink sleeving placed over the junction of the inner and one thermistor wire before a longer piece was fitted over both this and the junction of the screen and other wire, leaving just the bead of the thermistor exposed.

The control potentiometer and two LEDs should be fitted to the lid of the box and wired to the 5-pin connector. When positioning them, care should be taken to ensure that they will not foul on the transformer, and should be away from the mains end of the circuit board.

The thermistor is wired to the 2-pin connector using screened cable to prevent pickup of interference. Heatshrink sleeving is placed over the junction of the inner and one thermistor wire before a longer piece is fitted over both this and the junction of the screen and other wire, leaving just the bead of the thermistor exposed. If it was intended to be used in a damp environment the end could then be sealed with a suitable sealer, or epoxy resin, but this would reduce the responsiveness of the thermistor slightly.

Testing

With all components fitted to the circuit board, check that there are no shorts and that there is no continuity between the live side and the control side of the board. Temporarily remove fuse F2 but ensure both covers are in place before testing.

Before connecting the mains to the triac, it is preferable to check the operation of the rest of the circuit. If possible, wire to the terminal block via an isolating transformer, but take great care as mains is potentially lethal.

If you are using potentiometers P1 & P2, check that these are set to maximum resistance before powering. If no faults are found, power up and check that 12V is present on the regulator output, and that the mid-rail junction of R4 & R5 is at 6V.

If you have a scope, check the waveform at the output of the integrator IC1, pin 7. If this is present and only one of the LEDs is lit, check the voltage at pin 1 and see if it can be adjusted to about 6V by the temperature control. This should be possible, assuming the thermistor is at a temperature between the control range limits. If not, warm or cool the thermistor to bring it within range. The red LED indicates too hot, the green, too cold. When both are lit, the circuit is within the control range, and varying the thermistor temperature slightly will cause the brightness of the LEDs to vary, according to whether it was warmed or cooled; note, it is very sensitive. Assuming all is working, the mains connections to the triac circuit can now be made by inserting F2, and the load connected. If this circuit is being used to control a non-radiant heater, you may like to use a light bulb as a load initially to check that the triac is functioning correctly.

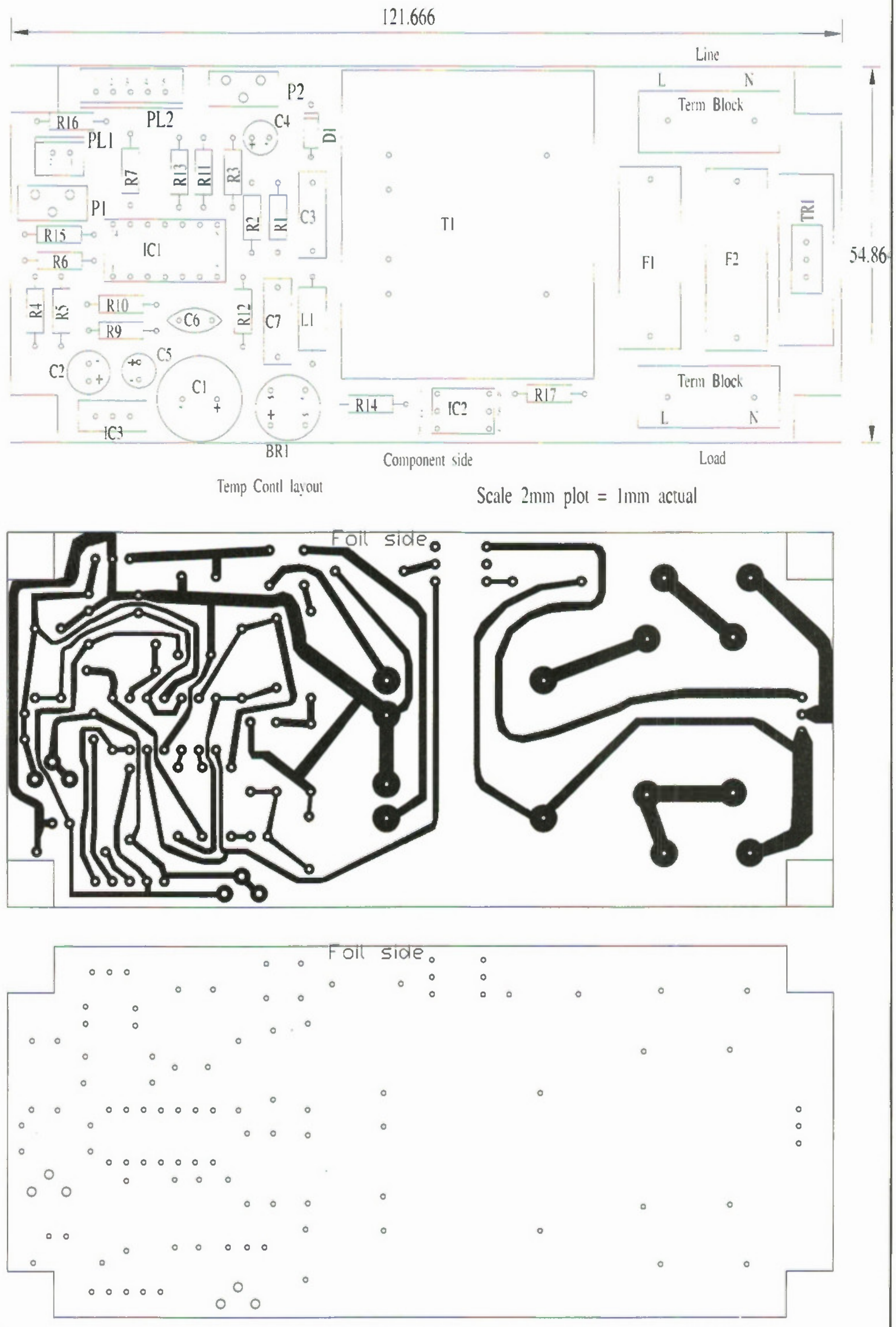


Figure 2. PCB legend and track.

Calibration

In order that this was not too lengthy, I laid the wine thermometer and thermistor on the top heat spreader plate with the thermometer bulb and thermistor in close physical contact, and a generous blob of petroleum jelly over both. This was then covered by a strip of wide sticky tape. It only took around 3 or 4 minutes for the temperature to stabilise, indicated by both LEDs being on to a similar extent. I started at the coolest setting, turned the knob a fraction at a time and made a mark to correspond with each mark on the thermometer. As a check, when I reached the maximum setting, I then turned it down a fraction at a time, checking that the marked values corresponded to the thermometer readings.

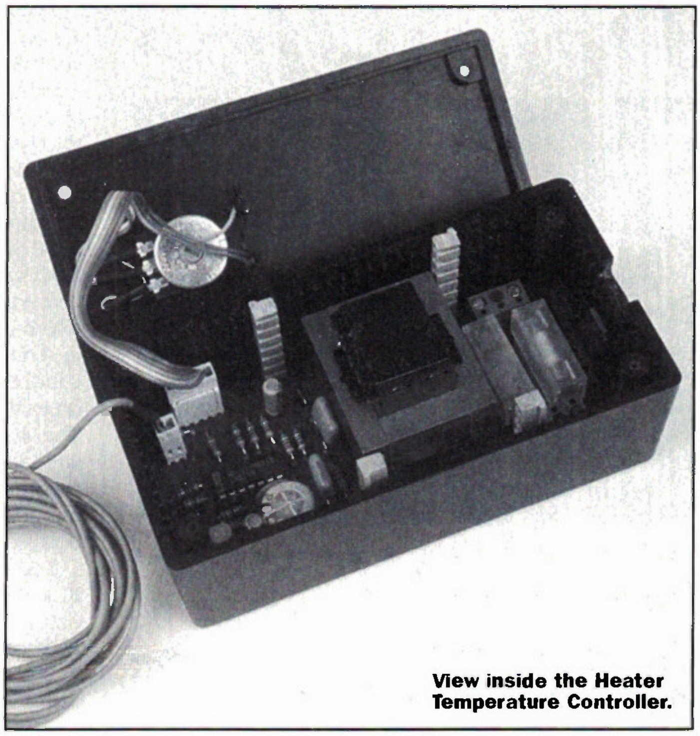
In other applications, it may be worth using a digital thermometer with an external probe, e.g. aquarium thermometer (RJ79L), placing the probe and thermistor in close proximity into or onto the device to be controlled.

Important Safety Note

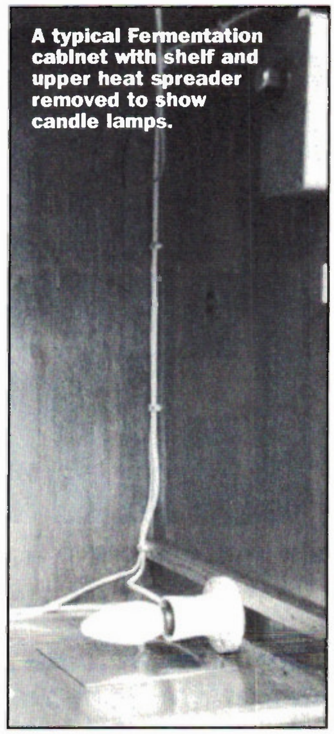
It is important to note that mains voltage is potentially lethal. Details of mains wiring connections are shown in this article, and every possible precaution must be taken to avoid the risk of electric shock during maintenance and use of the final unit, which should never be operated with the box lid removed. Safe construction of the unit is entirely dependent on the skill of the constructor, and adherence to the instructions given in this article. If you are in any doubt as to the correct way to proceed, consult a suitably qualified engineer.

The circuit has no earth, having been designed to go in a plastic box and having no exposed metal accessible. It comes into the double-insulated category, there being at least one insulating layer plus an air gap, between any part carrying mains potential, and the accessible parts. A fuse (F2) in the feed to the load is included on the PCB layout, and a separate fuse (F1) to the transformer as well.

Great care should be exercised when testing, as mains is potentially lethal.



View inside the Heater Temperature Controller.



A typical Fermentation cabinet with shelf and upper heat spreader removed to show candle lamps.

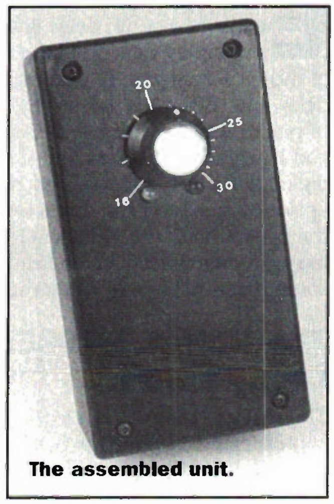
Other Uses

The prototype was designed with the purpose of producing a controlled heater for wine making, but could be used for any application requiring close temperature control where the ambient temperature may vary. In my application, I found that simply fastening the thermistor to the demijohn with Blue-tac maintained the temperature of the fermenting wine to within 1°C of the setting, even when the room temperature was varying by 10° or more (cold nights to sunny winter afternoons). The brightness of the lamps was a good indication of how cold it was.

This could also be used with a submersible heater for tropical fish, or photographic developing work. If the thermistor were enclosed in a sealed thin tube or suitably encapsulated, it could be placed directly into the liquid whose temperature it was required to maintain. In these kind of applications, it may be necessary to provide a bigger heatsink for the triac, depending on the power rating of the heater. The prototype has a small piece of 16-gauge aluminium bolted to it, but with the 80W load, barely seems to get warm, so a clip-on heatsink is specified for the PCB version. However, the triac is rated to 16A, so could drive a substantial heater with adequate heatsinking.

In such an application, the circuit board would need to be mounted in a different enclosure, and may need an earth to provide suitable protection.

The PCB design, by including header plugs and pads for trim potentiometers, should allow for most applications that might require a controlled heater, and by tailoring the choice of thermistor and bridge balance resistors, most domestic and several industrial applications should be covered.



The assembled unit.

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless Stated)

R1,2	1k5	2	(M1K5)
R3,11,13	4k7	3	(M4K7)
R4,5	2k2	2	(M2K2)
R6*	3k9	1	(M3K9)
or P1*	4k7 Vertical Enclosed Preset Potentiometer	1	(UH02C)
R7*	10k	1	(M10K)
or P2*	22k Vertical Enclosed Preset Potentiometer	1	(UH04E)
R8*	4k7 Linear Potentiometer	1	(FW01B)
R9,14-16	1k0	4	(M1K0)
R10	100k	1	(M100K)
R12	1M	1	(M1M0)
R17	470Ω	1	(M470R)

* See Text for Details

CAPACITORS

C1	1,000μF 35V Radial Electrolytic	1	(FF18U)
C2	100μF 25V Radial Electrolytic	1	(FF11M)
C3	47nF Polyester	1	(BX74R)
C4	4μ7F 63V Radial Electrolytic	1	(FF03D)
C5	47μF 25V Radial Electrolytic	1	(FF08J)
C6	0μ22F Ceramic Disc	1	(JL01B)
C7	15nF Polyester	1	(BX71N)

SEMICONDUCTORS

IC1	LM324	1	(WF26D)
IC2	Opto Triac	1	(QQ10L)
IC3	LM7812	1	(AV17T)
BR1	W01 Bridge Rectifier	1	(AQ95D)
TR1	C246D Triac	1	(QL14Q)
D1	1N4148	1	(QL80B)
D2	5mm Red LED	1	(WL27E)
D3	5mm Green LED	1	(WL28F)

MISCELLANEOUS

T1	12-0-12V 6VA Transformer	1	(YJ54J)
TH1	4k7 Thermistor	1	(FX21X)
L1	100μH choke	1	(WH41U)
F1	T100mA Glass Fuse	1	(CZ87U)
F2	T1A Ceramic Fuse	1	(DA11M)
	Fuse Holders	2	(DA61R)
	Fuse Covers	2	(DA62S)
	Clip-on Heatsink	1	(FG52G)
	Terminal Blocks	2	(JY92A)
	5-way PCB Header Plug	1	(FY93B)
	2-way PCB Header Plug	1	(RK65V)
	5-way Socket Housing	1	(BH66W)
	2-way Socket Housing	1	(HB59P)
	PCB Terminal Strip	1	(YW25C)
	M2 Knob	1	(RW89W)
	Heatshrink Sleeving	1	(BF89W)
	Screened Cable	As Req.	(XR13P)
	Hook-up Wire	As Req.	
	Solder	As Req.	

OPTIONAL

	Plastic Box PX2	1	(YU53H)
	PCB Adaptors	4	(YR72P)

The Maplin 'Get-You-Working' Service is not available for this project.
The above items are not available as a kit.

Audio Delay-line SYSTEMS AND CIRCUITS

PART 4

by Ray Marston

Ray Marston looks at the Holtek HT8955A low-cost digital delay line IC in the final installment of this 4-part series.

Earlier episodes of this 4-part series explained audio delay line basic principles, described the operation of modern analogue 'bucket brigade' delay line (BBD) ICs, presented a selection of practical BBD analogue delay line circuits, and explained the operation of modern digital delay line systems. This month's episode rounds off the series by explaining the operation of the Holtek HT8955A low-cost digital delay line IC and showing some practical ways of using the device.

The Holtek HT8955A Delay Line IC

The Holtek HT8955A is a low-cost but fairly sophisticated 24-pin IC that, when used in conjunction with an external dynamic RAM, acts as a complete 10-bit digital delay line system that – when operated at a 25kHz sampling clock rate – can generate delays of up to 200ms when using a 64k-bit DRAM or 800ms when using a 256k-bit DRAM. The IC is a CMOS type designed to operate from 5V supply lines, and incorporates a 10-bit ADC, 10-bit DAC and full control and DRAM-interfacing circuitry, plus a built-in analogue pre-amplifier. The device is intended for use in popular applications such as cheap voice echo units, low-cost Karaoke systems, and simple sound effects generators, etc.

Figures 1, 2 and Table 1 show the internal block diagram of the HT8955A, together with its outline and pin notation details, and Table 2 lists its claimed basic operating specification.

Note in Table 2, that the manufacturer's claims regarding the unit's S/N ratio and THD are in fact suspiciously optimistic for a mere 10-bit unit, and may not be attained in reality. In actual fact, the HT8955A functions as an excellent 'cheapo' delay line IC that gives exactly the kind of performance that would be expected from such a unit. Its output signals are noisy and badly distorted, but its range of delay times is excellent. In short, the IC offers an excellent low-cost introduction to the practicalities of modern digital delay line usage. The IC's basic operation is as follows:

The HT8955A has two built-in oscillators, a 'fast' one (controlled via pins 6 and 7) that controls – via the unit's timebase generator – the main ADC and DAC circuitry, and a 'slow' one (controlled via pins 8 and 9) that controls the system's Address register and thus exercises control over the delay line's actual delay time. The IC's analogue input signals are applied to the built-in pre-amplifier via pin 2 and are then passed on to the IC's ADC, which sequentially samples them and converts each sample into a 10-bit digital word, which is made available – when required – in serial form on a bidirectional data bus connected to pin 21, ready to be passed on to the external dynamic RAM (DRAM). The stored 10-bit data words of the DRAM are – when required – accessed (via a shift register) by the IC's DAC via the pin 21 data bus and are then made available, in time-delayed analogue form, on pin 4 of the IC.

The most complex part of the HT8955A IC is the section that controls the flow of data bits to and from the external DRAM. Each one of these individual bits (from the IC's ADC or to its DAC) is clocked into (or from) a unique address in the DRAM via the

Pin No.	Pin Name	Description
1	BIAS	Bias of internal pre-amp; connect to decoupler 'C'
2	IN	Audio signal input pin (inverting) to pre-amp
3	PREO	Pre-amp output pin
4	OUT	Delayed audio signal (from DAC) output pin
5	SEL	Delay-time select pin (open = 64k-bit DRAM size, +5V = 256k-bit DRAM size)
6	OSC1	'Fast' system oscillator input (timing) pin
7	OSC2	'Fast' system oscillator output (timing) pin
8	OSC3	'Slow' delay time oscillator input (timing) pin
9	OSC4	'Slow' delay time oscillator output (timing) pin
10	GND	Power supply ground (0V)
11	A6	Connect to external DRAM 'A6' Address pin
12	A7	Connect to external DRAM 'A7' Address pin
13	A5	Connect to external DRAM 'A5' Address pin
14	A4	Connect to external DRAM 'A4' Address pin
15	A3	Connect to external DRAM 'A3' Address pin
16	A2	Connect to external DRAM 'A2' Address pin
17	A1	Connect to external DRAM 'A1' Address pin
18	A0	Connect to external DRAM 'A0' Address pin
19	RASB	Connect to external DRAM 'RASB' Control pin
20	WRB	Connect to external DRAM 'WRB' Control pin
21	DATA	Data I/O pin to and from the external DRAM
22	A8	Connect to external DRAM 'A8' Address pin
23	CASB	Connect to external DRAM 'CASB' Control pin
24	+5V	Connect to positive (+5V) supply rail

Table 1. Table listing the HT8955A's pin descriptions.

Characteristic	Test Condition	Min.	Typ.	Max.	Unit
Operating voltage	–	4·5	5·0	5·5	V
Operating current	No load	–	2·5	8·0	mA
Pre-amp open-loop voltage gain (Av)	RL > 100kΩ	–	2,000	–	V/V
Input voltage range, with +5V supply	–	1·5	–	3·5	V
Maximum output volts	RL > 470kΩ	1·0	1·5	–	V
Maximum delay time, with 64k-bit DRAM	SEL = o/c 25kHz sampling	150	200	–	ms
Maximum delay time, with 256k-bit DRAM	SEL = +5V 25kHz sampling	600	800	–	ms
Signal-to-noise (S/N) ratio	Vout = 1V @ 400Hz, Bandwidth = 10kHz	–	55	–	dB
Total harmonic distortion (THD)	Vout = 1V @ 400Hz, Bandwidth = 7kHz	–	0·5	–	%

Table 2. Table detailing the basic working specification of the HT8955A IC.

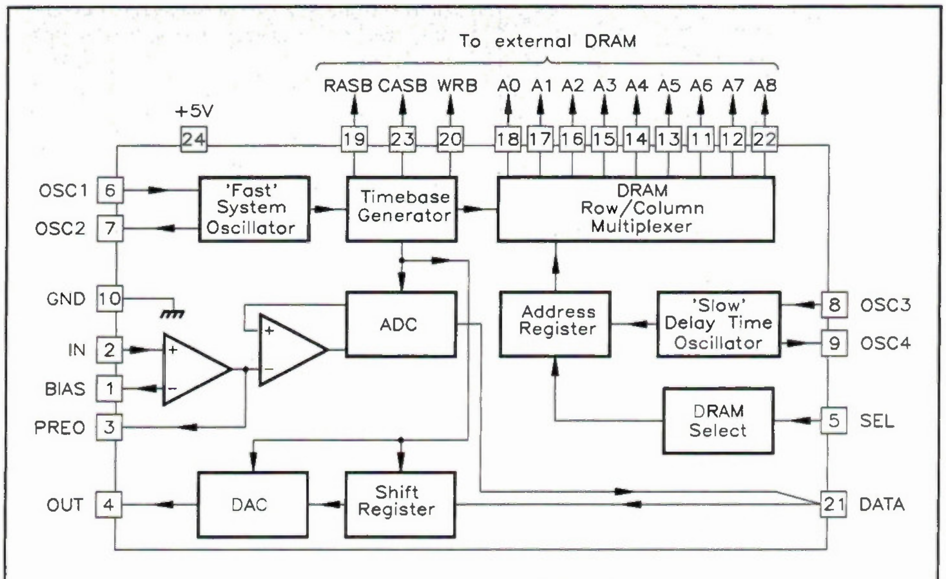


Figure 1. Functional block diagram of the Holtek HT8955A digital delay line IC.

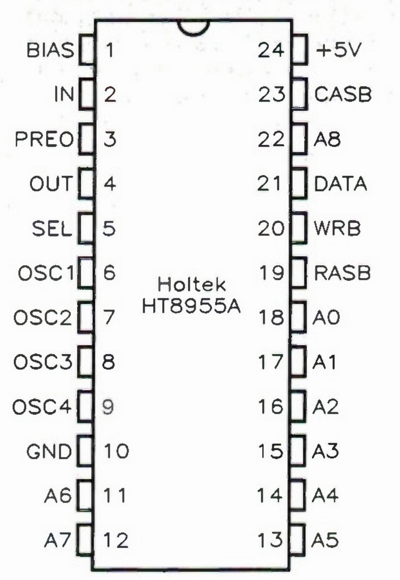


Figure 2. Outline and pin notations of the HT8955A IC.

IC's Address register and Row/Column Multiplexer, which can select any one of up to 262,144 addresses in a 256k-bit DRAM. This operation requires the use of an 18-bit address code, and this is applied to the DRAM in the form of one 9-bit (A0 to A8) row word (controlled via the Row Address Select or 'RASB' pin) followed by one 9-bit (A0 to A8) column word (controlled via the Column Address Select or 'CASB' pin). The direction of the data flow (to or from the DRAM) is controlled via the IC's Write/Read or 'WRB' pin. The actual data (from the ADC or to the DAC) takes the form of a 10-bit word that flows from or to the pin-21 DATA terminal of the HT8955A in serial form (one bit at a time). Each one of these 10-bit words thus occupies a 'field' of 10-bits of DRAM space.

Thus, in each 'slow' operating cycle of the HT8955A, the IC goes through the following operating sequence. First, it executes an ADC conversion operation, then opens up a new 10-bit DRAM field and accesses each individual part of its 10-bit data word, sequentially transferring each existing bit to the IC's DAC and replacing it with a corresponding new bit from the ADC. At the end of the sequence, the 'old' 10-bit data word has appeared in time-delayed analogue form at the IC's pin-4 output terminal, and has been replaced in the DRAM field with a new 10-bit data word derived from the IC's pin-2 analogue input terminal. The IC then moves on to the next operating sequence, during which it carries out similar operations on the DRAM's next multi-bit data field, and so on.

Basic Usage Data

The Holtek HT8955A is designed to be very easy to use, and is specifically intended for use with 4164 (64k-bit) or 41256 (256k-bit) dynamic RAM ICs. These ICs are 16-pin types, with very similar pin functions, as shown in Figures 3 & 4, which show the normal pin notations modified to conform with those used on the HT8955A IC. The only significant difference between the two DRAMs – from the user's point of view – is that the 41256 uses a basic 9-bit (A0 to A8) address system, with the A8 bit going to pin-1, and the 4164 uses a basic 8-bit (A0 to A7) address system, with the IC's pin-1 terminal internally unconnected. These facts enable the HT8955A and either type of DRAM to be used in the 'universal' basic delay-line circuit of Figure 5.

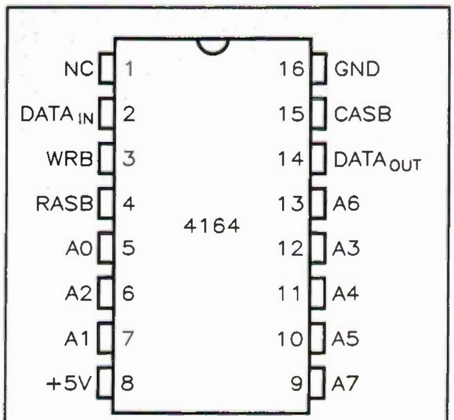


Figure 3. Outline and pin notations of the 4164 64k-bit dynamic RAM IC.

The basic Figure 5 circuit must be powered from a well-regulated 5V supply, and consumes up to 45mA when used with a 4164 DRAM or up to 70mA with a 41256 DRAM. If a 4164 DRAM is used, pin-5 of the HT8955A must be left unused, and if a 41256 DRAM is used, pin-5 must be tied to ground. To use this basic circuit in practical applications, the user must first connect pin-5 in the appropriate mode, connect a resistor between pins 6 & 7 to set the IC's 'fast' oscillator frequency, and connect a fixed and a variable resistor between pins 8 & 9 to set the desired 'delay' time of the system. C1 is used to decouple the internal pre-amp's built-in bias network, and R1 is an optional biasing resistor who's function is explained in the next few paragraphs. To use the pre-amp, an appropriate feedback network must be connected between pins 2 and 3 (the pre-amp's input and output pins), and an audio input signal applied to pin 2 will then produce a time-delayed audio output signal on pin 4.

The best way to learn about the HT8955A is to use it in a simple test circuit, and Figure 6 shows the connections needed to make the 'universal' HT8955A circuit act as a basic test unit that uses a 64k-bit (4164) DRAM, and Figure 7 shows the alternative connections for use with a 256k-bit (41256) DRAM. Note in these circuits, that the pin 6-7 resistor sets the frequency of the IC's 'fast' oscillator, the pin 8-9 components control the 'slow' oscillator, and the pin 5 connection selects '64k-bit' or '256k-bit' DRAM operation. In both cases, the IC's internal pre-amp is used as an audio amplifier that gives ×2 voltage gain and has its upper roll-off frequency set at 5kHz by the 100kΩ/330pF pin 2-3 R and C component values; the roll-off frequency is inversely proportional to the C value, and can be doubled by reducing the C value to 165pF.

To use the Figure 6 & 7 circuits, simply connect an audio signal (from an A.F. signal generator or from an entertainment source) to the circuit's input and then monitor (with an oscilloscope or a Hi-Fi system) the circuit's three audio output points, first at the pin-3 pre-amp output, then at the pin-4 'Delay OUT' point, and finally at the 'Delay output' point at the junction of the 10kΩ resistor and 3n3F capacitor. During these tests, increase the input signal amplitude until clipping occurs on the Delay output, then see if the performance can be improved significantly by fitting various

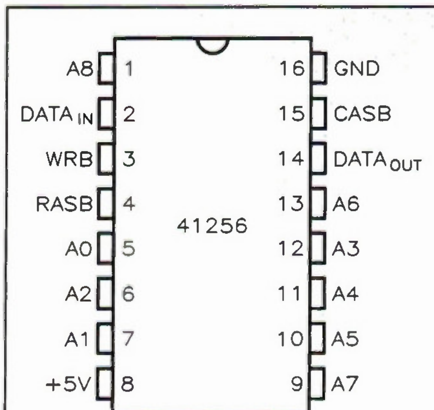
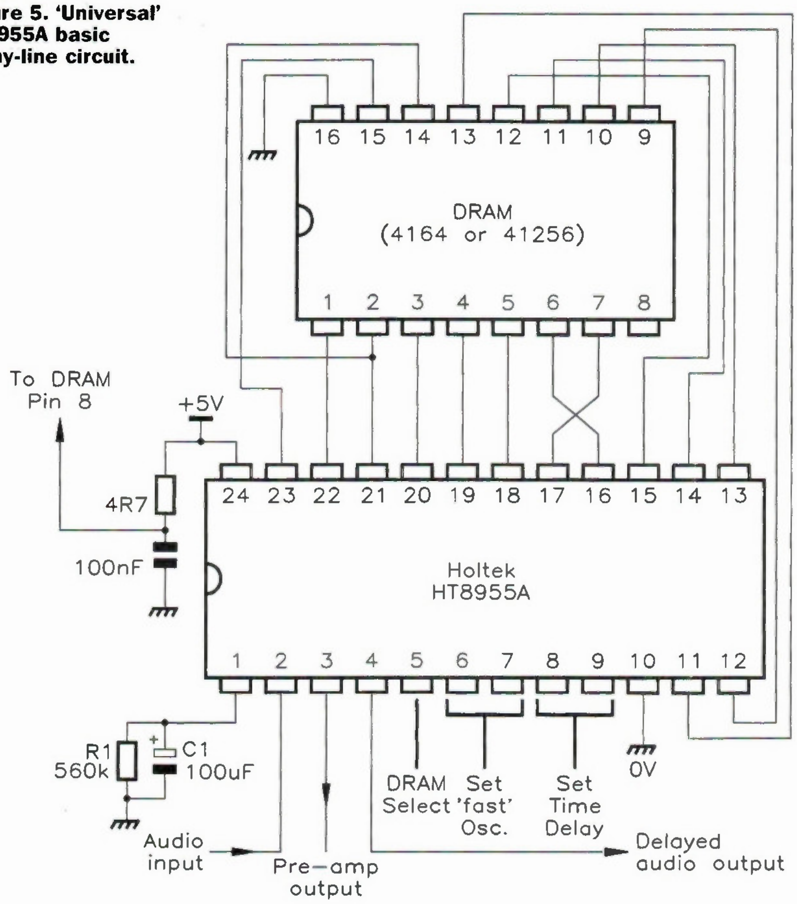


Figure 4. Outline and pin notations of the 41256 256k-bit dynamic RAM IC.

Figure 5. 'Universal' HT8955A basic delay-line circuit.



values (not less than 100kΩ) of R1 between pin-1 and either ground or the +5V supply rail. During these tests, you will probably note that the delay outputs are rather noisy and have a very limited useful dynamic range, and that the performance can be adversely affected by poor circuit layout.

When you have finished with the Figure 6 or 7 test circuits, you can move on and convert them into simple low-cost echo/reverb units by using the basic connections shown in Figure 8. This particular diagram shows the connections for use with a 256k-bit (41256) DRAM, but those for use with a 64k-bit (4164) DRAM are very similar. In both cases, the IC's internal pre-amp is used as a 1st-order low-pass filter with a 5kHz break frequency, and also as an audio mixer that gives ×2 voltage gain to the audio input signal and a ×0·17 to ×1·2 voltage gain to a 'reverb' feedback signal from the delay line's pin-4 output. Consequently, the output of the pre-amp consists of the original audio input signal plus 'reverberating echo' signals from the delay line output, and is made available via a 20kΩ volume control. The echo/reverb sounds are particularly impressive when used with voice inputs. Figure 9 shows a simplified equivalent functional diagram of the low-cost echo/reverb circuit, together with its basic waveforms.

Figures 10 to 12 shows three useful ancillary circuits that can be used in conjunction with any HT8955A delay line system. The Figure 10 circuit is that of a simple voltage regulator that can be used to supply the IC's +5V

Figure 6. The 'universal' HT8955A circuit wired as a basic test unit with a 64k-bit (4164) DRAM.

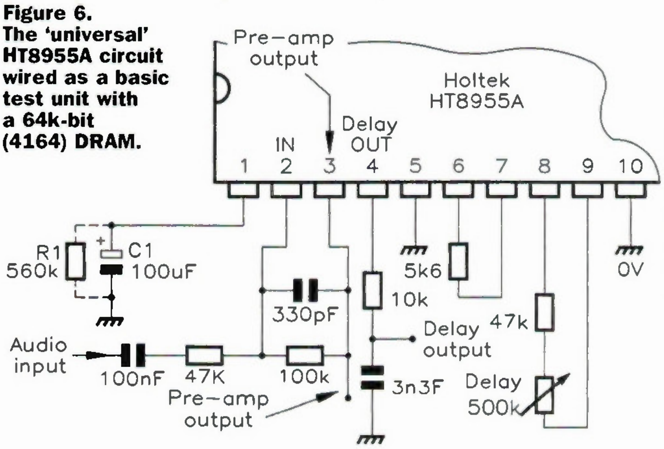


Figure 8. The 'universal' HT8955A circuit adapted as a low-cost echo/reverb unit with a 256k-bit (41256) DRAM.

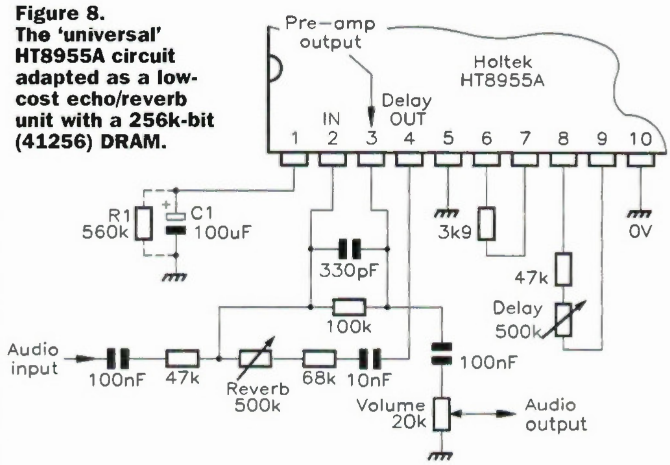


Figure 7. The 'universal' HT8955A circuit wired as a basic test unit with a 256k-bit (41256) DRAM.

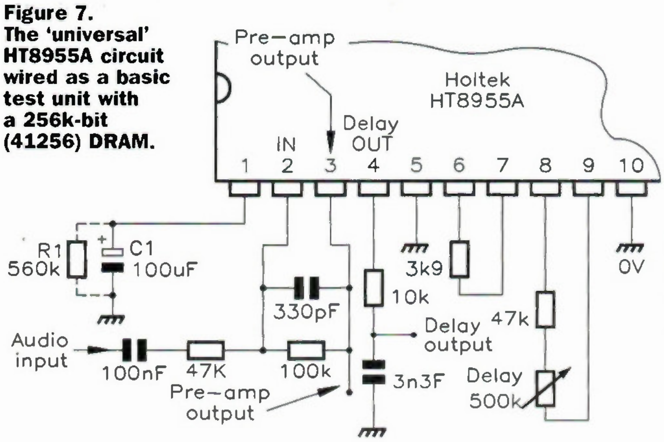
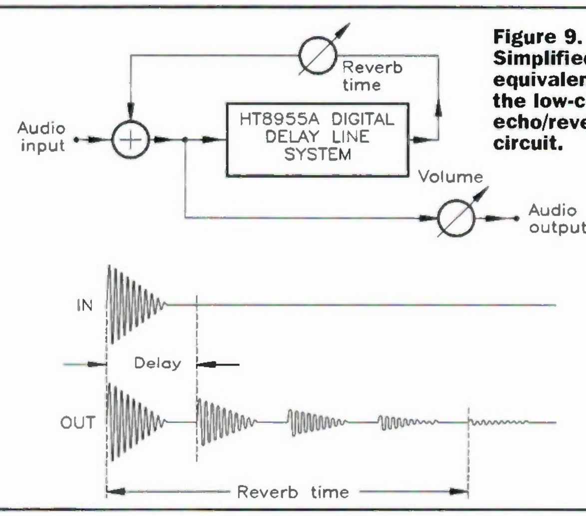


Figure 9. Simplified equivalent of the low-cost echo/reverb circuit.



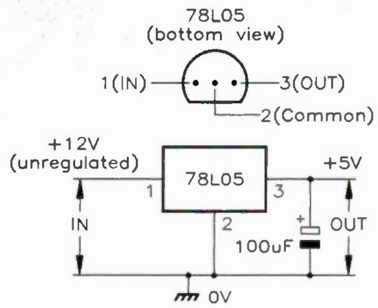


Figure 10. Simple +5V, 0-100mA regulated power supply circuit.

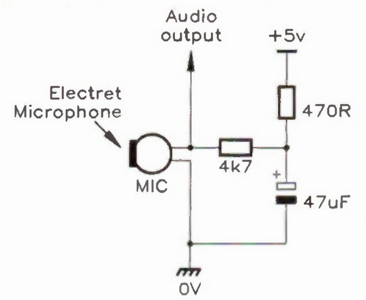


Figure 11. Way of powering an electret microphone from the +5V supply.

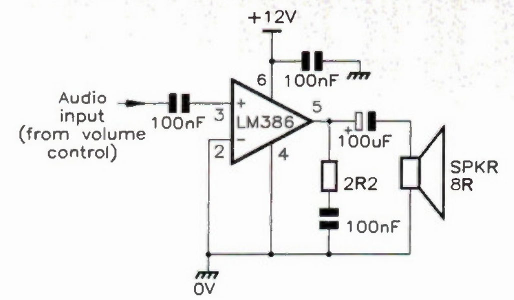


Figure 12. Low-cost power amplifier that can generate several hundred milliwatts in an 8Ω speaker.

regulated supply (at load currents up to 100mA); the circuit is powered from an unregulated input of about +12V, and is designed around a 78L05 IC that is housed in a 3-pin TO-92 plastic package and normally uses the pin connections shown in the diagram. Note, however, that a few manufacturer's versions of this IC have their IN and OUT connections reversed, so if this circuit fails to work, try swapping the IC's IN and OUT connections.

Figure 11 shows a simple way of connecting an electret microphone directly to the input of the Figure 8 circuit and powering it from the circuit's +5V supply. This type of microphone has a built-in FET amplifier, and in the diagram, the 4k7Ω resistor is used as the FET's drain load, thus making the microphone's output directly available.

Finally, Figure 12 shows a simple low-cost power amplifier that can be powered from an unregulated +12V supply (which is also used for powering the HT8955A system's +5V voltage regulator) and can be driven directly from the delay-line's volume control, and which can generate an output of several hundred milliwatts in an 8Ω speaker. The IC used is an LM386 type, which is housed in an 8-pin plastic package.

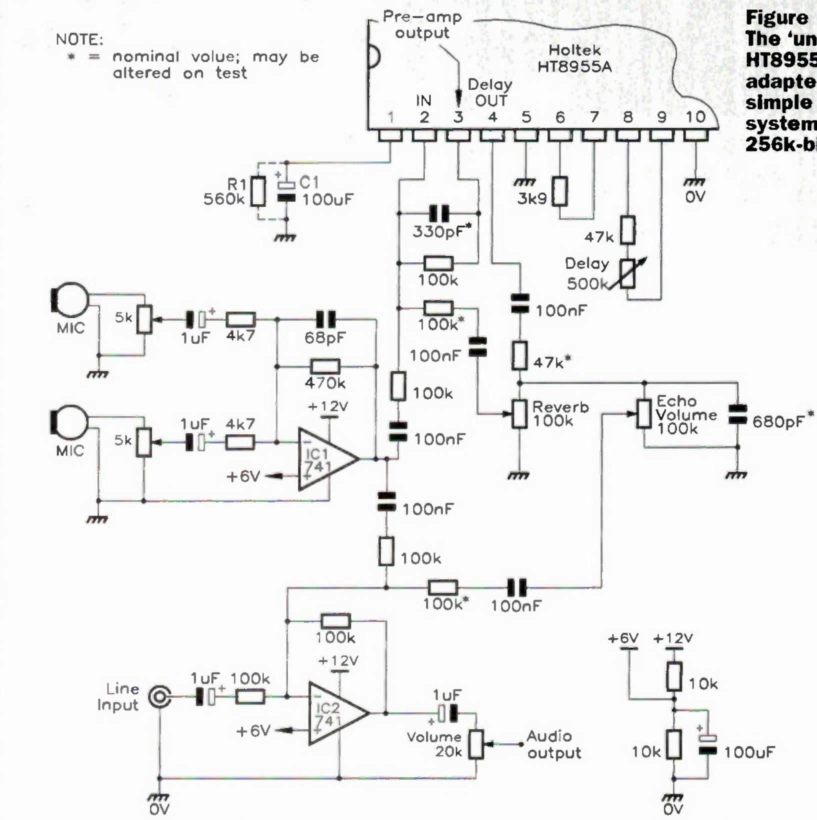


Figure 13. The 'universal' HT8955A circuit adapted as a simple Karaoke system with a 256k-bit DRAM.

A Karaoke Circuit

A major application area of the HT8955A is in simple Karaoke systems, in which the voices of one or more amateur singers are fed through an echo-reverb unit and are mixed with an unmodified music signal. To conclude this look at the HT8955A delay-line IC, Figure 13 shows how the 'universal' HT8955A circuit of Figure 5 can be adapted as a low-cost Karaoke unit with a 256k-bit (41256) DRAM, and Figure 14 shows – in block diagram form – the Karaoke unit's equivalent circuit.

The Karaoke unit can accept voice inputs from two dynamic (moving coil) microphones, plus a single 'line input' music signal. Each microphone input has its own volume control, and the outputs of these are mixed together in IC1, which gives a ×100 voltage gain to low-frequency signals; the 68pF capacitor wired across the 470kΩ resistor causes the gain to fall off at a 6dB/octave rate above 5kHz. IC1's output is tapped off in two directions; one output signal is fed to the input of the HT8955A's pre-amp, where it is mixed with part of the delay line's output to give a 'reverb' effect, and the other is fed to the input of IC2, where it is mixed with 'line input' music signal and with a fraction of the delay line's output to give a final composite audio output signal.

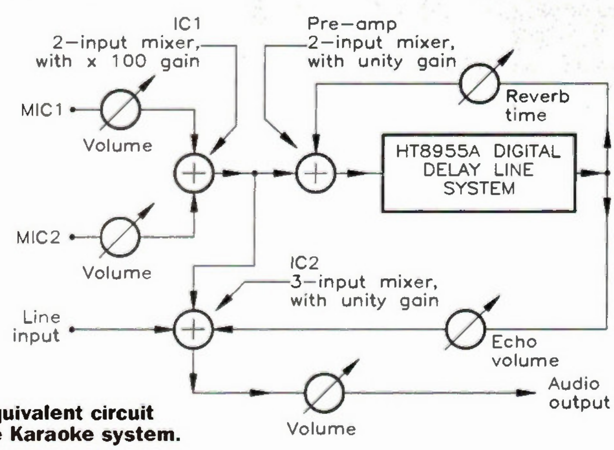


Figure 14. Equivalent circuit of the simple Karaoke system.

Note in Figure 13, that the non-inverting input pin of each 741 op-amp is biased at half of the op-amps +12V supply voltage via a decoupled divider made of two 10kΩ resistors. Also note that the values of the components marked with an asterisk (*) may be altered on test to give a modified circuit performance, to suit individual preferences. Thus, the values of the three marked resistors affect the voltage gain in various parts of the circuit, and the values of the two marked capacitors affect the frequency response. The circuit thus offers plenty of scope for experiment. ELECTRONICS

ELECTRONICS and Beyond

£25 CROSSWORD COMPETITION

To celebrate the launch of the new Maplin MPS catalogue, now in it's 25th year, we present the first in a series of crosswords for you to complete.

To mark the occasion we are giving away cash prizes of £25 to the first four correct entries received.

You will find some of the answers in our catalogue, so if you don't have a copy go out and search for one today and complete this crossword. Send it in to us using the following address:

Magazine Crossword 1,
Maplin House, PO Box 777,
Rayleigh, Essex SS6 8LU.

All entries must be received by 14th March 1997. All employees of Maplin Electronics are excluded from entering. Photocopies of the page will be accepted.

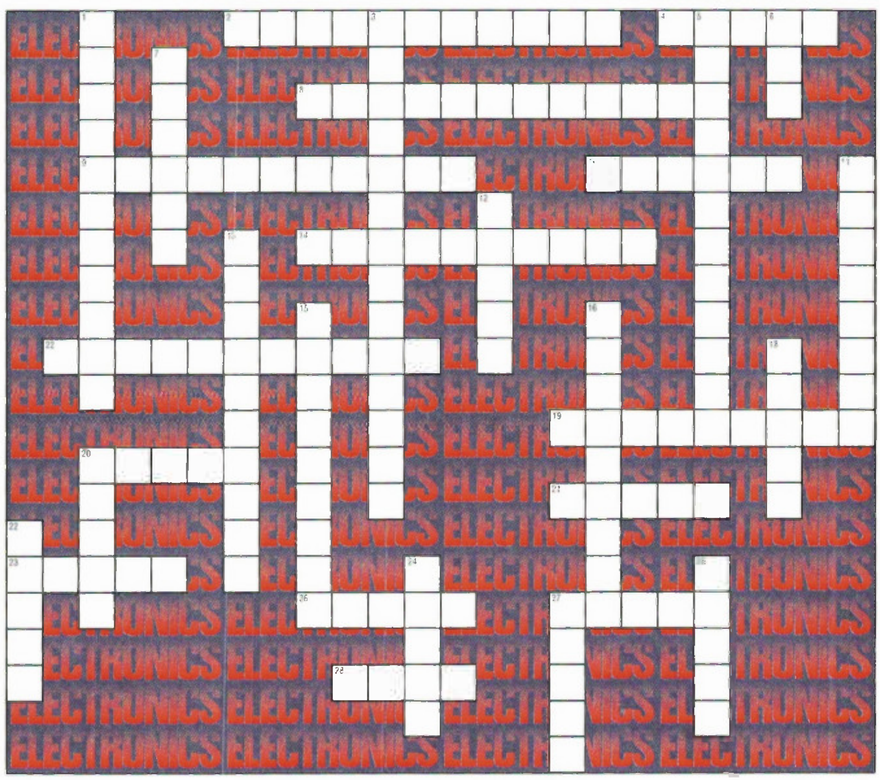
ACROSS

2. Capacitor for tuned, timing circuits and ceiling tiles!
4. Can't work without 1072 - 1111
8. Polarised capacitor
9. Use this to find the wire Mark
10. The best electronic products supplier
14. IDE, SCSI types store lots of data
17. What shape is this LED?
19. Better use a retractable than a bent coat hanger
20. Your gold plated jack
21. Garfunkel wasn't thinking about this midi when he sang
23. You won't find this order code driven on the underground
26. A type of race or switch
27. This order code will fly
28. Girls name fixed to the ceiling

DOWN

1. Test aid for logic circuits
3. Mount the sound GL18U
5. No needle or numbers, this instrument gives you a display
6. Display don't shine like LED
7. Inductor type construction, Robert
11. Type of transformer
12. Get the needle order code
13. Help get things together pages 332-377
15. These couplings are not on the high seas they're on page 353
16. No need to shout when holding this
18. Semiconductor device in Opto isolator
20. This two into one will go, why adapt
22. Switches on the heating before its freezing
24. Model making wood
25. Put your foot down and pump up the volume
27. This 2 Amp fuse blows quickly

CROSSWORD No. 1 April 1997



Name

Address

Postcode

Daytime telephone number

Photocopy entries will be accepted. Multiple entries will be disqualified.

DEVELOPING APPLICATIONS AROUND THE PIC ARCHITECTURE

PART 6

Building a Complete Solution

by Stephen Waddington

After separately considering both the hardware and software elements of the PIC family of microprocessors, this month, we take a look at developing complete applications. Here, Stephen Waddington matches hardware and software with a collection of design tools to create a very basic application based around the PIC architecture.

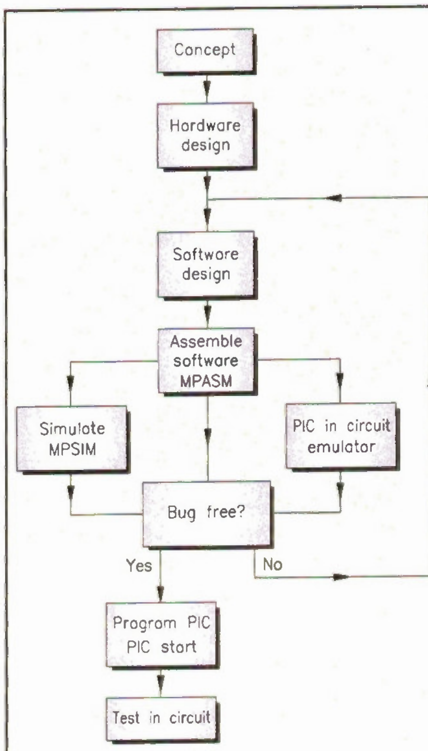


Figure 1. Development cycle for microprocessor application.

In the beginning, there is always a big idea. What's yours? What do you want to develop? All electronic design engineers start with an idea. In fact, we're short-cutting the design process before we've even started by deciding to work with the PIC family of microprocessors. You'll have to forgive me for this supposition, but I want to use this article to demonstrate how to create a PIC based solution from initial concept, through to a working design.

My idea is straightforward. I want to create a circuit which will flash two LEDs alternately on and off. And here, you'll understand the reason for my apology. This is not the most complex design – and could be solved using a basic flip-flop – but its simplicity will allow us to examine each element of the development cycle in detail. Once we've got the basics right, we can start to look at more complex problems.

Development Cycle

At the end of last months' feature, you may remember that we examined the development cycle for a microprocessor application. This is repeated in detail in Figure 1. We'll be concentrating on the left-hand side of the process without the luxury of an In Circuit Emulator (ICE) to test code. While the ICE approach can simplify debugging, it has a major downside in that the emulator hardware is expensive. A basic ICE costs approximately £500, placing it beyond the realms of the amateur developer. Instead of taking the ICE approach, we'll either download code directly to EPROM for testing or test it first using an event-driven software simulator.

As with the other parts of this series, we're focusing on the PIC16C84 as the target device. From a hardware point of view, this is complete overkill. The flip-flop application will require a fraction of the 1k-byte program memory available, will not require any of the four available interrupt lines, and will require only two of the available 13 output lines.

But the PIC16C84 is an excellent device to learn the basics of microprocessor and PIC development. It uses the standard PIC instruction set of 33 instructions, with only two additions to the address registers, which are unique to the device. This means

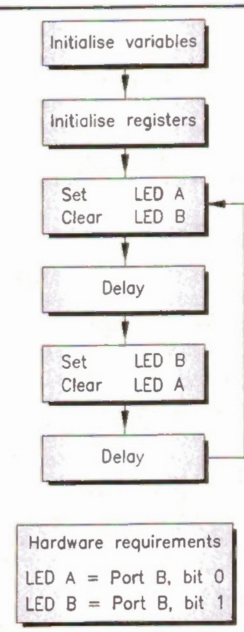


Figure 2. Development cycle for flip-flop application.

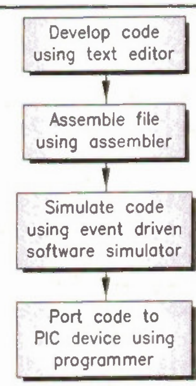


Figure 3. Assembling and porting PIC machine code.

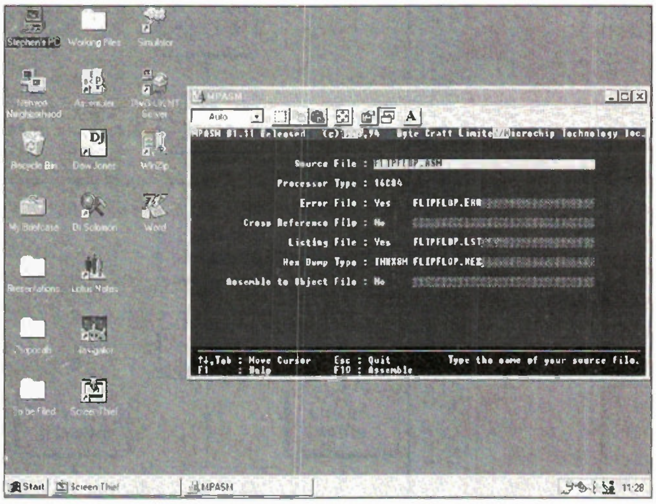


Photo 1. Microchip MPASM assembler environment.

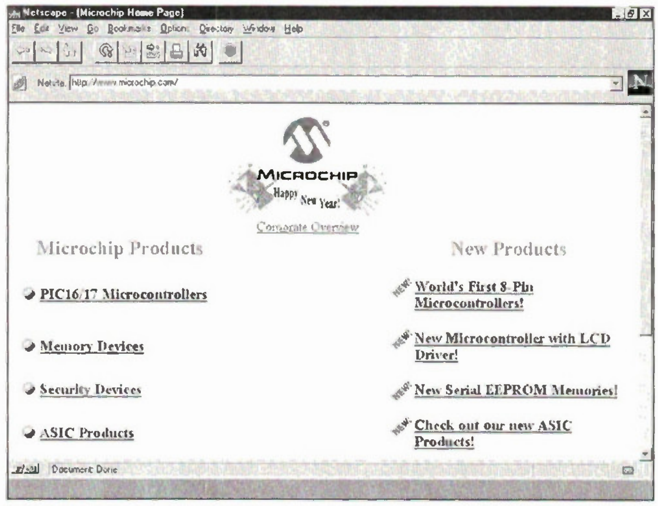


Photo 2. Microchip home page at `http://www.microchip.com`**.**

that once you have got to grips with programming the PIC16C84, you will be able to work with any of the other devices in the PIC family.

The PIC16C84 has other benefits in terms of the design process. Its 1k-byte of local EEPROM means that the device can be programmed and re-programmed electronically within 20 seconds. The majority of the other members of the PIC family are EPROM-based and require exposure to ultra-violet light to erase the contents of memory, before being reprogrammed. This typically takes up to 20 minutes. In later parts of this series, we will look in greater detail at other members of the PIC family and how to best match a device against a particular design requirement.

Design Process

The first requirement of the design process is to develop a flowchart for our flashing LED flip-flop problem. I've done this in Figure 2. The flowchart starts by initialising both the hardware elements of the PIC16C84 and software variables required by the application.

The remainder of the flowchart considers the configuration of the required outputs. In this sense, it is self-explanatory. Of two LEDs, LED A is switched on, while LED B is switched off. Following a delay, the situation is reversed so that LED B is switched on and LED A switched off. After a second delay, the program jumps back to the start to continuously repeat this loop.

After defining the function of the flip-flop application, it would be normal to match the hardware requirements against a target device, but we have already decided on the PIC16C84. What we can do though, is define the required outputs against available ports. For this exercise, we'll use PORTB of the PIC16C84 and defined bit 0 as LED A and bit 1 as LED B.

Our next task is to convert the flowchart into code. This is created in a text editor or word-processor. You can use the Notepad in Windows, Word or WordPerfect, since all enable files to be saved in ASCII format. Once complete, the draft program is saved as an assembler file in ASCII or raw text format with an .asm extension. A PIC assembler is used to convert the source code into hexadecimal format which can then be ported directly to the target microprocessor. This process is shown in Figure 3.

The Assembler

There are numerous PIC assemblers available on the market which could be used to convert the source code into a hex file. One of the most popular is a DOS based package from Microchip, called MPASM. This is a neat piece of software which, unlike many other PIC assemblers, has a reasonable user interface, as shown in Photo 1. The majority of assemblers don't even have this luxury, relying instead on the user inputting a complex DOS string. The first-time user should avoid these at all costs. The complexity which they add to the design process is unnecessary.

Writing Code

The MPASM assembler accepts source code in a standard ASCII format and allows the user to select the required output format on screen using a mixture of the <TAB>, <ENTER> and Function keys. It also has a reasonable level of error reporting for when things inevitably don't go right first time.

Each line of the source file may contain up to four types of information: labels, mnemonics, operands and comments.

The order and position of these are important. The MPASM assembler separates a line into a series of columns each denoted by a tab space. Labels must start in column one directly against the left edge of the page. Mnemonics may start in column two or beyond and operands always follow the mnemonic.

Comments may be added after either an operand, mnemonic or label, or can start in any column if the first character is either an asterisk or a semi-colon. The maximum column width is 255 characters. One or more spaces must separate the label and the mnemonic, or the mnemonic and the operands. Operands may be separated by a comma.

Labels

All labels, such as subroutine names, must start in column 1. They may be followed by a colon, space, tab or the end of line. Comments may also start in column 1 if one of the valid comment denotations is used. Labels must begin with an alphabetical-character and may thereafter contain alphanumeric characters. Labels may be up to 32 characters long.

Mnemonics

Assembler instruction mnemonics, assembler directives and macro calls must begin in at least column 2. If there is a label on the same line, they must be separated from that label by a colon or by one or more spaces or tabs.

Operands

Operands must be separated from mnemonics by one or more spaces or tabs. Operand lists must be separated by commas. If the operand requires a fixed number of operands, anything on the line after the operands is ignored. Comments are allowed at the end of the line. If the mnemonics permits a variable number of operands, the end of the operand list is determined by the end of the line or the comment.

Comments

Comments which are on a line by themselves must start with either of the comment characters, namely an asterisk or semi-colon. Comments at the end of a source line must be separated from the rest of the line by one or more spaces or tabs. Anything encountered on the line following the comment character is ignored by the assembler.

Developing Code

Before we examine the code for the LED flip-flop application in detail, let's run through some basic rules of microprocessor software development. These rules apply as much to development around the PIC architecture as any other microprocessor family.

Structure Software

Creating a flowchart of an application is a good way to start the development process, since it imposes structure from the outset. It enables you to remain focused on what it is you want to achieve.

Layout

Use a logical format to the structure of your software. Convention and logic dictates that initialisation routines come first, followed by the main program, and then any subroutines which the main program calls upon.

Labels

All subroutines should carry a logical name. This simplifies coding, since it is easier to jump to a logical name rather than specifying a hex address when you need to switch to a subroutine.

Variables

The same applies to variables. Wherever possible, use a logical naming convention for variables, rather than specifying a number. This makes code easier to debug and means that the function of a program is understandable at first glance.

Comment

Always annotate your software with comments. You will inevitably need to come back to review your software. Concise annotation makes that process far easier.

Header

Create a universal hearer for your programs. This reduces workload, creates a consistent format and limits the number of variables you have to remember.

If you find all these rules daunting don't be too concerned at this stage. The easiest way to learn a new software language such as PIC machine code is to examine plenty of examples. Consult the books recommended in the reading list at the end of this feature, or check out Microchip's home page at **http://www.microchip.com**, as shown in Photo 2. It provides numerous links to Web sites created by PIC development engineers. Also, flick through your back copies of *Electronics and Beyond*. Revisit PIC projects designed by the team of Maplin project engineers to check their code and target circuit designs.

Flip-Flop Application

The code for the flip-flop is shown in Figure 4. There are essentially four components to the programme, as denoted by comments in the program and the descriptions below.

Set Variables

Here, variables used throughout the programme, such as PORTB and COUNT, are defined.

Initialisation Routine

This is used to set the memory location for the programme, initialise PORTB for output rather than input and clear PORTB to zero.

Main Programme

This is the heart of the programme. It alternately switches bits 0 (LED A) and 1 (LED B) of PORTB on and off. A delay of 0·2ms is maintained between each state.

Delay Routine

The programme uses the PIC16C84's internal real time clock (RTCC) to create a delay. Bit 7 of the RTCC register – which hits 1 after 128 clock pulses – is used in a nested loop to create a delay. LONG2 loops until bit 7 of the RTCC register is set. This is equivalent to a delay of 32·768ms – 128 clock pulses multiplied by 256μs, assuming 4MHz clock, which gives a clock pulse width of 256μs. LONG2 is nested with JUMP which counts from 8 – the value of the variable COUNT – to zero. This creates an overall delay of 0·256s.

```
; Flipflop Routine - Filename: flipflop.asm
; Stephen Waddington
; Building A Complete Solution
; Developing Applications Around the PIC Architecture - Part6

; Set variables
PORTB       EQU 06H         ; PORTB is register 6
RTCC        EQU 01H         ; PIC RTCC timer register
COUNT       EQU 00H         ; Timer counter
TIME        EQU 08H         ; Timer period

; Initialisation routine
INIT    ORG  00H            ; Store programme at location 00H
        TRIS PORTB          ; Set PORTB as outputs
        CLRF PORTB          ; Clear PORTB

; Main programme
MAIN MOVLW B'00000001'      ; Set LEDA on, LEDB off
        MOVWF PORTB
        CALL DELAY          ; Hold LEDA on for 0.256ms
        MOVLW B'00000010'   ; Set LEDB on, LEDA off
        MOVWF PORTB
        CALL DELAY          ; Hold LEDB on for 0.256ms
        GOTO MAIN           ; Loop back to the beginning of MAIN

; Delay routine
DELAY   CLRWDT              ; Clear Watchdog timer
        MOVLW TIME
        MOVWF COUNT
        CLRF RTCC           ; Clear RTCC register
LONG    BTFSC RTCC,7        ; Test RTCC bit 7 (128 X 256µS = 32µ768ms)
        GOTO JUMP           ; If RTCC bit 7 set goto JUMP
        GOTO LONG           ; If RTCC bit 7 not set loop until set
JUMP    CLRF RTCC           ; If RTCC bit 7 is set clear RTCC
        DECFSZ COUNT,F      ; Decrement COUNT by 1 until reach zero
                            ; (32ms X 8 = 0·256s)
        GOTO LONG           ; Loop LONG if COUNT not equal to zero
        RETURN              ; Return to call location
RESET   GOTO INIT           ; On RESET goto INIT

    END
```

Listing 1. Flip-flop assembler code.

Having creating the source code in a text editor, it must be save in an ASCII format with an **.asm** extension, in this case, **flipflop.asm**. It can then be loaded into the MPASM assembler. After selecting the appropriate target microprocessor – in this case, the PIC16C84 – and Hex output – in this case, INHX8M – the file can be compiled. The MPASM assembler is able to create four different Hex output formats, depending on the format required by the PIC programmer. Make sure you select the correct format.

The assembler returns a series of statistics relating to the length of the assembled code as well as the number of warning and error messages, as shown in Photo 3. If the code contains any bugs, it will not run when downloaded to the microprocessor. Errors reported by the assembler can be examined in either the List or Error files. The assembler creates three other files in addition to the List and Error Files. These are detailed below and shown in Photo 4.

- **<filename>.asm**
  Default source code file.
- **<filename>.lst**
  Default output extension for listing files generated from the assembler
- **<filename>.err**
  Default output extension from MPASM for error details.
- **<filename>.hex**
  Default output code for porting to target microprocessor.
- **<filename>.cod**
  Default output extension for the symbol and debug file.

Software Debugging and Simulation

Using the Error and List files, the source code should be debugged and reassembled until it is error free. This can be a very tedious process and is why professional development engineers use an In Circuit Emulator (ICE). Microchip has developed a compromise solution in terms of cost, in the form of a discrete event software simulator. The Microchip MPSIM enables PIC code to be emulated by a PC and various program variables, interrupts, and ports to be monitored.

Like the Microchip assembler MPASM, MPSIM is DOS-based and as such, is not very user-friendly. It uses a set of proprietary instructions to both initialise the simulator environment and run an actual simulation. It's almost as if you need to learn an additional software language before you can run a simulation. For this reason, the majority of hobbyists tend to test software by downloading it directly to the target microprocessor.

Photo 5 shows the flip-flop application being simulated using MPSIM. The assembled PIC software has been loaded in hex format into the simulator and the different variables used by the programme set as flags to be monitored in the upper half of the screen. When the code is run and simulated by the PC, its effects on registers, variables, interrupts and the I/O ports can be monitored by observing the flags.

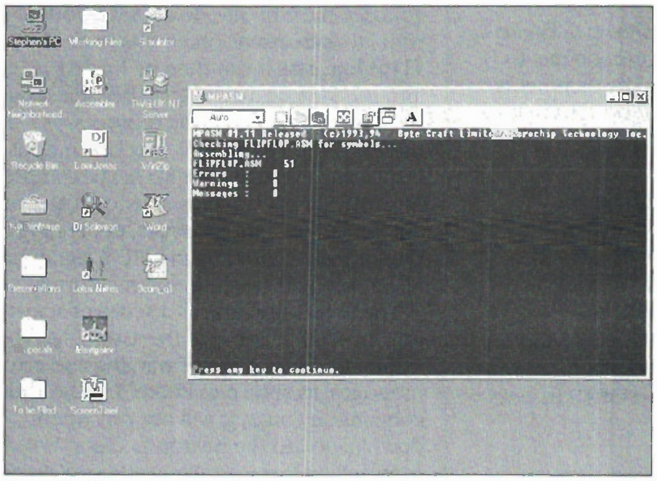


Photo 3. MPASM returns a series of statistics relating to assembled file.

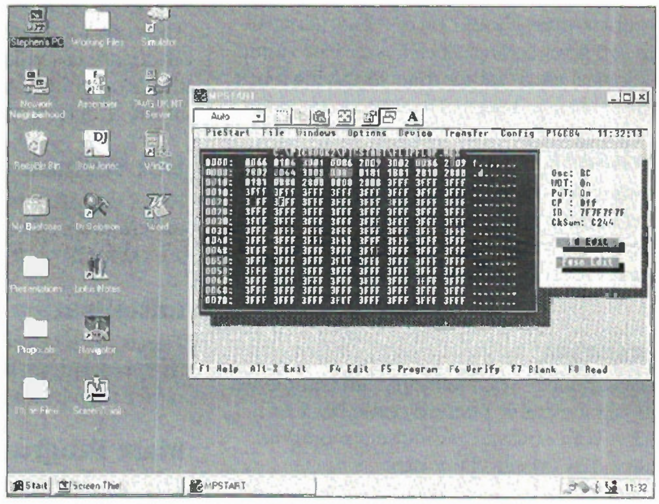


Photo 6. Porting code to PIC16C84 using PICStart.

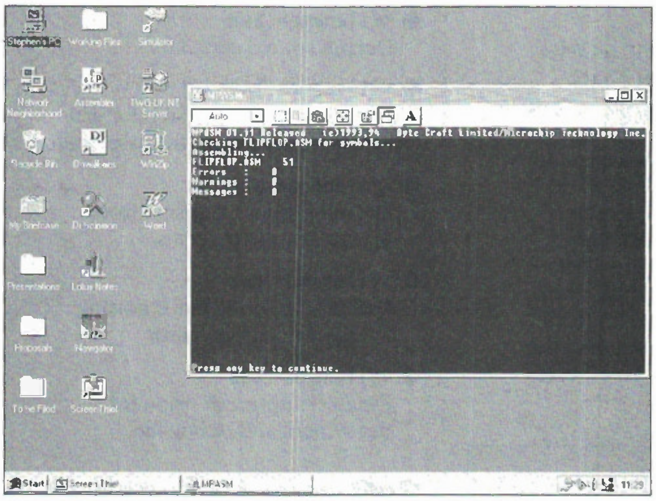


Photo 4. Output files from MPASM.

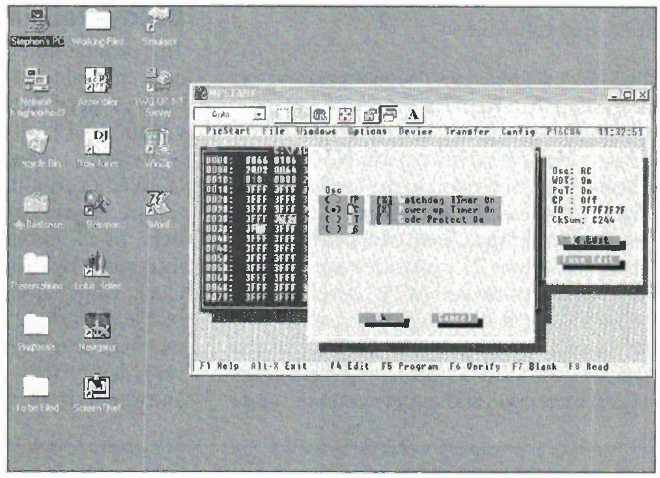


Photo 7. Making fuse selecting in PICStart development environment.

Photo 5. Simulating flip-flop application using Microchip MPSIM.

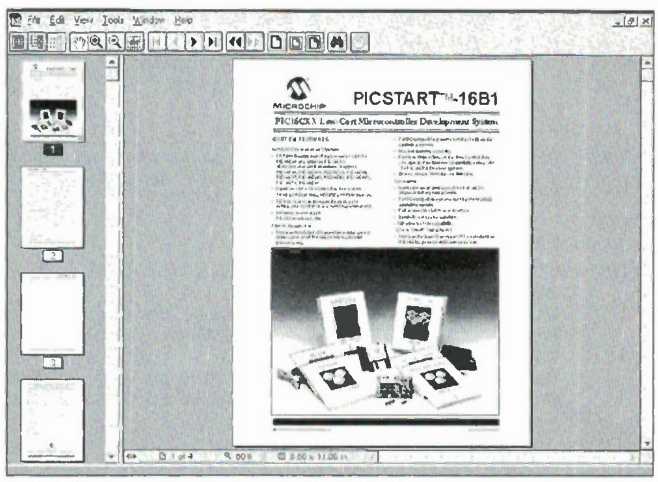


Photo 8. Datasheets in Acrobat PDF format can be downloaded from the Microchip Web site.

Hardware

Whether or not you decide to simulate your PIC code using MPSIM or a similar software simulator, you'll eventually have to download it directly to a PIC device. There are a number of programming devices available on the market. The most versatile and consequently, the most popular, is Microchip's PICStart. PICStart enables any device in the PIC microprocessor family to be programmed. By comparison, Maplin has developed a programmer kit project specifically for programming the PIC16C84. While this machine is specific to the PIC16C84, at approximately £20, it is relatively inexpensive compared with PICStart. The PIC16C84 was profiled in Issue 105 of *Electronics and Beyond*.

PICStart consists of two elements – a software programme and a programming board. The software programme, as shown in Photo 6, is used to drive the programmer. From here, the target programming board (shown in Figure 4) connects directly to the serial port of a PC. Power is provided by an auxiliary 9V mains adapter. The target PIC device is inserted on the programming board in a zero insertion force (ZIF) socket.

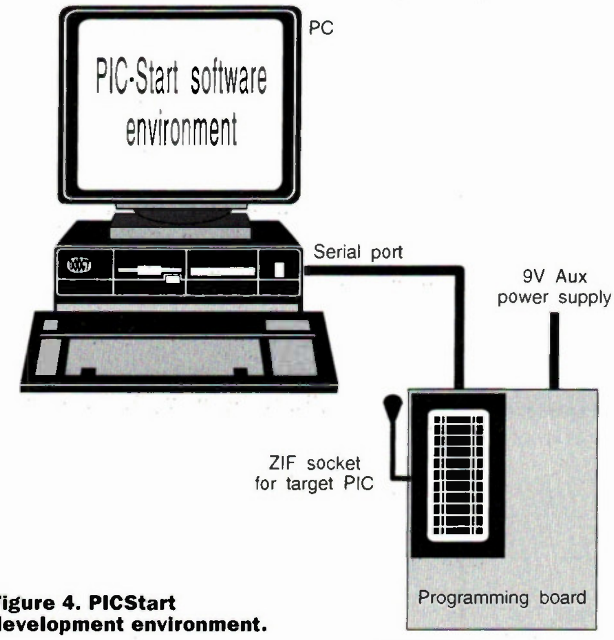


Figure 4. PICStart development environment.

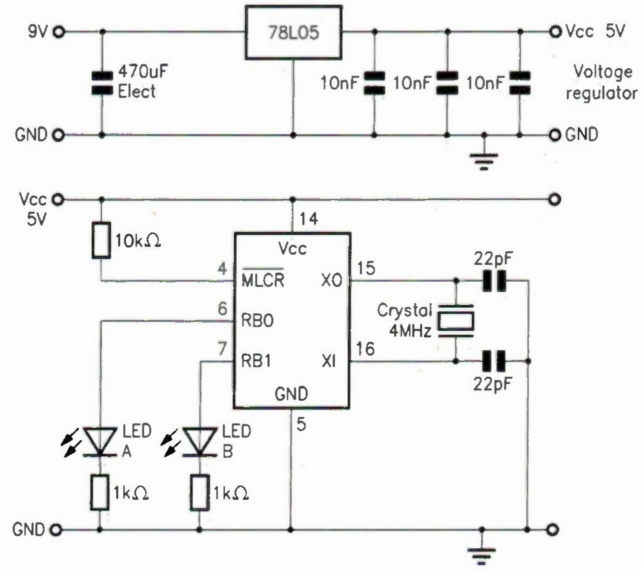


Figure 5. Target circuit for PIC16C84.

Unlike other elements of the development process, programming a PIC device is very straightforward. Having loaded the PICStart application and connected the programming board, the target device is selected. Next, the assembled code to be ported to the PIC device is loaded. Like the MPSIM Simulator, PICStart uses the INHX8M version of hex code.

Before the device can be programmed, the software programmable fuses such as Watchdog Timer, Start on Power up and clock format must be configured, as shown in Photo 7. Once this is complete, the target device is mounted on the programming board and the code downloaded. It takes approximately 20 to 30 seconds to programme a PIC device. During this time, the PC transfers the hex code and fuse selections to the memory of PIC device, before verifying the contents of all EEPROM memory.

Target Circuit

So, we've developed the flip-flop design from an initial concept, created a flowchart, written a routine in PIC assembly code, simulated it and finally downloaded it to a PIC16C84. What we need to do now is build a target circuit and test the device. Figure 5 shows a basic target circuit for the PIC16C84. There are four key elements to this design as follows:

Voltage Regulator

The operating range for the PIC16C84 is 2 to 6V. Consequently, a 78L05 voltage regulator is used to stabilise the voltage from a 9V battery at a constant 5V. This is not necessary if you have access to a stabilised 5V power supply.

Clock

Figure 5 shows a 4MHz crystal with two 22pF capacitors. This option has been selected for its simplicity. A resistor capacitor combination with an RC time constant of 4MHz could be equally used. Whichever clocking method you adopt, ensure that you select the appropriate fuse option when programming the target device. A 4MHz crystal falls within the XT region, as shown in Table 1 and discussed in Part 3 (Issue 109) of this series.

For timing insensitive applications an external RC clock offers cost savings. Figure 6 shows how the RC combination is implemented. For R_{ext} values below 2k2Ω, the oscillator operation may become unstable, or stop completely. For very high R_{ext} values above say, 1MΩ, the oscillator becomes sensitive to noise, humidity and leakage. Microchip recommend that R_{ext} is kept between 3kΩ and 100kΩ.

Although the oscillator will operate with no external capacitor (C_{ext} = 0pF), a value above 20pF should be used for noise and stability reasons. For these reasons, it is recommended that the novice developer use either a crystal or ceramic clock, since this avoids added complication. If you intend using a RC combination, select the RC option when programming the target device.

To achieve a clock speed of 4MHz using RC components, try around values of Rext = 20pF and Cext = 10kΩ.

Output

The PIC16C84 has an output current capability of 25mA. At 5V, this is sufficient to blow an LED. Consequently, 1kΩ resistors are used on the leg of each output to reduce the current to the LED to a moderate 5mA.

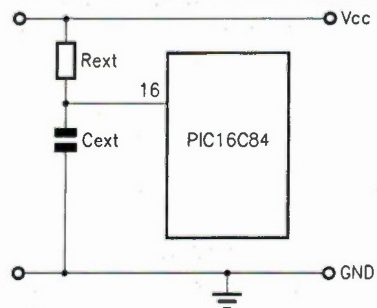


Figure 6. Driving PIC16C84 using a resistor-capacitor combination.

Option	Clock Speed
LP	0 to 200kHz
XT	100kHz to 4MHz
HS	4MHz to 10MHz
RC	0 to 10MHz

Table 1. Clocking rates and options

Reading List

The following books discuss many of the issues raised in this article in greater depth. They also provide examples of the PIC development cycle including many specific projects.

Microchip has produced documentation for all of its development tools. It has also produced datasheets for each of the PIC microprocessors. These can be downloaded in Acrobat PDF format, as shown in Photo 8, from the Microchip Web site. An Acrobat reader can be downloaded from the Acrobat Web site at **http://www.adobe.com**.

Description	Reference/Order Code	Cost
A Beginners Guide to the Microchip PIC	AD31J	£19.95
PIC Cookbook	DT76H	£19.95
Embedded Control Handbook	AD28F	£9.50
Microchip Databook	AD29G	£9.50
MPSIM for DOS User's Guide	http://www.microchip2.com/devtools/devtools.htm	–
MPASM User's Guide	http://www.microchip2.com/devtools/devtools.htm	–
PICStart-16B1 User Guide	http://www.microchip2.com/devtools/devtools.htm	–
PIC16C84 Application Note	http://www.microchip2.com/devtools/devtools.htm	–

Reset

The reset pin – pin 4 – is connected high. This causes the PIC16C84 to enter a power-up delay phase of approximately 72ms in order to enable the clock to stabilise at power on. This eliminates the need for external components usually required for Power On Reset. To reset the device at any stage during operation, pin 4 should be connected low for a brief period.

Initially, you should experiment using breadboard. It always takes a couple of iterations of both software and hardware to achieve the required operation. That said, having built the target PIC16C84 circuit, the programme should fire-up immediately on power-up and LEDs A and B flash alternately.

Next Month

Next month, we'll examine more advanced software techniques including the use of interrupts, look-up tables, reset vectors and the watchdog timer. We'll also look in greater details at how to debug object code.

ELECTRONICS and Beyond

Download List

Shareware versions of the majority of the development tools discussed in this feature can be downloaded from the Microchip Web site at **http://www.microchip2.com/softupdt.htm**. Specific references are detailed below. All files have been compressed using PKZIP. PKUNZIP – the decompress utility – can also be downloaded for the Microchip Web site.

Description	Software Tool	Full Length
MPASM Assembler	MPASM 1.40.00	487k-bytes
MPSIM Simulator	MPSIM 5.20.00	286k-bytes
PICStart (Software only)	PICSTART-16B1 5.00	125k-bytes

Catalogue References

Many of the items discussed in this feature can be purchased directly from Maplin, either by mail order or directly from one of the Maplin shops. Catalogue references and costs are outlined below.

Pic Resources

Description	Order Code	Cost
PIC16C84 Programmer Kit	95128	£19.99
PICStart-16B1 Development System	DM79L	£154.90
ICEPIC16CXX Real Time Emulator System	DT77J	£689.00

Target PIC16C84 Circuit

Component Type	No	Description	Order Code	Cost
Semiconductors	1	78L05 5V voltage regulator	WQ85G	£0.49
	1	PIC16C84	AD50E	£10.70
Capacitors	2	22pF mica	WX05F	£0.55
	3	10nF ceramic	BX00A	£0.11
	1	470μF, 35V electrolytic	AT62S	£0.36
Resistors	2	1kΩ resistor	U1K	£0.05
	1	10kΩ resistor	U10K	£0.05
Miscellaneous	2	Red LEDs	WL27E	£0.10
	1	9V PP3 battery	JY60Q	£1.90
	1	PP3 Battery clip	HF28F	£0.19

Lightning

PART 2

PROTECTING AGAINST IT

by Greg Grant

All the early electrical pioneers were fascinated by lightning, none more so than Michael Faraday, who would stand at the window for hours watching the effects and enjoying the scene. However, shortly after Samuel Morse got his eponymous code accepted and the earliest telegraph lines were up and running, attitudes changed markedly. One immediately noticeable problem was that lightning interfered with signals and damaged both lines and terminal equipment.

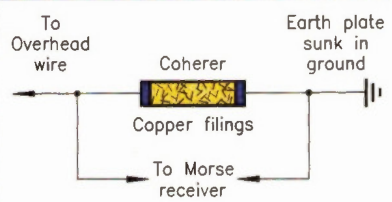


Figure 1. Edouard Branly's Coherer used as a lightning protection device for telegraph equipment.

These early circuits were 'single line' systems, where the earth itself was used as one cable. The overhead wire was connected to earth through the recorder coils, which meant that when it picked up a powerful electrical discharge, the resulting current flowed through these sensitive coils, usually damaging or destroying them.

This remained a problem until 1890, when the French physicist, Edouard Branly, developed the Coherer – see Figure 1. A glass tube filled with metal filings, this device was developed as the earliest receiver for the new experimental vogue of the day, radio waves. A coherer usually had a resistance of several Megohms, but when an electrical discharge occurred close to it, this resistance dropped dramatically to a few hundred ohms.

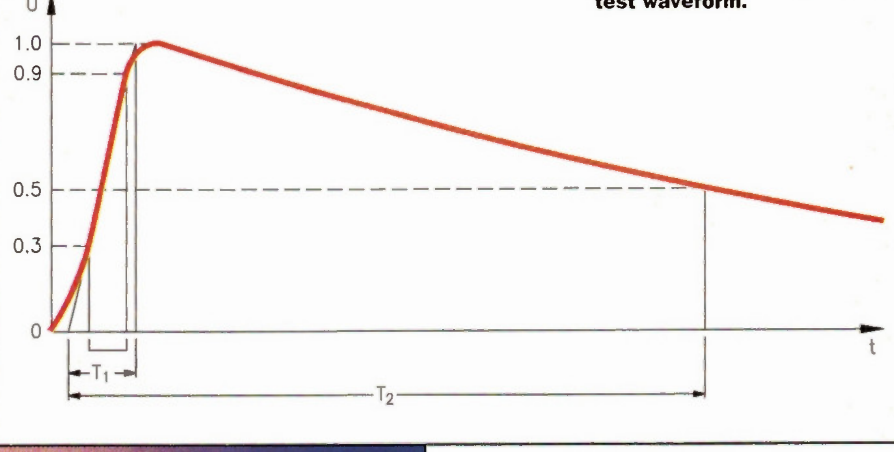
Whilst Branly continued with his radio experiments, others saw his discovery as one way of protecting telegraph lines. The Varley brothers – later famous for their test meters and other indicative devices – devised the circuit below, in which a coherer was placed in parallel with the overhead telegraph wire and the earth plate.

Generally, the coherer's high resistance did not interfere with the efficient operation of the telegraph but, when lightning struck the wire, the coherer became a near-instant good conductor, shorting the potentially damaging current. Thus, the overhead wire acted as an independent lightning conductor.

Another early electrical engineer who was greatly interested in lightning was the radio pioneer, Oliver Lodge, who popularised the coherer in Britain. In 1892, he took lightning protection that little bit further towards scientific enquiry by collecting together the various protective zones provided by a lightning conductor.

The point to remember about lightning is that the problems it creates can vary enormously, from one area of the world to another and from one locality to another within those areas. When it strikes the earth, for example, the potential gradient can exceed 1kV/m at a distance of 100m from the strike. Buildings separated by 100m can have ground potential differences of greater than 20kV. On directly striking an object, lightning is infinitely more dangerous, occasionally generating currents approaching a value of 10^6A for a duration of some 50μs.

Figure 2. The IEC's specified test waveform.



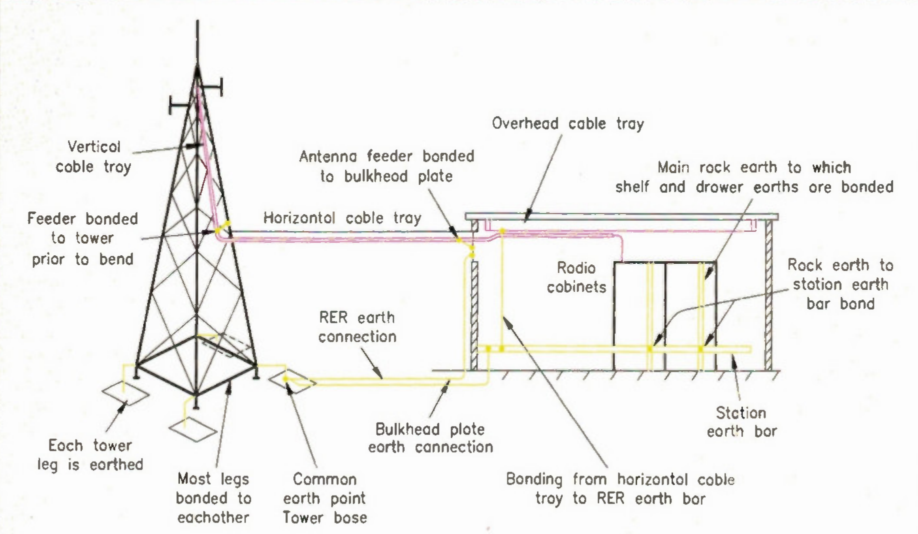


Figure 3. A typical Radio Equipment Room/Antenna Mast location.

Where protection for electronic equipment is concerned, therefore, there are three factors to bear in mind. Firstly, the number of flashes to ground per square kilometre annually; secondly, the earth resistivity reading and finally, the amount of shielding provided by the locality's buildings, power lines, communications cables and the like.

Figure 2, the test waveform of the International Electrotechnical Commission's (IEC) journal 'High Voltage Test Techniques', gives some idea of what the electronics profession in general is up against when lightning strikes.

It illustrates a waveform with an extremely rapid rise time – around 1μs – and frequency components in the Megahertz (MHz) range. Consequently, lightning precautions begin with the antenna mast and the Radio Equipment Room (RER), before considering the equipment itself.

The Equipment Location

The mast/RER location of Figure 3 is typical of many radio sites world-wide. Ironically, ideal conditions for communications equipment are equally as helpful to lightning. Antennas, of course, must have sufficient height to clear any surrounding obstacles, which can also cause problems with lightning.

Frequently, however, some lightning problems can be rectified by changing the antenna's physical location on the mast whilst in other areas, the likelihood of a lightning discharge is so remote that the normal earthing provided by a metal mast is more than sufficient.

Basically, there are two fundamental rules when protecting equipment from lightning strikes: firstly, prevent CURRENT from reaching the equipment and secondly, take precautions against external VOLTAGES.

An antenna tower is a complicated structure. The bonding paths have to make contact between the antennas on the tower and the equipment in the RER. In short, there is a metallic bridle path between the equipment and the tower, perfectly capable of introducing currents – and therefore, potential rises – into the communications equipment.

In Figure 3, the antenna cables are routed down the tower on the vertical cable tray, which bends at the bottom onto a similar horizontal tray, which carries the cables to the building entry point. From here, the cables enter the RER onto another tray, located above the communications system, prior to connection to individual equipment.

Figure 4 illustrates the multiple earth paths for a correctly bonded communications installation, which will divert the discharge currents away from the equipment. The result is a reduction in lightning voltage, brought about by the earth paths from the vertical cable to the horizontal cable tray and that at the RER cable entry point.

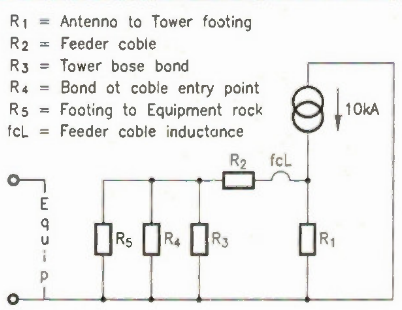


Figure 4. The earth paths of a correctly bonded radio communications installation.

Furthermore, the feeder cable inductance at the vertical-to-horizontal bend, fcL, provides additional series impedance to the lightning current, routing it through the antenna-to-tower footing path, represented by R1. The cable bend should be as close to the designed cable bending radius as possible, the tower bond being made ABOVE the bend. Inductance, however, can create as many problems as it solves, and usually unwittingly.

The majority of series paths use copper strip because of its low resistance and inductance, but a neat and tidy mind, the sort that bends the copper strip fastidiously around the tower structure, can actually re-introduce inductance into the earth path!

The better, not to say far safer, technique is gentle, untidy bends, none of which should be less than 450mm radius, as the potential difference between two points on a copper conductor with a small bend could cause an arc across the loop. Indeed, a hole THROUGH an obstruction is infinitely preferable to a loop around it.

The antenna feeders are earthed to the RER bulkhead plate which, itself, should be EXTERNALLY earthed to one of the tower base's common earth points. The equipment drawers and shelving are individually earthed to each cabinet earth bonding strip which, in turn, is bonded to the power system earth, which is also taken to one of the tower base earth plates, on a SEPARATE lead.

Protection Devices

The Franklin Rod, still much in use today as a glance at almost all church towers and steeples verifies, remained the major lightning protection device until the early years of the present century. However, the increasing use of electric power and the rise of the communications and broadcasting industries, made lightning protection something of a priority and manufacturers realise that new devices were needed.

Consequently, there is a wide variety of equipment available designed to thwart the demon that is lightning, such as voltage-limiting devices, current-interrupting systems, drainage coils, isolation transformers and many more. The following paragraphs give but a brief insight into a near-inexhaustible subject.

The earliest of the 'new' developments was the Zero Field Area, or Field-Free Space, based on an idea first put forward by Michael Faraday. In this concept, the walls of a RER or electronics laboratory are lined with wire netting or metal plating, joined together and efficiently earthed, giving a zero potential enclosure which no electric field can penetrate nor in which one can develop, thus protecting the equipment inside. This Faraday Cage, as the enclosure is termed, is widely used in communications and electronics, particularly in Electromagnetic Compatibility (EMC) testing and in Electromagnetic Pulse Protection laboratories.

By 1927, the Vacuum Gap Protector had been devised as a Lightning Arrester. It was triggered by the voltage developed on the power line by the lightning discharge. Another early protective device was the Air Gap, which used retort carbon for its electrodes, firstly for the material's non-corrosive properties, secondly for its high melting point. Indeed, many Air Gap protection devices are still in use today, world-wide.

The Gas Gap, or Gas Discharge Tube (GDT), was another lightning protection development, although the earliest examples suffered from a number of problems, among which was fragile construction, ineffective sealing and high cost. By the 1960s, however, modern manufacturing techniques had improved GDTs considerably.

Present-day versions, with two gaps enclosed in the same envelope, are very effective as both gaps tend to strike simultaneously. The Striking, or Sparkover, voltage depends on the product of the gas pressure and the electrode spacing. A hydrogen-argon mixture, at low pressure, is usually employed.

In equipment terms, protective devices must limit potential differences to a level where they will not cause damage, yet be rapid-acting. These requirements are usually met by a double protection system, similar to that of Figure 5.

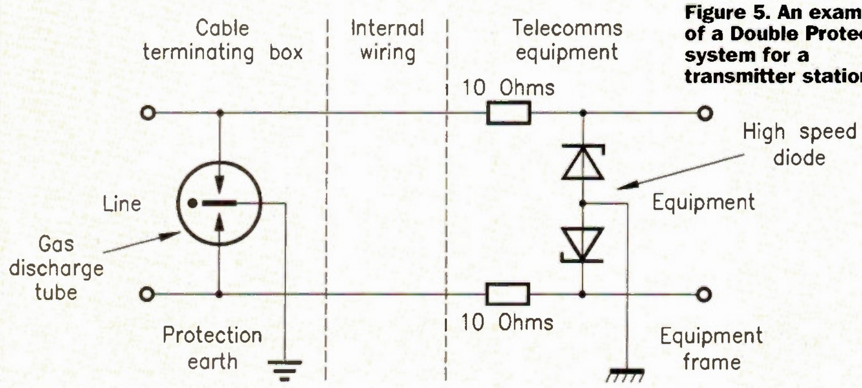


Figure 5. An example of a Double Protection system for a transmitter station.

The GDT clamps the high voltage, high energy surges, whilst the high-speed diode clamps the GDT's striking voltage which, at around 300V, could still cause equipment damage. The resistors isolate the tube from the diode, otherwise the former would not trigger because the diode would clamp the applied voltage to below the tube's triggering potential. This, in turn, would result in the diode taking the total surge current and would probably being destroyed as a result.

GDTs should be visually inspected on a regular basis and certainly before, and after, the winter months in the temperate zones. They should also be replaced bi-annually, as a matter of routine, and their replacement recorded.

Where power lines are concerned, protectors differ in many respects from those used in communications equipment. To begin with, the operating voltages are far higher and the protectors must reflect this. Consequently, Power Surge Arresters are used.

Power Surge arresters are designed to limit the magnitude of transient voltages and Figure 6 illustrates a 30kV, valve-type power station Surge arrester.

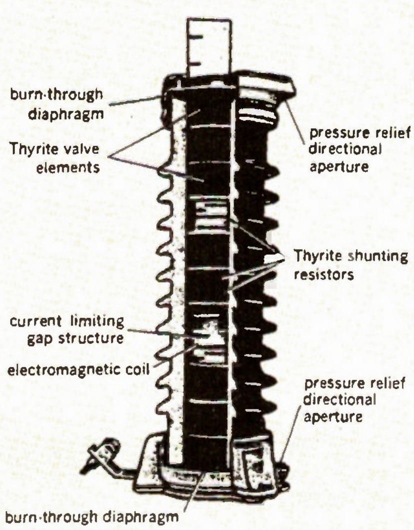


Figure 6. A valve-type power station Surge arrester.

The device consists of a gap structure in series with current-limiting elements. The gaps prevent current flow except when the voltage across the device exceeds the critical gap flashover level.

The current-limiting element is a non-linear resistor, whose resistance decreases considerably as the voltage across it increases. Since the Surge Arrester cannot, obviously, distinguish a lightning discharge from a power generator surge, it attempts to limit ALL abnormal voltages above the Gap Sparkover voltage.

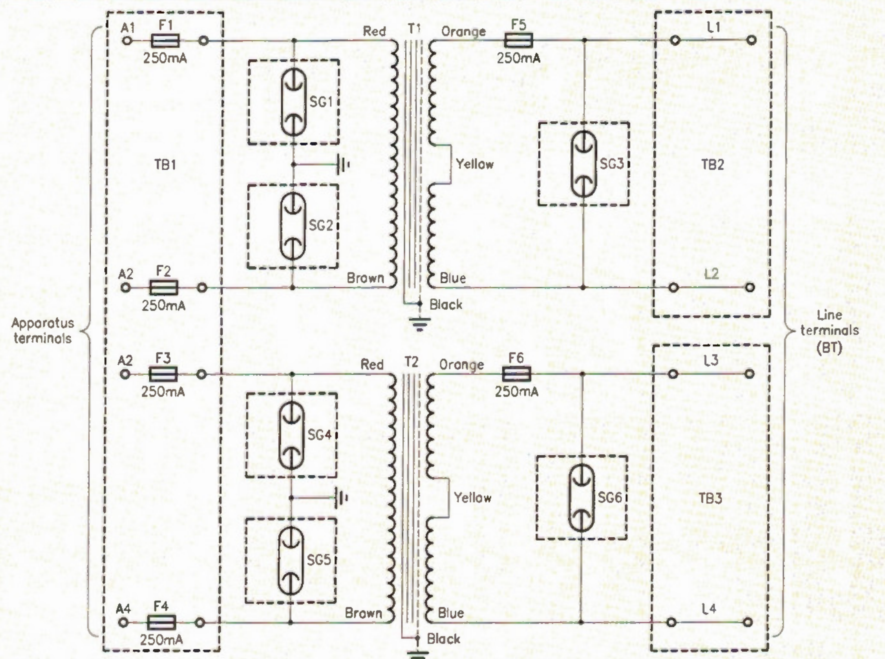


Figure 7. The circuit diagram of a LIne Barrier unit.

The unit's maximum Transient Voltage Level is determined by the Gap Sparkover voltage and the Discharge Voltage Characteristic. Taken together, they determine the arrester's Protective Efficiency. The Discharge Capability, on the other hand, is a measure of the device's endurance to severe lightning and switching voltages.

Another lightning protection device much used in communications is the Line Barrier, illustrated in Figure 7. Each unit provides isolation protection for two, 2-wire audio landlines, one barrier being used for each transmit channel.

When a voltage surge appears across the unit, the Surge Arresters, SG1-6, strike, the resulting current blowing the in-line, 250mA fuse, open-circuiting the line. The line transformers are of the 600Ω, 1:1 type, which introduces an insertion loss of 0·5dB across the audio band between 0·3 and 10kHz, a small price to pay for lightning protection. Each unit, which weighs a substantial 8·5kg, is connected to the transmitting station earth. The removal of this connection renders the unit inoperative.

Finally, there is, perhaps, the most controversial of protection devices, the Radioactive Lightning Preventer. This is based on the Franklin Rod Cone protection principle and utilises a radioactive source, raised above the area or building to be protected.

The radioactive source ionises the air above the building – an air traffic control tower, for example, or a power generating station – the resulting liberated ions greatly increasing the 'effective height' of its mounting pole. Consequently, the protective cone's base radius extends considerably, defending a far larger area than a single Franklin Rod could. However, given the health fears generated by the mere mention of radioactivity, this protective technique is little-used.

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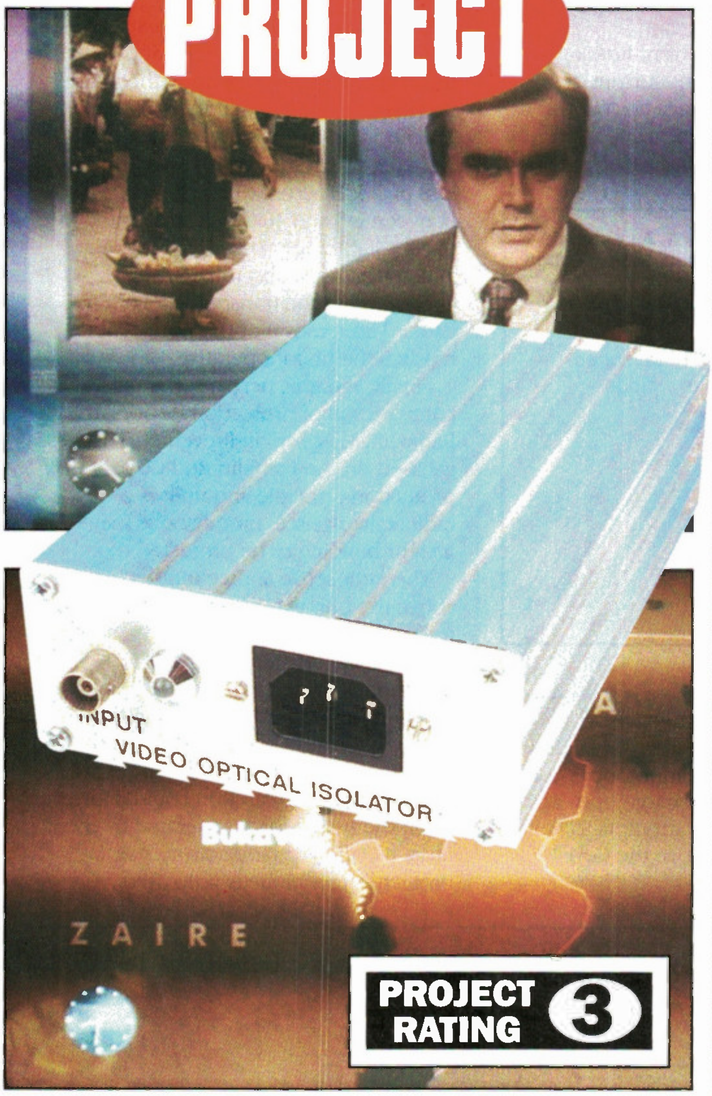
ELECTRONICS



PROJECT RATING 3

Video OPTICAL ISOLATOR

by Ian Berry

There are all kinds of interference signals which can appear on audio and video signals to distort them in one way or another. One of the most common is hum, at either 50 or 100Hz.

You will probably have encountered hum while working with audio and Hi-Fi equipment, and the methods of combating such are fairly well known. When hum appears in video equipment, it is just as annoying but usually much more difficult to get rid of. It can normally be seen as horizontal bands of alternate darkening and lightening of the monitor screen – see photographs. By and large, hum is introduced into a system, whether audio or video, through the interconnections between the system components. If hum is produced by an actual piece of equipment, the cause is much more likely to be a fault of some sort within the equipment itself.

Hum is usually 50 or 100Hz sine waves induced from nearby mains wiring or mains transformers. No one is immune from this problem. A few years ago, a large Broadcasting organisation were covering the snooker from the Guild Hall in Preston. The circus of OB trucks, VTR trucks, Graphics trucks and so on are connected by miles of video and audio cable. When all was connected, it was found that hum was present on just about every video circuit. After a great deal of running about, it was found that the spare mains cable from the lighting circuits had been coiled and shoved under a VTR truck out of the way. This made the biggest transformer primary you can imagine. In this case, there were so many circuits, it was not going to be possible to use elimination equipment to get rid of hum, but for only one or two circuits, methods are available.

Aspects of Hum

There are two different aspects to hum picked up by interconnecting circuits. These are common mode, where the hum is induced equally in both signal and ground wires, and single-ended, where hum is present in only one of the wires, usually the ground or braid of the coax. It would seem that if hum is present only in the ground wire, it would be shorted out at each end of the cable.

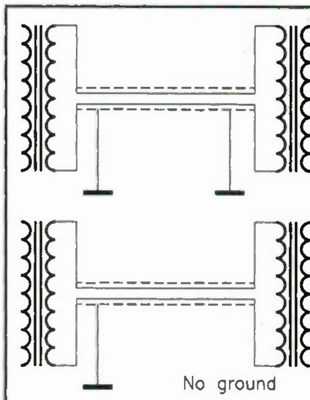


Figure 1. Balanced audio circuit. Note that one side of the braid may be disconnected without affecting the audio circuit, thus eliminating the hum loop shown in the next Figure.

If cables are very short, this is usually the case, but for longer cables, it is not so. It depends how you look at it. Relative to the wanted signal on the inner core of the cable, there is a hum on the braid or screen, it's going up and down in time with the hum. However, hold the screen at ground and relative to ground, the signal on the inner core of the cable is going up and down.

It's a bit like being on a boat. If you stand on the shore and watch the boat, it goes up and down with the waves. However, stand on the boat and it appears that the land is going up and down instead. So, the single-ended hum signal on the braid is effectively transferred to the input of the equipment.

If items of equipment are located some distance apart, hum loops are created by the two different paths of earths, one from the sending equipment to the power distribution system and then back to the receiving equipment, the other, the direct connection of the coax braid. The worst case is equipment located in different buildings, where the mains supply may not even be on the same phase.

With an audio installation, it is possible to reduce the incidence of hum by using balanced circuits (see Figure 1). Here, common mode induced hum is cancelled out at the transformer or balanced input

SPECIFICATION

Operating voltage:	230V AC mains
Overcurrent protection:	T500mA Fuse
Output voltage:	2V Pk-to-Pk, from twin BNC terminals
PCB dimensions:	159 × 100mm
Case dimensions (WHD):	108 × 47 × 168mm

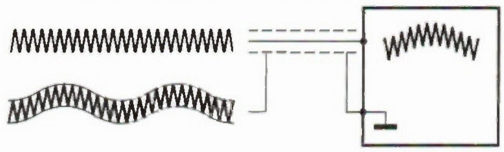
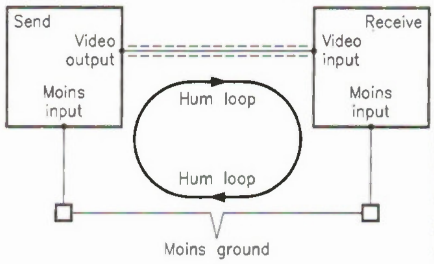


Figure 2. Unbalanced input with single-ended hum on the screening braid. Within the equipment, the hum is transferred onto the input.

Figure 3. Earth hum loop formed by ground braid and mains earths. To eliminate this, it is necessary to break the loop. This is only possible at the braid. For safety reasons, the mains earths must remain connected.



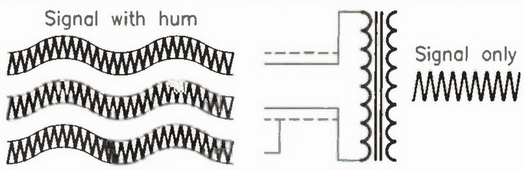


Figure 4. If signals appear in phase at each end of the transformer winding, there is no voltage difference, so no current will flow and no output will be induced in the secondary. Wanted signals will not be in phase, so will cause current to flow in the secondary and so will give an output.

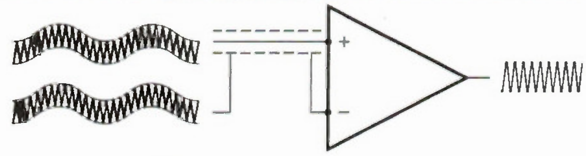


Figure 5. Differential amplifier for audio or video. The output is the difference between the two inputs. Output = ('+ve' input) – ('-ve' input). For in-phase signals, such as common mode hum, the output is zero, leaving the wanted signal only. The input socket must be insulated from ground.

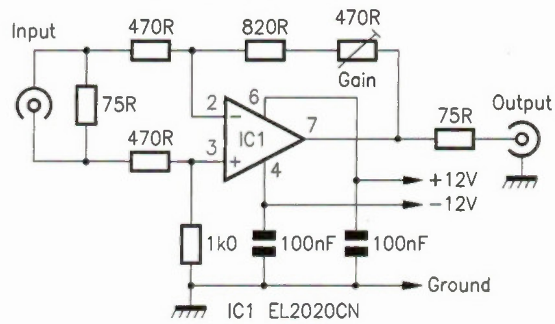


Figure 6. Differential input video buffer amplifier.

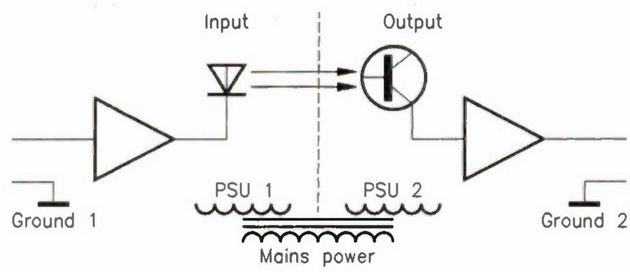


Figure 7. Within the optical isolator, there is no connection between input and output, so effectively breaking the hum loop.

to the equipment, since the hum signal is in the same phase at each end of the transformer winding or balanced input. Single-ended hum can be dealt with by disconnecting one end of the screening braid, thus breaking the loop. Since the braid is still connected at one end, its screen properties are retained more or less intact (see Figure 2). The other option, disconnecting one or both of the mains earths, naturally should not be considered, as this is very dangerous and foolhardy in the extreme.

This trick of disconnecting one end of the screening braid is rarely possible with video, the unbalanced nature of video interconnections made with 75Ω coaxial cable mean that one side of the transmission path is always connected to ground through the braid of the coax (refer to Figure 3). Disconnecting one end of the screening braid in this case will add far more problems in the form of mis-terminations, frequency response problems and reflections, and it probably would not get rid of the hum anyway. It is possible to transmit video by balanced circuits but much extra equipment is required in the form of sending and receiving interfaces and it is still not possible to completely isolate the sending equipment completely from the receiving equipment; there would still normally be a ground connection between the output and input. Video isolating transformers do exist (see Figure 4), but they are very expensive and require an equalisation amplifier after them to maintain the system frequency response.

Leaving aside the possibility of using a transformer, there are two methods of hum reduction. Number one will treat common mode hum and uses a differential input op-amp as a buffer at the input of the receiving equipment, as shown in Figure 5. In the same way as an electronically balanced audio input will have a 'common mode rejection', so will the differential video input. It will only buffer and pass on the difference between the two inputs. This is a very simple and cheap way to eradicate hum, but it will not break the earth loop between the equipment and is, therefore, not effective in eradicating single-ended hum. A circuit is included to show just how simple it is – see Figure 6. Method two will treat single-ended hum, as it gives gives true galvanic isolation between output and input by using an optical isolator – as shown in Figure 7.

Circuit Description

Refer to Figures 8 and 9, showing the block and circuit diagrams of the Video Optical Isolator.

The optical isolator used is very similar to normal chips found in all kinds of applications, but has a very large frequency response. It will handle up to 7-8MHz, contrasted with the ordinary opto isolator with a bandwidth of only a few kHz. Since there is no physical connection between the driving LED and the receiving phototransistor, it is possible to construct a unit which has no ground connection between input and output. To get around the problem of common power supply rails, two PSUs are used, one for send and one for receive, using separate windings on the same mains transformer. In this way, there is no connection between the two halves of the unit – refer again to Figure 7.

The unit is based on a HCPL 4562 Isolator (IC4), optimised for video use and made by Hewlett Packard. The input side of the unit is a simple current driver to vary the brightness of the LED in the package in response to changes in the video level. R16 applies the appropriate termination on the input cable and C1 blocks the DC bias voltage provided by R1 and R3 from appearing on the input socket. The bias voltage on the base of Q1 is chosen such that the video modulation is applied at the most linear part of the HCPL 4562 transfer characteristic. R4 and VR1 vary the gain of Q1 such that the video modulation is neither too low (where excessive amplification at the output would produce noise) or so high that signal clipping occurs. The gain of the amplifier in the output section is made such that VR1 can be used as an overall level control to ensure that the output from the unit matches the input.

In order to get the very wide bandwidth required for video, the detector part of the HCPL 4562 has a built-in buffer transistor with the base connection

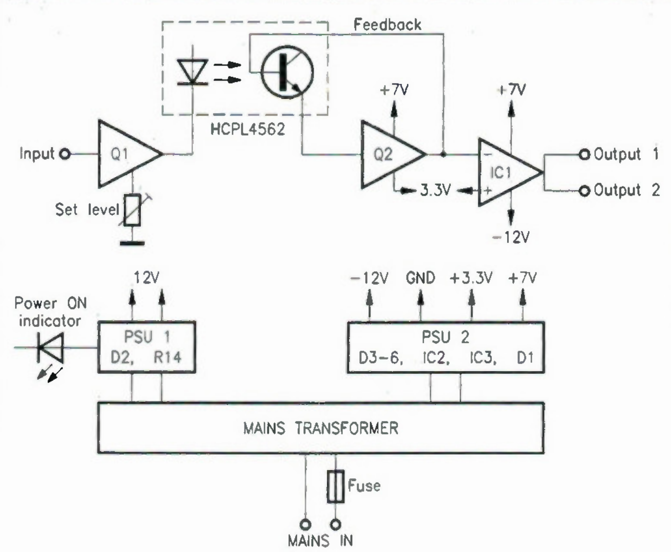


Figure 8. Block diagram of the Video Optical Isolator.

Power Supply Stage

At first glance, there would appear to be nearly as much power supply as actual signal processing. However, this breaks down into two or three chunks. There is the usual mains transformer, fuse, and input socket. This is obviously required to provide power to the unit. The transformer has two windings, each giving 18V AC. They are not connected together in any way, and so as one winding is used for the input current driver and one winding is used for the output buffer, there is isolation between the two sections of the unit.

As the input current driver takes very little current, around 20mA or so, a simple half-wave rectifier is used, with R14 acting as a dropper resistor to give a final voltage of about 12V. The LED power-on indicator is connected to this side of the power supply also.

Output Buffer Stage

The output buffer section is more complex. As the transformer has only one other winding, a virtual earth splitting system is used. The 18V AC is bridge rectified to give about 24V DC smoothed by C6. IC2 regulates this to 12V. This 12V rail is used as the ground rail for the output stage. This means, of course, that the negative end of C6 is at -12V with respect to the output ground rail and this is used as the negative supply for IC1. The unregulated 24V is also regulated by IC3, a variable

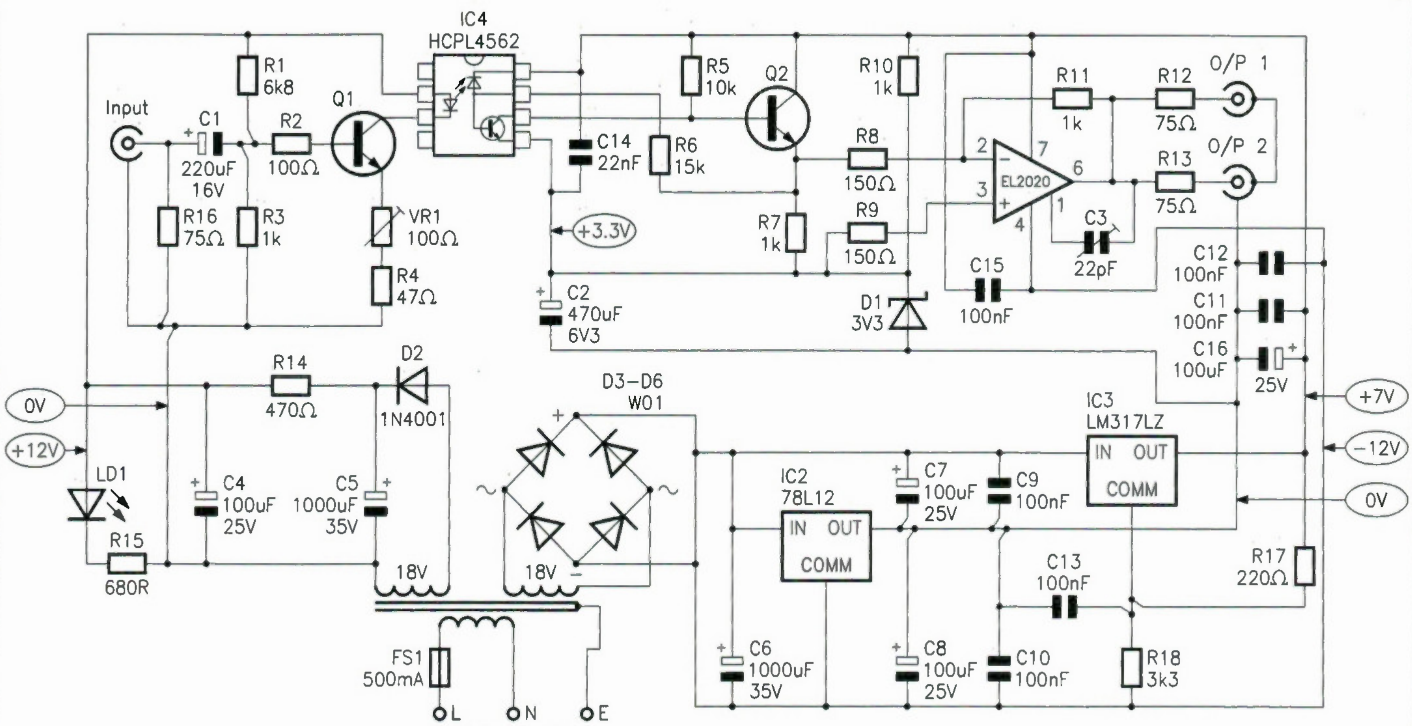
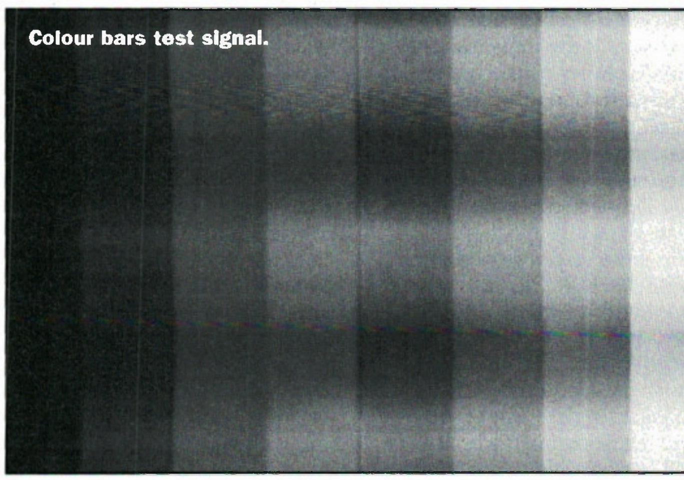
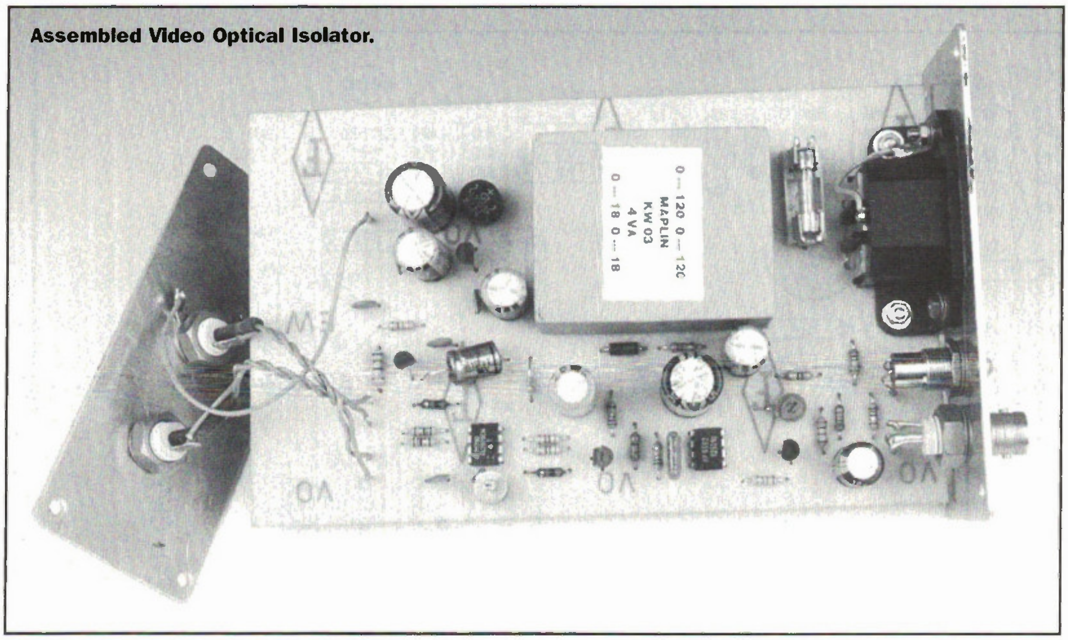


Figure 9. Circuit diagram of the Video Optical Isolator.

brought out so that the internal transistor may be included in a feedback path. Q2 acts as a buffer with R6 as a feedback resistor, which sets the output level at this point to about 1/3V Pk-to-Pk. At the emitter of Q2, the video signal is actually inverted.

IC1 is a wide bandwidth op-amp, chosen for the fact that not only is it stable at video operating frequencies with gains up to 10 times, but it will also drive two normal 75Ω back-terminated video loads. Thus, the unit has two outputs, one as a main and another as a monitor output if required. The arrangement is a perfectly simple inverting amplifier with a gain of about six times. Thus, the 1/3V of video at the emitter of Q2 is amplified and inverted and appears at the output of IC1 on pin 6, at a level of 2V Pk-to-Pk. 2V is necessary, as the 75Ω resistors in series with the outputs would be connected to a 75Ω termination to ground, giving a potential divider and thus, 1V Pk-to-Pk at the input of the next piece of equipment, which is correct – see Figures 10 & 11.


Colour bars test signal.



Assembled Video Optical Isolator.

regulator whose output is set to +19V by R17 & R18. With respect to the output ground, this rail is effectively at +7V and this is the main positive supply for IC1 and the isolator chip and Q2. In order to produce a reasonable DC level from the buffer Q2 for IC1's input, a Zener diode, D1, is used to lift the ground for the isolator chip and Q2 to 3·3V above normal ground. The positive input of IC1 is also returned to this point to give the correct input DC conditions. The result of this 3·3V lift and the apparently odd choice of power rails means that the 0V DC level of the output video signal lies at just about blanking level. In turn, this means that DC coupling can be used at the output without the need for capacitors, which would degrade the low-frequency response. Capacitors C7-16 are used for low- and high-frequency decoupling of the various supply rails.

In use, it was found that there is a slight loss of HF through the isolator. This shows up as a slight loss of chroma information. Normally, this would not be a problem, especially if the following equipment is a display monitor, which will restore the level using the colour burst as a reference which is reduced by the same amount, but to bring the response back to normal, C3 is fitted to the balance system of IC1 and can be used to increase the HF response back to normal. If no test equipment is available, setting C3 to its minimum position will give a loss of about 2% of chroma, which is virtually unnoticeable.

Construction Details

PCB Assembly

Figure 12 shows the PCB legend and track, to suit the specified CCN-style box. It is possible that constructors may wish to redesign this layout to suit a smaller box, perhaps. There are a couple of things to bear in mind. Take care with mains voltages if the transformer is to be fitted on the board. The tracks should be nice and thick and well spaced apart, both from themselves and from the low voltage part of the circuit. Take care when testing the finished unit out of its box, since the mains voltages on the board can be lethal.

The input section of the circuit should be as far away from the output part of the circuit as is practical. The idea is for the input section to be on one edge of the board and the output section to be on the other.

The actual layout of the board is not critical, except that long tracks should be avoided if possible, as this will lead to instability in the output section. If it is found necessary to fit C3, beware attempting to increase the HF response too much as this will make any instability problems worse. If the unit is to be used with monitors or any other units with automatic chroma control, it is best not to fit this component. With Black and White video, this component is not required at all. Assemble the components in order of ascending component size, and finally, clean excess flux off the PCB using a suitable solvent.

Box Construction

This is fairly straightforward, although one or two things are quite important. The first is that obviously the input and output connections should not be near enough to each other that there is a possibility that they could be bridged by anything metallic (for example, the metal body of another connector), as this will defeat the object. The version shown in the article has its BNC input and output connectors at opposite ends of a quite large box. Secondly, although the PCB could be mounted in a plastic box, the use of a metal box is to be preferred. The metalwork of the box can be connected to the mains earth for safety. The unit shown is used in a television outside broadcast environment and the CCN-style metal box is ideally suited, both for screening and mains safety earthing. Another point is the extremely rugged construction which can be achieved. The CCN-style box also accepts standard sizes of PCB and the internal circuit is designed to fit on such a standard size board.

The mains input is by a PCB-mounted IEC-type connector. This has mounting holes both for fixing to the PCB, for added strength, and normal holes to fix to a panel. The panel holes are used to fix the connector to one of the end panels of the CCN box. This, together with the PCB mounting slots in the body of the box, are all the fixings required. The earth pin of the IEC connector is wired to a solder tag attached to one of the mounting bolts.

Using a metal box, of course, means that insulated BNC sockets are required. It is quite common nowadays for equipment to use RCA Phono style connectors for video inputs and outputs. If phono sockets are to be fitted, then an insulated version will be required (e.g. JZ05F).

Setting-up Procedure

Setting-up of the unit only requires that VR1 is set such that the output signal matches the input. Ideally, this would be done with an oscilloscope using colour bars as a test signal. Setting may be approximately done simply by observing a monitor displaying first the input signal and then the output signal. For displaying on a monitor only, this would suffice, but for more demanding operation, a scope would need to be used.

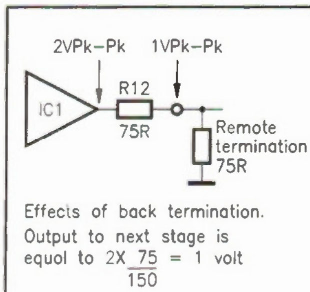


Figure 10. Effect of back termination. Output to next stage is equal to 2 × (75/100) = 1V.

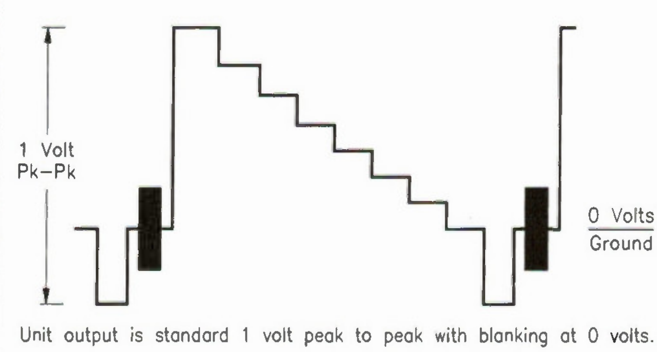
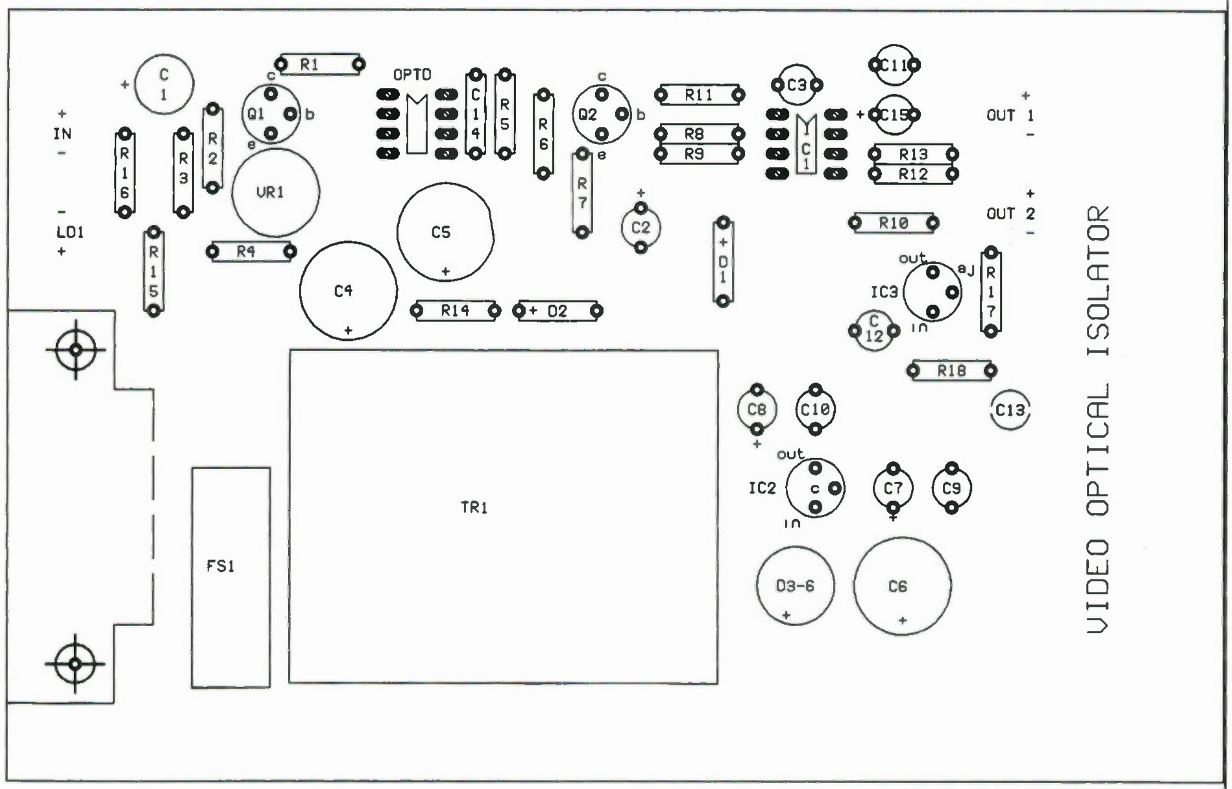


Figure 11. Unit output is standard 1V Pk-to-Pk with blanking at 0V.

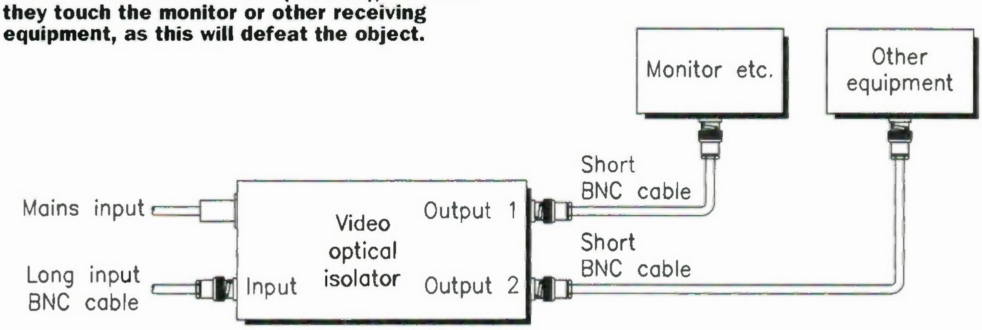
Figure 12. PCB legend and track.



Using the Isolator

In use, the unit is simply fitted in the coax circuit using a short BNC cable – refer to Figure 13, showing the wiring diagram. It is obviously important to ensure that the outer of the BNC plug on the input does not contact any metalwork associated with the receiving equipment, as this would restore the earth continuity and render the whole thing useless. This type of unit is invaluable for sending pictures around venues such as race tracks, football grounds, and anywhere where long cable runs exist.

Figure 13. Isolator in use. The two BNC plugs must not touch each other (difficult), nor must they touch the monitor or other receiving equipment, as this will defeat the object.



Isolator in use. The two BNC plugs must not touch each other (difficult) nor must they touch the monitor or other receiving equipment as this will defeat the object.

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless Stated)

R1	6K8	1	(M6K8)
R2,7,10,11	1k	4	(M1K)
R3	100Ω	1	(M100R)
R4	47Ω	1	(M47R)
R5	10k	1	(M10K)
R6	15k	1	(M15K)
R8,9	150Ω	2	(M150R)
R12,13,16	75Ω	3	(M75R)
R14	470Ω	1	(M470R)
R15	680Ω	1	(M680R)
R17	220Ω	1	(M220R)
R18	3k3	1	(M3K3)
VR1	100Ω Cermet Trimmer Potentiometer	1	(WR38R)

CAPACITORS

C1	220μF 16V Radial Electrolytic	1	(AT41U)
C2	470μF 16V Radial Electrolytic	1	(AT43W)
C3	22pF Trimmer	1	(WL70M)
C4,7,8,16	100μF 25V Radial Electrolytic	4	(AT48C)
C5,6	1,000μF 35V Radial Electrolytic	2	(AT63T)
C9-13,15	100nF Ceramic Disc	6	(YR75S)
C14	22nF Polyester	1	(BX72P)

SEMICONDUCTORS

D1	BZY88C 3V3 Zener Diode	1	(QH02C)
D2	1N4001	1	(QL73Q)
D3-6	W01 Bridge Rectifier	1	(AQ95D)
LD1	Panel-mounting Red LED	1	(YY60Q)
Q1,2	2N3904	2	(QR40T)
IC1	EL2020CN	1	(UR06G)
IC2	78L12	1	(WQ77J)
IC3	LM317LZ	1	(AV26D)
IC4	HCPL4562	1	

WOUND COMPONENTS

TR1	0-18V 0-18V 4VA Low Profile Transformer	1	(KW03D)

MISCELLANEOUS

	Video Input & Output Sockets	3	(CK05F)
	Mains Inlet Socket	1	(FE15R)
	Box CCN160	1	(YN51F)
	8-pin DIL Holder	2	(BL17T)
	Fuse Holder	1	(DA61R)
	T500mA 20mm Fuse	1	(CZ94C)
	PCB	1	

The Maplin 'Get-You-Working' Service is not available for this project.

The above items are not available as a kit.

40 Topical INTERNET TIPS

To the uninitiated, the Internet is no better than a library full of books that have all been tipped onto the floor. From getting online to locating useful information, the Internet can be daunting, and even for the experienced user, there is always something new to learn, new software to explore or a new Web site to investigate. Here, Stephen Waddington outlines his Top 40 Tips to getting the best out of the Internet.

Making a Connection

If you're new to the Internet, experiment with e-mail by sending messages to yourself. Do this by entering your own e-mail address on the To: line of a new message, as shown in Photo 1. This is useful for experimenting with formatting and attachments.

Internet Service Providers are struggling to keep pace with the growth of the Internet. And while there is little you can do to influence the speed of the Internet, you can ensure that you get the fastest connection possible to your ISP. Apple machines automatically tweak system settings to optimise speed. If you are a PC user you will need to do this manually. Check your PC is talking to your modem at the fastest possible speed. Most computers will have a fast UART chip. Run the MSD.EXE utility under DOS – you're looking for 16550A or above. If you haven't got a fast UART chip, you need to buy a high speed serial card. Finally, tweak your communications software to the highest speed possible. This should be 115,200k-bps.

If you have a problem getting online, flick through your manuals, but don't spend too long doing this. If you can't find what you're looking for after 10 minutes call you online provider. The problem is probably related to your service provider's software and its incompatibility with your mode's software or operating system.

Call Waiting on your phone line can cause you to lose connection to your ISP. When an incoming call is waiting to get through, Call Waiting produces a series of beeps which can disrupt the flow of data and cause the line to fall. If you use Call Waiting you should disable it prior to calling up your ISP's Point of Presence (POP). It is possible to use a modified modem connection script to handle call waiting – check with your ISP or modem manufacturer.

There are a few simple tricks that can be used to help get value for money out of BT. Make the Internet your friend. Register your local point of presence (POP) telephone number as one of your 'friends and family' numbers. This will save you an extra 10% on your calls.

Beware of minimum telecom charges for both BT and cable companies. The minimum charge for BT is 4·9pence. Make sure you stay online for at least this long. This equates to: daytime – 1min 3secs; evening – 2min 28secs; and weekend – 4mins 12secs.

If on the under hand, you are a cable user, ask your cable company which ISPs offer a cable connection. Connections between cable customers are free. In London, Videotron offers free connectivity to Demon and CompuServe. This means customers registered with these online services pay only the subscription costs.

Use a new ISP for at least a week to ensure it's running reliably before giving people your e-mail address, especially if you intend using it for business purposes. This should iron out any bugs between your operating system, offline reader, modem software and ISP. It isn't cool and it certainly isn't professional to call people up and ask them to resend mail because your offline reader crashed while downloading mail.

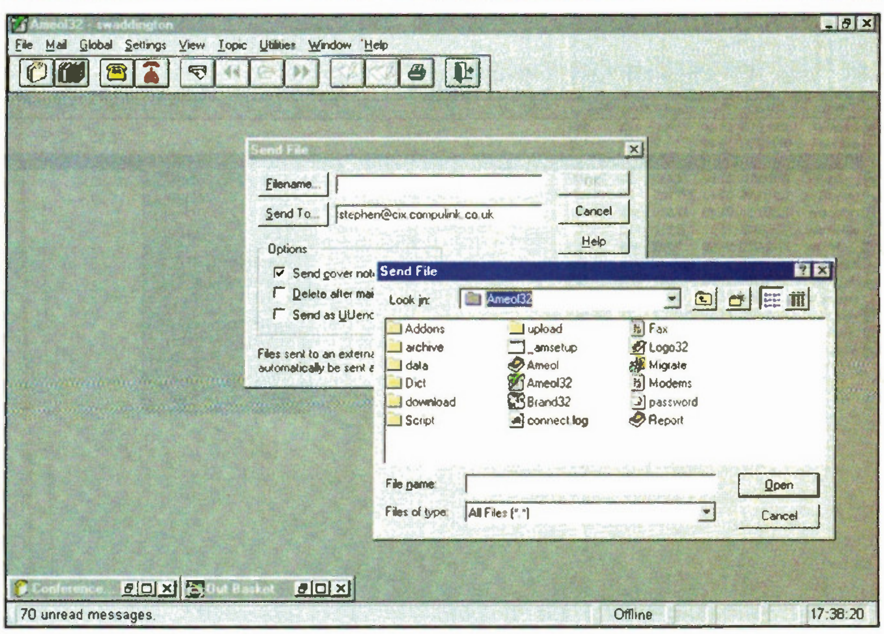


Photo 1. Send an e-mail to yourself to check formatting and experiment with attachments.

E-mail Basics

You can attach pretty much anything to an e-mail message. Pictures, documents, sounds and even software applications can be attached to an e-mail by selecting <Attach File> and entering the file name of the file to be sent with the e-mail.

The Internet's e-mail system was designed for raw 7-bit ASCII text, so if you want to attach anything else to your message, it must be converted into a compatible format. There are three common encoding formats: Uuencode, MIME and BinHex. The majority of e-mail applications will convert attachments automatically. For those that don't, download utilities from **http://snappy.globalone.net** for Uuencode, **ftp://ftp.andrew.cmu.edu:pub/mpack** for MIME and **http://www.aladdinsys.com** for BinHex.

Write and read e-mail offline to save online costs. When you connect to the Internet, you should send messages you've written and collect any messages you've been sent, rather than read and write mail online. The majority of e-mail applications work happily offline. Check with your ISP for details of compatible offline software.

Advanced E-mail

It is possible to send e-mail messages to fax machines in many parts of the world, via The Phone Company's fax service. Messages should be addressed to **remote-printer.user@faxnumber.iddd.tpc.int**, replacing 'user' with the name to go on the cover sheet and 'faxnumber' with the fax number minus any long distance or international access codes and punctuation. The Phone Company's Web site at **http://www.tpc.int** lists all the areas which are covered and provides more detailed instructions.

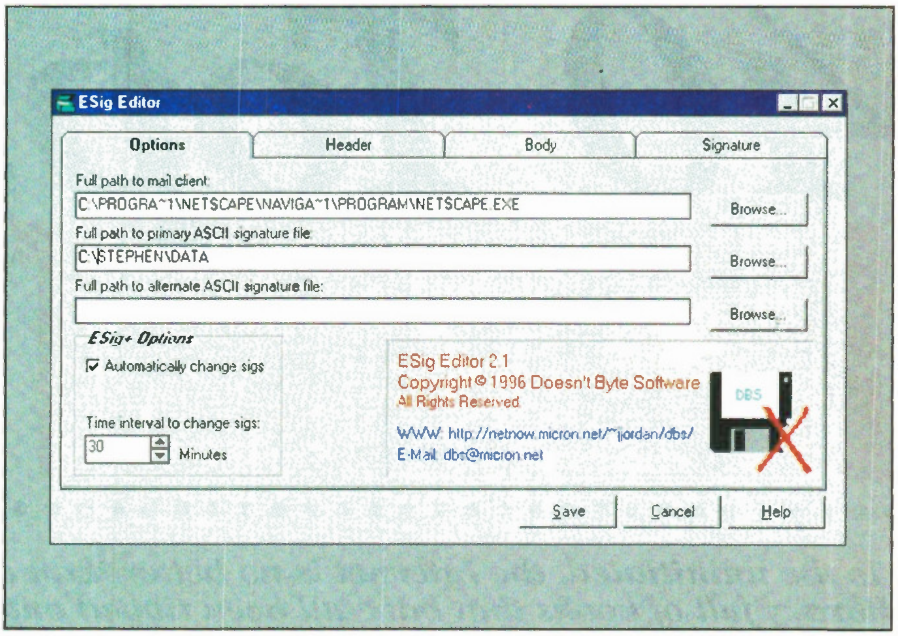


Photo 3. Insert your contact details or other information automatically at the foot of an e-mail with Esig Editor.

If you want to send a file across the Internet, do not make the mistake a colleague of mine made recently. He tried to send a 12M-byte Powerpoint Presentation across the Internet, with the result that it kept corrupting and consequently tied-up our leased line connection until it was deleted by the IT manager. Large files should be compressed using a utility such as WinZip at **http://www.shareware.com**, as shown in Photo 2. This can reduce the size of files by as much as 80%. But do ensure that the recipient has the software necessary to decode the compressed file.

Mailing lists enable you to participate in discussions or receive information on particular topics. There are lists for everything from electronics to films, and from gardening to woodwork. The majority of mailing lists are one-way informatio services such as newsletters or stock price information – the owner of the lists sends you news at regular intervals. There is a huge list of publicly accessible mailing lists at **http://www.neosoft.com/internet/pam** and a searchable database at **http://www.liszt.com**.

Sign off e-mail messages with a signature file. This is a small text file which is automatically appended to the end of every message you send. This usually includes contact details, business information or a favourite quote. The majority of mail applications automatically insert a 'SIG' file whenever a mail message is created. There are also several programs such as ESig Editor, as shown in Photo 3 at **http://netnow.micron.net/~jjordan/dbs** which allows you to have multiple signatur files or insert signatures at random.

It's not possible to catch a virus simply by reading a text-only e-mail message, but it is possible for attachments to be infected. Do not let your software execute an attached file automatically. It's a good idea to run a virus checker such as Dr. Solomon over any program file you receive. You should also watch out for documents that might contain macros, such Word and Excel files.

You want to send someone mai anonymously? Remailers remove your personal details from the header section of an e-mail message, then forwards it to whoever you wish to communicate with. You might want to use a remailer if you're contributing to a newsgroup which discusses sensitive personal issues or speak freely about your company without putting yourself in line for the sack. A list of re-mailers is maintained at **http://www.berkeley.edu/~raph/remailer-list.html**.

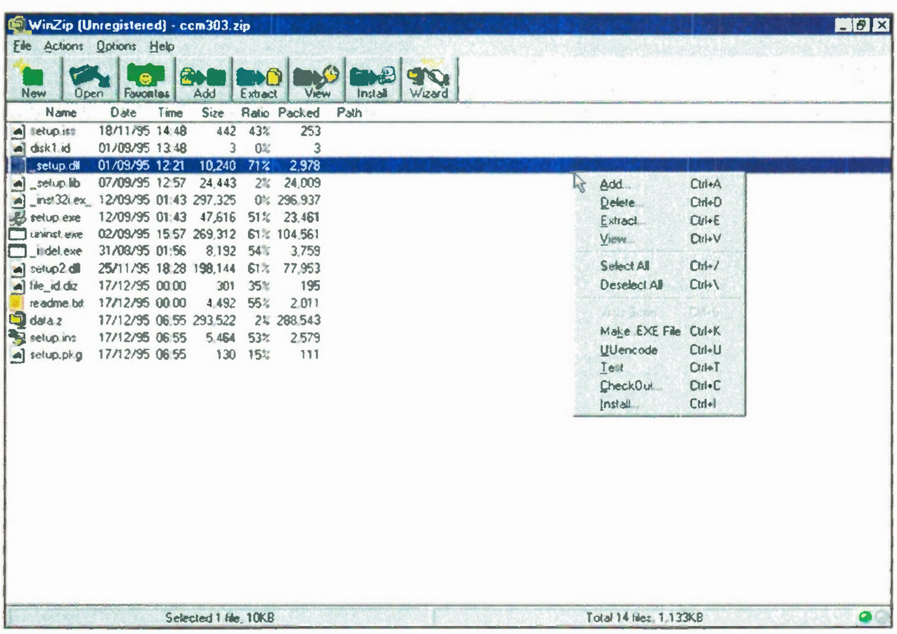


Photo 2. WinZip enables files to be compressed for dispatch across the Internet.

Polish the Dashboard

The world is standardising on Microsoft's Internet Explorer and Netcape's Navigator. Both browsers can handle multimedia plug-ins such as Shockwave, RealAudio and VivoActive, and are completely compliant with HTML 3.0, the standard document format of the Web. The majority of Web sites are benchmarked and tested against these two browsers. If you use a browser other than Explorer or Navigator, ditch it for one of the big two. Navigator 3.0 and Explorer 3.0 can be downloaded at **http://www.netscape.com/comprod/mirror/client_download.html** and **http://www.microsoft.com/ie/download**, respectively.

Maximise the size of a Web page on screen by removing the status bars, tool bars, location bars and directory buttons from your Web browser, as shown in Photo 4. In Internet Explorer, select <View> and then check either <Toolbar> or <Status Bar>. Use the mouse and cursor to select icons on the status bar. In Netscape Navigator, select <Options> and then select <Show Toolbar>, <Show Location> or <Show Directory Buttons> as required.

Both Netscape Navigator and Internet Explorer enable you to create a personal start page which displays your favourite links each time you long on to the Web. To create your own Web page, you're presented with a 'tick box' form, offering a selection of news, business, entertainment, sports and reference links. You can also type in URL's for other sites you'd like to include. If you're using Navigator, you can also choose the colour, the layout and the main image. Explorer only allows you to pick a background noise – don't, it will drive you mad.

Navigator users can now check if their favourite Web pages have been modified since last online. Version 3.0 includes a 'What's New' feature, which checks your bookmarked pages to determine whether they have been modified since your last visit.

Both Netscape Navigator and Internet Explorer enable two or more Web browsers to be opened at the same time. This means that you can download a sluggish image-heavy page in one window while you read a document in another, or keep an eye on a scrolling ticker information service as you browse.

To turbo boost your Web browser, set your browser preferences to download text without images until you're sure there is an image your want to view. In Netscape Navigator, image download is switched off by selecting <Options> and <Auto Load Images>. For Internet Explorer, select <View> and <Options> before checking the <Show Pictures> option from the General Menu.

Ever cleared your cache? Each time you go to a new Web page, your browser temporarily stores the page in a cache. When you press the Back or Forward buttons or choose a historical item, the browser automatically retrieves this cached copy. After a while, this temporary directory gets very full and it may take longer to load pages and you will probably be loading old versions of regularly updated pages. It can also cause instability within the browser and cause the program to shut down. In Navigator, clear your cache by selecting the <Options> menu and then <Preferences>. Click on <Network Preferences> before selecting the <Clear Memory Cache Now> and <Clear Disk Now> buttons. In Internet Explorer, the cache is accessed from the <Advanced> folder from the <View> <Options> menu.

Internet Tools

If you find the information you are looking for, save online costs by saving Web pages to disk to read in detail or print out later. One of the easiest ways to save a Web page is by either clicking your right mouse button over the image you wish to copy if you are using Windows or by holding down the mouse button for Macintosh users. Alternatively, select <File> and then <Save As> from your Web browser.

There's a cool utility that Windows NT and Windows '95 can use to trace the quality of network connections across the Internet and check on hold-ups. The program is called Traceroute, as shown in Photo 5, and it simply tracks the route a packet takes across the Internet. If you're a

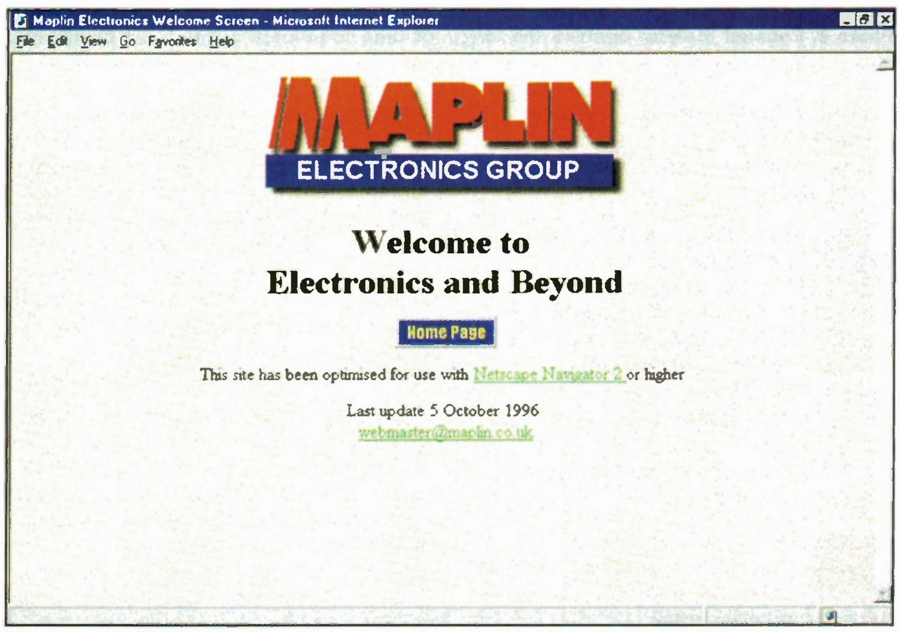


Photo 4. Remove status bars, tool bars, location bars and directory buttons from your Web browser to maximise viewing area.

Photo 5. DOS utility Traceroute tests the quality of your Internet connection.

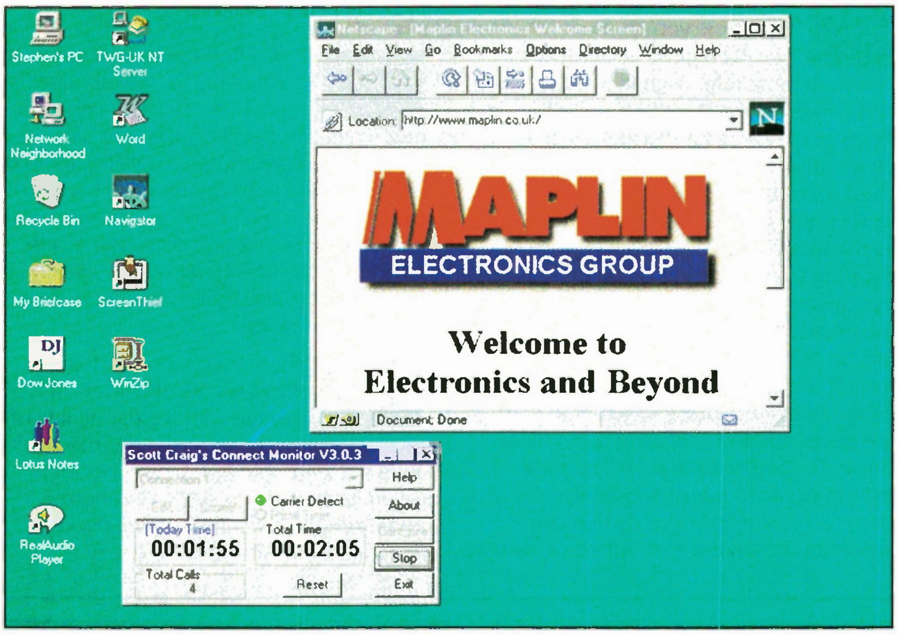


Photo 6. Connect Monitor enables the length of time connected online to be monitored.

Windows user and want to try the utility, go to the DOS prompt and type tracert followed by the host name or Web address you're trying to access.

If you want to explore the directory structure of a Web site, check out Apple's Hot Sauce at **http://mcf.research.apple.com**. Originally called Project X, this piece of software – which is still under development – allows you to view and explore the many layers of files contained on a Web site. Beta versions of plug-ins for both Internet Explore and Netscape Navigator are available.

Despite the interactive attractions of the Web, there are utilities available that download Web pages and even entire Web sites to your hard drive. This is useful if the site you're viewing contains the type of information you need, and there is a cost issue; viewing Web pages offline means reduced online costs. Travelling Software's WebEx at **http://www.travsoft.com/products/webex** or trial version at **http://tucows.cableinet.net/files/trial.exe** adds a toolbar to the top of your browser. If you want to download a page, or an entire site, click on the toolbar and enter details of how much of the site you want to download.

Make regular back-ups of your e-mail addresses and bookmarked URLs. You only need your browser to crash once while you're downloading a file to recognise the need for this discipline. Alternatively, create an HTML file of your favourite URLs. If you store this on a floppy disk, you can transfer it from machine to machine. Opening the file from a browser File menu on an Internet connected machine will enable you to jump backwards and forwards from your list of URLs to Web sites on the Internet. Both AOL and CompuServe bundle a basic HTML editor as part of the membership.

Save or bookmark every interesting link that you come across or you'll waste enormous amounts time trying to find that link that you previously visited. Keep a simple text editor like Notepad open while you're online. You can use cut <CTRL C> and paste <CTRL V> to transfer URLs and other useful information across to a file quickly. And after you've finished, take a few minutes to organise your bookmarks.

There is no easy way of keeping track of how long you've been online. Let's face it, ISPs have little interest in helping you monitor online usage, but there are a number of utilities which can help you keep track of online sessions and configure alarms when your nominated time has expired. My favourite is Scott Craig's Connect Monitor, at **http://tucows.cableinet.net/files/ccm303.zip**, which monitors your modem connection to check when you go online, as shown if Photo 6. Others include WS Timer at **http://tucows.cableinet.net/files/ws-timer95.02.00.zip** and NetClock at **http://tucows.cableint.net/files/nc4795.zip**.

32 How many e-mail addresses do you have? I currently have five. Using a forwarding service, I could reduce these to single address. The majority of ISPs will forward your e-mail for a nominal cost. In a similar way, NetForward at **http://www.netforward.com** gives you a simple e-mail address which can be re-routed wherever you want.

Searching

33 Finding information on the Web is, at best, hard work. Alta Vista at **http://www.altavista.com** is the most popular and comprehensive search engine, but others have their strengths also. Yahoo now has a site dedicated to purely to UK addresses at **http://www.yahoo.com**. Bookmark at least two or three search engines – one might succeed where others fail.

34 For sophisticated searches, fine-tune your search engines. For example, you can put speech marks around words that should appear together, such as 'Electronics and Beyond'. Without the quotes, the search would bring back every Web page that mentions 'Electronics', along with every page that includes 'and', as well as 'Beyond'. For tips similar to this, check the page of hints and tips that each search engine provides.

35 Want to trace a friend online or search for a long-lost relative? It is possible to find a person's e-mail address in the same way as you can find numbers using directory enquiries. Yahoo has introduced a really neat service at **http://www.yahoo.com/search/people**, as shown in Photo 7. Also try **http://www.four11.com**, **http://www.iaf.net**, **http://www.lookup.com** and Bigfoot at **http://www.bigfoot.com**.

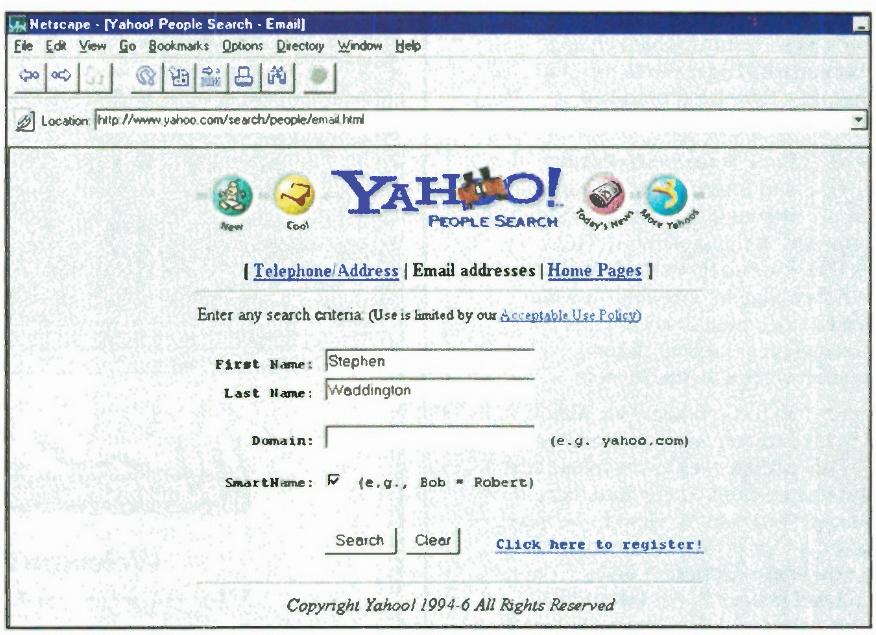


Photo 7. Search for lost friends and relatives using Yahoo.

Intelligent agents are the next generation of Internet application. Software applications such as NetMind's URL-agent add a dimension of intelligence and sophistication to the Web. By accessing the NetMind's URL-minder WWW site at **http://www.netmind.com/url-minder**, Internet users can register pages of interest. A Web agent will monitor registered pages and e-mail you every time your pages are updated. Autonomy is the first truly customisable intelligent software agent and is available from the Agentware site at **http://www.agentware.com**. As a user, you train a pack of cute dogs to run off and fetch information for you. Just like real pets, each time you repeat the exercise, they get better at it and return more appropriate data.

Inside Information

The current vogue is to quote addresses without the **http://** prefix, such as **www.maplin.co.uk**. All addresses begin with **http://** unless stated otherwise. If you use Navigator 3.0 or Internet Explorer 3.0, the **http://** prefix is automatically inserted.

You no longer need to pay for an e-mail account. If you already have a connection to the Internet via a university or company leased line, you can set yourself up with an account. Of course, there is a catch. You usually have to complete a detailed user profile to get your free account and these details are sold onto advertisers. HotMail at **http://www.hotmail.com** is an innovation system that offers a free e-mail account which you access over the Web. This means you can check your mail whenever you're passing a machine with a Web browser. Other free e-mail account providers include Juno at **http://www.juno.com**, Freemark Mail at **http://www.freemark.com** and StarMail at **http://www.starmail.com**.

According to the US analyst, IDC, the Web is doubling every 60 days. This might be due to the number of individuals building their own Web site. Have you got a personal site? If you subscribe to an ISP, you probably have at least half a megabyte of free space reserved for you – call your ISP to check. A number of US services give a limited amount of space free. Geocities at **http://www.geocities.com** is one such company.

The Web speeds up and slows down noticeably throughout the course of the day. You'll get the best performance by going online at quiet times. In the UK, the quietest time is 05:00hrs in the morning and the busiest, 20:00hrs at night. The weekend has little impact on these times. If you are accessing Web servers of the US, you will find the same peaks and troughs occur at roughly 8 hours later than in the UK.

E-mail Emoticon

E-mail is a fantastic means of communication, but it is difficult to convey feelings. Unlike other forms of communication, a response can be created and sent immediately without allowing time for reflection. If you need to convey an emotion, use the following emoticon symbols.

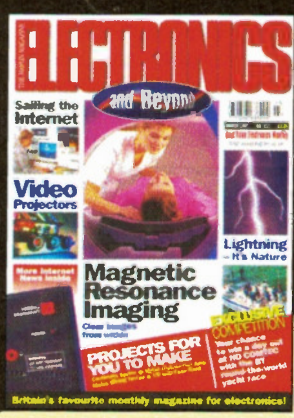
:-)	smiley face	:->	sarcastic
:-c	bummed out	:-@	screaming
>:->	devilish	:-/	sceptical
:-(	frown	:-o	surprised
:-S	incoherent	:-&	tongue tied
:-|	indifferent	:-O	uh, no
:-D	laughing	:-\	undecided
>:-<	mad		

If you do receive a message that you do not understand or could be misinterpreted, do not respond over e-mail. Call or meet with the sender party to clear up the intent of the message.

Site Survey

The month's destinations

See page 78 for this month's destinations



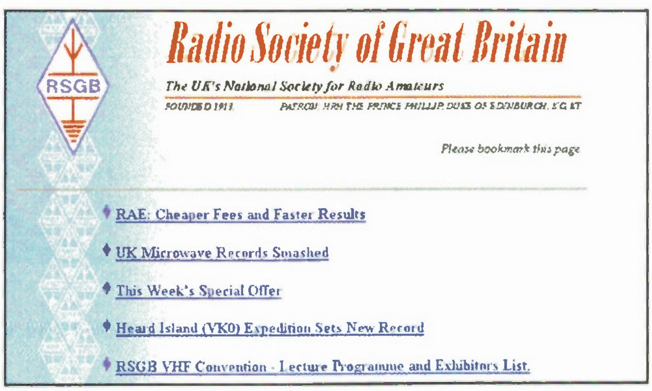
@Internet

If you create – or are even just planning to create – pages for a World Wide Web site, a first rule is that you need to be aware of the viewers of that site. More specifically, you need to be aware of what computer will be used to view the pages. There's no point in creating a wonderful, breath-taking souped-up colourful Web site if the people who are going to use the site don't see the benefits of it. In particular, if you use colours which can't properly be rendered by a computer, then the computer dithers the colour in a process which effectively ruins your planned visual appearance. By far the most popular computers used to surf the Internet have monitors displaying 256 colours. So, if the computer setup used to generate the Web pages has more than this, then it's possible that colours may be used outside the spectrum which can be properly viewed by the majority. Further, different computer types have different colour ranges within the 256 colours used. PCs, for example, have a different 256 colour range than Macintoshes.In fact, only 216 colours are used on both platforms. The only solution to avoid the possibility of incorrect viewing on either platform is to ensure that only those 216 colours are used in a Web page.

To make this easy, a new product – PANTONE's ColorWeb – helps the Web page designer choose colours in the viewable spectrum of either computer platform in a simple process. ColorWeb comprises two parts: a fan-out stack of cards printed with the 216 colours, from which the page designer can choose suitable colours, and a colour picker (the PANTONE Internet Color System – PICS) utility for the computer, from which the chosen colours can be selected. Apart from allowing the designer to select colours directly within a Web page design program like PageMill or HoTMetaL Pro, the utility (together with its sister utility ColorDrive – bought as a twin collection) allows you to export colour palettes of chosen colours in various formats to work with other applications such as desktop publishing or graphics packages.

It's an easy-to-use system which should have a valued place in every Web page designer's toolbox. The knowledge that your Web pages will look good on whatever computer is viewing them (or at least the colours you use will – the system still can't guarantee the quality of your content!) is a valuable asset. PANTONE colour systems are standards in the various printing processes used for books, magazines and newspapers. This new system for electronic publishing is a welcome addition.

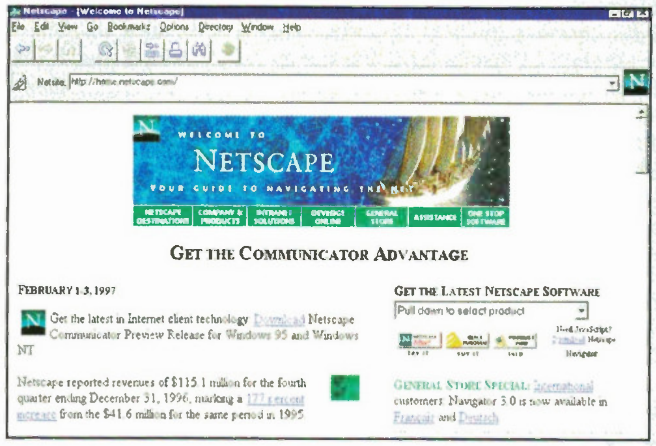
Big Hit RSGB Web Pages



The Radio Society of Great Britain (RSGB) Web site at **http://www.rsgb.org** is now recieving up to 500 hits per month from 28 countries, including Antigua, Australia, Russia and Singapore. The most popular pages include the contents pages (which details the latest amateur radio headlines and the GB2RS news script pages.

Visitors to the RSGB site can find out about amateur radio and discover the benefits of RSGB membership. The site currently contains the latest GB2RS News Bulletin Script, information about what is in the current issue of RadCom, the RSGB magazine, and an online book catalogue. The RGSB Web pages are currently updated twice a week.

Communicator is Latest Word in Browser Battle



Netscape has beat Microsoft by several months in releasing 'preview release' of Netscape Communicator, its open e-mail, groupware and browser suite.

Netscape estimates the total number of users of Netscape e-mail, available since the beta release of Netscape Navigator 2.0 and now available in Netscape Communicator, has reached approximately 12 million, making it one of the fastest-growing mail applications on the market. In addition, Netscape's In-Box Direct service, available for Netscape mail users, has received close to 3·5 million subscriptions in the last three months.

Netscape has also announced new services that will enable users to take advantage of the rich Web-based mail capabilities of Netscape Communicator, available now for downloading from the Netscape Internet site at **http://www.netscape.com**. New users of Netscape Communicator can establish a personal e-mailbox allowing them to test Netscape Messenger, the new Web-based mail component of Netscape Communicator.

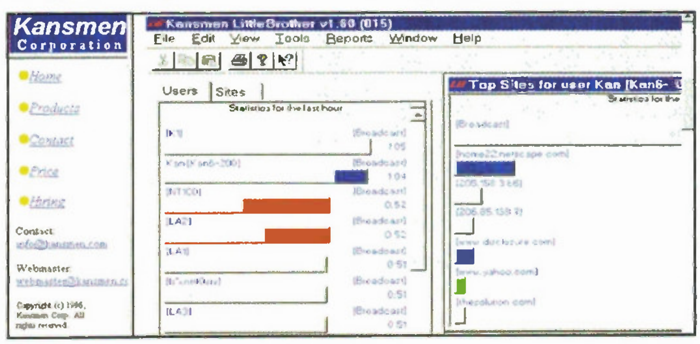
Microsoft will respond in the next few months with a new version of Explorer that incorporates technology that allows users to broadcast information to the desktop. Netscape's Constellation software will be added to its Communicator browser in the next three months, giving it similar capabilities.

LittleBrother Internet Monitor

Twelve years after 1984, Kansmen at **http://www.kansmen.com** has introduced its LittleBrother software, which takes the job of monitoring cyberspace away from Big Brother and puts it into the hands of the public. This state-of-the-art network and Internet/Intranet monitoring software allows system administrators to analyse usage, limit unproductive activity and block Internet sites not related to work.

Kansmen has launched two versions of the software: LittleBrother, which tracks and analyses network use and LittleBrother Professional Edition, which includes all the functionality of LittleBrother with added site blocking features.

LittleBrother allows managers to utilise a built-in, regularly updated database of web sites, while the software seamlessly configures and categorises web sites as productive or unproductive. The software alerts administrators of excessive unproductive usage and allows the blocking of web sites, online games and chat rooms. LittleBrother can also generate reports that reflect both current and past Internet use.

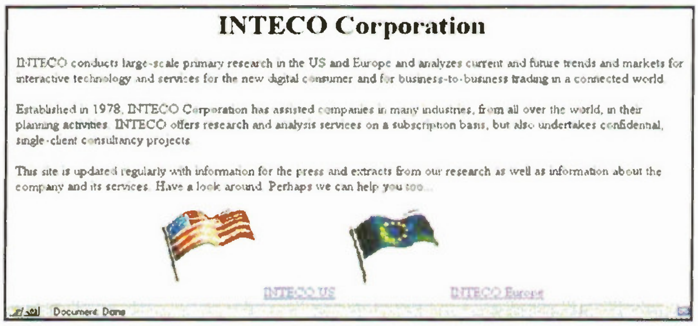


UK Takes Lead in Setting Workplace Internet Policy

Research for INTECO's Electronic Commerce in Europe study shows that UK companies are ahead of those in France and Germany in setting policy on Internet access from the workplace, but that non-business use is permitted by nearly 25% of respondents' employers.

When asked about company rules with regard to Internet use only 6% of active UK Internet users said that their company has no policy, another 15% were not aware of any policy. Germany trailed the field with 29% saying no policy was in place and with 22% not aware of any policy.

Around a quarter of respondents in each country said that their company's policy allowed personal activities, within reason. Official company activities only was the directive in only 11% of French and German organisations, and in 16% of those in the UK. In all three countries, the most frequently-mentioned policy was anything judged to be work-related. Around two million people in the UK have Internet access at work and more than half of recent users have used it for personal activities.



Big Two Target Europe

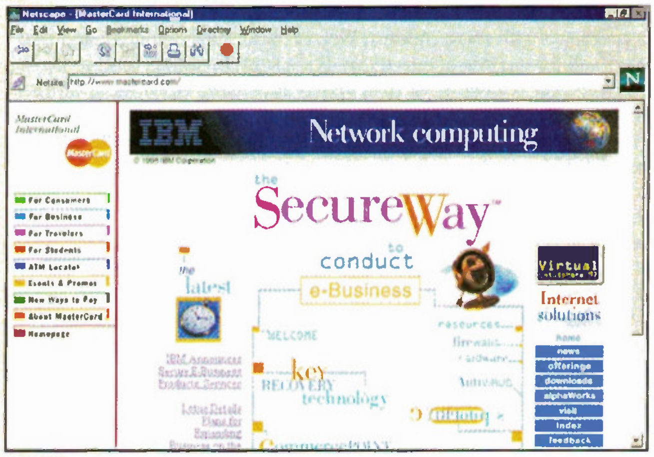
CompuServe, which already offers online access in the UK, Germany, France and the Netherlands, is expanding into four new European countries: Switzerland, Austria, Sweden and Belgium. The company currently has about 880,000 subscribers in Europe, compared with America Online's 400,000 and Microsoft Network's 100,000.

AOL Europe was first launched in Germany in November 1995, a service now accounting for two-thirds of AOL's European membership. The UK service, started in January 1996, accounts for almost 100,000 members, whilst the most recent service in France has approximately 25,000 members.

Meanwhile, AOL US says it intends to reduce its global advertising campaign budget by $300 million and plough an extra $100 million into building-up its network capacity to accommodate higher traffic loads. By downgrading marketing efforts, the company hopes to stem the flow of new subscribers that has overwhelmed AOL's ability to provide prompt connectivity.

The amount of time a member typically spends online has more than doubled, from 14 to 32 minutes, since AOL reluctantly adopted flat-rate pricing in the US in December. By the time the company completes its network expansion next June, it will be capable of handling 16 million online sessions each day, up from 10 million. According to UK managing director, Jonathan Bulkeley, it has no plans to adopt a flat charging scheme in Europe.

First End-to-End Secure Electronic Transaction over Internet



IBM, MasterCard, and Danish Payment Systems (PBS) has announced the first end-to-end secure Internet transaction using the Secure Electronic Transaction (SET) protocol. This first transaction under SET, the industry standard for securing online transactions, sets the stage for a pilot project involving three merchants and 500 to 1,000 PBS customers in Denmark who will use their Eurocard-MasterCard cards to make purchases via the Internet.

Carl Christian Aegidius, General Manager of IBM Nordic, was the first person in the world to complete a secure SET-based credit card payment via the Internet. The first transaction took place at the beginning of January, when Aegidius bought Stephen King's novel 'Rose Madder' at the first SET-certified merchant on the Internet, Lademanns Forlag, owned by the Danish Egmont group. Aegidius paid directly via the Internet with his Eurocard-MasterCard card using an attached Internet certificate which confirms the identity of participating parties.

This electronic commerce solution is the first of its kind and offers huge benefits to consumers and vendors in terms of availability, accessibility, convenience and choice. The pilot implementation uses IBM's Net.Commerce Payment, a suite of applications supporting the entire payment process and based on the global industry standard for SET.

In February 1996, MasterCard, Visa, IBM and other industry associations and vendors joined together to create a technical standard for safeguarding payment-card purchases made over open networks such as the Internet. MasterCard and Visa have been instrumental in the development of the joint SET specification and software solution that enables the secure use of credit cards on the Internet. The comprehensive SET specification released in June 1996, is based on advanced encryption technology, including among other things, digital signatures that electronically reconfirm the identity of each party to the transaction.

The SET standard introduces the integrated use of digital signatures or certificates issued by a trusted certification authority (in this case, PBS. The certification authority establishes a seamless digital information exchange that in a split second can validate that the cardholder is genuine and that the cardholder is indeed interacting with the intended merchant.

During the pilot, PBS customers will be able to make secure Internet purchases at three merchants. PBS will issue each customer an electronic 'wallet', which contains digital certificates that verify a customer's identity. When a customer wants to make a purchase, the transaction is encoded and includes the customer's individual certificate. The merchant's software accepts and processes the coded payment request, and forwards the information to PBS's gateway site. There, PBS will process the transaction as they do all other incoming credit card transactions.

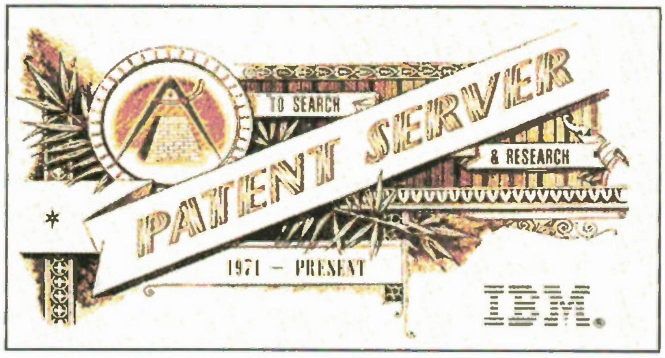
For further details, check: **http://www.mastercard.com** and **http://www.internet.ibm.com**.

@Internet

Browsing for the Rest of Us

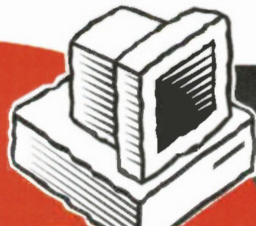
The problems with most modern Web browsers are manifold, and many readers will have come across them. For a start, browsers tend to be big, requiring large amounts of disk space and using up huge gollups of RAM. Secondly, they are often pretty slow in operation unless you have a super-fast new computer. In fact, these facts often preclude many computer users from surfing the Web at all. For Macintosh users with older machines, there has long been the possibility of Web browsing with the popular MacWeb shareware browser which has recently been upgraded to version 2, and allows several features only previously available with browsers of the likes of Microsoft Internet Explorer and Netscape Navigator. Now, with MacWeb version 2, you can browse the Web with e-mail, newsgroups, and many of the latest HTML features, in less than 3M-byte of RAM and 1M-byte of disk space. For interest, screenshots in Site Survey this month were all taken using MacWeb. Interestingly, while Tradewave, the publishers of MacWeb, have only just released the latest version, they no longer want to support the program, so it looks like version 2 will be the last version available. Get it while you can by checking out: **http://www.eden.com/~arena/jagshouse/Shareware.html**, where you'll find MacWeb versions 1 and 2, as well as some other nice shareware.

IBM Offers Free Patent Data Base on Web

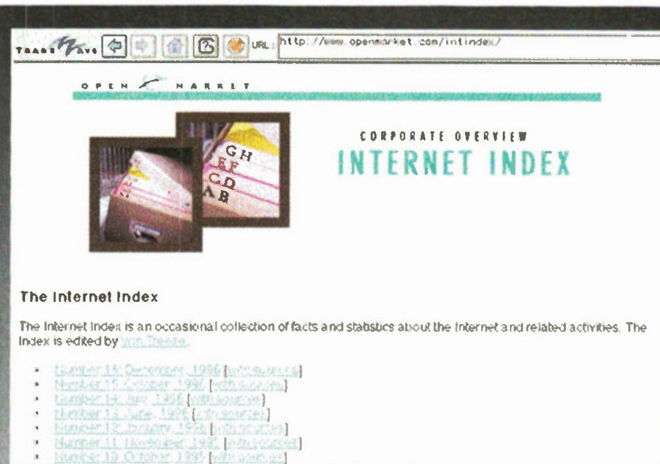


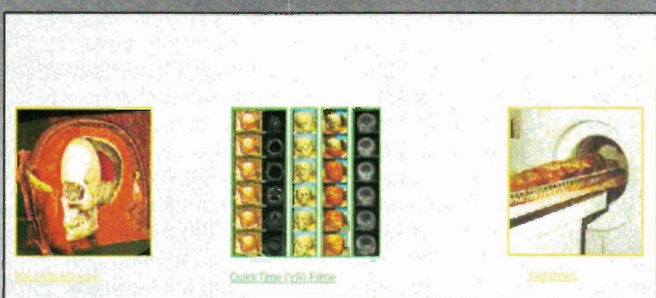
IBM plans to make the content of 2 million US patents dating from 1971 available free on its Web site at **http://www.ibm.com/patents**. Various companies currently provide patent access to patent directories for an annual fee. One such company, Questel-Orbit, charges $1,995 a year of access to its online directory.

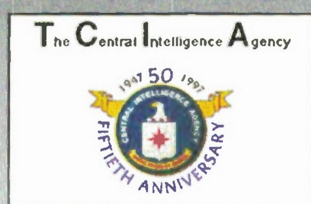
Site Survey

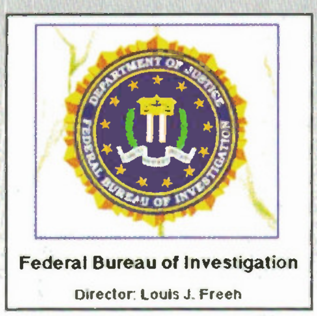


The month's destinations









Above: Internet Index home page

Far left: University of Hamburg's web site.

Left: The Central Intelligence Agency information web site.

Above: The Federal Bureau of Investigation web site.

The University of Hamburg has recently carried out quite a project to create a complete suite of computer movies of an Egyptian mummy. The mummy was taken apart layer by layer, with all stages being photographed and digitised. The setup is currently on display in real-time at a Hamburg museum, with museum visitors able to use the computer to visually access all internal parts of the mummy simply by zooming in and out on the computer screen. However, apart from allowing just the museum visitors to access the data, the University has made available some of the movies of the mummy for download off the Internet. They are in QuickTime VR virtual reality format, and are naturally quite large (the smallest weigh in at over 1M-byte), but are well worth the download time. Checkout **http://www.uke.uni-hamburg.de/Institutes/IMDM/IDV/Projects/Mumie/mumie.html**. Go to Apple's QuickTime Web site **http://www.quicktime.apple.com/** to download the latest QuickTime VR player for MacOS or Windows operating systems.

Government watchers should take a look at the two Web sites put up by the Federal Bureau of Investigation and the Central Intelligence Agency in the US. Try: **http://www.fbi.gov/**, and **http://www.odci.gov/cia/** for starters, where you can enter the respective sites.

The FBI's site is actually quite nice, but I can't say much for the CIA's use of overlarge capital letters in the heading of the home page – it looks a bit like a badly designed school newspaper. The CIA warning about monitoring the system usage is a little off-putting too. If you've ever wondered what the Internet is actually used for, take a look at the Internet Index, at **http://www.openmarket.com/intindex/**, where you'll find such incredible and useful information, such as the number of adult Americans who use the Web daily (9 million, wow), the number of Internet users in China (100,000, phew), the percentage increase in Internet traffic (30%, yawn), and the number of occurrences of the word *the* in documents indexed by the Alta Vista search engine (432,118,690, if you really want to know!).

Finally, why not surf over to **http://www.qkits.com** or **http://www.like.it/e2k** for some useful Maplin kit distributors' sites.

ELECTRONICS and Beyond

next issue

Don't miss another great assortment of entertaining and easy-to-make projects and essential electronics information aimed at the novice constructor in another of our special educational supplements.

1A Variable PSU

A useful general-purpose adjustable power supply, ideal for powering most projects.

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SDH & Sonet Interworking by Frank Booty describes transmission standards for high-speed digital telecommunications networks.

Audio Basics from Ray Marston is a two-part feature looking at basic audio system principles.

PIC Programming Part 7 by Stephen Waddington examines more advanced software techniques, including the use of interrupts, look-up tables, reset vectors and the watchdog timer.

In Part 3 of What's in a Name?, Greg Grant recounts the pioneering designers of the oscillator.

Surface Mount Technology Today and Tomorrow from Ian Davidson picks and places present and future developments in component miniaturisation.

- Martin Pipe reviews the PowerMac 9500/200 and AKD General Coverage Receiver.

Issue 113 on sale Friday 4th April

ELECTRONICS and Beyond

BRITAIN'S BEST MAGAZINE FOR ELECTRONICS

Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:

PROJECT RATING 1 — Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering, side cutters, pliers, wire strippers, and screwdriver). Test gear not required and no setting-up needed.

PROJECT RATING 2 — Easy to build, but not suitable for absolute beginners. Some test gear (e.g. multimeter) may be required, and may also need setting-up or testing.

PROJECT RATING 3 — Average. Some skill in construction or more extensive setting-up required.

PROJECT RATING 4 — Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.

PROJECT RATING 5 — Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

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TECHNOLOGY WATCH

with Martin Pipe

Loudspeaker design has not really changed much in the last 60 or so years. Pretty much all of the loudspeaker drive units built since then have been moving-coil types. They consist of a permanent magnet, which reacts with a voice coil (driven by the audio source) to generate a piston-like linear motion. This piston is coupled to the cone, which is used to shift air and generate sound. The speed of cone vibration corresponds to frequency, while the travel of the cone corresponds to amplitude. OK, the materials employed in the magnets, voice coils and cones have improved sound quality and efficiency, while a range of driver types have been optimised to specific frequency ranges (i.e., woofers and tweeters), but in terms of basic design, they're pretty much identical to those Thirties efforts.

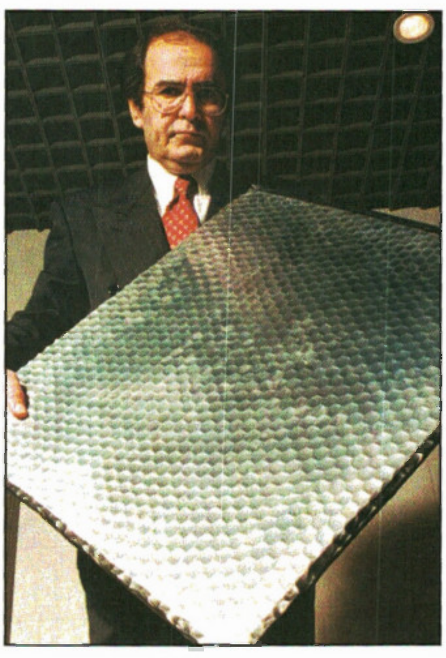
Some different transducer approaches have been tried. Piezo-electric drivers can handle high powers, and are commonly used as disco tweeters where absolute sound quality isn't required. Their basis is a piezo-electric crystal that physically distorts when a voltage is applied across it. This movement is coupled to a diaphragm and horn. There have also been experiments with ribbon drivers, in which the diaphragm, the driven element, having such a low impedance that a matching transformer is required, takes the form of a ribbon suspended between two permanent magnets. Ribbon speakers are used as high-quality tweeters; the most famous example is the Decca model. They are somewhat fragile, though (just like the similar ribbon mikes that were popular in professional audio applications).

Quad's Electrostatic speaker, introduced in the 1950s, was a full-range (although it was a bit low on the bass side) Hi-Fi speaker that resembled a small electric radiator. Quad still make electrostatic speakers – the ESL model – albeit in small quantities. The operating principle behind the electrostatic speaker is essentially a capacitor. One of the capacitor's plates is a fixed electrode, while the other is a taut plastic membrane coated with a conductive substance. The audio signal is used to modulate a high DC polarising voltage, which is applied across the plates. The varying voltage causes the charge between the plates, and hence the attractive force, to change in proportion. This force, the attraction of which varies with the voltage, causes the film to vibrate, producing sound.

Other approaches have been tried. Another 50s design, the French Orthophase, was a clever flat variant of the moving-coil speaker, in which the diaphragm was a rectangular aluminium coil glued to a thin piece of expanded polystyrene. The magnets protruded between the coil elements. Wharfedale updated the Orthophase concept, and used it as the basis of the 'Isodynamic' product range in the 1970s. Similar techniques were used by esoteric US Hi-Fi manufacturers, Apogee and Magneplanar. All of these approaches are based on an idealistic 'zero mass' approach that's unattainable in practice. You can, however, come close. The lighter the diaphragm, the wider the potential frequency response (particularly at the high end), the greater the efficiency, the lower the non-linearities (i.e., less colouration) and the better the transient handling ability. A side-effect of the zero mass approach is that the speakers can, in many cases, be flatter (and hence, less obtrusive). Flat speakers can be employed within a range of applications, since they don't rely on the bulky cabinet of convention. If the transducer is flat and handles all frequencies, then the 'point source' effect of conventional speaker systems based around (multiple) moving-coil drive units is eliminated.

The Verity Group, which acquired Quad, Wharfedale and indeed, Mission, also owns a speaker design company by the name of New Transducers Limited. It is working on a radically new type of flat full-range speaker design, which goes by the marketing name of NXT (engineers prefer to call it the distributed-mode loudspeaker, or DML). There's a web site, which can be found at `http://www.nxt.co.uk`.

The original idea, interestingly enough, was the accidental brainchild of researchers at the Ministry of Defence's Defence Research Agency, who were at the time trying to reduce noise levels in aircraft cockpits. The basic ideas, conceived in 1994, were licensed exclusively to Verity. NXT's developers made use of complex mathematical modelling techniques, made a practical possibility with advanced computer systems that didn't exist until comparatively recently. NXT is now covered by over 20 patents.



Unlike conventional moving-coil speakers, NXT does not rely on a electromagnetically-driven piston. It uses a stiff but lightweight panel, the characteristics of which were accurately determined during the computer modelling stage. The panel doesn't have to be flat, and various shapes could, theoretically, be employed within NXT speakers. Such characteristics include density, stiffness, geometry, and internal damping. The panel, which can be between 3 and 25mm thick, is excited by one or more transducers (Verity discusses electromagnetic and piezo drivers), the positions of which are determined by Fourier analysis. This sets up a series of complex vibration modes on the surface.

If all of the contributory factors were correctly determined in the first place, these vibrations will constructively interfere to generate sound waves. New Transducers Limited claims that a typical domestic NXT design, with a 1·5m area, has a frequency response of 60Hz to 18kHz and an efficiency of 88dB (measurement characteristics not specified). One can only imagine that the limits will be extended with further work, or subwoofers and super-tweeters will be required (defeating the object somewhat!). Many applications don't, however, need a full 20Hz to 20kHz bandwidth.

Other advantages claimed over conventional speaker designs include the elimination of the inefficient frequency-dividing network (crossover), a more predictable amplifier load and immunity from the destructive interference caused by room boundaries. There's no cabinet, mounting arrangements are flexible, weight low and manufacturing costs economical. What's more, the speakers could be shaped to fit into hitherto-impossible places. Car audio manufacturers are obviously interested. NXT panels can be made to any size – between 25cm and 100m, in fact.

Speakers suitable for a range of applications – from laptop PCs, through car audio, to PA systems – are thus possible. The larger panels offer a better low-frequency response, and are likely to form the basis of unobtrusive Hi-Fi and home-cinema speaker systems. The home cinema system's centre (dialogue and effects) speaker could, theoretically, be the screen itself – when affordable flat hang-on-the-wall displays at last become a reality. For the first time ever, speech will appear to directly originate from the people on-screen! Needless to say, Verity's speaker manufacturers are likely to bring the first NXT products to the marketplace.

E-mail your comments or suggestions to Martin Pipe at whatnet@cix.compulink.co.uk.

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