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ELECTRONICS and Beyond

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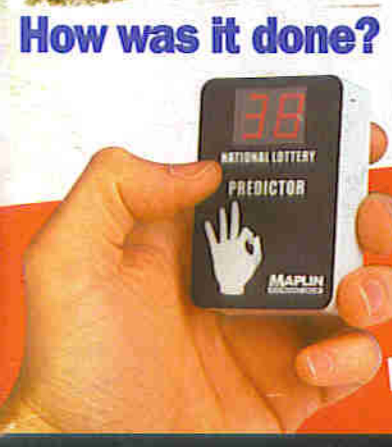

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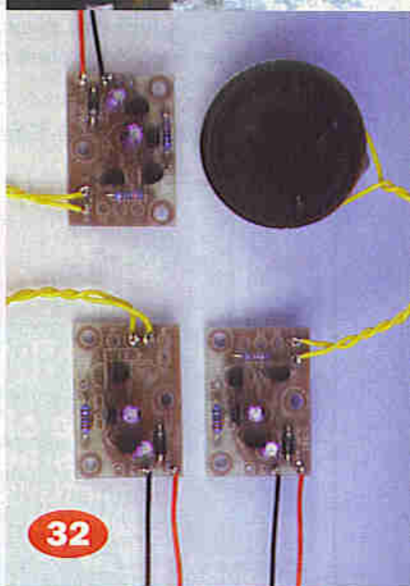

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ELECTRONICS and Beyond

This issue has something of a marine flavour to it and to that end we look at marine navigation and communicating through water.

Now communicating through water has historically always been a bit tricky. As we know ordinary radio waves just don't like going into water. They get scattered and attenuated. The air/water interface is a bit like a partial mirror - a high proportion of the energy bounces off. Very low frequency radio waves (VLF) have a better chance and submarine communications can work in this way. Trouble is, the lower the frequency, the longer it takes for the factual content to get through. So is there another way and have any other methods been tried but not further investigated? Read our article on Pre-Hertzian wireless and find out.

Congratulations

Writing for Multimedia book competition

Here are the ten lucky winners: Carl Wilkinson of Bootle, V S Chang of Sheldon Birmingham, R E Hogben of Dover, G M Grant of Sudbury, Les Green from Pwllheli Gwynedd, W Hauxwell from Basingstoke, A Jones of Swansea, W M Bromfield from Bridgewater, R Mitchell of Morpeth, and finally D J White of Shanklin.

Paul Freeman-Sear, Publishing Manager

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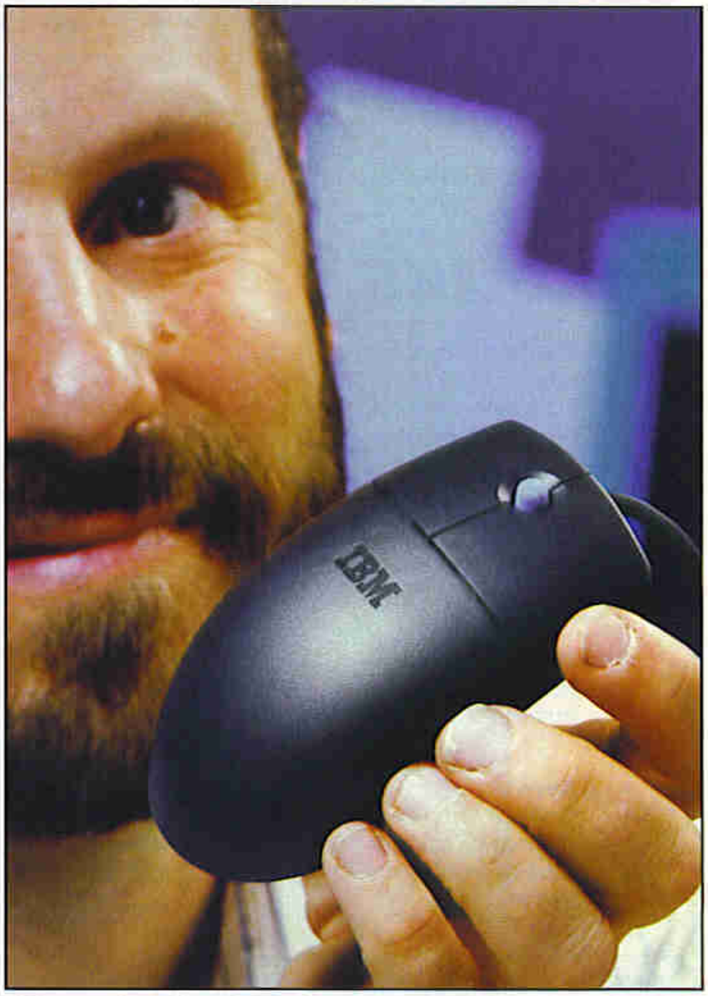
NEWS REPORT

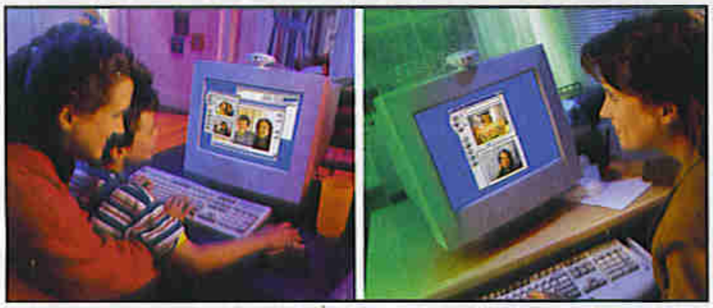


Consumers Break the Scroll Barrier with IBM ScrollPoint Mouse

The ScrollPoint Mouse is a new IBM innovation that supports one-touch, 360° scrolling, enabling consumers to more easily surf the Internet and quickly navigate through long documents and spreadsheets.

The ScrollPoint Mouse eliminates the need to use 'scroll bars', allowing PC users to move up, down, left, right and diagonally with the touch of a finger.

For further details, check: www.ibm.com.
Contact: IBM, Tel: (0990) 426426.



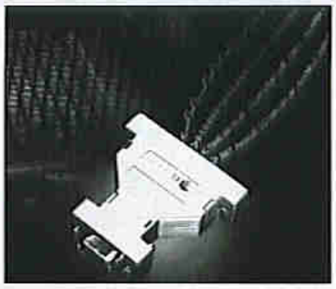
Intel Launches Create & Share Camera Pack

Intel has announced the Intel Create & Share Camera Pack, an all-in-one PC communications, photo and video editing package that plugs into Pentium processor-based high performance PCs.
The Create & Share Camera Pack includes an Intel PC Imaging Camera, hardware and an integrated suite of communications and image-editing software. The software suite enables consumers to make, enhance and organise snapshots and videos that can be passed onto others in print, on screen or over the web. The Intel Create & Share Camera Pack also includes the Intel Video Phone with ProShare technology.
The Intel Create & Share Camera Pack includes the necessary ingredients for making video phone calls over the web as well as over regular phone lines, taking snapshots from a PC, making short videos, sending e-mail postcards, and enhancing, and printing snapshots. An Intel PC camera sits on top of the PC's monitor and serves as the centre of the Create & Share software suite.
For further information, check: **www.intel.com.**
Contact: Intel, Tel: (01734) 403000.

Connectivity with No Wires Attached

Lascar Electronics has launched a pair of short range infra-red communications modules. The PANEL-IR and EL-LINK-IR modules convert serial data such as RS232 to infra-red and vice-versa. PANEL-IR is designed to fit directly into a control panel, while EL-LINK-IR is a self-contained 9-to-25 D-type adapter making it suitable for direct equipment such as laptop PCs.

Contact: Lascar Electronics, Tel: (01794) 884567.



Big Performance from Tiny Camera

Hardly bigger than a credit card and weighing in at just 158g, Panasonic's latest digital camera, known as the NVDC1000B, is claimed to be the world's smallest with a liquid crystal display (LCD). Thanks to digital technology, there is no need to wait for pictures to be developed; the NVDC1000B offers automatic playback, enabling users to instantly view each shot on a built-in 1·8in. LCD screen. The camera's 2M-byte built-in memory can store images in three picture quality modes: normal mode which records 94 pictures; fine mode (32 pictures) and super fine (16 shots). Priced at £450.00, the NVDC1000B achieves high quality images everytime. Equipped with a progressive 350,000 square pixel charged couple device, the camera ensures that photos have amazing clarity and details, while VGA compatibility enables pictures to be transferred to a PC in high quality 640 × 480 pixel format.
For further details, check: **www.panasonic.co.uk.**
Contact: Panasonic, Tel: (0990) 357357.

Storage Oscilloscope in the Palm of Your Hand

Once, oscilloscopes were heavy and clumsy to handle, but over the years, they have got smaller and smaller. The latest development is osziFOX, a 20MS/s hand-held scope with PC link, priced at £80.

Despite its small size, its performance can match that of a service oscilloscope. With a sample rate of up to 20MS/s, even signals in microprocessor circuits can be recorded. Using the voltmeter function, numeric AC and DC voltages can also be measured.

The osziFOX can also be used for making measurements in amplifiers, digital circuits, telephone installations, hobby electronics, production line tests, servicing and on-the-spot measuring.

With the supplied software for DOS and Windows, recorded signals can be shown simultaneously on a PC screen using the supplied serial cable.

For further details, check: **www.picotech.com.** Contact: Picotech, Tel: (01954) 211716.

NEWS BYTES

Flatbed Scanner Aimed at the First Time User

PC peripheral supplier, PRIMAX has launched the Phodox UltraScan 300, priced at £240, designed to make scanning simple for home users. The device plugs into the PC's parallel port and enables users to scan paper images, photographs or documents directly onto a PC to be displayed and edited.
Contact: PRIMAX UK, Tel: (01235) 546020.

Sainsbury's Selects Checkpoint Anti-Theft System

Sainsbury's is rolling out the Checkpoint Systema radio frequency electronic article surveillance (RF EAS) anti-theft system across their supermarkets, as the first step toward the implementation of a source tagging program.

Source tagging involves the insertion of a paper-thin RF label into products or packaging at time of manufacture. This provides the retailer with items that require no further anti-theft tagging on the shop floor – saving time and money.

It also offers an even greater deterrent to theft as no-one, not even staff, is aware of which products are tagged, or where the tag is hidden.

For further details, check: **www.checkpointsystems.com.**
Contact: Checkpoint Systems, Tel: (01279) 452 233.

New Chip Records and Plays Video

A new processor developed by C-Cube Microsystems can both record and play back video in digital format, replacing up to three chips used in current systems. The DVx chip could be the first step toward inexpensive video cameras and video disc players. The device is currently being tested by Scientific-Atlanta and Japan's JVC.
For further details, check: www.c-cube.com.
Contact: C-Cube Microsystems, Tel: (01293) 651100.

Deep Blue Just Got Deeper

The IBM RS/6000 supercomputer Deep Blue, widely known for its chess victory over world chess champion Garry Kasparov, has received hardware and software enhancements expected to make that product line 58% faster. Much of the speed increase is due to the latest version of IBM's 604e Power PC microprocessor.

For further details, check: **www.ibm.com.**
Contact: IBM, Tel: (0990) 426426.

NEWS BYTES

Intel Delivers Breakthrough Memory Technology

Intel's new 64M-bit StrataFlash memory stores two bits of information in each memory cell, compared to current memory technologies that store only one.

This breakthrough technology enables Intel to market higher density flash memory products at a lower cost-per-bit than traditional single-bit-per-cell components.

For further information, check: www.intel.com.

Contact: Intel, Tel: (01734) 403000.

ITC Joins Digital Television Group

The ITC is joining the Digital Television Group (DTG), a group of broadcasters, manufacturers and network operators. The group's aim is to work towards the successful launch of digital television in the UK.

The ITC Engineering Division will take an active role in the activities of the Digital Television Group, especially in the development of implementation guidelines for digital terrestrial television. In joining the DTG at this stage, the ITC wishes to encourage co-operation between the digital multiples licensees, manufacturers and network operators in the development of a coherent digital television infrastructure.

The ITC is currently developing the technical regulatory regime, which will apply to digital terrestrial broadcasters. This includes finalising the technical documents issued last October as part of the invitation to Apple. The ITC also expects to produce guidance to broadcaster on matters such as network operations, reliability and picture quality.

Contact: ITC, Tel: (0171) 255 3000

Digital Unveils StrongArm Mobile Microprocessor

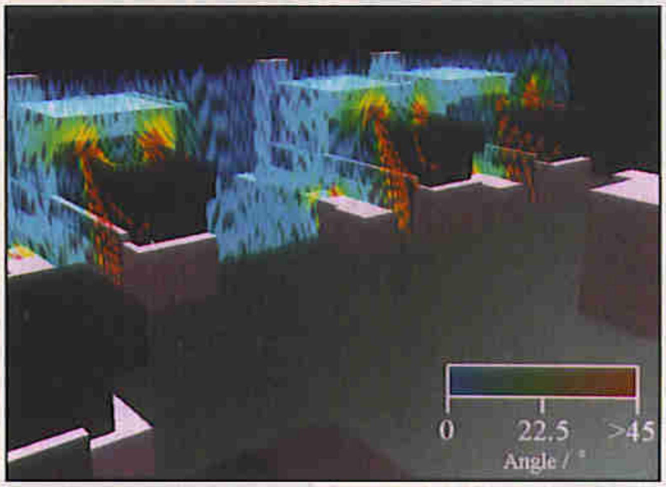
As the majority of the chip business, led by Intel, focuses on microprocessors to boost notebook PC performance, Digital's Semiconductor division is thinking much smaller, in terms of personal digital assistants.

Digital has announced its intention to ship the StrongARM SA-1100, a 133 and 200MHz embedded processor that will be supported by nine different operating systems. The StrongARM microprocessor was co-developed with Cambridge-based Advanced RISC Machines (ARM).

For further details, check: www.digital.com/semiconductor.

Contact: Digital, Tel: (01189) 868711.

Keeping Semiconductor Facilities Clean



Maintaining a clean semiconductor manufacturing facility by creating a consistent downward laminar or uni-directional airflow to control air particles is critical to the profitability of the semiconductor industry. But it is a difficult requirement to satisfy, In practice, essential operational features can disrupt the uniform nature of airflow, so causing contamination, which ultimately leads to lost wafer yield.

Flovent, from UK-company Flomerics, a new computational fluid dynamics package, is the first such program designed specifically to address these ventilation issues. It can be used effectively to optimise ventilation by modelling the airflow for different manufacturing facilities.

By using Flovent at the design stage, engineers can evaluate the ventilation performance of the empty facility. By adopting this approach, it is possible to identify potential problems associated with the design, enabling design modifications to be made and the need for costly on-site modification minimised.

For further details, check: www.flomerics.com.

Contact: Flomerics, Tel: (0181) 547 3418.

HP and Mitsubishi Pact to Ultra Portable

With the intention of expanding its product line with the thinnest, lightest notebook PCs ever, Hewlett-Packard has announced a collaborative relationship with Mitsubishi.

The relationship will enable the two companies to combine Mistubishi's superthin keyboard, battery and LCD display technology and manufacturing strengths with HP's notebook PC system expertise, distribution and support infrastructure.

HP marked an industry first by showing a concept product that weighs only 3·1lb, is less than 0·75in. thick and has a 12·1in. viewable-image Thin Film Transistor display.

For further details, check: www.hp.com.

Contact: Hewlett-Packard, Tel: (01344) 360000.

Confidence in CDT Clear

Cambridge Display Technology (CDT), the UK company leading the research and development of Light Emitting Polymer (LEP) technology for display applications, has announced secured funding of up to £6·6 million.

The investment, being made by a group of entrepreneurs headed by Lord Young of Graffham, chairman of Young Associates and formerly chairman of Cable & Wireless and Secretary of State for Trade and Industry, reinforces the confidence shown by early investors.

The funding means that CDT can expand its research and development, continue to build on its existing intellectual property and negotiate future licensing agreements from a position of strength.

LEP technology is emerging as a strong contender to replace the existing liquid crystal and cathode ray technologies currently existing in the majority of flat panel displays and computer monitors, respectively. Under the terms of the agreement, CDT has received an immediate investment of £2 million, plus the option of additional investment up to £4·6 million over the next 4 years.

CDT is using the initial cash injection to extend both technical resource and facilities, with a further boost to the ongoing recruitment of research and development staff predicted. The company is planning to construct a clean room at the current site, and ultimately, will expand into new offices on the West Cambridge Science Park.

For further details, check: www.cdtltd.co.uk.

Contact: Cambridge Display Technology, Tel: (01223) 276351.

That 'hole' may be better than the parts!

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Photo 1. Endeavour, pictured on her maiden voyage off Freemantle. (Credit, John Lancaster).

Marine NAVIGATION TECHNOLOGY

by Douglas Clarkson

GPS Navigation is the latest aid for ships to find their way around the globe but the prime catalyst for advances in marine navigation technology has been determined by military expediency. Both World Wars and the Cold War, set in train episodes of rapid technological advance which have resulted in today's diverse set of marine navigation aids.

GPS Navigation systems will no doubt make other less accurate forms of marine navigation obsolete. There are some though that have reservations about being in thrall to essentially a military installation and the accuracy for public use is reduced for reasons of national security. Why not have a dedicated commercial system with higher resolution than public access GPS? The answer may be the price tag.

Sea-going vessels, are likely to retain backup systems for navigation using independent technologies such as LORAN C. Also, marine navigation on ships tends to be undertaken with an integrated system of connected equipment. Although GPS is taking on a dominant role for positional data, other systems such as gyro compass and radar provide key information about ship status and navigation safety.

Also, with increasing technology available, it could be imagined that this would in turn lead towards safer seas. The trend towards use of flags of convenience, and use of inadequately trained and experienced crews is a worrying one. Safety is not totally about technology.

The Return of the Tall Ships

The abiding interest in Tall Ships, is an indication that in an age with ever more complex technology, the attraction of the elements of the sea is itself as strong as ever. Modern day replicas such as the *Endeavour,*

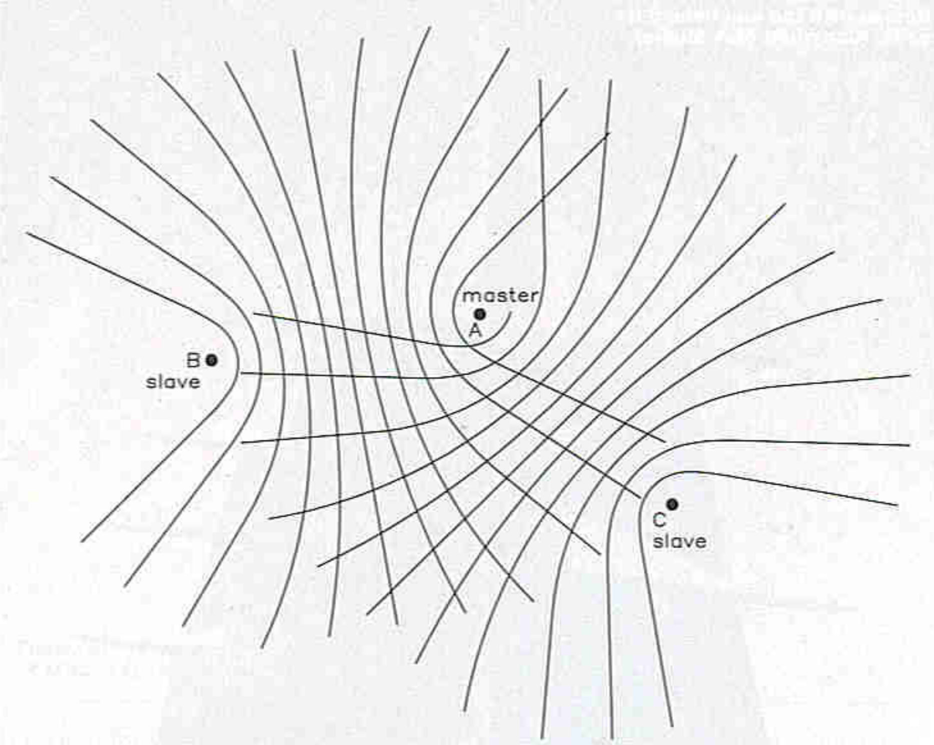


Figure 1. Cartoid signal response of twin loop plus vertical aerial element.

shown in Photo 1, are very much kitted out with state-of-the-art marine navigation technology, though it is discretely hidden to maintain an appropriate aura of history.

In the USA, the clipper *Pride of Baltimore*, initially launched in 1977 as a promotion for its city namesake, perished in a storm near Puerto Rico in 1986 with the tragic loss of the captain and three crew. The ship has since been rebuilt as *Pride of Baltimore II* and fitted out with advanced navigation technology. It was launched in 1988.

The fascinating world of the Tall Ship has in particular been brought to life by the photographer Max Mudie, based in Lymington in the UK. Photo 2 shows a classic image of the ship Nelson with the sun behind its sails.

The Magnetic Compass

At the time when all manner of exploits were being undertaken to determine the longitude accurately, the use of magnetic compasses on ships was generally poorly understood and with them typically being defective in operation. This was principally because the nature of magnetic fields was poorly understood. Even navigators as expert as Captain Cook were apparently not aware of the influence of iron objects on compass bearing.

As ships began to be constructed in iron and steel, problems in determining magnetic compass bearing became more acute. Ships themselves became, in effect, permanent magnets whose field dwarfed that of the Earth.

It was only around 1835 that the compass bearing of ships at sea began to be compared against fixed land-based bearings. Also, it was understood that compasses on a quayside could be influenced by a berthed ship. More to the point, it became apparent that two ships sailing close to each other could cause deviation in each others' magnetic compasses. Contributions from Sir George Airy in 1837 and Archibald Smith during the 1840s further developed models of compass behaviour and corresponding correction. Further significant work was undertaken by William Thompson – later to be known as Lord Kelvin – who patented in 1876 a compass with various adjustments to correct for known errors associated with a ship's own magnetism. Short, powerful magnets were used and mounted on a dry card, which itself was pivoted on knife edges.

Since submarines were totally enclosed metal surfaces, it was impossible to operate a magnetic compass within one. It was possible, however, to implement a magnetic compass on the upper coning of the submarine and in turn, view this through specialist projector optics.

Eventually, a liquid-filled compass would find widest acceptance to cope with more abrupt changes of course. But as the magnetic compass was being perfected, the gyro compass was being developed – initially for military applications.

Waves Around the World

One of the earliest applications of radio in navigation was that of radio direction finding, i.e., the determination of bearing with reference to a fixed transmitter. Where a simple vertical coil is rotated in the reference frame of a horizontally propagated radio wave, a zero of signal occurs when the coil axis is parallel to the incident beam and at a maximum where it is at right angles to it. This gives two possible bearings, 180° apart at null signal. By adding a component of a simple vertical aerial and changing its phase relative to the loop by 90°, a cartoid polar diagram, as indicated in Figure 1, is obtained.

Variations in detecting coil design were developed, based on rotating a crossed loop antennae and decoding the received signal amplitudes of each coil.

In terms of direction finding systems, some effort was directed towards complexity of the transmitter and with utilising a very basic receiver. One trial system developed by Telefunken consisted of an array of 32 receiving antennae – each aligned to a point on the compass. Initially,

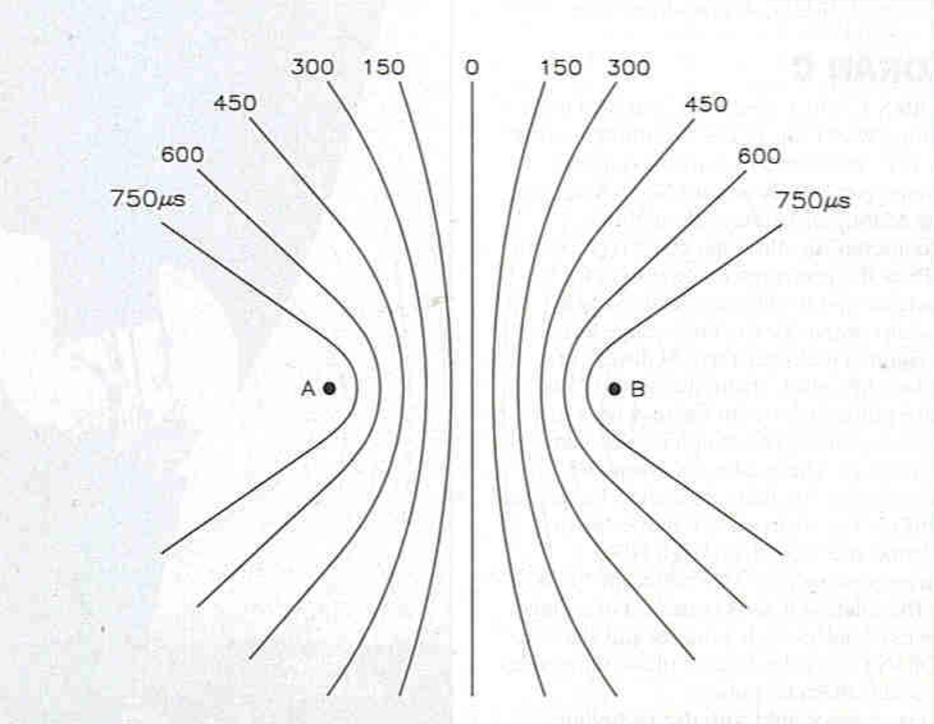


Figure 2. Loci of location of zero time difference in signal reception is also on the centreline and with loci of constant time difference along parabolas.

all antennae were activated, followed at regular intervals by the single antenna at specific compass points. By decoding the line at which the loudest single beam was detected, the direction could be determined to an accuracy of around 10°. Such a system was used in the bombing of London by Zeppelins during the First World War.

A revised system developed by Marconi was a more developed 'wireless lighthouse' – where a revolving paraboloid antennae system rotated one revolution every 2 minutes with a different letter of the alphabet radiated in each sector. By reducing the signal until only the loudest signal remained, the radial could be identified. This system, installed at Inchkeith in 1921, used a 50MHz signal.

While directional signals with individual transmitters could give useful bearing data when used singly and appropriate bearing data when used in pairs, there was a perceived need to determine position when distant from land surfaces and possibly in conditions of darkness or cloud. Considering Figure 2, where transmitters A and B are synchronised to radiate at exactly the same time (pulsed), the locus of zero time difference of receiver stations will be along the centre line. The locus of constant time differences will occur on parabolas passing across the baseline between the two transmitters.

Thus, in Figure 2, for transmitters A and B, a series of patterns is developed. An observation of a delay, for example, of 450μs, limits position to lie on two separate parabolas on opposite sides of the baseline. When this is combined with another baseline series involving another slave transmitter, a more exact determination of position is possible. Also, in practical terms, the navigation position is probably known to within a few tens of miles in any case.

One of the most widely used hyperbolic systems, LORAN C, is now discussed.

LORAN C

LORAN C, which developed out of LORAN A during World War II, was first implemented in 1957 and now covers major shipping routes, particularly around North America, the Atlantic and Europe along the Mediterranean. Although being replaced by GPS as the prime reference system for navigation, it is still being retained as a backup system for the foreseeable future.

Figure 3 indicates a typical display of pulses. In a given chain, the order of master, slave pulses is constant for anywhere in a receiving chain. This simplifies decoding techniques. These different chains are identified by the Pulse Repetition Frequency (PRF) of the chain master. In the North Atlantic, the 7930 chain has a PRF corresponding to a cycle period of 79,300μs.

The initial LORAN A consisted of a single series of pulses from a master and slave. LORAN C provides relative phase differences between alternate pulses.

Errors associated with this technique include variability of speed of propagation over different surfaces such as land, sea or ice. Also, signals can be modified within the

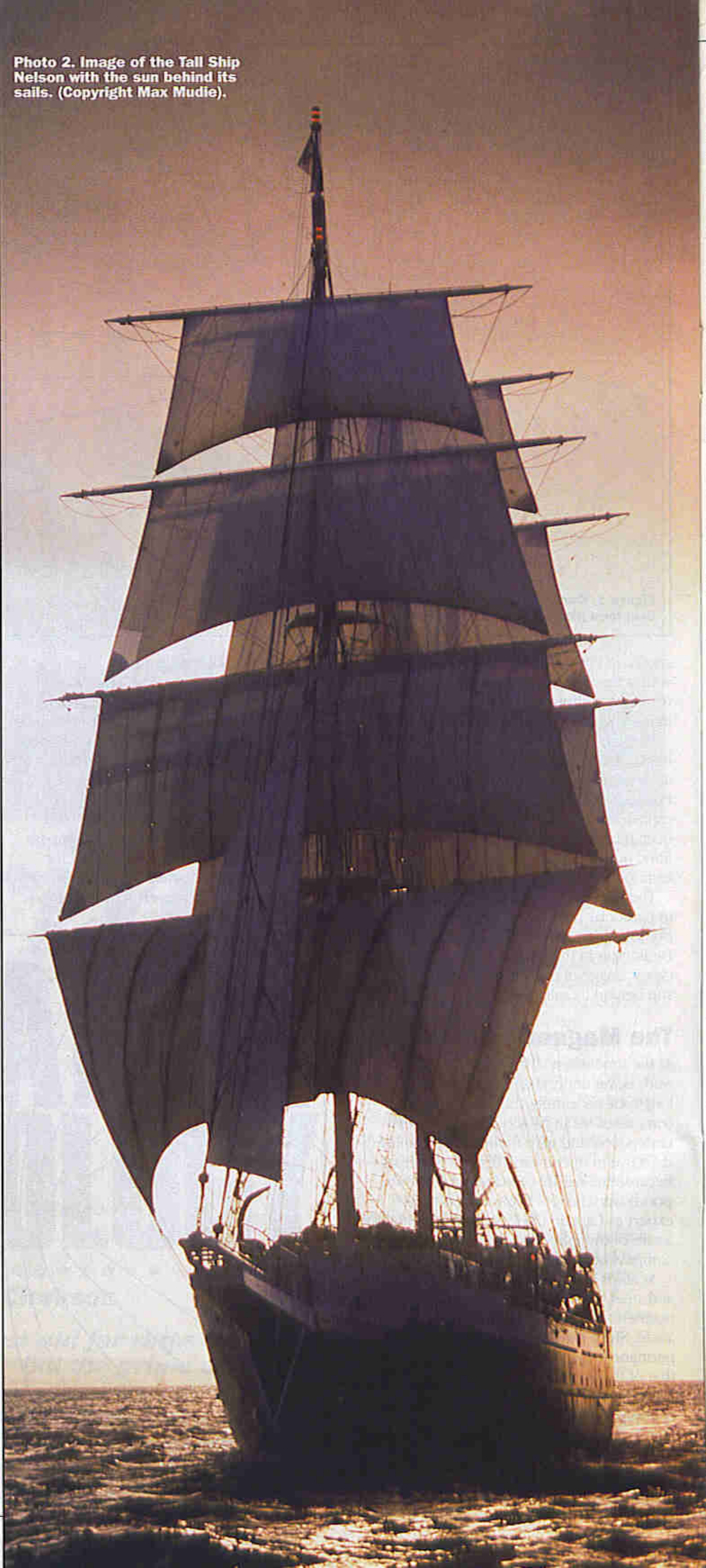


Photo 2. Image of the Tall Ship Nelson with the sun behind its sails. (Copyright Max Mudie).

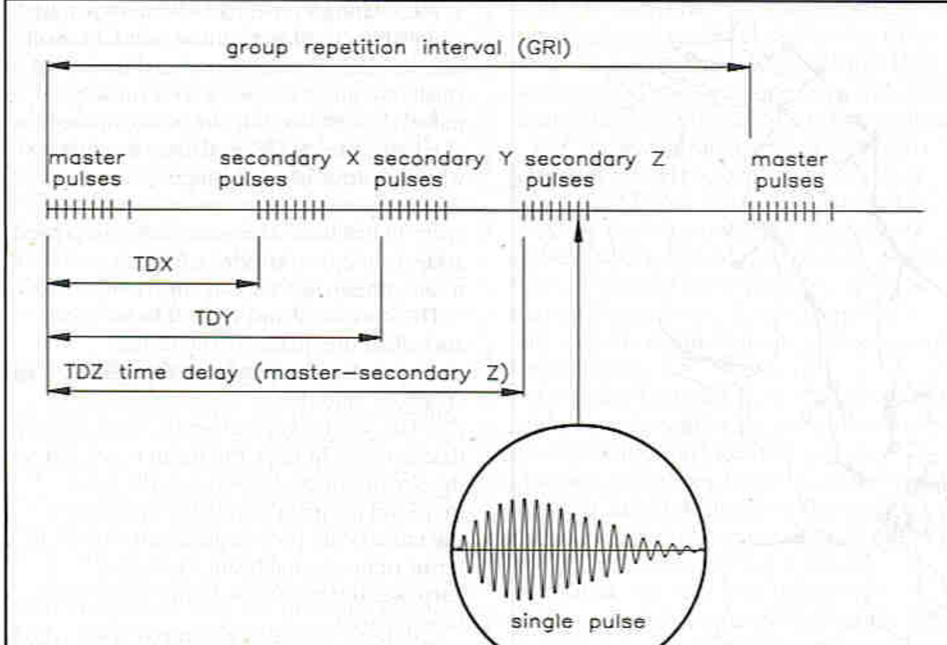


Figure 3. Typical sequence of LORAN C pulses.

24 hour daily cycle of propagation changes in the ionosphere.

LORAN C lattice tables are published for areas of coverage with included superposition values of chain coverage. Errors are least on the baseline and increase away from it. Signals are typically broadcast at 100kHz. Usually, detectors detect the 3rd cycle tracking point in the sharply rising pulse shape. Accuracies of between 50 to 300ft. are routinely achieved in areas with good signal coverage. Hyperbolic systems such as LORAN C, however, have good repeatability.

Sonne and Consol

The Consol system was developed from the Sonne system used by Germany during World War II – in particular, being used to give bearings to U boat commanders. Although Consol is more of historical interest now as a means of navigation, it is relevant to describe the techniques used. As a word of warning, however, an understanding of Consol is not easy to obtain.

Consol was an example of a collapsed parabola system. Rather than having a master and two slave transmitters separated by hundreds of kilometres, a series of transmitters A1, A0 and A2, are separated approximately 3 wavelengths apart. At an operational frequency of 300kHz, this corresponds to the transmitters being 3km apart.

The transmitters A1 and A2 alternately radiate for 0·5s with the phase of the outer transmitters maintained at +90° and -90° to the central transmitter and with this phase reversed for 0·125s. Along hyperbolae lines, the phases of A1 and A2 will always cancel and an equisignal tone is heard. Where the signals of A1 and A2 are received in phase during the 0·5s cycle, this will give rise to a zero signal and during the corresponding 0·125s antiphase cycle, no signal will be detected. The signal will be heard as a sequence of dashes. Where the signals of A1 and A2 are received in anti-phase during the 0·5s cycle, this will give rise to a zero signal and during the corresponding 0·125s antiphase cycle, a brief signal will be detected. This will be heard as a sequence of dots.

As a static system, Consol would not be very useful. In any position, all that would be heard would be either dots, dashes or the equisignal. The usefulness of Consol, however, lay in the sweeping of phase during part of the transmitter output sequence so that equisignal lines were swept round the transmitter focus. By altering phase difference by equal and opposite amounts around the central A0 transmitter, the equisignal lines were typically swept clockwise in the upper half and counterclockwise in the lower half of an installation. The operator counted the corrected number of dots and dashes until an equisignal line was detected from the start of the phase sweep cycle. This gave a subdivision of 60 parts within a sector of the Consol system. A Consol system installed at one time at Stavanger in Norway had around 12 working sectors. At best, the system gave an angular error of 0·3° during the day and 0·7° at night.

The system could also broadcast a continuous tone for conventional direction finding (DF) bearing, in order to resolve sector ambiguity. The advantage of the system was to subdivide the sectors into at best 60 sub-units of angle.

Decca Navigator

While hyperbolic systems can provide location finding systems from relative time differences of signal between master and slave transmitters, use can also be made of relative phase differences. The Decca Navigator system can be traced to a system devised by W. J. O'Brien while working in the USA in 1937. This system was extensively developed for the Normandy landings in 1944.

Figure 4 shows the parabolic pattern of zero phase differences arising from two stations radiating in phase. A typical baseline pair separation would be 120km. A lane can be considered to exist between lines of zero phase difference. Within a lane, the system can further resolve phase into centi-lanes – corresponding to phase differences of 3·6°. While it is simple enough to determine the relative phase within a lane, the basic system does not resolve the lane corresponding to the parabolic phase difference.

To provide lane identification, master and slave transmitters will broadcast on a set of related frequencies, as outlined in Table 1.

In this example, the decoding system multiplies the master frequency by four and the red slave by three to derive a 340kHz signal for phase comparison with an associated lane width of 440m.

A key issue with such a system is lane identification. One option is, of course, to identify a lane by comparison with known landmarks and for the system to maintain a lane count as lanes are crossed. The system,

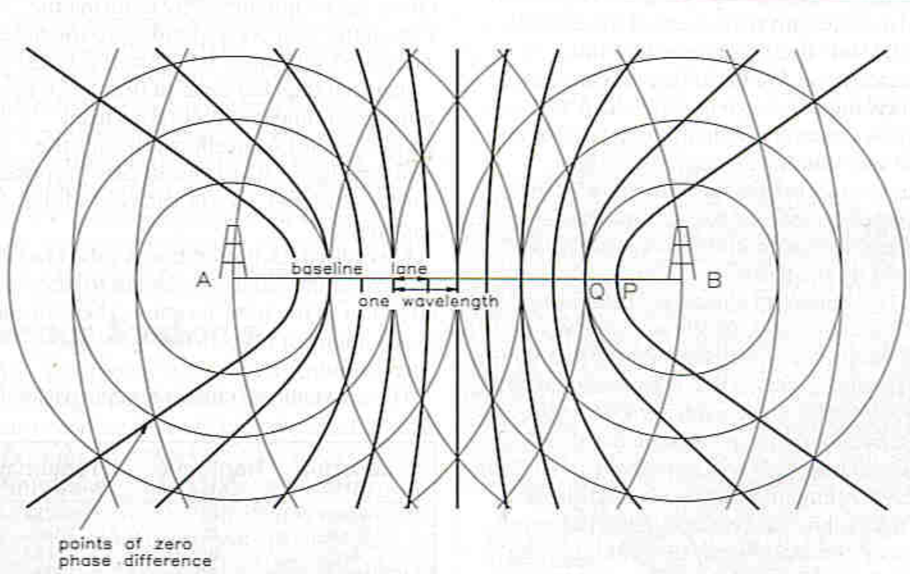
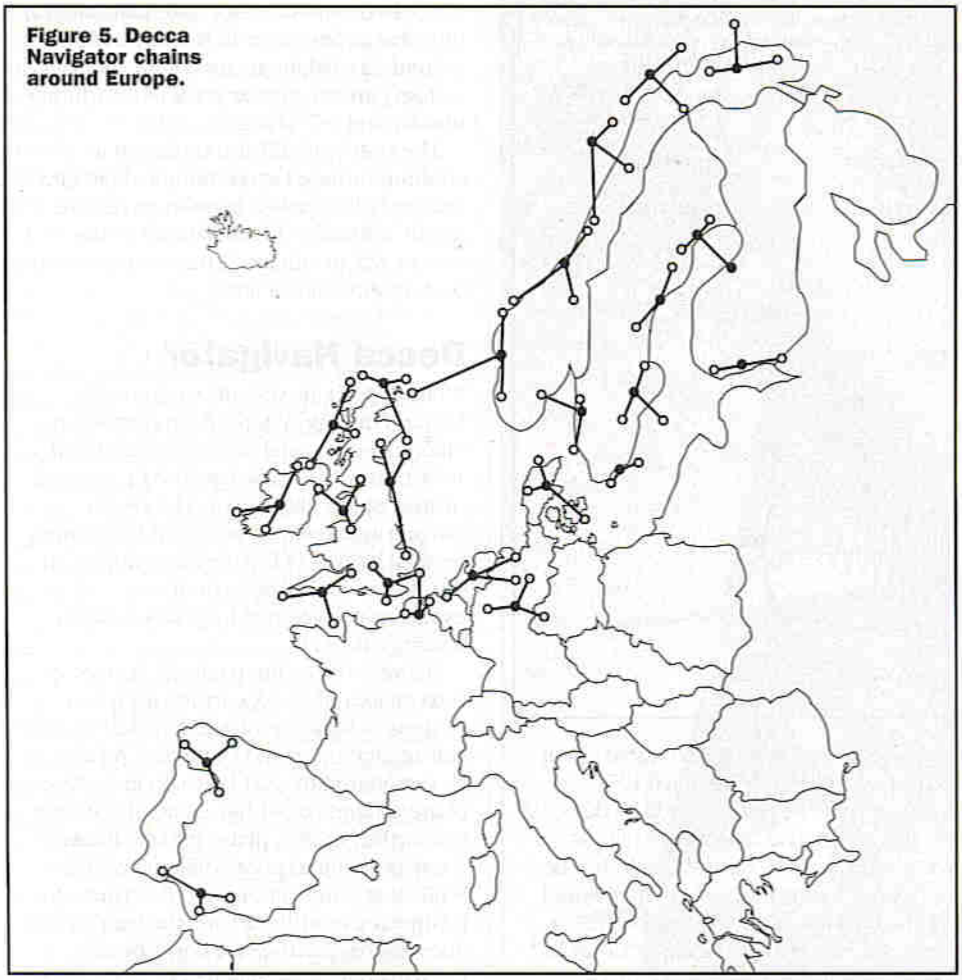


Figure 4. Hyperbolic pattern of zero phase differences arising from two stations operating the Decca navigator system.

Figure 5. Decca Navigator chains around Europe.



however, allows each transmitter in turn to broadcast all the frequencies of the chain at the same time. This allows the relative phase of a signal at fundamental frequency f to be derived – in the case of the red chain, identifying lanes of width 10·5km wide. This in turn allows lane count to be re-established if lost. Figure 5 indicates the Decca Navigator chains around Europe.

Radar

In increasingly congested waters, the use of radar provides invaluable assistance in navigation. Historically, the great impetus to radar came with the advent of the Second World War. The development of the Magnetron in 1940 by a British team was a critical breakthrough in this field. Also, by rapidly communicating these details to the USA and utilising its extensive manufacturing capability, aircraft systems rapidly became available to hunt and destroy U boats in the North Atlantic and hence tip the balance of the war.

The principle of radar is simple – pulses are radiated and their echoes are detected. The frequency of the radar tends to be in the GHz range. A typical magnetron resonating at 10GHz will produce a wavelength of 3cm. The pulse duration is usually adjusted automatically with selected range.

Depending on range, the pulse duration of radars tends to be automatically selected. Thus, pulse lengths can be varied through 0·08, 0·25, 0·5 to 1·0µs to optimise clarity of image in varying range from around one nautical mile to 50 nautical miles. Options exist also to interface to a navigation system to indicate North Up display rather than the conventional 'heading up' display. The typical beam profile is indicated in Figure 6.

The shorter the pulse length, the higher the chance of resolving objects that are close together. As pulses are made shorter, however, less energy is radiated back and the system loses sensitivity. At the extremes of range, however, pulse lengths require to be longer to ensure sufficient energy is reflected back.

In the immediate vicinity of the transmitter, echoes from waves will tend to give the appearance of 'sea clutter'. This effect can be minimised by reducing the transmitter gain corresponding to the time associated with such 'sea clutter' echoes.

Rain can degrade radar performance by returning numerous reflections from raindrops. By taking effectively only the leading edge of signals for display purposes, such 'rain clutter' signals can typically be suppressed.

Specialised navigation buoys called racons retransmit the radar wavelength to draw attention to the buoy location. They appear as a point from which a fan like signal spreads out.

The conventional radar is always imagined as the rotating V antennae where microwave energy is focused in a narrow beam. In small marine radars, however, use can be made of small waveguide designs with accurately milled slots on one side. Increasingly, use is also being made of phased array technology where an array of small copper pads is selectively energised to 'sweep' a beam in space in real time. The waveguide and phased array techniques provides effectively a rotating beam but without any moving parts.

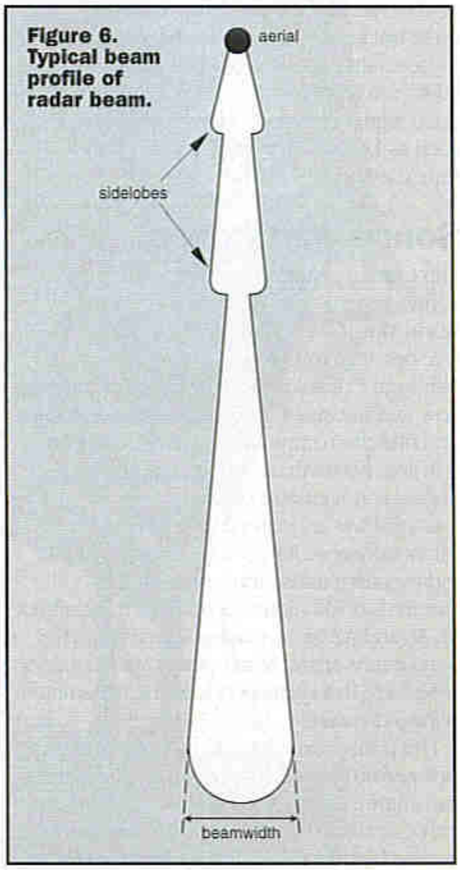
The horizontal and vertical beam width also affect the quality of the display obtained. A typical horizontal beam width is around 4° and that of the vertical around 25°. The greater vertical beam width ensures that as the boat rolls, the beam is not lost to the sky or directed down into the sea – there will normally always be a portion of the radar beam propagating horizontally. In terms of horizontal beam width, the narrower the beam, the better objects can be separated.

The range of radar tends to be limited by the curvature of the Earth. For a height above the sea Ha in metres and a target height Ht in metres, the range R in nautical miles is given by:

$$R = 2{\cdot}2\,(Ha^{0{\cdot}5} + Ht^{0{\cdot}5})$$

Thus, for a height above sea of 3m, a boat some 10m high will be able to be detected at around 11 nautical miles range. Thus, small boats have an inherent problem with

Figure 6. Typical beam profile of radar beam.



Location (kHz)	Harmonic (kHz)	Frequency width (m)	Harmonic	Frequency	Lane
Master	6f	85·00			
Purple	5f	70·83	30f	425	352
Red	8f	113·33	24f	340	440
Green	9f	127·5	18f	255	586

Table 1. Relationship of master transmitter to purple, red and green chains in English Channel (code 5B).

range. It would be pointless, therefore, to install a 100 nautical mile range radar on a small vessel.

In terms of radar technology, increasingly sophisticated systems are being produced for smaller boats. Using slotted waveguide technology, for example, the Navico R1000 provides peak pulse power of 1·5kW output from a continuous power consumption of less than 30W. Target capture is offered from 200m to 16 nautical miles. The radone enclosed aerial is less than 30cm in diameter.

GPS Technology

In the 24 satellite GPS system, each satellite broadcasts on two radio frequencies – L1 is set typically at 1·57452GHz and L2 at 1·2272GHz. These frequencies are selected as multiples of a base atomic clock frequency of 10·23MHz.

The L1 signal is in turn modulated with a high frequency P-code for precision ranging and a lower frequency coarse acquisition code – the CA-code. The L2 signal is modulated with a different P code. Subtle relativistic corrections have to be applied to the atomic clocks onboard the satellites to account for the different values of gravitational field present between orbital position and the notional surface of the earth and also for the different values of orbital velocity relative to the velocity at the Earth's surface.

The P codes basically contain more information than the CA-code and differential P code measurements can correct for propagation errors through the atmosphere.

A series of tracking stations with the headquarters at Colorado Springs in the USA compute the exact orbital path of each satellite. Is there any significance here that this was also the site chosen by Nicola Tesla for his famous set of experiments? Remember, also, it was one of Tesla's goals to use a transmitting site to communicate time to the entire world. Variations to correct in the satellite trajectories include minute orbital drag, gravity anomalies on the surface of the Earth and variations in gravity arising from the sun and the moon.

Measurements undertaken by typical GPS receivers utilise pseudo range calculations, where the receiver locks onto a pseudo random signal from a satellite and performs iterative calculations to determine the distance from the satellite. With each satellite radiating its 'absolute' positional information relative to the surface of the Earth, a GPS observer is able to fix an absolute location – latitude, longitude and altitude from four satellites. On the ocean surface – assumed to be on the zero of altitude – readings from three satellites are sufficient to determine position.

Utilising GPS Technology

The use of GPS technology has introduced wholly new concepts into marine navigation. There is, however, more than ever the requirement to interface GPS technology to other navigation equipment. This is achieved by means of the National Maritime Electronic Association (NMEA) interface language developed in the USA. Most low cost commercially available GPS systems exist as stand-alone units with no requirement for interfacing to other systems.

Not surprisingly in marine use, there is invariably added to GPS function various 'nautical' features. Thus, in addition to standard latitude, longitude, course over ground (COG), speed over ground (SOG), features present could include a position mark/man overboard function, anchor watch alarm, route planning and way point identification.

An array of systems now interface to maps of the world's waterways, with the software package identifying features such as channels, coastlines, listed navigation buoys, shallows, etc. By clicking on destination points on the display, automatic details of course setting to each point can be calculated. The set of Navionics Microchart codes are widely acknowledged as the best in their class. A useful feature also, is the Track History, where the logged position is tracked on the GPS display. In competitive sailing, the use of Speed over Ground (SOG) is ideal for optimising a boat's performance. This technology has, therefore, allowed boat performance – whether sail or power – to be monitored with a high level of accuracy and precision.

Systems also have a waypoint arrival alarm, which sounds when the boat comes within a certain preset range of a target waypoint. The anchor watch alarm function provides warning if the boat moves more than a set distance from a notionally stationery position. The use of GPS equipment in the marine environment requires additional levels of weatherproofing to be implemented.

Tiller Pilots

In large sailing vessels, the control of the tiller is typically augmented by a mechanical drive system. Tiller pilots are hand-held control units which allow rapid control of rudder function. Having typically port and starboard steerage changes of 1° or 10° steps, an 'auto tack' control will turn a sailing vessel directly when making a 90° course change. When tiller pilots are interfaced to other navigation aids, options such as steer to compass bearing, steer to wind setting and steer to GPS bearing can be implemented at the touch of a button. Thus, modern sea-going yacht races are very much undertaken using state-of-the-art high technology navigation tools.

Sonar Systems

The use of sonar systems in marine technology ranges over the need for a simple indication of depth of water beneath a boat to the detection of shoals of fish by trawler fleets. The velocity of sound in water is affected both by temperature and salinity. A velocity value of 1,500m/s is typically taken for water at 13° C and 35 part per thousand salinity. Variations of these values can cause errors of several percent to develop. There is also an effect of change of velocity with water depth, though in most typical applications, this error is not significant. Most low cost units (under £500) provide values of depth under the transducer with a resolution of 0·1m.

Sidney George Brown and the Gyro Compass

S. G. Brown was to patent over a thousand inventions in diverse fields, including those of submarine cables, signal repeater systems, the 'loud speaker', bone conduction systems for the deaf and radio direction finding systems. Born in Chicago in 1873 of English parents, the family returned to England in 1879. After distinguishing himself in many fields where his great practical and intuitive skills in science and technology become apparent, it was in the improvement of the gyroscope necessitated by the outbreak of war in 1914 for which he is principally remembered.

When S. G. Brown undertook the task of improving the gyro compass, the principle error of such systems was that any significant rolling motion of the ship caused the gyroscope to wander from its true indication. Brown solved this problem by detecting such motion and damping it before system accuracy could be degraded.

At one time, he was able to demonstrate a gyro compass which outperformed both the Sperry system from the USA and Anschultz design from Germany. Much to S. G. Brown's dismay, however, the Admiralty sold his patent to Sperry. Today, the company S. G. Brown still continues to make high quality gyroscopes and inertial guidance systems, principally for marine navigation. Photo 4 shows a model SGB 1000S – the 'offshore survey gyro standard' manufactured by S. G. Brown.

Basics of the Gyro Compass

Gyro compass technology is very complex. At the heart of a mechanical gyroscope is a wheel spinning at around 15,000rpm. This is associated with a vector of angular momentum which is considered to be invariant – unchanging if no forces act to degrade its value. If a gyroscope was set spinning with a fixed direction of angular

Photo 3. The model SGB 1000S – the 'offshore survey gyro standard' manufactured by S. G. Brown. (Courtesy, S. G. Brown).

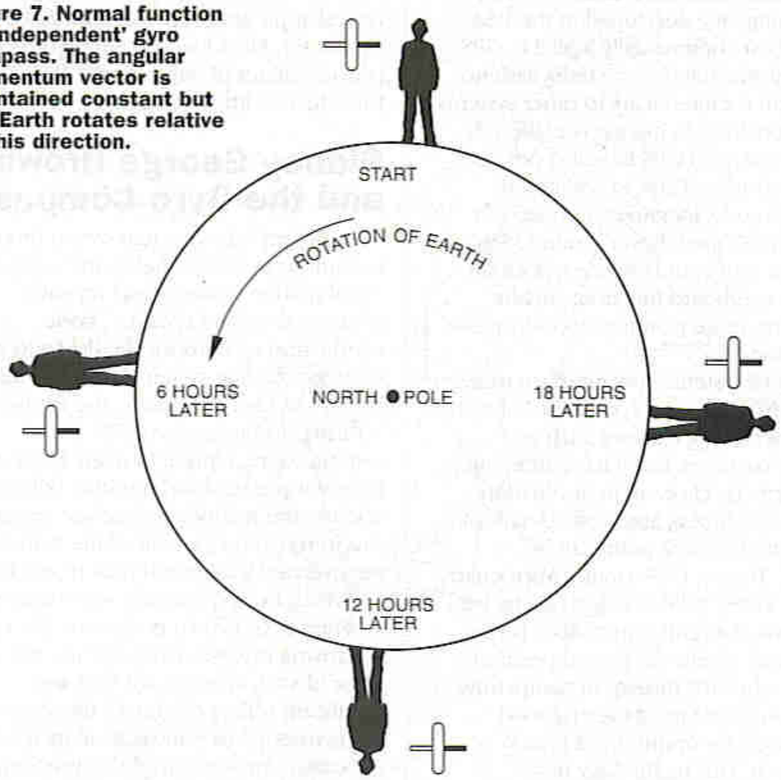


Figure 7. Normal function of 'independent' gyro compass. The angular momentum vector is maintained constant but the Earth rotates relative to this direction.

momentum then to an observer, the vector would appear to change – with the rotation of the Earth, as indicated in Figure 7.

If a weight is hung on a support bar under the spinning wheel, this acts to turn the gyroscope axis to a north south direction. This is the direction to which the gyro compass will remain aligned, as indicated in Figure 8.

In addition to determining heading, the gyro compass will also indicate pitch and roll. Conventional gyro compasses also have a finite settle time to take up a correct heading. This is typically around 10 minutes at dockside and 20 minutes at sea.

Ships sailing under IMO rules must have an operational gyroscope system before sailing.

Corrections required to be supplied to typical gimballed mechanical gyro compasses include latitude and craft speed for which NEMEA 0183 interface connection is typically used. Most conventional gyro compasses are designed to operate between 80° north latitude and 80° south latitude. Also, gimbal limits of ±45° of roll are typically specified.

Specialist 'gyropilot' systems interface using NMEA 0183 to gyro compasses for automatic control of rudder steering systems. Such systems give indication of heading and rudder angle and in particular, provide essential data for rudder control for the steering of large vessels. Photo 5 shows the NT 925G Universal Autopilot, manufactured by Navitron Systems Ltd., which control other ship systems based on signals from a master gyroscope.

Gyro compass technology, however, is rapidly developing. Recently developed systems use solid-state accelerometer type devices, either singly or in association with ring laser technology.

Summary

A wide range of navigational systems are used in marine navigation technology. The trend is towards integrating as many discrete systems together and utilising GPS as the prime system for determining position and derived qualities such as speed over ground (SOG) and course over ground (COG). The existing positional accuracy of GPS is entirely adequate for maritime navigation purposes. A study of this field, however, reveals the great ingenuity directed towards navigation, in particular, with diverse methods of surface-based radio location systems.

Further Information

Marine electronic navigation, S. F. Appleyard, Routledge & Kegan Paul, London, 1980.

From sails to satellites: the origin and development of navigational science, J. E. D. Williams, Oxford University Press, 1994.

Navigation: Time-Life Library of Boating, 1975.

A small boat guide to RADAR, Tim Bartlett, Fernhurst Books, 1991.

Navigation: An RYA Manual, David & Charles, 1991.

Yachtsman's GPS Handbook, Colin Jones, Waterline Books, 1995.

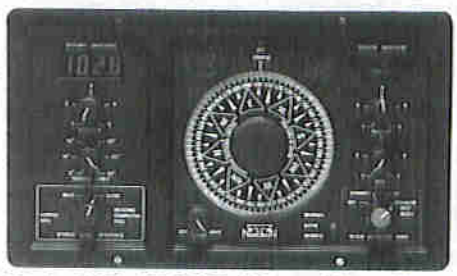


Photo 4. The NT 925G Universal Autopilot, manufactured by Navitron Systems Ltd. (Courtesy, Navitron Systems).

Points of Contact

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Max Mudie, Tall Ship Photographer, Bywater Lodge, Pierside, Lymington, Hants., SO41 5SB. Tel: (01590) 672047. Fax: (01590) 677085.

Navitron Systems Ltd., Osborne House, 25 E Brockhampton Lane, Havant, Hampshire, PO9 1JT.

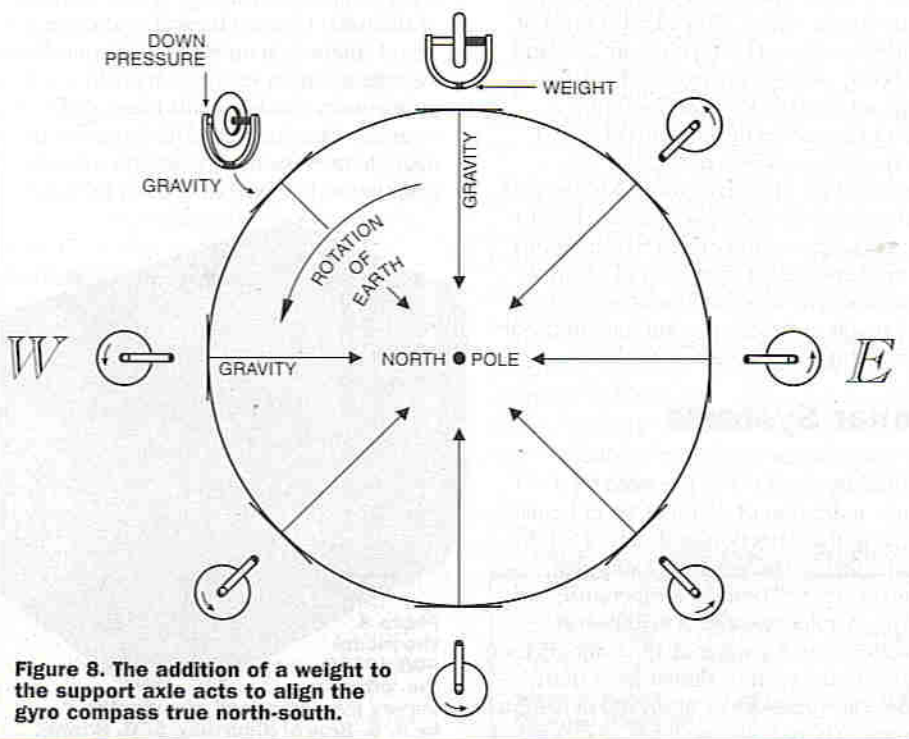


Figure 8. The addition of a weight to the support axle acts to align the gyro compass true north-south.

National Lottery PREDICTOR

Software written by Julyan Ilett
Design by Julyan Ilett, S. Litchfield BEng AMIEE and R. Nisbet

Since the introduction of the National Lottery back in November 1995, a small number of people have become very rich. The rest of us, however, must have realised by now what odds of '14 million-to-1 against' actually mean. So, can anything be done to improve ones chances of winning?

FEATURES

- Ideal beginners project
- Generates random numbers
- Simple to use - one switch operation
- Automatic switch off saves batteries
- Full source code available

APPLICATIONS

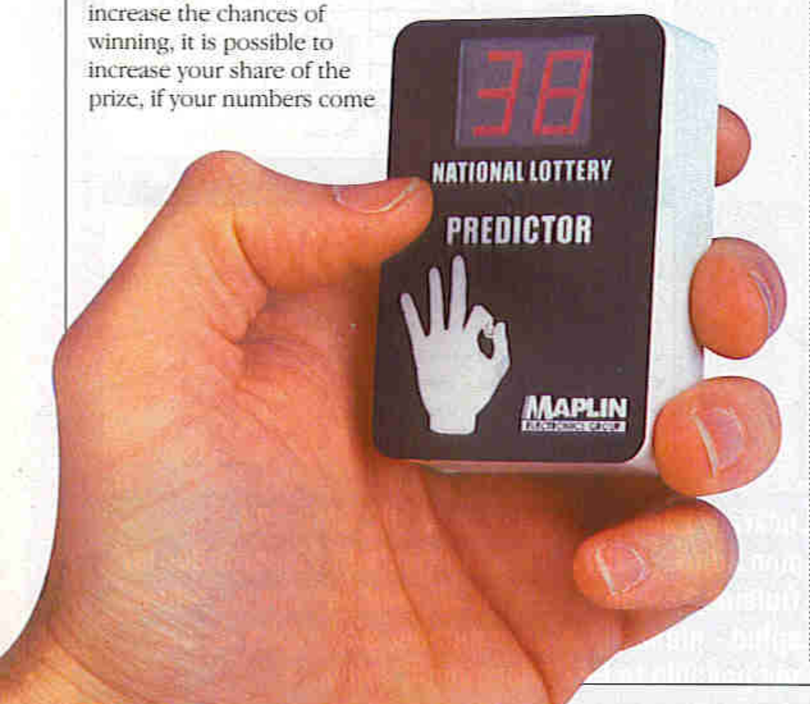
- Use to choose your lottery numbers!
- Excellent introduction to microcontrollers
- Produce random numbers for games

The idea of accurately modelling the machine used by the lottery organisers is simply out of the question. The behaviour of a single ball, bouncing around inside a Perspex sphere, would be practically impossible to predict. The paths of forty nine balls, all colliding with each other, can be considered utterly random. Would it be possible, then, to predict the next draw from analysis of previous draws? The mathematics of chance say not! The likelihood of any particular combination of numbers being drawn is precisely the same as all other combinations, and is not influenced in any way by previous events.

Although it isn't possible to increase the chances of winning, it is possible to increase your share of the prize, if your numbers come up. The idea is to avoid combinations that other people are likely to select.

Choosing numbers in any other way than completely at random, will inevitably be affected by various psychological factors. Winning combinations, for example, that consist of four or more numbers greater than 31, will completely eliminate anyone who used birth dates to make their selection!

A random number generator is therefore essential, and if nothing else, it gives the electronics enthusiast a good excuse to get started on an interesting new gadget! The unit presented here, generates numbers between 1 and 49 in a random sequence, and displays them on a two digit, 7-segment LED display. A single push-switch is used to turn the unit on, display all the numbers, and reset the device ready for a new number combination.



Circuit description

The complete circuit of the National Lottery Predictor is shown in Figure 1. IC1, a PIC16C54 microcontroller, is driven by a very simple clock circuit consisting of just one resistor and one capacitor, R3 and C2. The frequency of oscillation is about 800kHz using the values shown. The components R1, C1 and R2 generate the reset, and wake-up-from-sleep pulses.

There are two input/output (I/O) ports, one 8-bit and the other 4-bit. The 8-bit port, port B, is connected to the eight segments (seven plus decimal point) of both digits of the dual display, via resistors R6 to R13. Port A, the 4-bit port, is divided into one input bit and three output bits.

Outputs A1 (pin 18) and A0 (pin 17) are connected to the bases of PNP transistors, TR1 and TR2, via resistors R4 and R5 respectively. The display is a common anode type, which means that current must be sourced through the common anode connection, and sunk via each segment (cathode) connection.

The push-switch, S1, is read by the microcontroller by first taking output A2 (pin 1) low. Then, input A3 (pin 2) is read, after which A2 is taken high again. In this way, capacitor C1 is not discharged when the push-switch status is read at the same time as it is pressed, because output A2, does not go low for long enough.

When the microcontroller is in sleep mode, however, output A2 is left permanently low. Now, when the push-switch is pressed, C1 discharges through resistor R1 and the microcontroller is reset, which wakes it up.

Much of the circuit design, in particular the clock, reset and wake-up circuitry, is taken straight from the Microchip data book and applications book.

Software design

The program performs several distinct functions, each of which is described below and can be related to Figure 2.

SPECIFICATION

Voltage	3.0 to 5.0V DC
Current	36.5mA (max.) 25mA (ave.) @ 3.6V DC
Standby current	14µA (max.) 5µA (typ.) @ 3.6V DC
Battery life	More than 2 years with normal use (Duracell batteries)

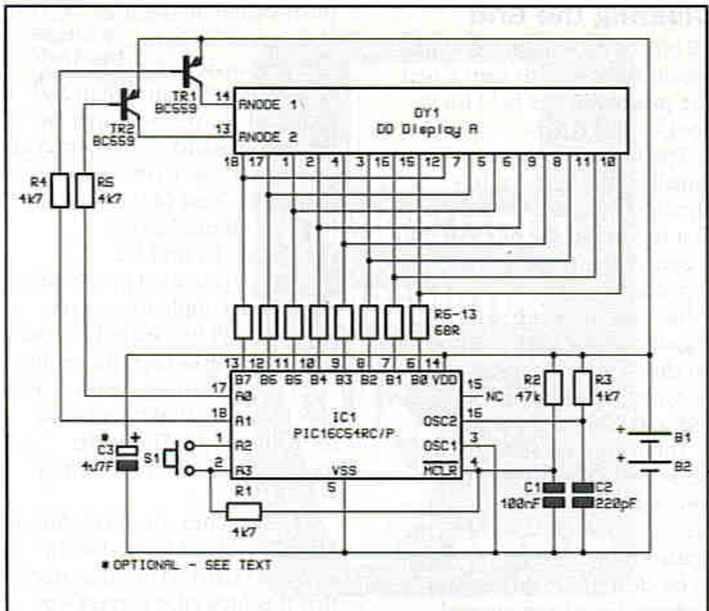


Figure 1. Circuit diagram of the National Lottery Predictor.

Display Multiplexing

Every time the software loop is executed, only one digit is displayed, both digits taking turns. The digit whose turn it is to be displayed, is identified by testing one bit in a register. The appropriate data is then taken from either of two digit registers, and the appropriate transistor turned on by lowering either bit 0 or bit 1 of port A. As long as the software loop keeps running at a fast enough rate, both display digits appear to light continuously.

Random Number Generation

The random number variable is incremented each time the loop is executed, unless it exceeds 49, whereupon it is set back to one. When the push-switch is pressed, the current value of this variable is used as the random number. A reduced version of the software flowchart appears in Figure 3 which clarifies the method of random number generation.

The random behaviour results from the delay between presses of the push-switch. The person operating the unit cannot see the value of the counter, so the random numbers cannot be influenced directly, although deliberate, rhythmic button pushing can result in sequences of similar numbers.

Binary-to-Decimal Conversion

When the random number has been generated, it is converted into two decimal digits by repeatedly subtracting 10 from the number until it underflows (goes negative).

Each time the subtraction is carried out, another register is incremented, indicating the number of times 10 has been subtracted. This number becomes the ten digit.When the number does underflow, ten is added back restoring the remainder, which becomes the data for the units digit.

Digit Character Generation

Character data for the 7-segment display is taken from a table, indexed by the decimal number to be displayed. The table contains ten items corresponding to the digits 0 to 9.

The table is read twice, once for the tens digit and again for the units digit. Leading zero suppression is achieved by replacing the tens digit with a blank character whenever it is zero.

Forty-nine bits of RAM hold the data indicating whether a number has already been used. When a number is displayed, the corresponding bit is set. If the unit attempts to use that

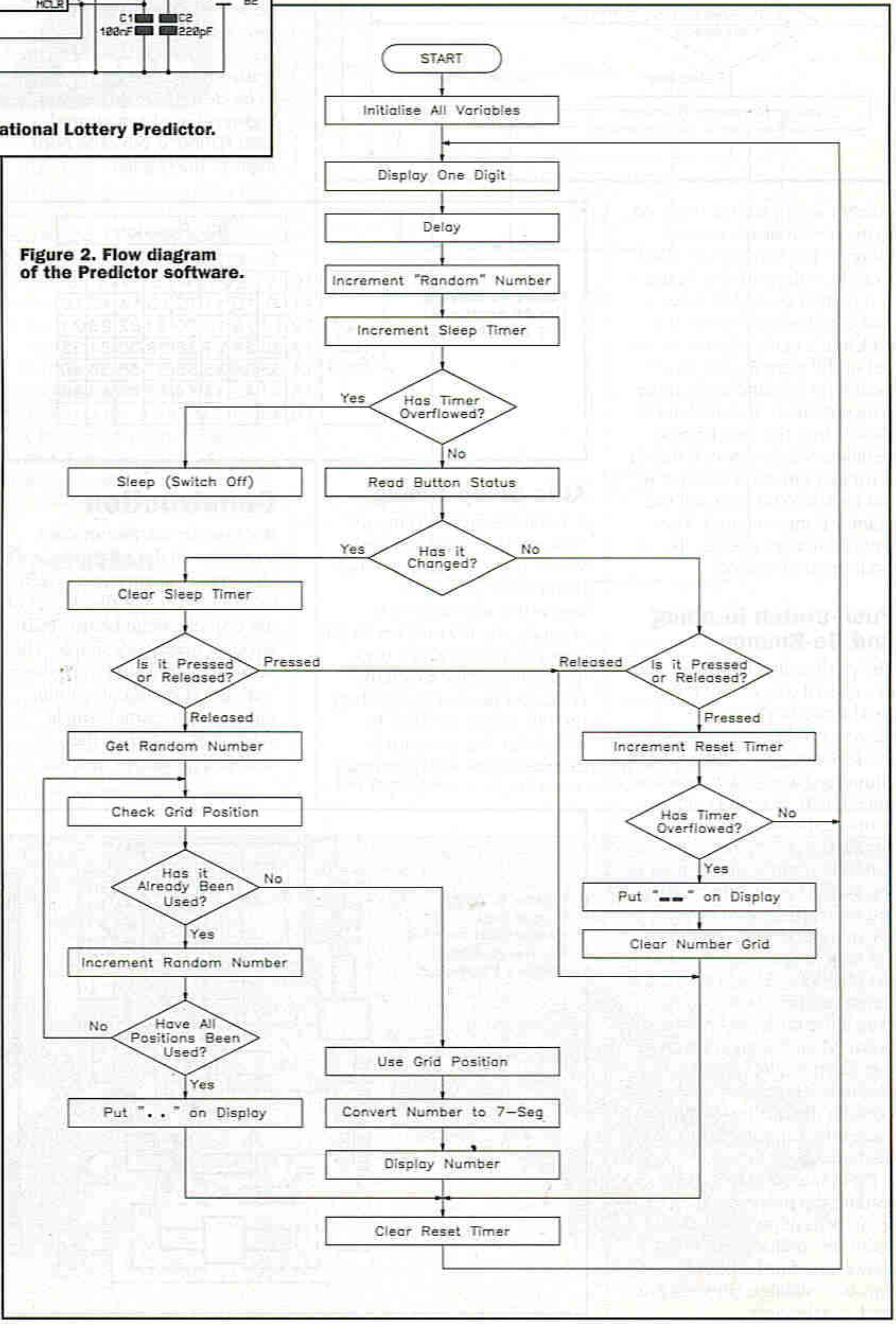


Figure 2. Flow diagram of the Predictor software.

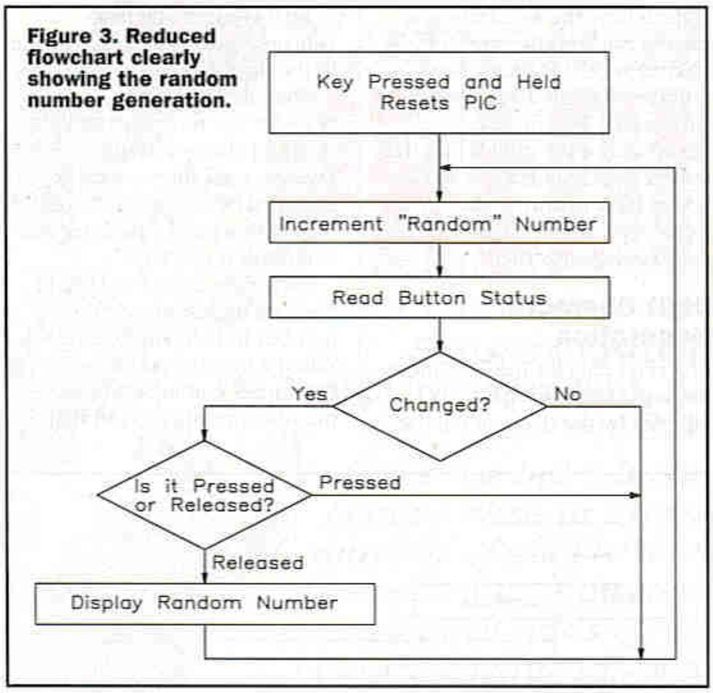


Figure 3. Reduced flowchart clearly showing the random number generation.

number again, it must move on to the next available unused number. Two variables are used to address the grid. See Figure 4.

A pointer is used to index one of the seven bytes in the grid, and a mask selects one bit out of the eight in each byte. Each time the random number is incremented, the mask bit is rotated into the next highest significant bit position. If the bit is rotated out of bit seven, it is put back into bit zero and the pointer is incremented. This pair of variables operate like an octal (base-8) counter.

Figure 4. Storing the 49 numbers in 7 data bytes.

Reg No. (Hex)	Bit Position 0	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7	8
11	9	10	11	12	13	14	15	16
12	17	18	19	20	21	22	23	24
13	25	26	27	28	29	30	31	32
14	33	34	35	36	37	38	39	40
15	41	42	43	44	45	46	47	48
16	49							

Push-switch Reading and De-Bounce

The push-switch has to be read in a special way so that it can also be used to bring the microcontroller out of sleep mode. One side of the switch is connected to an input which is pulled high. The other side is connected to an output, see Figure 1.

If the output is high, pressing the switch has no effect. When the push-switch is to be read, the output is briefly taken low, but only long enough for the read function. This prevents the microcontroller being reset, even if the push-switch is held down.When the microcontroller is in sleep mode, however, the output is left at a low level. Pressing the push-switch then causes the capacitor C1 to discharge.

De-bounce is achieved by reading the push-switch input at intervals of no less than about two milliseconds. This allows time for the bounce signals to stabilise between one read and the next.

Auto-Sleep Timing

A 16-bit counter increments continuously while the push-switch remains inactive. When the counter eventually overflows, after about 15 seconds, the I/O pins are all put into a condition which uses least power, after which the controller goes to sleep.When the PIC microcontroller is woken up, the program is executed from the beginning.

Clearing the Grid

All bits in the number grid must be cleared or set to zero when the push-switch is held for a couple of seconds.

The file select register (FSR) is initially set to register 16 (hexadecimal 10). This is the first register in the number grid. A general purpose counter (gp_counter) is then given the value 7, as there are seven registers in the grid that need to be cleared. The indexed grid register is then cleared indirectly using the FSR as a pointer.

The counter is then decremented and tested for a zero value. If the counter is not yet zero, the FSR is incremented ready for the next grid register to be cleared. When all seven registers have been cleared, a dash symbol is put onto both digits of the display.

Construction

Because the microcontroller integrates all the essential elements of a computer system into one tiny chip, the design of the printed circuit board (PCB) layout is made very simple. The PCB legend is found in Figure 5.

All the components mount directly on the small, single sided PCB, including the double-digit display and the push-switch. Remember, there is no on/off switch.

Construction of the PCB is very straightforward. Start by fitting all the resistors that lay flat to the board but save two of the cut-off legs to make the wire links. Next fit the two wire links and then the two capacitors, C1 and C2.

C3 (not provided in the kit) is used to decouple the supply rails and will be needed if a DC power supply is used for testing.

Fit the remaining resistors R6 to R13 noting that they are all the same value. These are mounted on end as shown in Figure 8.

The PIC chip should be fitted next. This is soldered directly into the board so double check that it is fitted the correct way round, see Figure 8 and component legend. Do not uses an IC socket as this will make the PIC too high to fit into the case.

CAUTION – Wait a few seconds between soldering each pin of the PIC. This will stop the chip being damaged by overheating.

Fit the display with the decimal points toward the PIC chip and then solder switch S1 in place.

Turn the PCB component side down and fit each of the battery clips to the solder side. The pads and the battery clips are quite large and so require a substantial amount of heat. They should be soldered with a high, 25 Watt plus, soldering iron.

Apply a small amount of solder to the tip of the iron and then press it firmly to the bottom of the battery clip where it contacts the board. Wait a few seconds and then try applying solder to the outside edge of the clip at the point

Figure 5. Track layout and component overlay for the National Lottery Predictor.

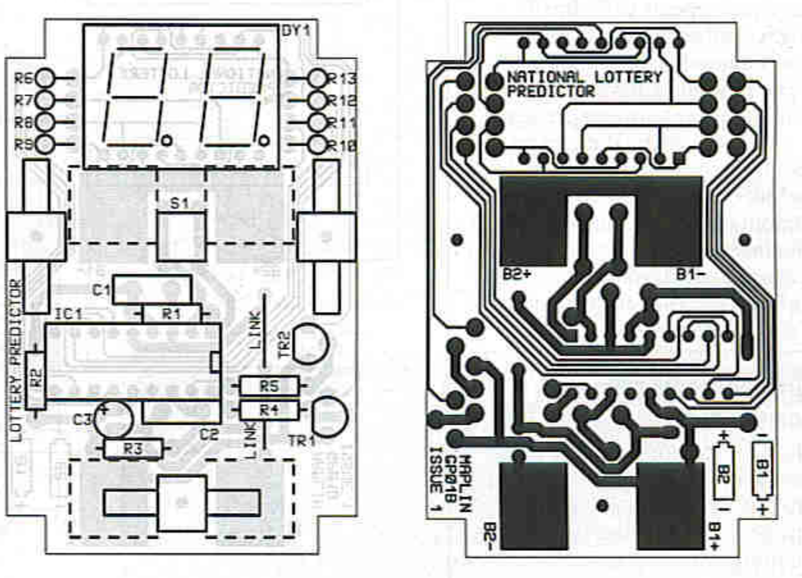
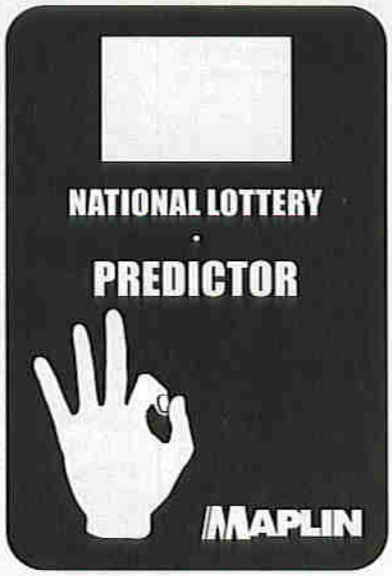


Figure 6. The front panel label.



where it meets the PCB pad. The solder should melt and be drawn under the clip giving a secure bond to the PCB. If the solder will not melt after 10 seconds then a larger soldering iron is required.

When all the clips are soldered in place and have cooled enough to touch, place a length of the heatshrink sleeving over the *positive*, +, terminals. Shrink the sleeving tightly over the terminals.

This is normally done with a hot-air gun but you can use a (very hot) hairdryer instead. If neither of these is available use a soldering iron held close but not touching the sleeving. As a final resort a match or gas-lighter flame held close will do the job but be careful not to burn the board or components.

Trim the stand-offs as shown in Figure 8 and fit these from the component side of the board. The PCB is now complete and ready for testing.

Carefully check all components are the correct type and value and fitted the right way round. Check all solder joints for poor workmanship as per the constructor guide. Look out for any solder bridging joints and tracks.

Finally fit the two AAA batteries, observing the polarity. The correct orientation is labelled on the solder side of the PCB and shown in Figure 8.

Fit C3 (not supplied) if testing is going to be carried out with a DC power supply.

Operation

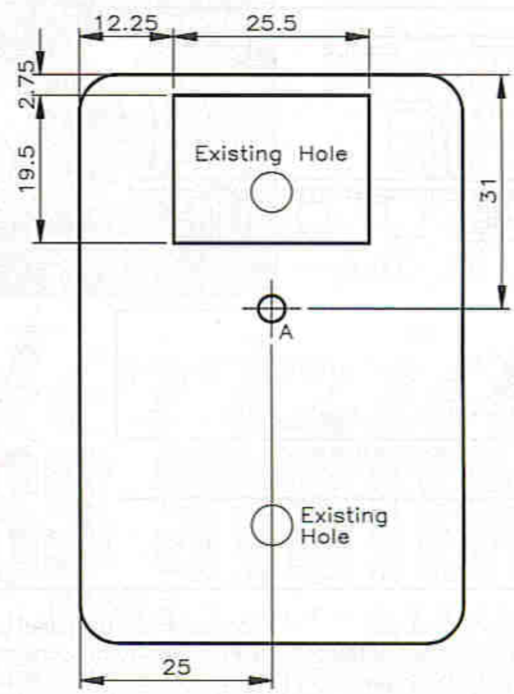
Inserting the batteries switches the National Lottery Predictor on. The display initially shows '- -', indicating that it is reset and ready to start a new number sequence. Pressing the switch again displays the first random number. Subsequent presses generate further numbers until all 49 numbers have been displayed. With no more numbers available the display shows '• •', although normally, only the first six numbers will be required.

At any time, the push-switch may be held down for a couple of seconds which will clear the grid ready for a new set of numbers. If the unit is left for more than about 15 seconds without the push-switch being pressed, the National Lottery Predictor goes into sleep mode, effectively switching itself off. All these functions are achieved using just one switch!

Pressing the push-switch while the National Lottery Predictor is in sleep mode will switch it back on. Operation is then the same as above from the point where the batteries were inserted.

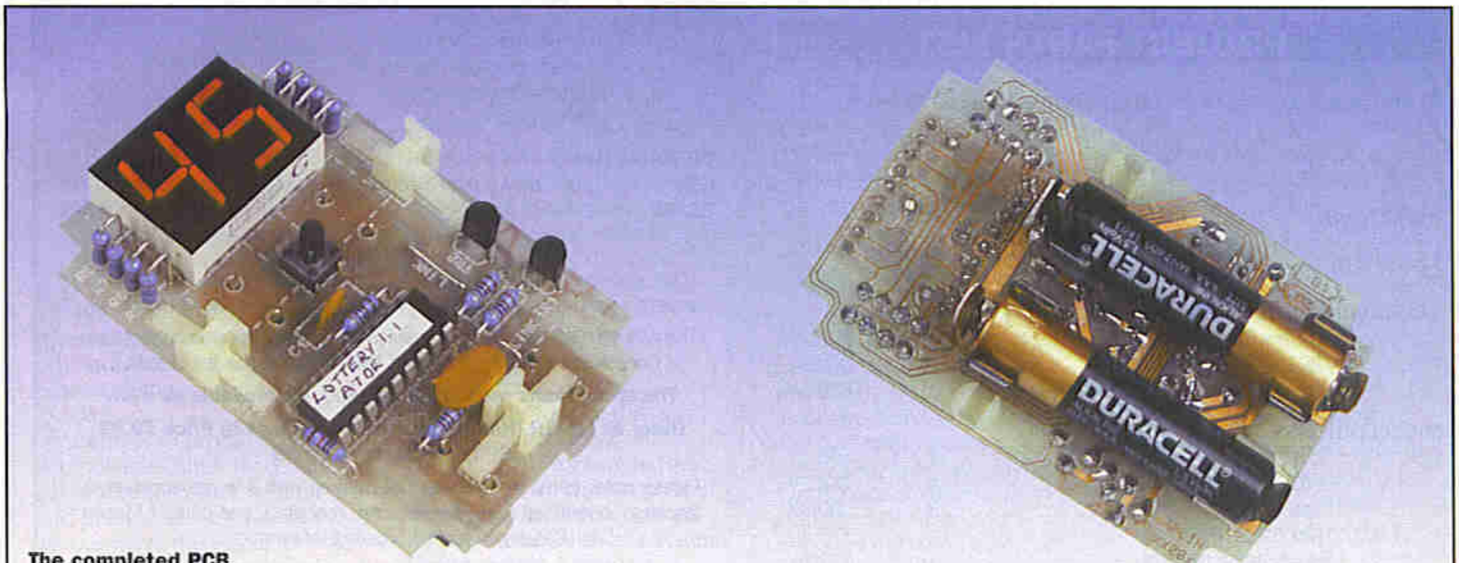
On the case

The case used to house the National Lottery Predictor requires 1 cut-out and 1 drill hole in the front panel (actually the base). The provided case holes are not used although one of them makes a good



Hole Data		
Ref	Size	No.
A	ø3.5	1

Figure 7. Case dimensions, drilling and cutting details. The front panel label is used as a template for the switch hole.



The completed PCB.

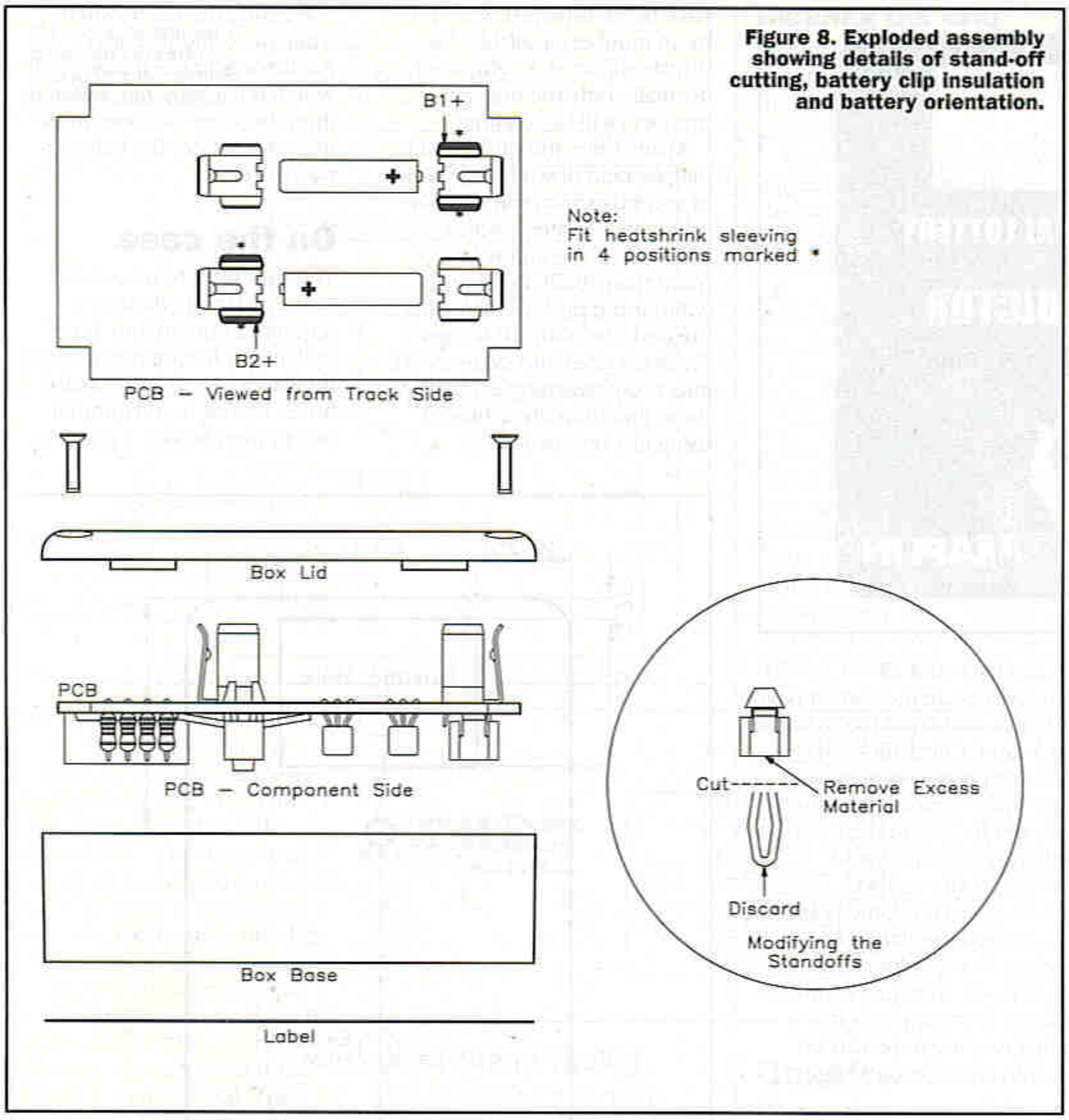


Figure 8. Exploded assembly showing details of stand-off cutting, battery clip insulation and battery orientation.

starting place for the display cut-out. The dimensions of the cut-out are detailed in Figure 7. The panel label covers the cut-out and fits quite snugly around the display. This should help hide any ragged edges or accidental scratches! Remove all burrs from the cut-out as these will lift the label and spoil the finish.

Before fitting the panel label, clean the mounting surface of the case thoroughly to remove any grease or oil. Again ensure that there are no raised surfaces from burrs, scratches etc.

Peel back 1 inch of the protective film from the top of the panel label. Carefully position each top corner without allowing too much of the label to make contact with the case. Once stuck, removal is difficult and may damage the label. If the worst happens then a replacement label, NV71N, can be purchased. Smooth the label down gently onto the case using even pressure and working from the middle to the edges. Gradually peel back more of the protective film, pressing down as you go. This process should prevent air bubbles and give good adhesion.

When all of the label is in place, drill the hole for the switch. The hole position is marked on the label and the drilling must be done from the label side. This prevents damage to the label as the drill comes through the case but doesn't prevent damage if the drill slips (be careful).

The PCB is mounted on three stand-offs which set it at the correct height. Before fixing, remove the top of these and file them flat as shown in Figure. 8. The assembled PCB, with stand-offs, should drop neatly into the case with the display fitting almost flush to the label window. The switch knob should protrude far enough through the case to allow unrestricted operation. If the switch is difficult to operate, or cannot be operated, then remove the PCB and file a little more off the top of the stand-offs.

Finally, fit the box cover and fasten with the four self-tapping screws. The National Lottery Predictor is now ready to help choose that winning combination!

Disclaimer

Winners of large sums of money, who choose their numbers with the Predictor, are advised that Maplin cannot be responsible for future misery. Nor can Maplin be held responsible for the unfortunates who never win!

Acknowledgement

Design originally published in Everyday Practical Electronics magazine.

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)			
R1,3,4,5	4k7	4	M4K7
R2	47k	1	M47K
R6-13	68Ω	8	M68R
CAPACITORS			
C1	100nF Ceramic	1	YR75S
C2	220pF Ceramic	1	WX60Q
SEMICONDUCTORS			
IC1	Lottery Predictor PIC	1	NV72P
TR1,2	BC559	2	QQ18U
DY1	Double, 7 segment LED Display	1	BY66W
MISCELLANEOUS			
S1	Click Switch	1	KR91Y
	PCB Battery Clip AAA/N	4	GU65V
	Stand-off	3	JK44X
	Box 321	1	FK73Q
	Heat Shrink CP 48★	1m	BF89W
	Lottery Predictor PCB	1	GP01B
	Lottery Predictor Label	1	NV71N
	Lottery Predictor Leaflet	1	XZ46A
	Constructors Guide	1	XH79L
OPTIONAL ITEMS (Not in Kit)			
C3	10uF 63V Radial Electrolytic	1	AT77J
B1, B2	Duracell AAA	2	JY50E

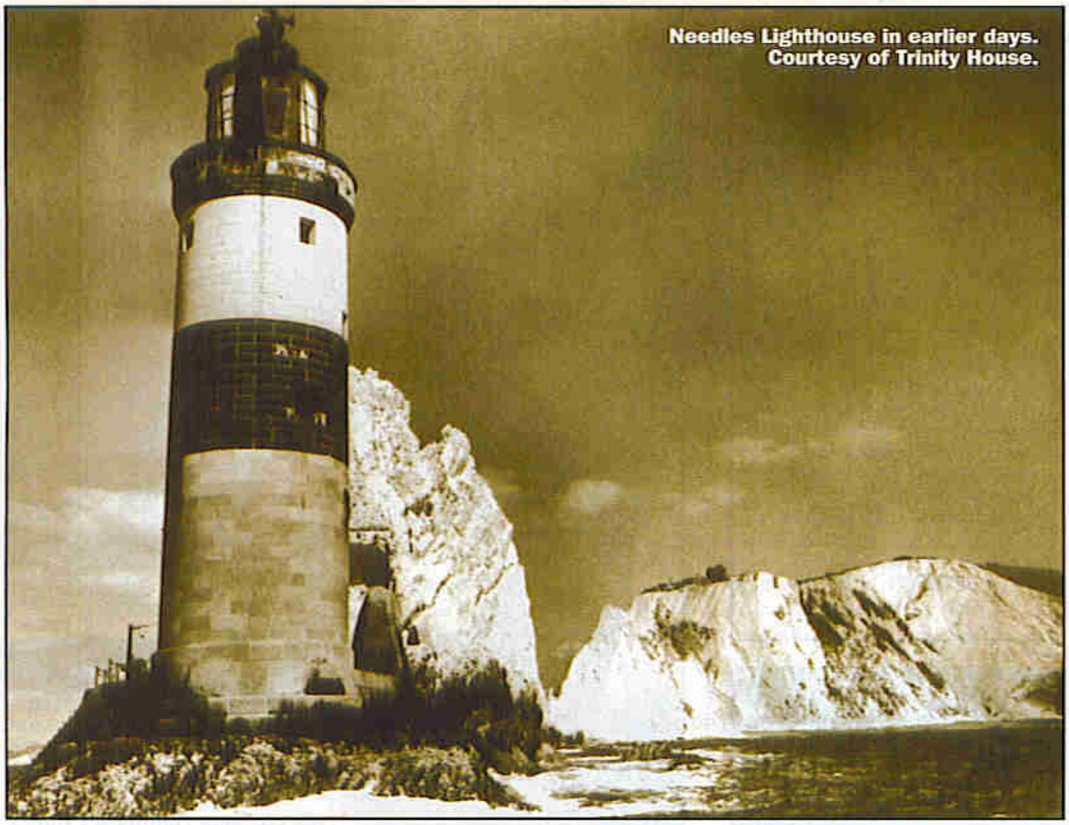
Fully commented source code for the National Lottery Predictor is available from the Maplin web site at **http://www.maplin.co.uk**

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.

Order as LU61R (National Lottery Predictor Kit) Price £9.99
GP01B PCB only - £2.99

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.



Needles Lighthouse in earlier days. Courtesy of Trinity House.

Pre-Hertzian WIRELESS SYSTEMS

PART 1

Water as the Natural Conductor Johnson's System & Willoughby-Smith's System

by George Pickworth

The term 'wireless' is derived from "electric telegraph without connecting wires" and this study is about two very successful, but virtually forgotten pre-Hertzian wireless systems based on the peculiar characteristics of current field lines in water.

As the water served as a natural conductor, they were, by definition, true wireless systems. In Part 1 of this study, we look at how the pioneers exploited the peculiar characteristics of current field lines to overcome the problem of isolating outgoing and return currents in a single expanse of water. It is supported by small scale reproductions of this early system. In Part 2, we look at the hitherto unrecognised role of polarisation in the operation of these early wireless systems and this is supported by practical experiments which can easily be reproduced on a micro scale with minimal equipment in a large plastic tub or even the domestic bath.

India

The earliest practical wireless system was developed in India to extend the telegraph system across rivers too wide to be spanned by land line wires. At that time, the India telegraph land lines employed galvanized iron wire supported by porcelain insulators attached to wooden poles. It was a 2-wire DC system and receivers were essentially galvanometers; operators read signals by observing the swing of the needle.

Attempts to produce submersible cables by coating galvanized iron wire with tar and pitch were only partially successful as the insulation was soon scoured off; armoured gutta-percha insulated cable was still only a concept. The solution was to abandon the submersible cable approach and terminate the land lines with electrodes inserted into the bank on either side of the river and employ the water itself as a natural conductor. The feasibility of such a system had been demonstrated in 1842 by Morse in North America but he did not develop his system; this was left to O'Shaughessy, Blisset and Johnson working in India.

However, for the purpose of this study, the India system is referred to as Johnson's system. Unfortunately, Johnson's system was limited to rivers a few hundred metres wide, but it enabled the telegraph system to extend to hitherto inaccessible areas and this had a profound effect on the history of the subcontinent.

Needles

The other system, developed by Willoughby-Smith just before the turn of the century, provided an electric telegraph link with the Needles lighthouse and later with Fastnet lighthouse. Paradoxically, reliable submarine cables were then available, but waves which pounded the rocky islands on which the lighthouses were sited, repeatedly washed away the cables where they were brought ashore.

Willoughby-Smith's system overcame the problem by terminating the submarine cable with an electrode on the sea bed, using the sea itself to provide a link with its complementary electrode securely anchored to the rock. The system was reliable, efficient and for a non-Hertzian system, it could not be improved upon.

Current Field Lines

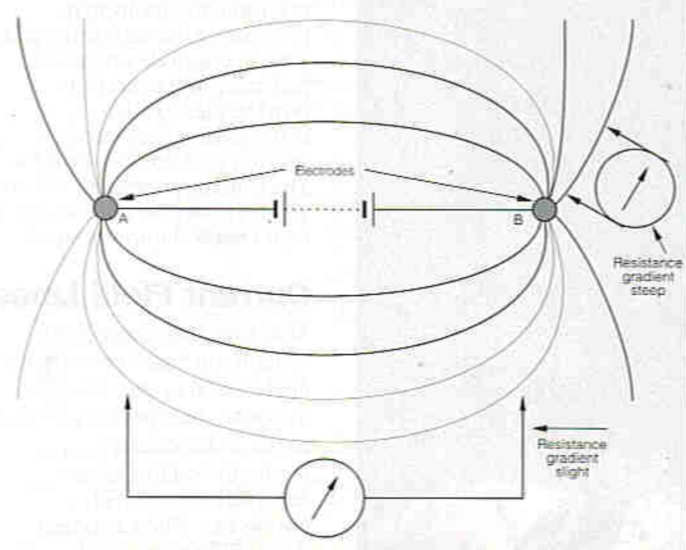
As already mentioned, both systems are based on current field lines; they are, of course, imaginary, but they do provide a means of describing a phenomenon that would otherwise be well nigh impossible. When a current flows between a pair of electrodes in earth or water, it does not take the short, direct path but spreads out in a pattern similar to magnetic field lines extending from the poles of a bar magnet – see Figures 1 & 2.

For clarity, current field lines are depicted in this study in plan view whereas in reality, they form a distorted hemisphere which extends into the earth below the river bed and laterally into the adjacent land. Theoretically, the field lines extend to infinity.

Resistance Wire Analogy

Let us now consider current field lines as lengths of resistance wire and that a potential difference (p.d.) occurs between two points along these wires. However, the

Figure 1. Current field lines, showing variation in resistance gradient.



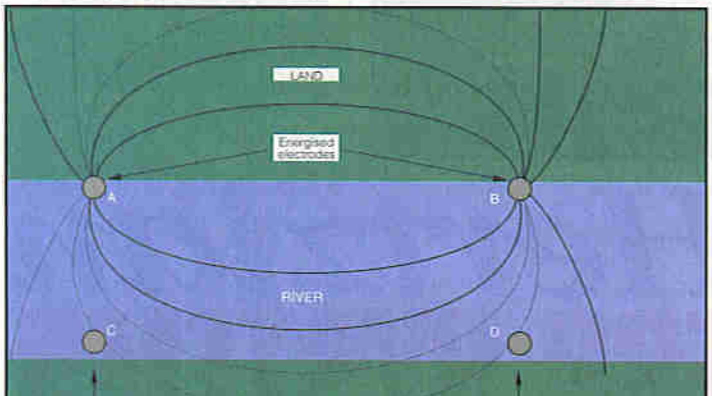


Figure 2. Morse's experiment, showing field lines extending across the river.

The Needles Lighthouse today. Courtesy of Trinity House.

resistance gradient is steepest where field line density is greatest, i.e., where the lines converge on an electrode. The gradient declines exponentially with distance from an electrode.

Indeed, with Johnson's system, the resistance gradient on the opposite side of the river declined to the point where in order to produce a useful p.d., the probes had to be widely spaced, as shown in Figure 3. Indeed, it was this dramatic reduction in the resistance gradient that limited the range of Johnson's system.

Field lines converge on both electrodes from 360°, so a p.d. occurs across a pair of probes aligned radially with either electrode. I have called the above phenomenon the '360° effect'. However, to demonstrate the effect, spacing of the probes must be only a fraction of the energized electrodes. This will be apparent from Figure 1.

Moreover, as the field line resistance gradient is very steep near an electrode, a significant p.d. occurs even when the probes are relatively closely spaced and this was fundamental to Willoughby-Smith's system – refer to Figure 4. It follows that if the current to the energized electrodes is keyed, a meter connected across a pair of distant probes will respond accordingly, thereby providing a basics of practical wireless system.

Complicated

So far, we have considered field lines as a single 'set' extending from a single pair of electrodes, whereas in reality, there are numerous individual 'sets'. Some are man made and some seem to occur naturally. All create electric and magnetic fields which presumably interact, so the actual field line pattern would seem to be very complicated.

However, my experiments have shown that where two or more sets of field lines are present, there is a degree of cancelling with field lines of opposite polarity and the potential developed the probes is set by the collective effect of all the field lines present.

Induction

Field lines in conjunction with electrodes and connecting wires form a single turn loop on an horizontal axis; it therefore responds to changing magnetic fields. By the same token, if the loop is energized with AC or

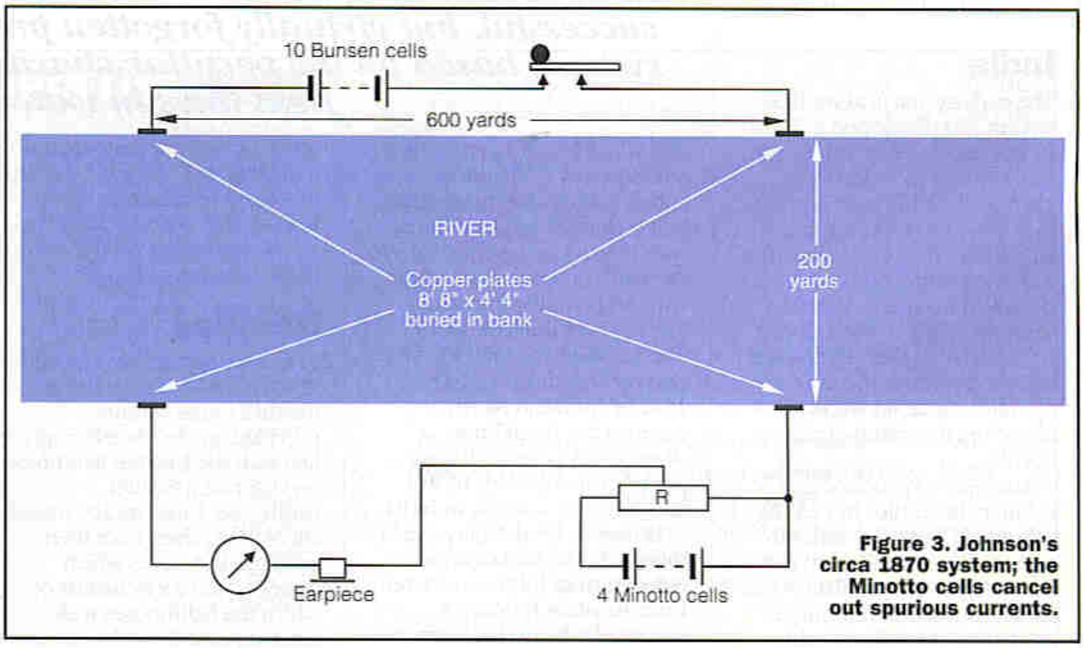


Figure 3. Johnson's circa 1870 system; the Minotto cells cancel out spurious currents.

pulsed DC, the resultant magnetic field can induce currents in a distant similar loop; this was the basis of World War I 'Earth current' signalling systems. Inductive coupling was manifest with Johnson's system as 'clicks' in a telephone earpiece when the key was pressed and released; indeed, one of Johnson's innovations was to complement the galvanometer with a telephone earpiece so that operators could read signals both visually and orally (see Figure 3).

Morse

Morse was drawn into experimenting with wireless systems by accident. In 1842, he was demonstrating to the American Institute of Science in New York the practicability of linking Governors Island with Castle Garden, a distance of 1·5km, with a submersible insulated with tar and bitumen. Although successful, the cable was unfortunately ripped up by a ship's anchor.

Morse realised that for a cross-river wireless telegraph system, range need only be the width of the river and this motivated him to look at the possibility of employing the water as a natural conductor. To ensure clarity and consistency in describing Morse's experiments and indeed all experiments, the energized electrodes will from now on be referred as electrodes AB and the probes as electrodes CD, unless of course, some other term is more appropriate – refer to Figures 2 & 3. Their roles obviously reverse during 2-way working.

During his experiments, Morse used identical 4 × 8ft. copper plates for electrodes AB and CD which were placed in a canal close to the bank, with each pair directly opposite each other. But as electrodes CD were located where the resistance gradient was slight (see Figure 1), the electrodes had to be widely spaced, otherwise the p.d. across CD was too low to operate the galvanometer. Morse found that the spacing of AB and CD should be at least three times the width of the river.

Johnson

Johnson's practical system was essentially the same as Morse's experimental system, except that Johnson buried the electrodes in the river bank, presumably to prevent them being washed away. Branches extended from the land line along the river banks to accommodate the wide spacing of the electrodes. Johnson experienced spurious currents which were cancelled out by applying a small opposing current. Similar currents were experienced during my experiments and were, no doubt, caused by natural field lines.

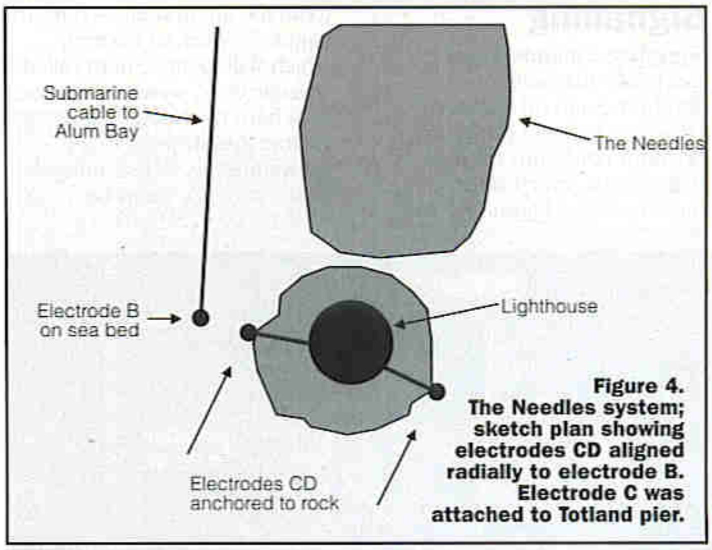


Figure 4. The Needles system; sketch plan showing electrodes CD aligned radially to electrode B. Electrode C was attached to Totland pier.

Willoughby-Smith

The pioneers were aware that field lines converged on an electrode from 360° (see Figure 1). This can easily be reproduced in the domestic bath. However, Willoughby-Smith seems to have been first to find a practical application for the phenomenon.

Willoughby-Smith's original objective was to develop a wireless telegraph system for wooden lightships which swung 360° around their anchors, but these were rapidly being replaced by steel ships. The steel would obviously 'short' electrodes attached to the hull, so Willoughby-Smith directed his attention to lighthouses on small rocky islands, particularly the Needles and Fastnet.

Sunk Light Vessel Courtesy of Trinity House.

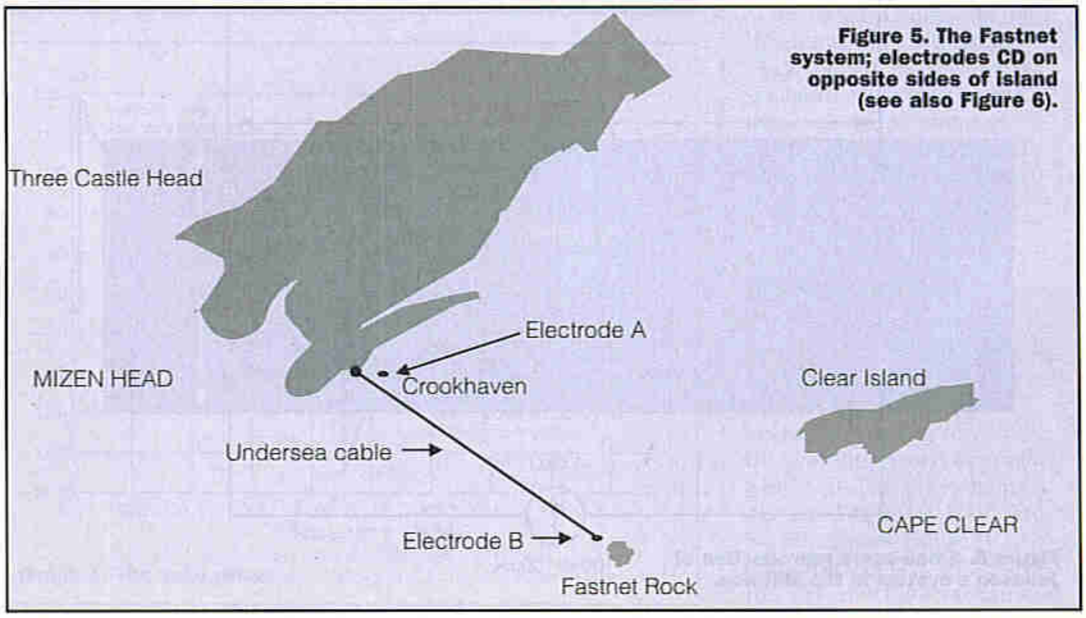
The Needles and Fastnet installations, as already mentioned, were based on field line density being high where they converged from 360° on electrode B (refer to Figure 1). The resistance gradient in the vicinity of electrode B was steep enough to produce a p.d. capable of operating the signalling equipment when spacing of electrodes CD was limited to the short distance across the islands. During early trials, a lightship was simulated by a rowing boat on a lake but in later trials, simulated the Needles lighthouse. The trials provided Willoughby-Smith with sufficient data to persuade the Telegraph Construction & Maintenance Company to invest a large amount of money in the Needles system.

Installations

With the Needles installation, electrode B was placed on the sea bed near Lighthouse Rock and connected to the shore station by a submarine cable which came ashore in Alum Bay. However, we have seen that the spacing of CD must be only a fraction of AB, so to attain the required spacing of AB, electrode A was attached below low water level to Totland pier. Electrodes CD were aligned radially to electrode B and securely anchored to opposite sides of Rock, as Figure 4 shows.

The Fastnet installation was basically the same as the Needles system, but electrodes CD were copper rods inserted into sloping holes drilled through the rock, extending into the sea below low tide level, where they were relatively safe from wave damage. The

Figure 5. The Fastnet system; electrodes CD on opposite sides of island (see also Figure 6).



wires leading to the lighthouse were buried in deep groves filled with concrete – see Figures 5 & 6. The Fastnet system was very difficult and expensive to install, and was therefore delayed until the Needles system had proved reliable.

Signalling

Signalling equipment was essentially the same on both lighthouse and on shore. However, to avoid having an operator constantly on duty, a relay device, which activated a buzzer, alerted lighthouse staff to an incoming signal – refer to Figure 7. Spurious current, which Willoughby-Smith called 'sea-currents', were experienced with both the Needles and Fastnet installations, so galvanometers were employed which could be easily be compensated for these currents.

Whilst it is not difficult to visualise 2-way signalling with Johnson's system where spacing of electrodes AB and CD was the same, it is more difficult with Willoughby-Smith's system, where the spacing of CD is much less than AB; nonetheless, as we will see, my experiments demonstrated that signalling was possible in either direction.

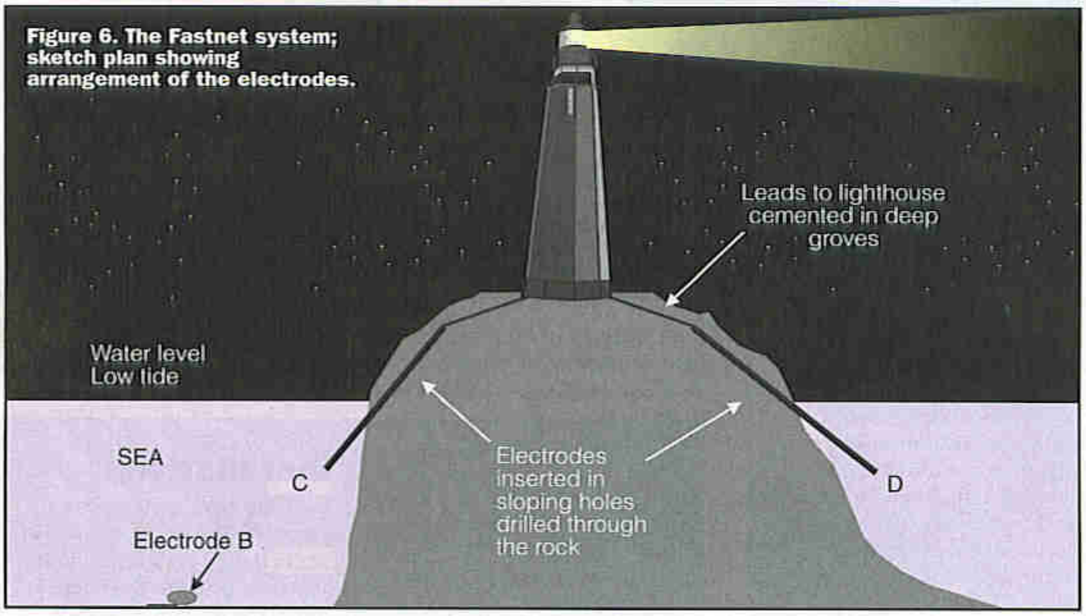


Figure 6. The Fastnet system; sketch plan showing arrangement of the electrodes.

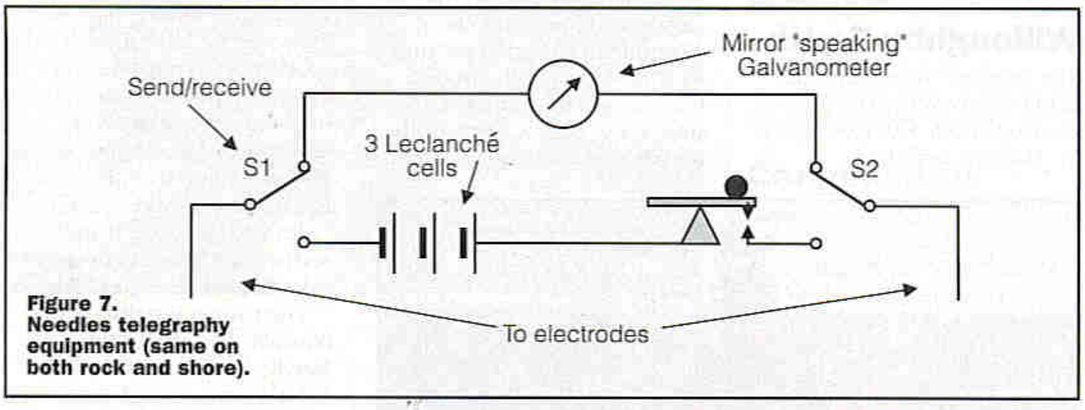


Figure 7. Needles telegraphy equipment (same on both rock and shore).

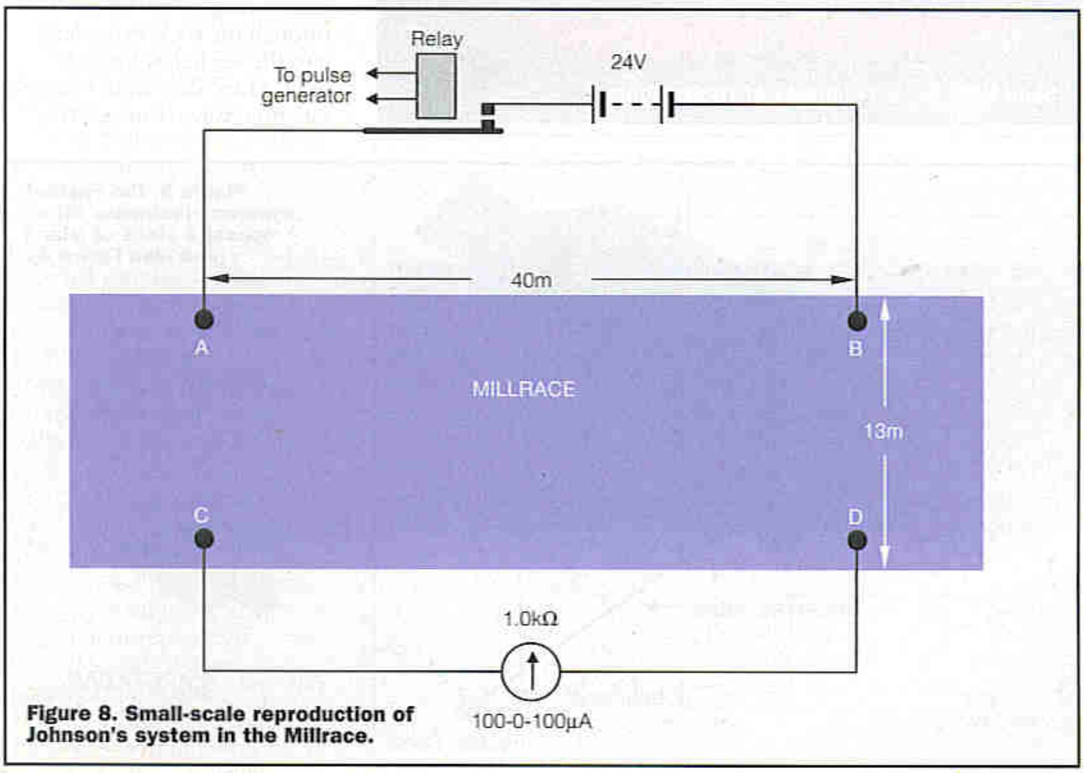


Figure 8. Small-scale reproduction of Johnson's system in the Millrace.

Reproduction of Willoughby Smiths Lake Experiment

I was fortunate in having the use of a GRP (fibreglass) dinghy and access to a large but fairly shallow lake on which to reproduce Willoughby Smith's lake experiment. Electrode A was placed in the water close to the bank whilst an insulated cable (automotive wire) extended to electrode B. The plastic bottle served as a marker and kept electrode B in the vertical position. A 6V lantern battery supplied the energizing current to AB but a Morse key was inserted in the circuit.

Electrodes CD were suspended from the bow and stern of the dinghy and electrode C was maintained at a constant 1·5m from electrode B as the dinghy was swung 360° around this electrode.

Surprise!

During set up, the meter registered virtually zero, but the moment my assistant pressed the key, the meter indicated a transient current of about 200μA, gradually declining to a steady 40μA, which was maintained for as long as the key was held down. I refer to this as the steady current.

More remarkably, when the key was released, there was a reverse transient current of about -200μA then the current slowly fell to almost zero. The above effect remained virtually the same as the dinghy was swung 360° around electrode B.

The steady current demonstrated the '360° effect' and indeed, was expected, but the forward and reverse pulses were quite unexpected and for the sake of a better name, I have called this the 'lake effect'. It opened up a new field of study.

Pulse Generator

During a second series of experiments on the lake, electrodes AB were energized with 6V on/off pulses produced by a relay type switch driven by a pulse generator; this enabled the on/off frequency to be varied between 0·1 and 3·0Hz. On the dinghy, the meter connected across electrodes CD was complemented with an analogue-to-digital convertor (ADC) and a laptop computer. The effect was displayed by the computer – refer to GRAPH 1, which with the annotations, is self-explanatory. Unfortunately, it was not possible to employ the ADC/computer to monitor pulses transmitted from the dinghy.

The wide spacing of electrodes AB caused this circuit to behave as a large loop antenna. Consequently, induced AC, mainly 50Hz, but also VLF, masked the DC pulses. On the other hand, with analogue meter, the inertia of its needle limited its AC response to a maximum of a few Hz. Indeed, with pulse rates up to about 1·0Hz, the analogue meter gave a good visual indication of peak forward and reverse potentials and their duration. The analogue meter was, therefore, adopted to observe the effect when pulses were transmitted from the dinghy – see Figure 9.

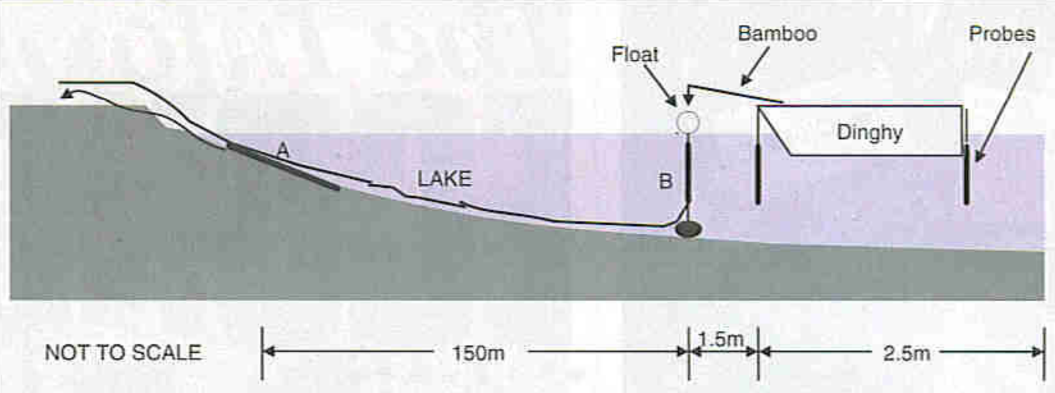


Figure 9. Reproduction of Willoughby-Smith's Lake experiment; electrode B held vertically by float.

Anomaly

During this second experiment, the magnitude of forward and reverse pulses was significantly less than with the previous experiment, but the 'lake effect' still occurred. However, steady current increased to almost 60μA. At that time, I attributed the anomaly to the wider spacing of CD, but later experiments suggest it was caused by electrode A laying on lake edge mud.

Small Scale Reproduction of Johnson's System

It was not easy to find a stretch of water free from anglers and boats that was suitable for a small scale reproduction of Johnson's system, and I am indebted to the proprietor of the Mill Marina, Thrapston, Northants, for allowing me to conduct experiments on the millrace. Moreover, there was a convenient bridge which greatly facilitated the experiments.

Because of the wide spacing of each pair of electrodes, induced AC precluded the use of the ADC/computer. So, measurements were made with a centre-zero microammeter with a resistance of approximately 1kΩ. Readings could, therefore, be taken as either mV or μA. I used a centre-zero meter to avoid damage if polarity was wrong, but also to note the effect of changing polarity of AB in relation to the natural field line. All four electrodes were aluminium tubes 20mm diameter and 750mm long, all the electrodes laying on river bed mud.

Spacing of AB and CD (40m) was approximately equal to three times the river width. Four 6V lantern batteries provided the 24V energizing current for AB; this was periodically interrupted by the same relay/pulse generator as used with the previous experiments. Prior to the experiment, with AB not energized, a spurious current indicated +15μA, but the moment the relay contacts closed, the meter across CD indicated a peak current of +80μA before falling back a steady +50μA.

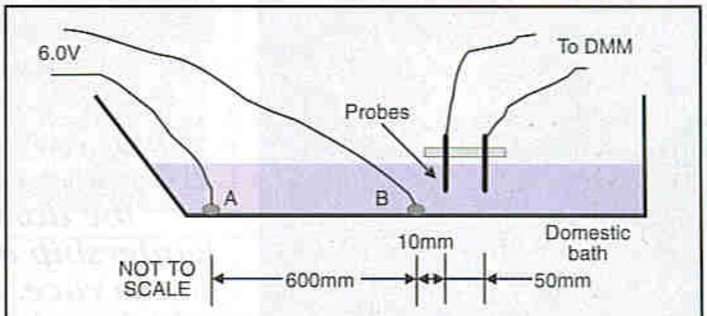
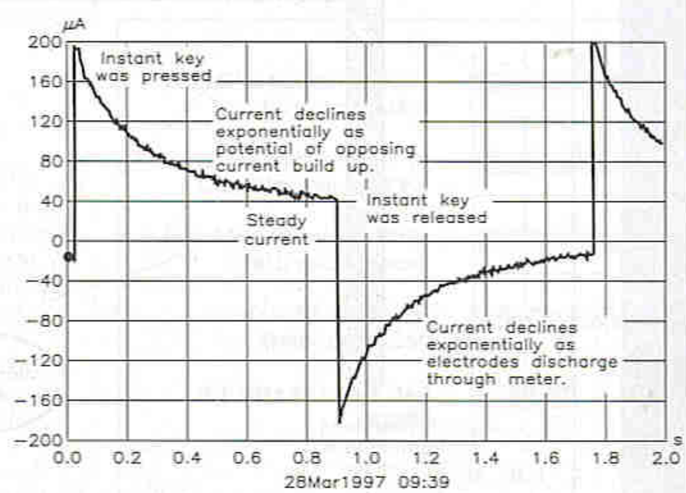


Figure 10. Simple demonstration of the 360° phenomena.

Equipment used with tub experiment, left to right - electrodes CD coax open with wire adaptor - computer.

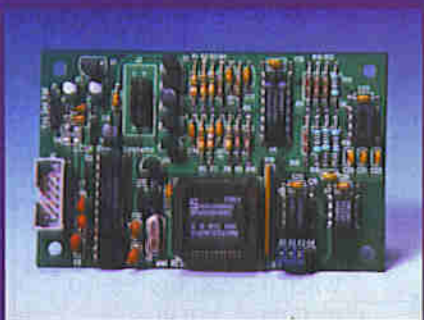


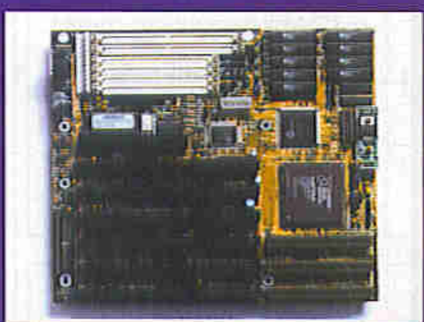
Graph 1. The 'lake effect'.

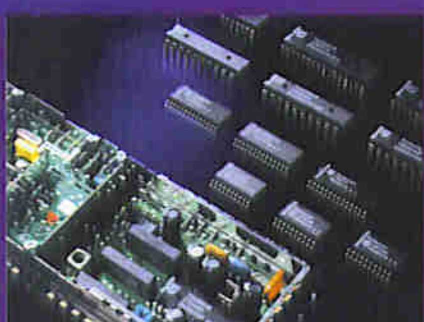
When the contacts opened, peak reverse current as indicated by the meter was -85μA, but as needle was offset +15μA by the spurious current, the reverse pulse was a virtual mirror image of the forward pulse. Similar results were obtained when the aluminium tube electrodes were replaced by copper tubes. During a further experiment, electrodes CD were suspended in the water from long bamboo canes; the effect now was that peak forward current dramatically increased to almost +200μA and once again, the reverse pulse was a virtual mirror image of the forward pulse. But, the steady current fell to about 35μA. Indeed, the effect was similar to when electrodes CD were suspended from the dinghy and clearly indicated that the 'lake effect' was not attenuated by the wider electrode spacing.

Polarisation

The logical explanation for the 'lake effect' was that electrodes CD emulated a capacitor or cell and this was caused by polarisation, but in some way, this was suppressed by contact with mud. This phenomena is discussed in Part 2. For home experimenters, Figure 10 demonstrates how to achieve the 360° effect in your bathtub!







The Information ECONOMY

PART 4

The Chips Business

by Stephen Waddington

Chips are the engine of every computer and item of consumer electronic equipment. In this space, Intel is the dominant supplier in terms of technology leadership and market share. But it is far from a one-horse race. Other companies lead the embedded and high-end microprocessor businesses. Here, Stephen Waddington examines the dynamics of the market, key players and major trends into the next decade

Microprocessor technology is evolving in two dimensions of integration and performance. Figure 1 demonstrates this in graphic form. In the vertical axis, individual component lines are becoming finer and finer, enabling manufacturers to cram increasing levels of functionality onto a single piece of silicon. In the horizontal axis, improvements in microprocessor architecture, for any given technology, bring greater levels of performance.

Intel remains the commercial trendsetter for the microprocessor business, at least in the desktop space. The company's incredible history began 26 years ago with the launch of the 4004 discrete microprocessor. Launched on November 15th, 1971, the 108kHz 4-bit device was manufactured using a 10μm process included 2,300 transistors and found applications in calculators and adding machines.

Progression

Let's benchmark the 4004 against the latest device to roll off the Intel production line. The 300MHz version of the Pentium II processor as shown in Photo 1, launched on May 7th this year is built using 7·5 million transistors in a 0·35μm process. It has 64-bit system bus and cache bus and an addressable memory, which give an addressable range of 64G-byte. The device is already being designed into high-end business desktops, workstations, and servers.

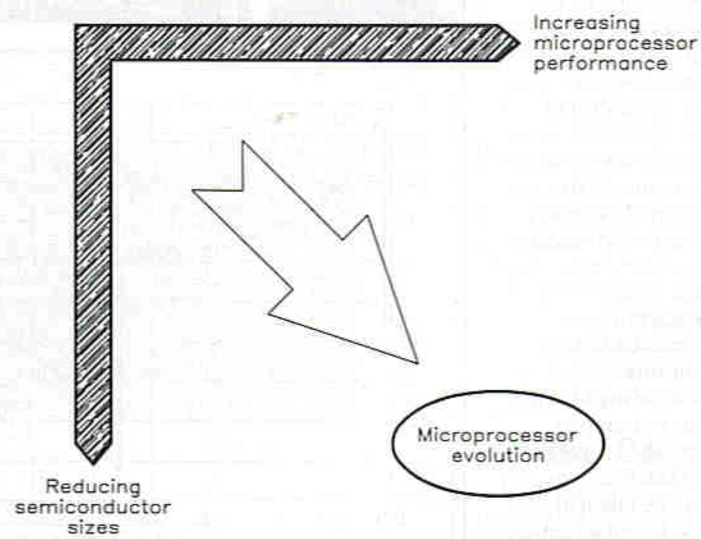


Figure 1. Microprocessor technology is evolving in two dimensions of integration in the vertical axis and performance in the horizontal axis.

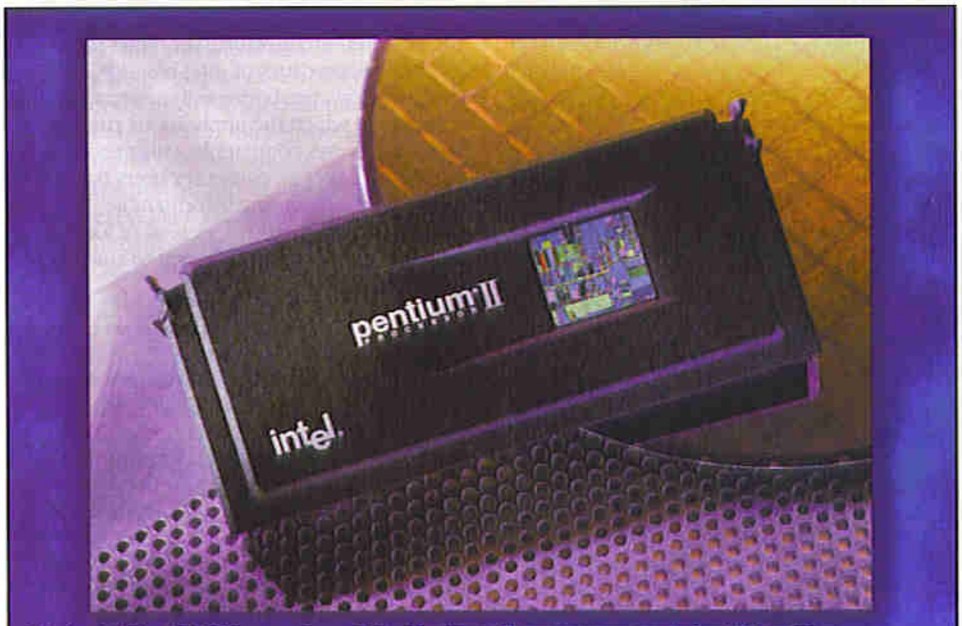


Photo 1. The 300MHz version of the Pentium II processor contains 7·5 million transistors and is manufactured using 0·35μm process.

So what happened between the 4004 launched in 1971 and the 300MHz Pentium II launched earlier this year? Figure 2 shows a historical roadmap of Intel's microprocessor devices against axes of time and processing power.

What is interesting here is that the pace of technological development has been logical and consistent. Each iteration of the basic Intel processor design has brought predictable speed improvements and reduced manufacturing size. By comparing the Intel 4004 with the Pentium II processor, we can immediately see how far the industry has moved during the last quarter of a century. Clock speeds have been cranked up 1,000-fold, while at the same time, there has been an almost 100-fold reduction in processing size, while bus sizes have increased by a cool 400%.

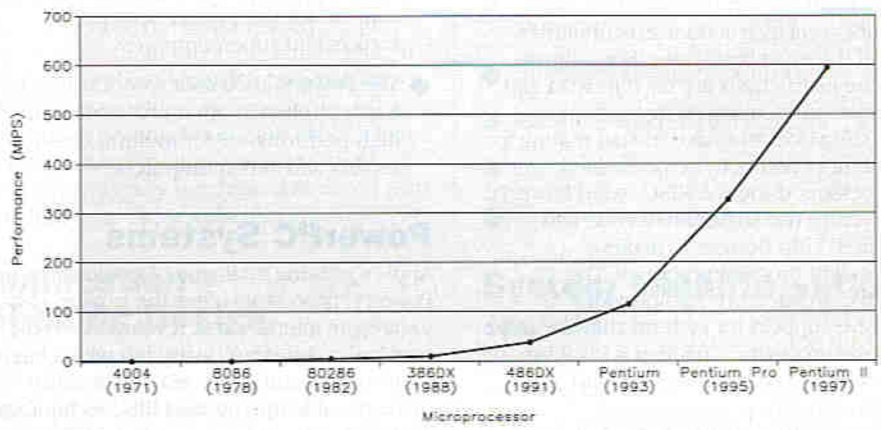


Figure 2. A historical roadmap of Intel's microprocessor devices from the 4004 launched in 1971 and the 300MHz Pentium II launched earlier this year, against an axes of time and processing power.

Continuous Development

But is this pace of development set to continue during the next 25 years? There certainly seems to be no slow-down in sight. Using the last decade as a guide, it is possible that within the next ten years, we'll see clock speeds break the 500MHz barrier and extend up towards 1GHz, similarly, bus widths are likely to double, and then double again to 256-bit. And as we will see later, it is likely that architectures will fall below 0·1μm, or new processing techniques will emerge to take manufacturing process way below this figure.

The P6 microprocessor is currently the flagship processor under development from Intel, which is expected to be manufactured using a 0·35μm CMOS process and run at 433MHz, combining dynamic execution and MMX multimedia technology. Prototype versions of the P6, developed for technology demonstration purposes, consist of 7·5 million transistors on a 203mm² silicon chip, utilising a 2·8V, 0·35μm CMOS manufacturing process.

But – difficult as it might be to believe – Intel does not have a total monopoly on the evolution of the microprocessor, despite the fact that it is the industry's dominant supplier. Semiconductor manufacturers Advanced Micro Devices (AMD), Cyrix and the PowerPC Forum, are battling with Intel for a piece of the action in the desktop and server space. While Intel may have market lead, it is constantly battling with these other microprocessor developers to create the latest hot chip.

PowerPC Alliance

In October 1991, Apple, IBM, and Motorola forged the PowerPC alliance with the common goal of developing a new design model for the microprocessors that drive personal computers. Here, the driving force was a desire to dislodge Intel from its dominant position as the leading supplier of microprocessors for the desktop market. The PowerPC Forum wanted to move away from the Intel design model favoured by AMD and Cyrix and create a completely new innovative design.

In technological terms, it is surprising that no one made an attempt to dislodge Intel earlier. Apple and Motorola shared a common design heritage for many years in the form of the 68000, the processor at the heart of the generations of the Apple Mackintosh. But even when Apple was at its peak in the mid-1980s, it secured only 15% of the desktop PC market. It is easy, therefore, to see why AMD and Cyrix designed to mimic the Intel instruction set, rather than create a new breed of microprocessor.

Intel has not always maintained a technological lead, but it has developed a very strong relationship with Microsoft, the dominant desktop operating system supplier, coupled with a very smart sales

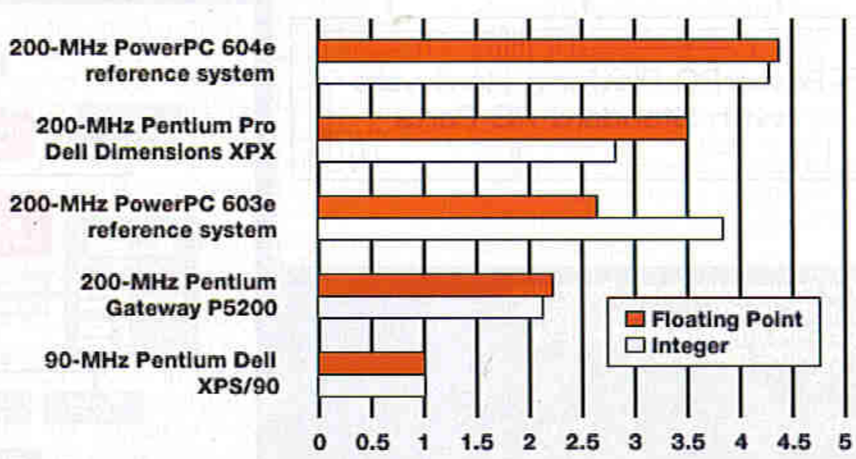


Figure 3. Performance comparisons between Intel and PowerPC-based desktop machines.

and marketing operation. Together, these two facets have meant the company has been able to maintain a dominant market position.

The PowerPC Forum made a brave move in its attempt to redesign the microprocessor for the desktop. Since the early nineties, Apple, IBM, and Motorola focused their combined expertise on a new microprocessor architecture, now in its fourth iteration. In a recent benchmark, US technology publication, Byte compared Intel's 200MHz Pentium and Pentium Pro processors against Motorola's 200MHz 603e and 604e PowerPC processors, respectively. The PowerPC processors outperformed their Intel counterparts in integer calculations by as much as 81% (Pentium versus 603e) and in floating point calculations by as much as 26% (Pentium Pro versus 604e), as shown in Figure 3.

Taking a RISC

The PowerPC architecture is based on a Reduced Instruction Set Computer (RISC) architecture. This type of microprocessor design breaks down the tasks that the machine-level instructions execute into a core of the most basic ones. For example, separate instructions are used to read and write data to memory, so instruction processing does not have to stall waiting for the memory access to be performed.

Processors using the RISC-based PowerPC architecture use streamlined code and optimised chip designs to achieve outstanding processing speeds. The PowerPC architecture also provides extensive support for systems that use more than one processor – making it ideal for servers, high-end workstations, and supercomputers.

The real differentiating factor between PowerPC microprocessors and Intel is the PowerPC Forum's open standards approach. PowerPC microprocessors are able to run operating systems including AIX, Mac OS, and Windows NT, compared with Intel's total reliance on the Windows operating system. The device's scalable architecture means that the processors used in hand-held computing devices can use the same instructions as those in large multiprocessor servers and workstations.

Already, Motorola's family of PowerPC semiconductor products covers the spectrum of computer implementations, and each member of the family spans a wide range of frequencies and features.

- The PowerPC 601 microprocessor.
- The first member of the family providing economical performance for powerful desktop PCs.
- The PowerPC 603 family. Low-wattage implementations well-suited for portable and battery-powered applications and powerful desktop systems.
- The PowerPC 604 family. High-speed, super-scalar engines that power the some of the world's fastest desktop systems. Provides multiprocessing support for the next generation of servers and supercomputers.
- The PowerPC 620 microprocessor. A full 64-bit implementation providing ultra-high performance for multiprocessing servers and supercomputers.

PowerPC Systems

Apple's growing catalogue of systems that use PowerPC processors offers the familiar, easy-to-navigate interface that revolutionised the personal computer industry, but with a leap in performance and expanded functionality made possible by advanced RISC technology. This performance advantage is gained without sacrificing compatibility with older 68000-based applications. The systems using PowerPC processors shipped by IBM, Motorola, and others provide the benefits of the PowerPC architecture, yet retain many legacy characteristics of Intel-based PC designs. However, because the operating systems on which the applications run are were not always compatible with the other hardware platform, computer users have had to choose from among incompatible hardware configurations, instead of focusing on what applications they need to solve their problems.

Standards

To solve these problems facing customers and developers, Apple, IBM, and Motorola examined various ways of combining the two hardware architectures into a common system architecture. In November 1994, the three companies announced an agreement to develop a common hardware architecture that supports operating systems ported to the family of PowerPC processors. With the introduction of systems based on the new architecture, software vendors can anticipate a large, compatible hardware base and are motivated to create or modify their code for PowerPC processors.

Apple, IBM, and Motorola co-developed a Common Hardware Reference Platform (CHRP) specification that defines the hardware and firmware interfaces that a compliant platform must make visible to software, as shown in Photo 2. The specification emphasises the programming model of a compliant system. As a design reference, it is specific enough to guarantee software compatibility among operating environments, yet broad enough to cover a range of systems, from portables through to servers.

PowerPC Hardware Reference Platform

The PowerPC Platform specification, as shown in Photo 3 – a blueprint for system vendors and independent hardware vendors

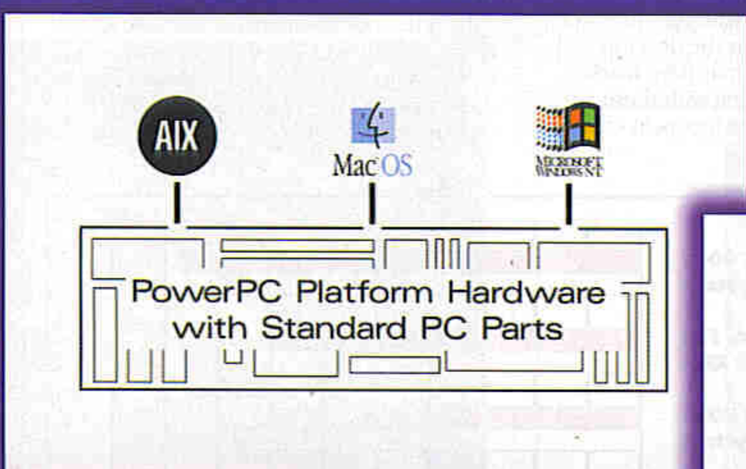
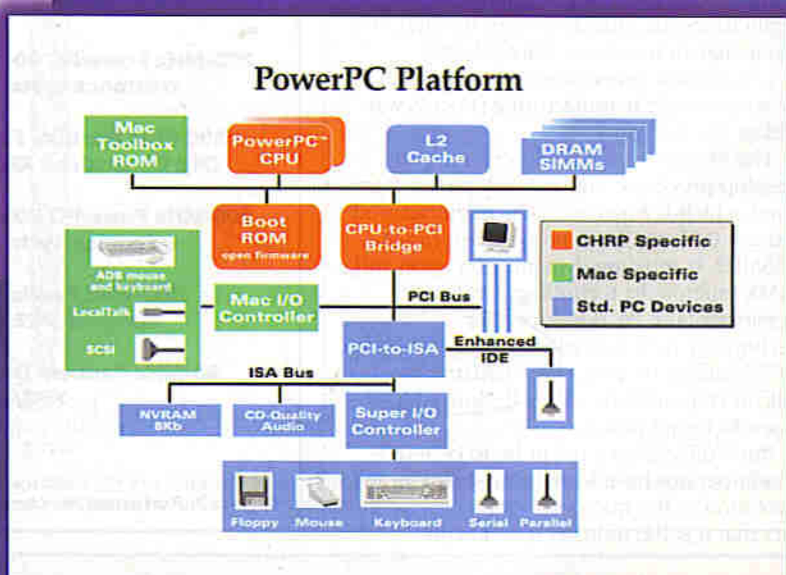


Photo 2. The Common Hardware Reference Platform (CHRP) specification that defines the hardware and firmware interfaces for compliant PowerPC machine.

Photo 3. The PowerPC platform.



– specifies the kinds of input/output interfaces, bus standards and other system-level functional elements needed to implement a single, unified architecture around the PowerPC microprocessor.

The PowerPC alliance companies of Apple, IBM and Motorola have published the PowerPC Platform specifications as part of their initiative to create a superior, industry-wide RISC-based alternative to the CISC-based X86 offerings. The PowerPC Platform provides a standard architecture for the next generation of personal computing – an architecture that is open, multi-operating system (OS) capable, scalable from portables to high-performance servers, and free from the limitations of Intel-based microprocessor architectures, which have had to incorporate RISC-like features to avoid reaching their performance peak.

High End Business

The desktop microprocessor business is pushing performance up to workstation and mainframe performance. Leaders in this pack that have Intel and the PowerPC developers in their sights include Hewlett-Packard, Silicon Graphics and Sun. In May this year, Silicon Graphics announced its MIPS microprocessor roadmap, unveiling three successive 64-bit family designs, the MIPS R12000 processor followed by the code-named H1 and H2 generations. The H1 and H2 designs are expected to achieve very high levels of computing performance by maximising memory bandwidth and eliminating processor-to-memory bottlenecks. With their expanded bandwidth capacities, the new designs will move and process larger and more complex types of data on and off the processor as fast as possible.

Until now, increasing CPU core clock speeds alone allowed processors to boost application performance. However, because clock speeds have increased at a faster rate than memory interface speeds, this technique results in relatively higher memory latency and proportionally, slower overall application performance. The MIPS R10000 processor, shown in Photo 4, improves memory latency tolerance by combining out-of-order execution with a split-transaction bus, as will the future MIPS R12000 design. These features allow the processor to dynamically reorder and execute instructions, thereby reducing stalls and decreasing the effects of memory latency.

Higher Speeds

In the future, delivering the highest application performance will also depend on memory bandwidth capacity and how this maximises data transfer efficiency on and off the processor. As CPU cores become faster and micro-architectures smaller, CPU cores must be supplied with instructions and data at faster rates, intensifying the need for greater bandwidth. At the same time, the fact that CPU clock speeds continue to outstrip memory interface speeds increases the need for bandwidth to

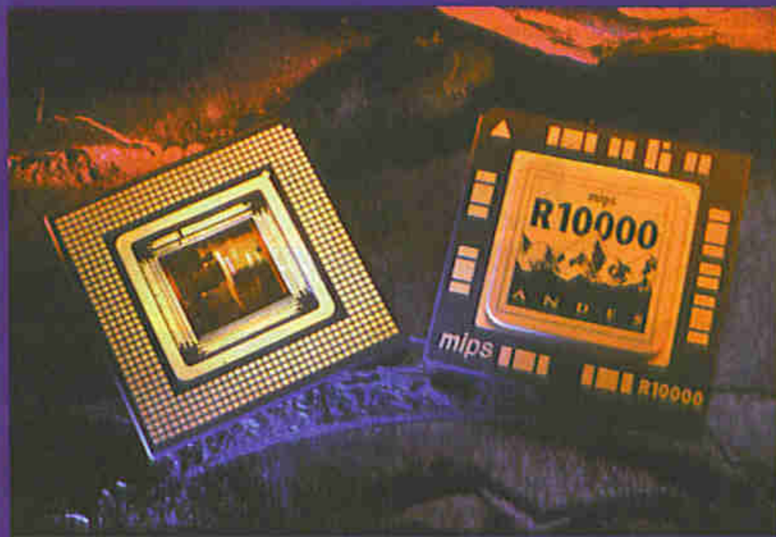


Photo 4. The High-end R10000 RISC microprocessor from Silicon Graphics.

offset the effects of latency. The growing size and complexity of software application codes also present challenges. For example, object-oriented or multithreaded applications strain cache capacity, adding to the bandwidth and input/output burden. The problem of available memory bandwidth becomes especially acute when scaling to large multiprocessor systems, given the memory overhead associated with building large cache coherent systems.

Application Specific Design

While Silicon Graphics, Intel, AMD, Cyrix and the PowerPC Forum focus on the development of killer microprocessors, the more traditional semiconductor manufacturers such as Texas Instruments, Cirrus Logic and VLSI Technology, are striving to pack increasing levels of discrete functionality into smaller and smaller packages. VLSI is currently top of the pile, with integrated circuitry lines of just 0·20μm in width. By reducing a chip geometry's, manufacturers are able to speed up device performance and reduce the cost of individual devices.

As we have already seen, system miniaturisation, a long-time trend in the electronics marketplace, is markedly evident in the computer industry, where form factors have been reduced by two times every five to seven years. Texas Instruments researchers are at work on differentiated miniaturisation technologies that will allow these shrinking form factors – defined by the sum of length, width and height of a device – to add considerable value to future systems.

Comprehensive miniaturisation requires a variety of technologies, among them scaled and low-power IC design and fabrication, as well as efficient and low-power hardware. Currently, in small form factor battery-powered systems, integrated circuits consume only a small part of total board space. The majority of board space is filled with other components. To address the issue of scaling down systems, researchers are developing novel technologies in:

- Integrated circuit packaging
- Passive components such as resistors and capacitors
- Substrates and interconnects
- Assembly input/output devices
- Energy sources
- Mass memory storage

System Miniaturisation Trends

Much of the progress in solid-state microelectronics has come from the continuous downscaling of transistors that comprise integrated circuits (ICs). At most, memory ICs now hold 256 million transistors and the most advanced-logic ICs have approximately a twentieth of this complexity.

For integration to continue from the mega-scale to the tera-scale, where each integrated circuit contains one million million components, device size must be reduced to a few nanometres (10^{-9}m or 0·001μm). However, at this scale, the quantum-mechanical wave nature of electrons becomes strongly evident, requiring entirely new device and circuit architectures. The scaling and speed advantages of these new 'quantum' devices portend 1,000-time increases in the functional performance of future-generation integrated circuits. Texas Instruments has demonstrated a multi-valued logic integrated circuit with ten times speed increase and five times component reduction, relative to conventional implementation.

Nanotechnology

Texas Instruments nanotechnology research and development is proceeding along three fronts: hybrid GaAs-based nanoelectronics for near-term applications, silicon-based nanoelectronics to take full advantage of the proliferation of silicon-based technology, and the creation of the superchip with gate

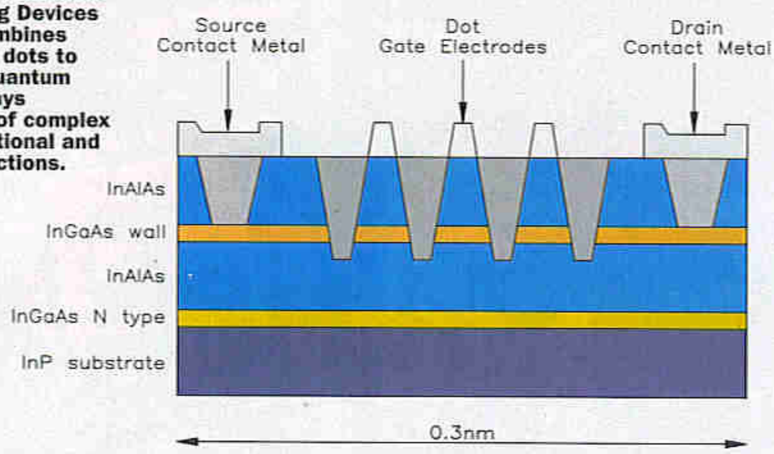


Figure 4. Resonant Tunnelling Devices (RTD) combines quantum dots to create quantum gate arrays capable of complex computational and logic functions.

densities of 1012 per chip for future electronics applications.

Texas Instruments believes such miniaturisation will be possible by tweaking manufacturing techniques and adopting novel semiconductor architectures. For example, by combining GaAs and InP-based Resonant Tunnelling Devices (RTDs) with conventional GaAs, as shown in Figure 4, researchers have demonstrated arithmetic functions with ten times speed improvement and five times density reductions. InP-based opto-electronic receivers with 40:1 component reduction and speeds exceeding 1G-bps will be demonstrated in the next year.

Work is also under way to develop silicon-based, room temperature RTDs on silicon substrates. Future integration of RTDs with MOS technology will allow introduction of memory ICs that will store multiple full-length motion pictures.

The Super Chip

The long-term outcome of quantum electronics is the super chip. It will consist of a three-dimensional network of trillions of switching elements. The basic building blocks are quantum dots, vertically and laterally interconnected as three-dimensional computational arrays exhibiting terahertz-switching speeds.

This completely reprogrammable device will be realised with each quantum dot's function, determined by charge-flow software. Since the chip volume will be dynamically reprogrammable, optimisation between algorithms and hardware will be simplified and transparent to the end user. The resulting chips will enable designers to create products such as a teraflops workstation or a computer inside a wristwatch.

Academic Research

Is research and development in this sector also occurring within the academic sector? University teams are striving to take a step further beyond manufacturers such as Texas Instruments. Researchers at Cornell University in the US have developed a new process for manufacturing semiconductors with even smaller sizes than any of the commercial manufacturers.

The key to the new process is the creation of a universal substrate, or base, on which many different types of semiconductors can be built. With a universal substrate, there are no compatibility issues between the film deposited and the supporting substrate. Cornell University scientists have achieved what they claim to be a 'Holy Grail' of materials science – pure, single crystal growth of any film on a semiconductor substrate, a technique that holds promise to revolutionise electronics.

The research team at Cornell has, for the first time, demonstrated a 'universal substrate' on which a crystal of any material can be grown. The technique opens the door for manufacturing new classes of devices in optoelectronics and microelectronics, for such items as new lasers, detectors, sensors, imaging systems, signal processing and computer chips, compact discs, data storage and dozens of other examples. The ability to grow single crystals of any material on silicon, for example, may breed an entire new generation of electronics.

Physics and Chemistry

Semiconductors are tiny crystals, such as silicon or germanium, that conduct electricity. Each single crystal is characterised by its lattice structure and lattice constant. When a crystal layer is grown on a bulk crystal substrate, even a mismatch of 1% in their lattice constants, as shown in Photo 5, causes problems. But the Cornell technique, for which Cornell has applied for a patent, shows that a mismatch of 15% can be overcome – a feat previously unachievable.

The Cornell team solved that problem by what might be called a simple twist of fate. By rotating a thin film slightly and bonding it to a substrate, the surface of this new substrate becomes flexible, or compliant, and a crystal of any material can grow on its surface. They call it a twist boundary, in which the crystal materials are bonded by angular misalignment, and they call the new substrate a new compliant substrate.

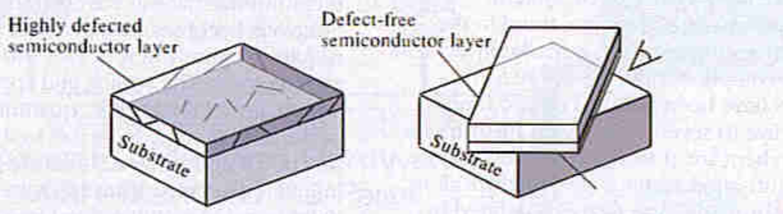


Figure Caption: Schematic shows how the Cornell technique (b) creates a defect-free semiconductor layer on a lattice-mismatched substrate whereas the conventional approach fails to do so. The key of the Cornell technique is to first form an ultra thin layer twist-bonded to the substrate before the layer growth. This technique could lead to new generation of semiconductors for micro- and optoelectronics.

Drawing by F.E. Ejeckam, M. L. Seaford, and Y.H. Lo at Cornell University and H. Q. Hou and B. E. Hammons at Sandia Labs. M. L. Seaford is also affiliated with the Wright Patterson Airforce Lab.

Photo 5. The universal substrate eliminates many of the obstacles to semiconductor manufacturing. It involves bonding a thin film at a misaligned angle on a bulk substrate, so that a pure, defect-free single crystal of any material can be grown on any substrate.

Photo 6. The thin film is twist-bonded to the Gallium Arsenide crystal in a technique developed by Cornell scientists. The boundaries are defect-free, making it suitable as a semiconductor.

The Cornell team demonstrated the technique with thick, pure crystal layers of indium gallium phosphide, gallium antimonide and indium antimonide, with mismatches as high as 15%. They successfully grew these crystals on a gallium arsenide wafer that had a flexible layer thin film, as shown in Photo 6. With traditional methods, it would not have been possible.

In microelectronics, the next generation Ultra Large-Scale Integrated (USLI) circuits can be made using this technique. If the technique is successful on a silicon substrate, then no other substrate material would be needed, the researchers say. Since this lattice engineering technique is a structural phenomenon, there is no reason why it should not work with silicon.

Memory

In terms of integrated circuits, the price and availability of memory is one of the key issues that could potentially limit the growth of the electronics business. A shortage of memory in the early nineties kept PC prices artificially high. An ongoing reduction in manufacturing costs and manufacturing sizes is like to see the price of memory maintain its steady price erosion into the next century.

The memory industry is at the best of times because end users just can't get enough of it to run their memory intensive software and operating systems like UNIX, OS/2, Windows NT and Windows 95. However, the flip side is that it must constantly develop memory products that support the latest Original Equipment Manufacturer (OEM) products. This often requires using new semiconductor technology that may be in limited supply such as synchronous DRAM.

DRAM: Smaller, Faster and Higher Density

Dynamic Random Access Memory (DRAM) semiconductor chips are the primary components used in memory systems. Most DRAM is made using Complimentary Metal Oxide Silicon (CMOS) semiconductor technology, ranging from 0·3- to 0·8μm in size.

The size of DRAM has been getting smaller and the density of the chips has been rapidly increasing. For example, only a few years ago, 1M-byte and 4M-byte DRAM were considered state-of-the-art. Today, 16M-byte technology is the standard, with 64M-byte DRAM on the horizon. In fact, some semiconductor companies have successfully built 256M-byte DRAM in their research labs, with 1G-byte DRAM being planned.

With these technology advances, we have also seen a reduction in voltage requirements. Just a few years ago, 4M-byte DRAM chips were primarily 5V devices. Presently, 16M-byte DRAM is being made in both 5V and 3·3V. In the near future, 64M-byte will only be 3·3V technology. Lower voltage requirements are particularly useful in portable computing applications, where they extend use between battery charges and prolong battery life. Also, as voltage requirements drop, speeds increase via reduced access times.

Emerging EDO

DRAM chips are designed with a great deal of features to satisfy many applications. The most common today is Fast Page Mode. However, Extended Data Output (EDO), also called Hyperpage Mode, is starting to replace Fast Page Mode because of its superior performances.

EDO memory will become common as more and more chip set vendors fully support it. The conversion is starting to happen this year. Some of the desktop OEMs have already implemented EDO, while the notebook OEMs are just beginning to introduce the EDO feature in their products. The workstation developers are currently designing in EDO.

SDRAM: Supercharged Memory

Synchronous DRAM or SDRAM improves computer system performance because not only is it fast, but it also utilises a clock that is synchronised with the processor. This allows the processor to know when operations are going to be completed and when data is going to be available. Therefore, the processor can perform other operations and does not have to wait for the memory to locate the address or to read or write the data.

Embedded Microchip Business

Finally, let us end our tour of the chip business with the embedded semiconductor market. Embedded microprocessors find applications in a vast array of products, from CD players to freezers and from radio alarm clocks to burglar alarms. Devices in this sector are typically buried deep within a product and are invisible to the consumer. For example, it is estimated that the average car rolling off a production line today, contains at least eight microprocessors to manage many of the functions of the engine, braking system and fuel injection control.

Traditionally the preserve of 8-bit microprocessors, this area embraces fabless chip companies such as Advanced RISC Machines that have created discrete device designs which they license to companies looking to develop a bespoke single-chip solution for consumer applications. Advanced RISC Machines (ARM) designs, licenses and markets the leading microprocessors and peripherals where computing, communications and consumer electronics converge.

Products in these markets require the optimal balance of performance, cost, size, weight and battery consumption. Companies developing these systems want the broad range of application expertise, extensive development support and reliable supply.

Partner Business Model

ARM's partnering business model enabled the ARM architecture to be adopted globally far faster than possible for a traditional semiconductor company. ARM licenses its technology to semiconductor partner companies, who focus on manufacturing, applications and marketing. ARM partners with firms that will grow the total ARM market by integrating their own intellectual property around ARM processor cores.

Processor Performance

ARM processors feature the best performance/cost and performance/power consumption ratios in the industry – so good, that they are enabling whole new classes of portable and consumer computing devices. Even better, ARM delivers these ratios across a very wide performance range. The ARM7TDMI core delivers from 1 to 40MIPS of performance in a very small 4·2mm², while the recently introduced StrongARM110 pumps through an impressive 230MIPS flat out and a breakthrough 185MIPS at 450mW.

Closing Trends

We started this feature by examining the key drivers in the semiconductor business and we will finish in the same vein. Increasing processing power allied to a steady reduction in chip sizes are the two major trends. Together, these are creating a third trend of the single-chip product. Here, all the functions and thus, components of a piece of electronic equipment, are integrated onto a single chip. We have already seen companies such as Intel add multimedia capability to its microprocessor core for use in desktop PCs. Beyond this, Intel designers talk of adding video, networking and modem technologies alongside on the same device, and embedded microprocessor companies such as ARM are working with other semiconductor company's to build single chip products based around the ARM core.

But, if we want a ultimate sign of the way this industry is developing, we should look to the recent merger between discrete chip supplier National Semiconductor with microprocessor manufacturer, Cyrix. The main aim of the merger is to enable the new company to develop system-on-a-chip technology for entry-level PC, Net-PC and information-appliance markets. National's strength has traditionally been in analogue chips. Add to this Cyrix's microprocessor technology and the manufacturing experience of both companies and it's clear that Cyrix/National is positioning itself strongly as a contender to develop the next breed of microprocessor technology.

Further Reading

Company:	Web Site:
AMD	www.amd.com
Apple	www.apple.com
ARM	www.arm.com
Cornell University	www.cornell.edu
Cyrix	www.cyrix.com
IBM	www.ibm.com
Intel	www.intel.com
Motorola	www.motorola.com
National Semiconductor	www.national.com
Silicon Graphics	www.sig.com
Texas Instruments	www.ti.com

Melody GENERATORS

Design by Steve Litchfield BEng (Hons) AMIEE and R Nisbet

Do you remember those awful Christmas and Birthday cards that used to drop through the post ten years ago. The ones that played 'Jingle Bells' or 'Happy Birthday To You' using only one note! You must remember – some companies still play them on their telephones when they put you on hold. Well, like all technological innovations, time moves on and the products improve. Those simple tune (what tune) generators have certainly improved and are now capable of playing pretty good renditions of most popular melodies.

The Maplin range used here have a wealth of features. They are low-cost (very low cost in fact), simple to use, difficult to destroy and come in a handy little package. All this and they sound pretty good too. In fact some sound so good that they are now called 'Melody Generators'.

The range selected by Maplin for their Catalogue include popular songs, classical hits and well-known nursery rhymes. This kit allows the user to select one of 15 different tunes and connect it easily to a variety of batteries, power supplies or other equipment. A speaker is included so that the result can be heard immediately.

The supplied Melody IC IC1 can be replaced with a different Melody IC without changing any other components except, possibly, the speaker connections. *See current Maplin catalogue for the full range of Melody ICs available.* If a socket is used to hold the Melody IC then the user can change the tune as frequently as they wish.

A pleasant, but noticeable, alarm sound has been added to complete the range. This is called a Warning Tone but it is actually a pulsed chirrup. This particular device needs only the speaker and a battery to operate!

FEATURES

- Ideal beginners project
- Safe, low voltage operation
- Low current giving long battery life
- Directly drives speakers (included) or piezo sounders
- Large range of melodies supported (15 available)

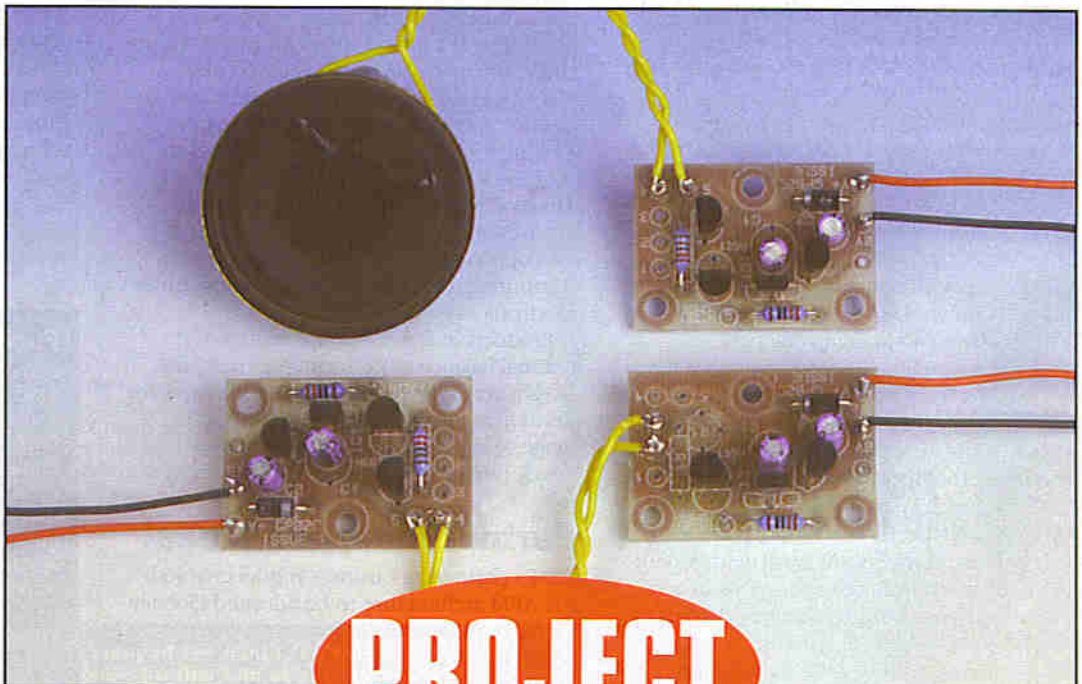
APPLICATIONS

- Children's toys
- Teaching nursery rhymes
- Turn ordinary cards and gifts into novel presents

Circuit description

The complete circuit diagram of the Melody Generators is given in Figure 1. Most of the components shown are optional parts. Power is normally applied to the terminal marked B+ but the maximum input voltages given in Table 1 must not be exceeded.

To allow for supply voltages that exceed the maximum for the Melody IC IC1 a voltage regulator RG1 is used. The incoming supply line is decoupled by C2 and reverse polarity protection provided by



PROJECT

SPECIFICATION

Supply voltage (without regulator)	1.2V to 3.6V DC (M66T series) 2.4V to 5.0V DC (HT381series) 1.3V to 3.3V DC (UM66 series)
Supply voltage (with regulator)	3.2V to 12V DC (M66T and UM66 series) 3.2V to 12V DC (HT381series)
Supply current	50mA max, 25mA typical
Standby current	<< 100μA (without regulator) < 130μA (with regulator)
Speaker impedance	64Ω
Speaker power	100mW (200mW max.)

Note: Speaker connection to be twisted pair 100mm max. Power connections to be 100mm max.

voltages higher than 3V DC as TR1 collector-base junction will forward bias and IC1 could be destroyed.

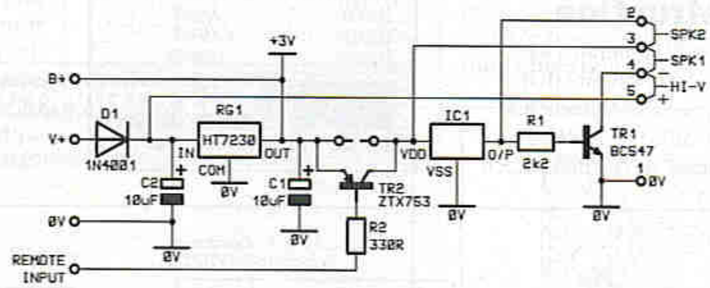
A simple power amplifier is added to the circuit to allow the Melody ICs to drive a small (up to 200mW) speaker. R1 limits the current sunk by the base of TR1, IC1 providing the necessary bias.

Because of the slight differences between the various Melody ICs it is necessary to provide two options for output connections. These same options allow the direct connection of piezo transducers but the results are rather poor. An alternative connection is added that allows IC1 to drive a piezo transducer at a higher voltage.

This connection can also be used to drive the speaker at a high volume. The full connection details are given in Figures 3 and 4, and Table 1.

The M66T series device generates harmonics at 35MHz that must be removed to comply with EC directives. C3 is provided in the kit to filter this noise and must be fitted if a M66T series device is used. See Figure 3.

Figure 1. The complete circuit diagram for the Melody Generators.



Glimpse inside a Melody IC

The Melody IC, is a very complex device, a fact that is completely cloaked by the simple package. For example, the UM66T series contains an in-built oscillator, 190 note / 14 scale tone generator, 64 note ROM and can manage 15 different beats and 15 different

D1. These parts are optional and are not supplied in the kit.

No reverse polarity protection is provided on the B+ terminal because this can prevent the circuit operating when the batteries are running low. C1 decouples the supply to IC1.

The PCB connections for TR2 allow several circuit switch options (See Figure 2):

1. The tracks are made to form a link that allows continuous operation (except the UM66 series which goes into standby after playing once) or an external switch in the power line. This solder link can be replaced by the 'good old wire link' if desired.
2. An external switch wired across the tracks. This interrupts the power to IC1 but leaves C1 in circuit. This is not a great problem because C1 will only slowly discharge the battery. A good AA battery should last around the same time as it would when stood unused on a shelf! C1 can be replaced by a Tantalum type if leakage is a problem.
3. An internal switch such as the Maplin Tactile Switch KR91. This can be connected on either side of the board and alternatives are available with different shaft lengths.
4. An electronic switch formed by fitting R2 and TR2. TR2 is a PNP transistor that conducts when its base is pulled below the supply voltage. The base current is limited by R2 to less than 10mA making it suitable for connection to open collector, TTL buffers or, digital and analogue circuits connected via a transistor buffer. A connection is provided for the remote input but this is not marked on the PCB. Refer to Figure 2 for guidance.

CAUTION: The electronic switch has no turn off resistor and should not be left floating. If it not used, do not fit R2 and TR2, or tie the remote input pin to 0V. Do not use gate

Melody IC Series	Input Voltage TO B+	Battery Connection normal	recharg.	Output SPKR	PIEZO
HT381	2.4 to 5.0	2 x 1.5V	2 or 3 x 1.2V	3 / 4	no
UM66	1.3 to 3.3	1 x 1.5V	2 x 1.2V	3 / 4	no
M66T	1.2 to 3.6	1 x 1.5V	2 x 1.2V	3 / 4	no

Melody IC Series	Input Voltage to V+	Output-Lo SPKR	PIEZO	Output-Hi SPKR	PIEZO
HT381	3.2 to 12	3 / 4	no	4 / 5	4 / 5
UM66	3.2 to 12	3 / 4	no	4 / 5	4 / 5
M66T	3.2 to 12	2 / 3	no	no	4 / 5

Table 1. Supply voltage and speaker connection guide.

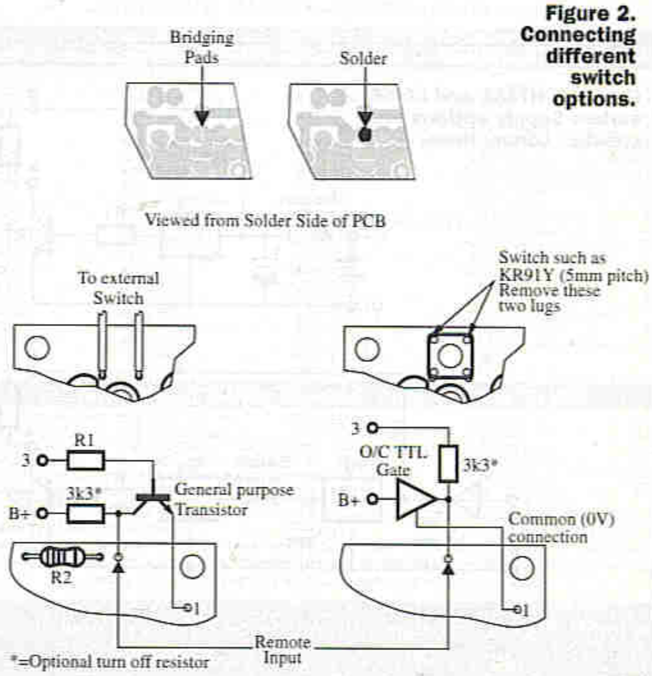
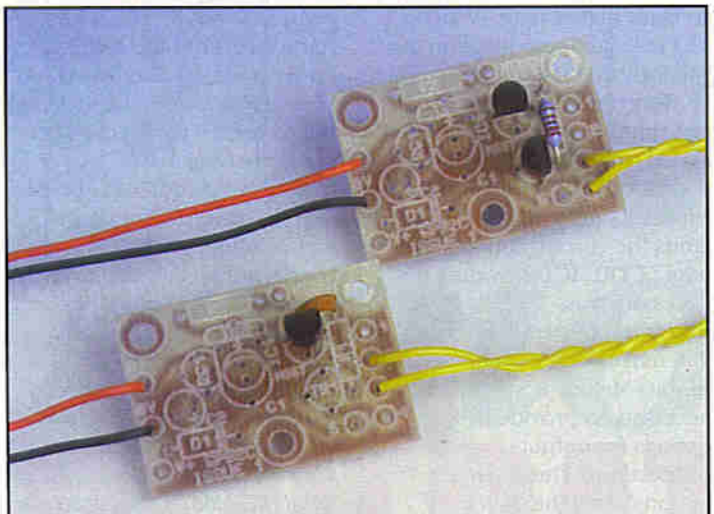


Figure 2. Connecting different switch options.



Melody Generators in their simplest form.

tempos. The HT3810 series contains two tone generators, a 'cha' accompaniment circuit , envelope generator, time base generator, 128 note ROM and output amplifier.

Construction

The Melody Generator kit contains components that allow any of the Melody ICs from the M66T, HT381 or UM66 series to be fitted. Each Melody IC is marked with its series or use Table 2 which provides a cross reference from the Maplin Stock Code. Next, read the text below to decide which connection to use. Note that the higher voltage options will require additional parts to be purchased.

Kit Code	Device Series
LU64U	HT38I
LU66W	HT38I
LU67X	HT38I
LU68Y	HT38I
LU69A	HT38I
LU70M	HT38I
LU75S	HT38I
LU76H	HT38I
LU77J	HT38I
LU80B	HT38I
LU81C	M66T
LU84F	M66T
LU90X	M66T
LU91H	M66T
LU92A	UM66T

Table 2. Maplin kit codes to device series cross reference.

Identify the parts you need from the drawings and separate these from the rest of the kit. The following assumes that all parts are fitted so pick from the text only those parts that apply to the selected option.

Begin by soldering across the link pads. Fit R1, R2 and D1. Next fit C1, C2 and C3.

Fit IC1, RG1, TR1 and TR2. Fit the switch option required.

Remove 5mm of insulation from one end of the red and black wire, tin the stripped ends and solder them through the PCB holes as indicated in Figures 3 or 4. Prepare the other ends as required by the power source used.

Cut the yellow wire in half and remove 5mm of insulation from each end of both pieces. Tin the stripped ends and form one end of each wire into a 'hook'. Twist the wires together with both 'hooks' at one end. Pass the hooks through the

Figure 3. M66T series. Supply options.

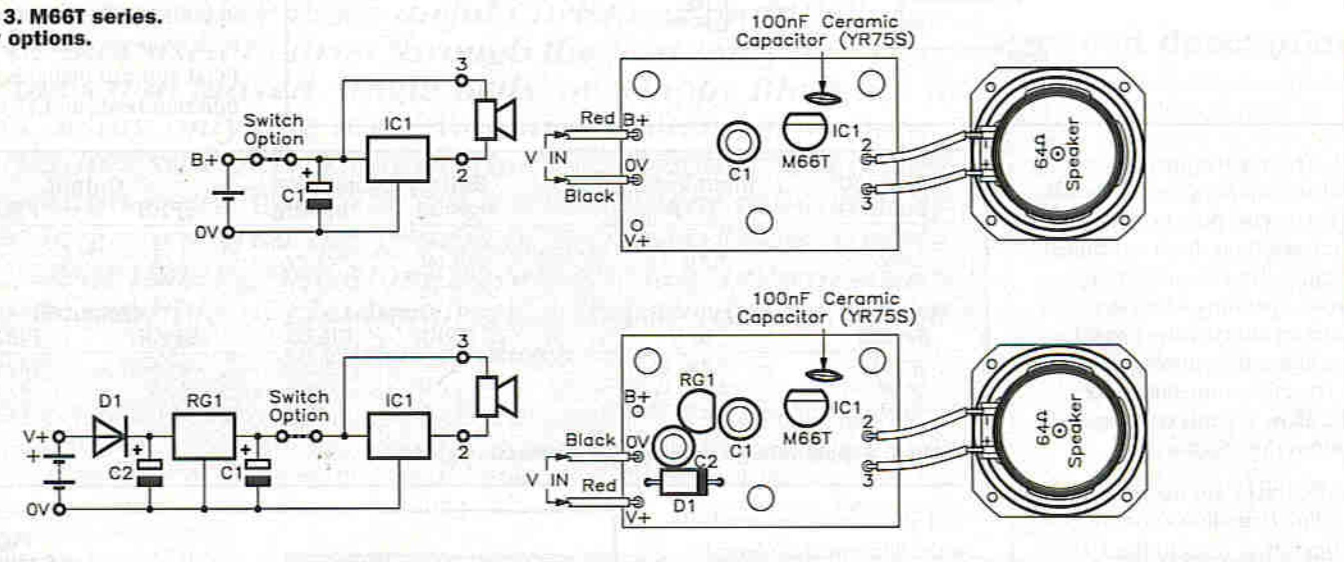
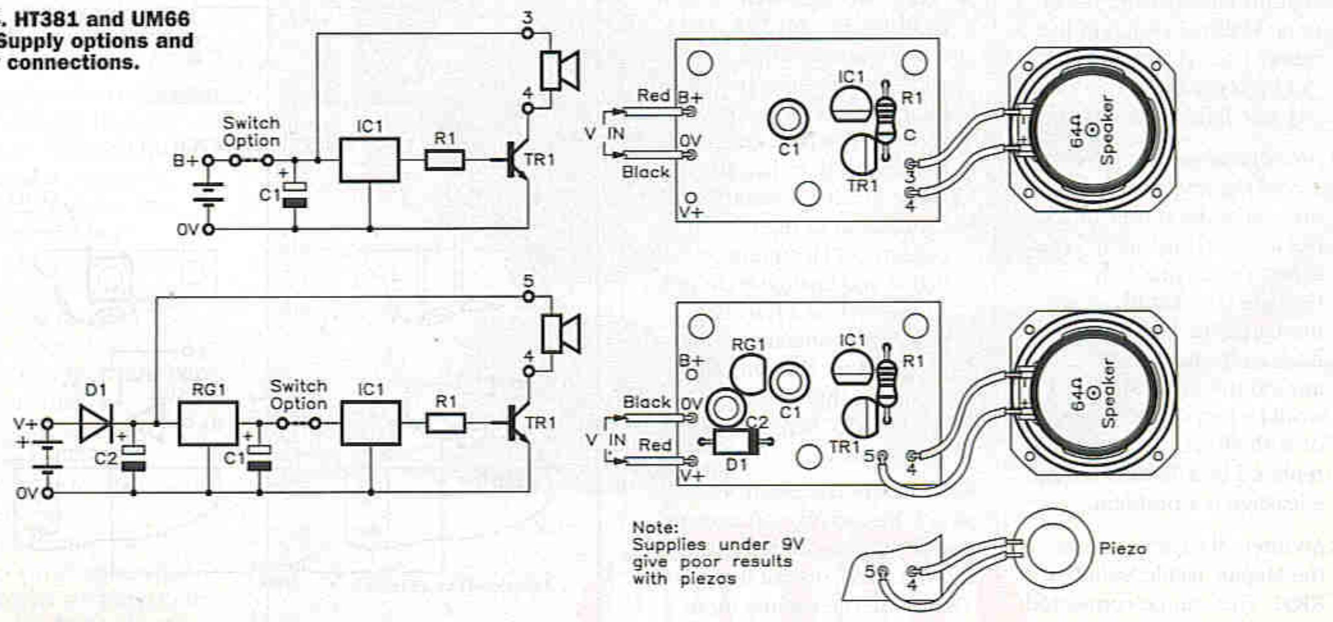


Figure 4. HT381 and UM66 series. Supply options and speaker connections.



speaker terminals and solder them in place. Solder the other ends through the PCB holes as indicated in Figures 3 or 4. It does not matter which way round the speaker terminals are connected.

The wire lengths for the supply and speaker connections can be increased. The prototype units conformed to CE directives when lengths of 5 metres were used. The speaker wire must be twisted to ensure compliance.

Carefully check all connections and solder joints. Equally carefully, check that the correct components are fitted the right way round and in the right place. The circuit is ready to use as soon as the power source is connected.

M66T series

Figure 3 shows the connections that can be made to the M66T series Melody IC. The upper figure shows the kit configuration for low voltage operation and speaker connection. Table 1 gives information on the supply voltage and how this is obtained.

The lower figure shows the connection for high voltage driving the Melody Generator. The battery could be a PP3 type or a car battery via a suitable fuse. High voltage drive does not affect the volume produced by the M66T series significantly. Note that the kit does not contain the parts required for the high voltage drive.

To comply with the EMC regulations it is essential that C3 is fitted as shown.

HT381 / UM66 series

Figure 4 shows the connections that can be made to the HT381 series and the UM66 'Wedding March' Melody Generators. Once again, the upper figure shows the kit configuration for low voltage operation and speaker connection. Table 1 gives information on the supply voltage and how this is obtained.

The lower figure shows the connection for high voltage driving the Melody Generator. The battery could be a PP3 type or a car battery via a suitable fuse. Using a PP3 and this connection gives a much louder sound than the low voltage connections.

Also shown is the method of adding a piezo sounder to the Melody Generator. If a piezo sounder is used this should be mounted on or in a resonant enclosure. The Maplin Design Team used a small cardboard box, measuring 40 x 40 x 18mm deep, to test the piezo sounder. If one is supplied with the speaker it should be just about the right size. Press the face of the piezo sounder that is not connected to the wires, flat to the largest face of the box. The sound should come from inside. Presto, a resonant chamber!

Note that the kit does not contain the parts required for the high voltage drive or the piezo sounder. ELECTRONICS

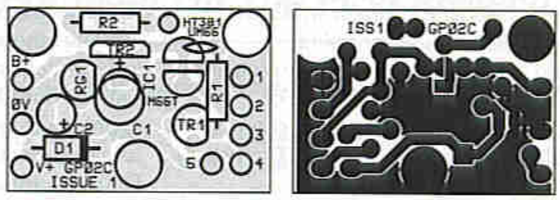


Figure 5. Track legend and component overlay for the Melody Generator.

PROJECT PARTS LIST

RESISTORS: All 0.6W 1% Metal film (Unless specified).			
R1	2K2	1	M2K2
CAPACITORS			
C1	10µF 63V Radial Electrolytic	1	AT77J
C3	100n Ceramic	1	YR75S
SEMICONDUCTORS			
IC1	Melody Generator IC	1	As supplied
TR1	BC547	1	QQ14Q
MISCELLANEOUS			
	Speaker 64Ω 200mW	1	YT27E
	Wire 7.02 Black	10cm	BL00A
	Wire 7.02 Red	10cm	BL07H
	Wire 7.02 Yellow	20cm	BL10L
	Melody Generator PCB	1	GP02C
	Melody Generator Leaflet	1	XZ47B
	Constructors' Guide	1	XH79L
OPTIONAL ITEMS (Not in Kit)			
R2	330Ω	1	M330R
C2	10µF 63V Radial Electrolytic	1	AT77J
RG1	HT7230 3.0V Regulator	1	LE77J
TR2	ZTX753	1	UH53H
D1	1N4001	1	QL73Q
	Veropins	100	FL24B ★
	Transistor Socket	1	WR29G
	Click Switch	1	KR91Y
	PP3 Battery Clip	1	HF28F
	Duracell PP3 battery	1	JY49D
	Duracell AA battery	As req.	JY48C

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.

Order as:

LU64U Happy Birthday
LU67X Old McDonald
LU69A Love Me Tender
LU75S Merry Christmas
LU77J You Are My Sunshine
LU81C Twinkle Twinkle
LU90X White Christmas
LU92A Wedding March
LU66W London Bridge
LU68Y Greensleeves
LU70M Jingle Bells
LU76H 12 Days of Christmas
LU80B I Just Called
LU84F I'd Like To Teach
LU91H Warning Tone

All kits are priced at £4.99 each
GP02C PCB only - £2.49

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.

COMMENT

by Keith Brindley

An interesting and thought-provoking report found its way onto my desk recently. The *School Managers' Report on IT in the Curriculum* should be compulsory reading for all teachers responsible for IT purchase in schools, all department heads, all head teachers, all local authority IT advisors, all school governors, all parents, as well as being force fed to any and all members of Parliament who have anything to do with the control of education. What the report actually contains is factual evidence of how IT – and of course, this particularly means the computer – is used in our schools and what IT trends might occur over the coming years.

At the core of IT in schools is the undoubted ability of the very children being taught to adapt to change. However, the changes often being forced upon them aren't necessarily being made for educational reasons. In many cases, computer systems that schools are being made to use aren't always the best systems for what schools actually need. There is a rush – if rush is the word, given the small budgets schools have to purchase computer systems – to standardise on industrial standards of computers, and often little thought has been applied to any better standards that will be beneficial to educational use.

The report points out that industrial computers are most often single-user machines, running no more than three or four specific applications directly related to business needs. In the classroom, on the other hand, computers can be used by 30 or 40 pupils a day, running 20 or 30 vastly different applications. As a result, the report argues, the two environments of industry and education can't be equated. The environments are different, like chalk and cheese. In effect, what might be standard in industry isn't necessarily suitable in education and certainly, we must think very seriously before we assume it should be an educational standard.

Putting names to computers, it has to be said that the report publisher, Xemplar, is the company jointly owned by Acorn and Apple. Together, some 70% of schools use Acorn or Apple computers, while the majority of the remainder of computers in schools are manufactured by Xemplar's main competitor, Research Machines – which makes Windows-based computers of the so-called industry standard. Naturally, Xemplar has a vested interest in Acorn and Apple computers, so some might say that the report is biased.

However, the report deals in hard facts which will probably come as no surprise to Acorn and Apple computer users, but should make interesting reading for Windows-based computer users. For example, the report highlights an independent survey citing the number of calls for outside support from schools using Acorn and Apple computers against those using Research Machines computers. Despite having a user base of nearly twice that of Research Machines' (3 million computers) in schools, Acorn and Apple (5·4 million computers) computer users in schools make less than a third the number of calls for support (200 per day, against 625 per day). All of which can be taken to mean that a user of Windows-based computers is six times more likely to need outside support than a user of computers from Acorn or Apple. This is fact, remember, taken from an independent survey of computers used in schools.

Another point raised in the report is useful lifespan of computers. While a Windows-based computer can generally only run software from its own era, both Acorn and Apple computers are forwards-compatible – eight year old machines can (and regularly do) run today's software, if a little slowly. In contrast, a Windows-based machine of eight years of age (of course, at that age, it's a DOS-based machine) will only be able to run the software it was bought with. As more than 50% of computers in schools are over five years old, this is – or at least, should be – of vital concern to schools which must make the best use of their investments.

To keep to an industrial standard with computers, investments ideally have to be to industrial standards, too. In industry, computers are usually changed at least every two years, but schools simply can't afford that. All of which means that schools have to live with the consequences of their purchases.

The questions raised by the report are important, and should be noted by all those making educational policy decisions. It is particularly relevant to the Government's recent initiative in development of the National Grid for Learning (NGL) which, among other things, is intended to provide all schools (and museums and libraries, too) with Internet access and to effectively approve computers and software for their use.

A recent development in terms of the National Grid for Learning is Microsoft's direct involvement. Microsoft's chief, Bill Gates, has agreed to act as advisor to our Government on hardware and software for use in schools. Now as such, this is no bad thing; Gates is in a prime position in the computer world to do this. Yet, his very involvement also causes many observers to wonder what it implies. In the best case, Microsoft will be able to offer support and advice to the benefit of all in UK education. In the worst case, on the other hand, things might be a little more sinister. Microsoft naturally has an incentive in being involved. Its own software is already very popular in schools, and the National Grid for Learning is the ideal public relations exercise to create more sales. But, even more cynically, Microsoft produces the Windows operating system. More sales of that to schools means fewer relative sales of Acorn and Apple operating systems.

Of course, all my musings here and the resultant cynical hypothesis of others that Microsoft is only in it for the money might be totally unfounded. Gates might have reached the conclusion that he will aid UK education for the very purpose of social good. He might donate all his software free of charge to the National Grid for Learning purely for selfless reasons. He might even say OK, I've nothing against Acorn's RiscOS or Apple MacOS computers, so Microsoft won't change the fundamental relationships of computers in schools. He might change his whole business philosophy of making money from software just for the UK National Grid for Learning. As the world's richest man, he could well afford it. But, as the world's richest man, he didn't reach his position by doing anything like this before, did he?

Copies of the report *School Managers' Report on IT in the Curriculum* are available from Xemplar Education on (01223) 724201.

The opinions expressed by the author are not necessarily those of the publisher or the editor.

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ARS (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Crescent, Kincorth. For details contact: Martin, (CM0JCN), Tel: (01569) 731177.

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Bury St. Edmunds Amateur Radio Society. Meetings held at Culford School, 7.30pm for 8.00pm on the third Tuesday of each month, unless otherwise stated. Further details from Kevin Waterson, (G1GVI), 20 Cadogan Road, Bury St. Edmunds, Suffolk IP33 3QJ. Tel: (01284) 764804.

Crystal Palace and District Radio Society meets on the third Saturday of each month at All Saints Church Parish Rooms, Beulah Hill, London SE19. Details from Wilf Taylor, (G3DSC), Tel: (0181) 699 5732.

Derby and District Amateur Radio Society meets every Wednesday at 7.30pm, at 119 Green Lane, Derby. Further details from: Richard Buckby, (G3VGW), 20 Eden Bank, Ambergate DE56 2GG. Tel: (01773) 852475.

Electronic Organ Constructor's Society. Details of programme magazine and membership from: Don Bray (Hon. Sec.), 34 Etherton Way, Seaford, Sussex BN25 3QB. Tel: (01323) 894909.

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SEEMUG (South East Essex Mac User Group), meet in Southend, every second Monday of each month. For details Tel: Michael Foy (01702) 468062, or e-mail to `mac@mikefoy.demon.co.uk`.

Southend and District Radio Society meets at the Druid Venture Scout Centre, Southend, Essex every Thursday at 8pm. For further details, contact: P.O. Box 88, Rayleigh, Essex SS6 8NZ.

Sudbury and District Radio Amateurs (SanDRA) meet in Gt. Cornard, Sudbury, Suffolk at 8.00pm. New members are very welcome. Refreshments are available. For details please contact Tony, (G8LTY), Tel: (01787) 313212 before 10.00pm.

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Thanet Electronics Club. For school age Ham Radio and Electronics enthusiasts, enters its 16th Year. Meetings held every Monday evening from 7.30pm at The Quarterdeck, Zion Place, Margate, Kent. For further details contact: Dr. Ken L. Smith, (G3JIX), Tel: (01304) 812723

Wakefield and District Radio Society meet at 8.00pm on Tuesdays at the Community Centre, Prospect Road, Ossett, West Yorkshire. Contact Bob Firth, (G3WWF), (QTHR), Tel: (0113) 282 5519.

The (Wigan) Douglas Valley Amateur Radio Society meets on the first and third Thursdays of the month from 8.00pm at the Wigan Sea Cadet HQ, Training Ship Sceptre, Brookhouse Terrace, off Warrington Lane, Wigan. Contact: D. Snape, (G4GWG), Tel: (01942) 211397 (Wigan).

Winchester Amateur Radio Club meets on the third Friday of each month. For full programme contact: G4AXO, Tel: (01962) 860807.

Wirral Amateur Radio Society meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the the first and third Wednesday of every month. Details: A. Seed, (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE.

Wirral and District Amateur Radio Society meets at the Irby Cricket Club, Irby, Wirral. Organises visits, DF hunts, demonstrations and junk sales. For further details, please contact: Paul Robinson, (G0JZP) on (0151) 648 5892.

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AVR Project
PROGRAMMABLE LOGIC CONTROLLER

by Kevin Kirk

This month, we are looking at developing a project using the AVR. The difference between this, and other articles you are going to find in the magazine, is that we shall be working through the project stages step by step. In this way, you should be able to see how a project is developed, so you can go off and try one on your own. The AVR lends itself very well to this type of project development (i.e., learn as you go) because of the fact that it not only has in system programming capability but also it has a 1,000 reprogramming lives, which is more than ample for most applications.

The project itself is a mini PLC. A PLC (Programmable Logic Controller) is used in industrial environments to control machines. Very useful in a domestic environment, huh? In actual fact, they are, except that they normally cost a couple of hundred quid or so and so it would be a little tricky getting that one past the other half if you wanted one to control your trainset! This one should set you back twenty quid or so and it will be capable of providing the sort of performance that you can expect from the low end commercial PLCs. You can use the finished unit to control virtually anything that can be controlled digitally. Train layouts, central heating, burglar alarms, computer systems, school experiments (it is perfect for meeting the criteria of the national curriculum for Computer control) and robotics spring to mind. In fact, its uses are really only limited by your ingenuity.

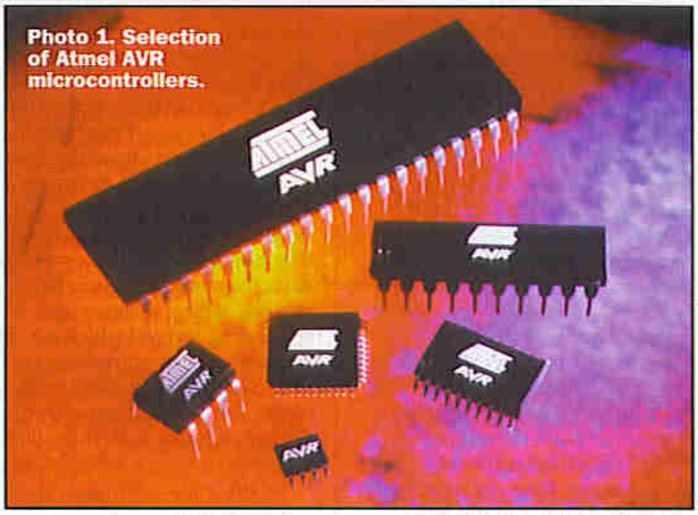


Photo 1. Selection of Atmel AVR microcontrollers.

The Hardware Design

Before we can rush off and design things, we need to sort out the specification of what we want the unit to do. So, this is always the first step. The unit itself is going to be a general purpose digital controller, with some analogue capability thrown in. So first of all, we need to look at the Input and Output requirements.

The initial I/O spec looks something like this:

Inputs: 6 Digital Inputs
2 Analogue Comparator Inputs
1 Interrupt input / uncommitted bit
Outputs: 6 Digital Outputs

This configuration has two distinct advantages. The first is that it gives you the maximum flexibility, the second is that it makes the software easier because we'll effectively be using one port for input and the other for output (the interrupt is the exception, but that's easy to get around).

The next stage is the actual hardware functionality. Now, we could opt for a very simple, non-isolated, system where we just feed in the digital inputs in raw and drive 'things' with the outputs, again, directly. The advantage here is that it is cheaper. However, it could give you problems, especially if you wanted to use this system to control mains devices and also in respect of common mode offsets. So in retrospect, we'll give the unit some isolation from the outside world. The easiest way to do this is via opto isolators. On the outputs, we'll use stand alone packages, one per output. The reason for this is that we can use either transistor-based devices (for controlling DC) or Zero Crossing TRIAC versions (for controlling mains). You just choose the one you want at build time, depending on your requirements. Note that they can be 'mixed and matched' with some DC and some AC circuits. The circuit options are shown in Figure 1a (for DC) and Figure 1b (for AC).

Watch the creepage distances if you are using mains though. This is the minimum distance you must allow between the mains carrying tracks and the rest of the circuit. BS EN 60950 gives the value as 4mm, but I recommend you double that. It goes without saying that you

Figure 1a.
DC output circuit.

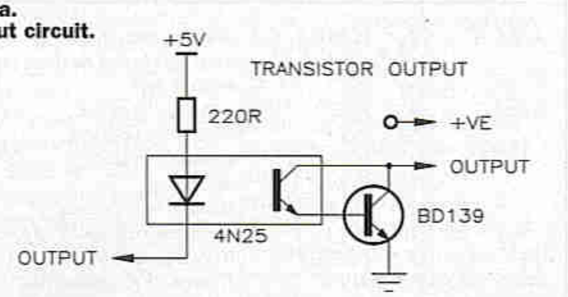
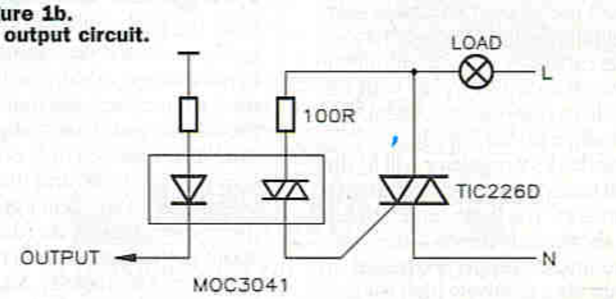


Figure 1b.
AC output circuit.



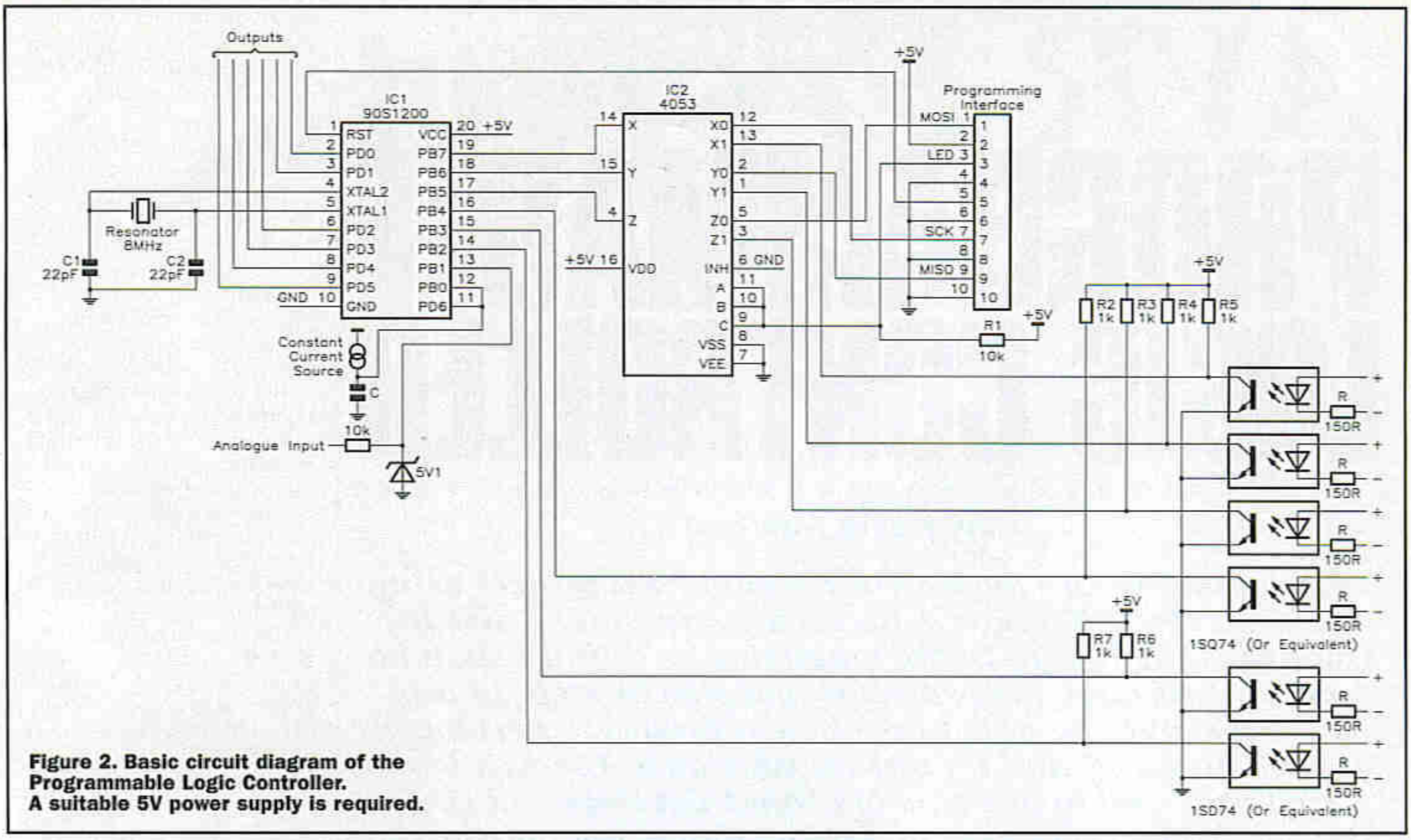


Figure 2. Basic circuit diagram of the Programmable Logic Controller. A suitable 5V power supply is required.

should keep your fingers off it while it is live! The inputs will also be isolated but here, we'll just use multiple opto isolator packages. Incidentally, because of the opto isolators, we now look for a '0' being a true value (i.e., ON) and a '1' as a false (i.e., OFF). This is the case for both inputs and outputs. So, we clear (set to a 0) to switch on and set (set to a 1) to switch off. Now, we'll choose ourselves a clock. Timing is not super critical in this application, so we can live with a ceramic resonator, rather than a crystal. To keep the maths easy, we'll choose an 8MHz version (Scientific, isn't it?).

The programming interface is next. Ideally, we should have the capability of swapping the programming port to general I/O for normal use; we need some sort of multiplexing. This is not as nasty as it sounds. We just need to divert 3 signals so we can plonk a 3-pole changeover switch in the circuit that is controlled from the microcontroller reset line (which the programmer itself uses to switch the microcontroller into programming mode). For this, we'll use a standard CMOS part called the 4053. Now we have the capability of programming in system so we can 'play' with the code to our heart's content. Finally, a power supply. A standard 5V regulator will fit the bill nicely, so we'll drop one of those in. The basic circuit diagram is shown in Figure 2. Note that the unused inputs are pulled high via a relatively high value resistor. The reason is that the AVR itself is CMOS and it is NOT a good idea to leave inputs floating.

We could add an analogue-to-digital convertor (ADC) if we wanted. This could be a very simple circuit based on the single slope principle. Essentially, all you do is to feed a capacitor with a constant current supply, which results in a straight line charge slope (rather than the rather nasty logarithmic slope that capacitors prefer). You then compare this constantly changing value with the input and when it exceeds (slightly) the input, then you know the value. To get the value, you simply set a timer running when the capacitor starts charging and then stop it when you reach the crossover point. This timer can be in software if you want, however, we have got a perfectly serviceable timer in the AVR itself, so we'll be using that. We'll cover this next month, but in the meantime, you can look at the components that the ADC uses, which are shown on the circuit diagram inside the dotted lines.

Program Design

Now, the tricky bit! There is one golden rule that you should bear in mind when working with microcontrollers, and that is that they are stupid. That's why we love 'em. They will only do what they are told to do and they will get all sulky if you don't give them something to do (thinking about it, they are the exact opposite of teenagers). So, we have to think the software through so that it covers all eventualities, because if they encounter something we hadn't planned for, then they'd just wander off and do their own thing (i.e., they'll crash!). Now, at this point, we could leap off into reams of flow diagrams, project planning, etc. We could, but we won't, because there is very little need in this case (I can hear the howls of protests from the micro teachers from here). What we will do is create a simple flowchart (without the symbols) that gives us a broad overview of what the system is trying to achieve, which will give us a framework around which we can plan the various software modules. To give it its scientific name, this is called 'top down design'. It looks something like this:

Set up
Scan inputs
Set outputs
Loop to Scan Inputs

It looks suspiciously simple, doesn't it? There is a very good reason for that, it is simple. All a PLC does is to look at the inputs then to change the outputs based on the combinational effects of the inputs. For example, if you have a machine with two protective safety guards on it, then you want to only switch the output on when the guards are in place AND the start button has been pressed AND NOT if the stop button has been pressed. This is a straight Boolean function which can be expressed as:

(Guard1 . Guard2 . Start) . !Stop

('.' is the symbol for AND and '!' is the symbol for NOT – incidentally, '+' is the symbol for OR).

This can be rendered into the following software expression (assuming port D bit 0 is the output and port B bits 0 and 1 are the guards, bit 2 is the start and bit 3 is the stop):

This piece of code, which at first glance looks complicated, will actually cover the last three 'sections' of our functional flowchart. It needs a few bells and whistles to set it up and to provide some protection against noise spikes invading the circuit, but in essence, that's all it needs to perform the task. It may be worthwhile, if you are new to

```
loop1:  SBI   PORTD,0   ;switch output off – 1 is off
        SBIC  PINB,2    ;see if start button has been pressed
        RJMP  loop1     ;loop if it isn't
loop2:  SBIC  PINB,0    ;is guard 1 in place?
        RJMP  loop1     ;No! so loop until it is
        SBIC  PINB,1    ;is guard 2 in place?
        RJMP  loop1     ;No! so loop
        SBIS  PINB,3    ;Has stop been pressed?
        RJMP  loop1     ;Yes so switch off and wait for start again
        CBI   PORTD,1   ;If not then switch on
        RJMP  loop2     ;Then check for guards and stop switch again
```

this game, to read the code and look up what each instruction is doing (the full instruction set was in last month's magazine) so you can get a 'feel' for it. Note that the label (i.e., loop1) is on the left and is delimited with a colon, the operator (i.e., the instruction) comes next and is indented (or tabbed) and finally, the operand (i.e., what it is working on and where it should stick the result).

The I/O ports on the AVR are true tri-state devices. That means that they have 3 possible states a 1, a 0 or off. The latter may be confusing until you realise that it is being driven neither high nor low but it is merely floating, i.e., it will follow whatever value is presented to it, in other words, this is the input state. The AVR uses a special register called the Data Direction Register to determine whether the port is used for input or output. A 0 in this register will set the corresponding port pin up as an input and a 1 will set it up as an output. You may have noted that the code refers to the input ports as Pins whereas the outputs are Ports. The reason for that is that the port is actually a latch and is a mirror of the output, whereas the pin reads the pin itself.

So, to start off, we need to set up the relevant ports as inputs or outputs. We'll use one of the general purpose registers to assemble the bytes required. As the top 16 (of 32) registers are capable of being used to load immediate values and for directly accessing the I/O, we will use R16. Incidentally, we'll be using the lower 16 registers for Scratchpad (temporary) storage as the project progresses. So, the first thing we do after a reset is set up the watchdog. This system is designed for control use and the last thing you want when you are controlling something is for it to go berserk. Thus, we use a watchdog to keep it in check. In this instance, we can live with the maximum prescaler value on offer which is /2,048, which with its 1MHz clock, gives us a timeout of around 2ms. We are not in any particular hurry, so this is fine. We will need to keep it sweet by resetting it and the less we have to do it, the better. Our start up code now looks like this:

```
LDI R16,$0F              ;set up values for watchdog
    MOV  WDTCR,R16       ;Put them into watchdog control register
    LDI  R16,$00         ;Set port b to inputs (this is reset value!)
    MOV  DDRB,R16
    LDI  R16,$FB         ;Set port d to outputs except bit 2
                                                  (interrupt)
    MOV  DDRD,R16
```

There are a couple of points to note. The first is that the code, as it stands, makes no allowance for the interrupt vectors, which have been omitted for clarity, and which would normally require a jump from the reset vector (Vector is a Techie way of saying address) to the start of the code. The other is that if you add the previous piece of code to this end of this, then it will nearly work. What we need to do is to add our Watchdog reset instruction and we are in business. You need to add it into your main loop(s) so the following instruction must be added to the previous code:

```
    loop1:       SBI   PORTD,0     ;switch output off – 1 is off
and the:
                 CBI   PORTD,1     ;If not then switch on
instructions:
                 WDR
```

The system will now work. In fact, because of the way the code has been written, you could actually leave the watchdog reset instruction (WDR) out of the code after the first instruction line. Can you see why? I'll leave you to work that one out.

The unit will, so far, perform the same task as a piece of relay-based ladder logic, but it can have extra functions added without having to resort to a soldering iron. It takes a lot less power too.

Next month, we will look at adding extra functionality such as an ADC and we'll also look at writing specific code to perform your own control tasks. Finally, it would be a worthwhile investment to get hold of the Atmel AVR data book, which fully describes all of the functions of the various registers, etc. The Maplin Order Code is **NR22Y** and the price is £11.75. Alternatively, there is also a fully fledged training system available for the device called the AVR Explorer (Order Code **NR41U**) which is on page 931 of the catalogue and is priced at a whisker under £99. This takes you from zero to full speed and comes complete with hardware, software and coursework.

Fax Friend UNDER TEST

Want to use a modem and telephone on the same line without the pain of constantly switching between the two devices? Check out the Avro Pacific Fax Friend, an intelligent switch that detects the type of call and routes it accordingly. Stephen Waddington investigates.

E-mail and fax are claimed to have heralded new levels of personal communication and interaction. Never before has it been physically easier or less expensive to send a message to anyone, anywhere in the world. It is ironic, therefore, that these new methods of electronic communication are responsible for numerous missed phone calls and faxes. The reason? It is simple. While analyst house INTECO reckons 28% of homes in the UK now have either a fax or PC based e-mail connection, British Telecom claims that the majority of these still only have a single telephone line.

Screeching Tones

Does this sound like a familiar scenario? How many times have you picked up the phone, heard the screeching tones of a distant fax machine and scrambled to switch phone connections? Or vice-versa, how many times have you had your fax answer the phone when you have forgotten to plug it back in after surfing the Internet or sending a fax. While it is possible to have both a phone and a fax or modem on the same line with the latest fax and modem products, equipped as they are with tone recognition, historically, faxes and modems have been relatively dumb, reliant on human intervention to switch the telephone line between the two devices.

But there is now a solution. Fax Friend is an automatic fax and data switch that allows a fax, modem, answering machine and any number of telephone handsets to be connected to a single telephone line. And what's more, Fax Friend will identify incoming calls and route them to the appropriate piece of equipment. Similarly, it will only allow the line to be accessed by a single type of equipment at anyone time. So, no more picking up a remote handset to the sound of modem tones, and no more sending a fax when someone else is making a voice call.

Cost

So what's the catch? The catch is that Fax Friend is not a low cost adapter. It is a neat piece of microprocessor-based electronics, which costs £59.99. But it is cheaper than installing a dedicated data line for a fax machine and modem. And if you factor in additional monthly or quarterly line rental, the relatively high one-off cost becomes marginal.

Installation

Fax Friend is surprisingly simple to install. It can be plugged directly into 90% of domestic telephone circuits without any prior configuration. The palm-sized unit has a standard telephone cable lead which can be plugged into any telephone extension, a socket for an external power supply, a set of four selector switches on the rear and two standard phone sockets. Where prior configuration is required, this is done using a series of selector switches. A red LED on the top of the device confirms that it is powered-up.

The Avro Pacific Fax Friend Automatic Fax Switch

Under Test

Fax Friend is supplied with a wiring diagram, which shows a variety of configurations of just about every device you could ever wish to connect to a telephone socket. Figure 1 shows the conditions under which we tested Fax Friend using a PC with modem/fax card, an answering machine and three telephone handsets.

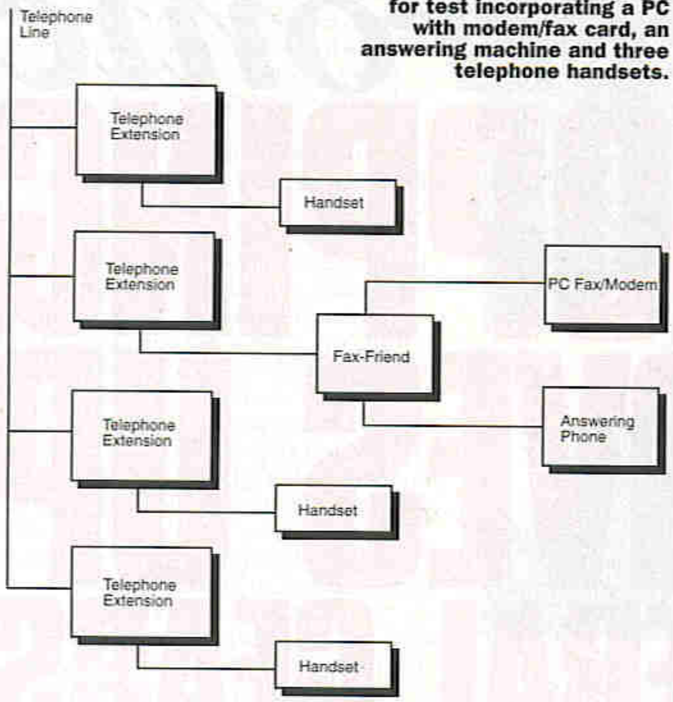
In the first test, we checked Fax Friend's performance to incoming voice and data calls. During a period of 60 minutes, we got a three colleagues to make random calls from a fax, modem, fax/modem and telephone. During the first 30 minutes, if a call rang through to one of the handsets, we picked it up. For the latter 30 minutes, we let calls go though to the answering machine if they rang through on the handset.

In the second test, we were looking to check how Fax Friend coped to outgoing calls. Numerous attempts were made during an hour period to make a telephone call while the modem was occupied and vice-versa. And while it was possible to get multiple parties on the line at any one time as you would expect, it was not possible to persuade Fax Friend to let a voice and data call to share the same line.

Results

Fax Friend stood up to the test period remarkably well. Not once did a call get misdirected, and despite numerous reported engaged tones – when the line

Figure 1. Schematic diagram for test incorporating a PC with modem/fax card, an answering machine and three telephone handsets.



was clearly busy – all faxes got through unhindered. If I have a criticism, it is this. When an incoming call is received, Fax Friend does not transfer it immediately. Instead, the call rings on all phones and is only transferred to the PC/modem when a handset is lifted. This process is silent, but even so, it requires intervention on the part of the user.

If the call is not answered, Fax Friend routes it through to the answering machines and in the case of a data call, does not transfer it to the PC/modem until after the answering machine has played its outgoing message. This means that the outgoing message must be shorter than the 15-second timeout period for the majority of fax machines and fax modems. By contrast, Fax Friend worked seamlessly for all outgoing calls.

How it Works

The reason that Fax Friend cannot respond to a call automatically without intervention from either a user or an answering machine is straightforward. The telephone line must be 'picked up' before the device can recognise the type of call. In the case of a fax or data call, the device recognises a calling tone known as the CNG tone and so is able to route the call silently.

If you can forgive Fax Friend for the fact that you either have to answer a call or have the answering machine play its outgoing message before a data call is routed to a fax or PC/modem, then it is an excellent product. If you are not forgiving, remember that the process is completely silent to the user and that all outgoing calls are managed perfectly, which is a great improvement over the option of constantly switching a fax/modem and telephone manually between a single telephone line.

Availability

The Fax Friend automatic fax and data switch is available from Maplin Electronics, priced at £59.99, Order Code YD61R. See page 1187 of the latest catalogue for details.

Benefits

- Fax and phone on a single line
- Easy to install
- Fully approved and PABX compatible
- Cost-effective solution to second line
- Silent operation – no tones or clicks
- Compatible with all fax and answering machines
- Does not increase REN loading
- Can be used with fax and data modems

Electronic SHOPPING MOVES UP SEVERAL GEARS

by Alan Simpson

For once, all industry pundits agree Electronic shopping will be the major source of business over the next decade. There will be no holding back the global retailing of multimedia-based products and services over the Information Superhighway into the home, store and office.

According to the influential Electronic Shopping Forum, the difficulty for the business community is keeping abreast of all the new services and technologies on offer. To foster the growth of electronic retailing and help senior executives keep ahead of developments, the Electronic Shopping Forum and the Electronic Commerce Association (ECA) have announced plans to join forces.

By bringing together Directors responsible for electronic retailing – merchants, retailers, distributors, service providers and suppliers – the Electronic Shopping Forum aims to speed the flow of information between suppliers and merchants and stimulate electronic commerce.

Powering the Electronics shopping revolution is, of course, the Internet. As Digital put it: the great thing about doing business on the Internet is that it doesn't matter where you're based or how remote and scattered your customers are. Provided you have a reliable and responsive Web site and a secure transaction system, you can conduct virtually any type of commerce over the Internet.

No one knows the absolute size of the Internet or just how many businesses across the world are involved in electronic commerce. Analysts make conflicting claims about the business potential of the Web and its rate of growth, making it difficult to separate marketing hype from reality. What we do know is that it's vast and growing. Even if all the predictions are out by a factor of ten – or even a thousand – the opportunities are still enormous. That's why the Internet must figure in the marketing strategy of any retail organisation.

The European Electronic Messaging Association (EEMA) Agrees

Electronic Messaging is increasingly being used by organisations for a wide range of business applications that offer opportunities for improving business effectiveness and competitive advantage. It is most usually thought of as e-mail and Electronic Data Interchange, but embraces a wide range of services, equipment, technologies and business practices.

For the UK government, however, the move toward Electronics Messaging will have a major spin-off by encouraging the introduction of teleworking. This, in turn, will encourage employers to allow their staff to work from home, thereby contributing to solving the transport pollution problem.

Mondex – A Payment Card – Even Better than Cash

At the centre of the electronic messaging world is Mondex – a payment smartcard. Mondex is a new payment smartcard which brings together the advantages of paying by cash with the convenience of paying by card. Mondex is being introduced by leading banks and retailers in America, Asia, Australasia and Europe, and will be appearing in people's pockets and purses in the next five years.

The Mondex smartcard uses a secure microchip to store cash value as electronic information rather than notes and coins. Because Mondex is cash, it is not just for people with bank accounts or credit ratings – anybody can have Mondex, even small children. And because Mondex is electronic, it can be sent down the telephone line, or used to buy goods on the Internet as well as making everyday payments when shopping.

Mondex makes getting cash easier – you can even get it down the phone. Just like cash, you can get Mondex from an ATM (cash machine) or from your bank branch – but more conveniently, you can get Mondex down the phone-line in your home, in shops and from public payphones. In each case, the electronic cash is loaded onto the Mondex smartcard.

And Mondex makes your cash more secure. If you lose physical cash in the street, it is almost certain you have lost the value. Someone else will pick up the cash – and without knowing the owner, will probably keep it. Even if there is identification alongside the cash, it is still up to the finder whether to spend the cash or return it to you. But with Mondex cash, you can use a personal code to lock your Mondex Card, so that money cannot be spent from the card. Anybody finding a locked card cannot spend the cash and is far more likely to return the card to the rightful owner.

Mondex is the most 'cash-like' of the electronic cash smartcards which are being introduced by banks around the world – indeed, it is so like cash that it allows informal payments to be made between individuals – just like notes and coins are used by family or friends. With other payment cards, you need to be a recognised organisation (such as a retailer) before you are able to accept payment.

The Mondex card and balance reader.

Mondex is special among smartcards in that it has the security and the sophistication to permit 'person-to-person' movement of electronic cash – just as you can give a member of a family or a friend some cash. Other smartcards act more like debit or credit cards which need their transactions to be reported to a central computer system and so can only allow cash to move from customer to retailer and from retailer to bank.

As a result, Mondex can be used for small informal transactions (such as a collection at work for somebody's leaving present) or small informal businesses (such as a charity car boot sale), or for informal transactions or business over the Internet.

Mondex is also the only one of the electronic cash smartcards which allows several, different currencies to be carried on the card at the same time – in separate 'electronic pockets'. This means that you can take your Mondex card with you when you go abroad on holiday, on business, and change your currency for that of the countries you are visiting and carry on shopping as normal. Each Mondex card can carry up to five different currencies at any one time. Mondex equipment works in the same way, and uses the same icons wherever the holder is around the world – so you can always be sure you know what is happening to your money.

Mondex compatible telephone.

Throwing Open the Gates of Electronic Commerce

Earlier this year, the outlook for the future of electronic payment on the Internet received a major boost. In a ground-breaking initiative, a consortium of world-class companies came together to co-operate on the development of Open Trading Protocols (OTP), with the aim of establishing an open global standard for all forms of trade on the Internet.

The announcement was historic for several reasons. The full list of the companies involved reads like a Who's Who of Internet technology and includes Hewlett-Packard, Sun Microsystems, VeriFone, Open Market Inc, CyberCash, Hitachi, Nokia, IBM, Actra, British Telecom, Dot Matrix, Oracle, Unisource and AT&T, as well as MasterCard International and all of Mondex International's Global Founder banks. Between them, these companies have the expertise and market presence to drive forward the global acceptance of new industry standards, which will ensure that commercial transactions on the Internet are simple, logical and consistent. They also have the development and distribution muscle to put products into the marketplace in the shortest time-frame possible.

Consistent and Secure Trading Standards

With the information of the OTP consortium, another vital piece of the Internet jigsaw has fallen into place. One obvious requirement has already been satisfied – the need for a secure form of electronic payment capable of handling low values across the Web, Mondex, with its chip-to-chip value transfer and advanced cryptographic protection, is ideally suited to this application. But more is needed. For consumers to realise the full benefits of an open market in Web commerce, there is a clear and urgent requirement for standard business protocols, operating across the Internet, to ensure that consumer buying and selling is easy and consistent. The development of OTP will enable purchasing on the Internet to have a common 'look and feel', irrespective of the precise form of electronic payment being used.

OTP will achieve this, and ensure global interoperability for consumer, merchant and bank, with a consistent and documented transfer of value. At the same time, it will also help open the way for chip cards and the Internet to become the principal drivers for each other, as the traditional separation between stored value, Internet and home or remote banking will disappear.

Untangling the Web

The exponential growth of the Internet says Digital has created enormous business opportunities. It has also opened up new and cheaper communication channels. And for the first time, software such as Web browsers provide a true, common client Interface across all operating platforms.

For once, says Digital, the business need and the technological solution are in step. But can you make the best use of the technology? And do you have the expertise to take full advantage of the business opportunities?

Security – or Lack of – A Barrier to European Trade

The electronic messaging and electronic commerce industries are continuously challenged by European businesses to prove

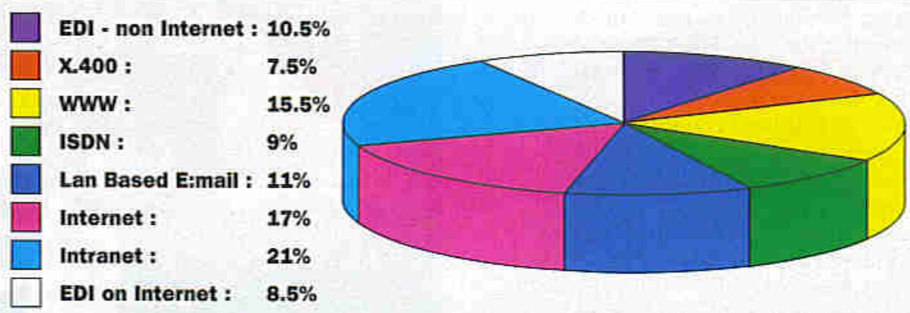


Figure 1. The following elements of electronic commerce business users think will be the single most important technology for their company in the next 12 months. (Courtesy, Noiseworks, June 1997.)

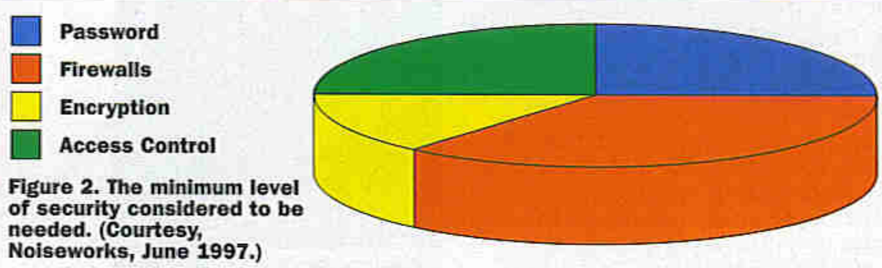


Figure 2. The minimum level of security considered to be needed. (Courtesy, Noiseworks, June 1997.)

that commercial transactions can be made securely, and can be implemented in Europe, according to EEMA.

The security issue is very real and very 'hot' – since the issues are more to do with the legal and regulatory constraints than with technical considerations. Within Europe, we have a position where it is actually illegal to encrypt messages across certain national boundaries.

However, despite the work needing to be done to assist the European harmonisation process, there is a lack of information concerning the current ability of the technical infrastructure to support business-level message encryption. Combined, the perceived lack of an available infrastructure for message security within Europe is now being seen as a limiting factor in the adoption of electronic commerce across the business spectrum.

Chris Taper, chairman of the EEMA Security, Privacy and Legality Committee said, "something as young as the Internet takes time to mature as a business tool, so there are obvious concerns over security".

Hot Encryption

Encryption restrictions was the hot topic at the recent Electronic Commerce Conference organised by EEMA at Maastricht.

EEMA slammed out in all directions, making clear its disappointment with government, with the US, UK and France. Taking some heavy knocks, in particular, EEMA made public its exceptions to the Department of Trade and Industry (DTI) proposals for digital data encryption. EEMA warns that implementation of these proposals will seriously hamper the take up of Electronic Commerce. The UK's plans copy those suggested by the Clinton administration in the States, namely the adoption of 'key escrow'.

Key escrow is based on the requirement that anyone that sends an encrypted message must make the key to decrypt it available to the Government. The DTI's proposal will involve Trusted Third Party (TTP), who will hold copies of the keys to unscramble the data. The TTPs will be obliged to hand over the keys to the judicial authorities upon request.

In some European countries, individuals have the legal right to confidentiality of communications. If the proposals are accepted, the DTI will insist on having access to the decryption key of any encrypted mail entering the UK. EEMA believes this could cause many of Britain's foreign trading partners to cease trade electronically with British companies.

Whilst individual countries within Europe are developing national approaches to the encryption issue, EEMA strongly recommends that European legislation be developed to provide a common market platform. This legislation should encourage and stimulate the growth of Electronic Commerce rather than stifle it. If the DTI proposals are passed, the UK government is in danger of forcing the UK industry out of the electronic marketplace by setting inappropriate and non-compatible regulations.

Meanwhile, EEMA is actively lobbying the European Commission in Brussels to improve competition in the Global Information Society. In a letter sent to Karel Van Miert, the Commissioner for Competition, the Security, Privacy and Legal committee of EEMA, has identified that European companies are being severely disadvantaged by not being able to use secure messaging transmission techniques in conducting legitimate electronic trading.

EEMA recognises that the principal reasons for this are the disparate European legislation controlling the use of encryption and the fact that inter-working with dominant US-based computer software (operating system and application software) is subject to US legislation and restrictions.

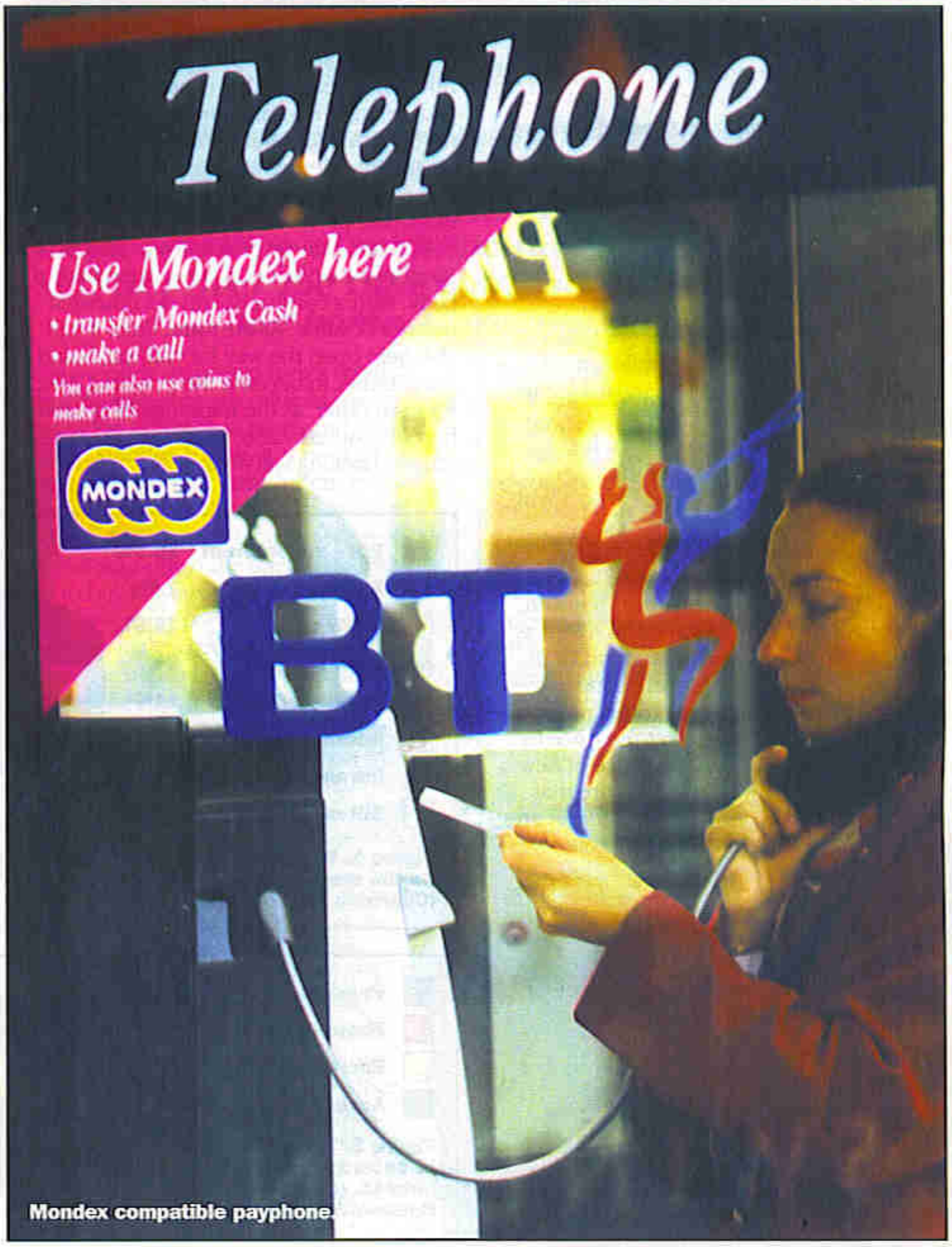
US Legislation Controls have inhibited European industry access to effective security products and even worse, block European suppliers from competing on equal terms with their non-European competitors. Even more damaging is that EU suppliers are prohibited from supplying their own products into their national markets.

Much of the attention at the Maastricht event was focused on Challenge '97, a global industry. The World Electronic Messaging Association Challenge '97 displays the technological benefits and business applications achievable through the creation of a global X.500 directory infrastructure. In addition to resolving a number of technical interoperability issues, another important aim of the Challenge is to clear up the procedural and regulatory difficulties encountered when implementing global directories and the secure exchange of electronic documents.

During EEMA's Challenge.97@Electronic Commerce.Europe, having built an X.500 directory infrastructure that can be used for White and Yellow pages applications, the same directory infrastructure will be used to obtain the security and addressing information required to facilitate the exchange of secure documents via electronic mail.

X.400

But, as The Hill Wick Group points out, the Internet smart Mondex cards are only part of electronics commerce. Another important form of electronic communications – X.400 – is also widely used by major organisations and can provide a complementary or alternative form of communications to the Internet.



Mondex compatible payphone.

The Mondex wallet.

X.400 is a broad-based messaging standard which includes e-mail facilities. It has considerable advantages over many another e-mail protocols as messages can be transferred within the same format in which they were created (for example, Microsoft Word or Excel). X.400 can also be used to transfer EDI (Electronic Data Interchange) information, and to send and receive messages on the Internet. The standard has several inbuilt security features.

Like the Internet, X.400 was established many years ago but has only fairly recently been part of the revolution in electronic communications. In fact, the increase in awareness created by the Internet has also raised the profile of X.400.

Major European telecommunications providers such as Racal, British Telecom, Cable & Wireless and France Telecom have all made a commitment to providing public services based on the X.400 standard. Indeed, it is anticipated that soon all major European telecoms providers, together with the majority of their counterparts in Asia and South America, will offer these services. Also, X.400 is the European Community standard for electronic message exchange.

Using X.400-based services, it is possible to send electronic messages to subscribers connected to most electronic mail systems, including the Internet, CC-Mail, MS-Mail, etc.

Mondex till machine.

The Challenging World of Multimedia

For the world of commerce, the Internet says Digital is developing as a multimedia and entertainment medium in ways that few people have imagined even two or three years ago. The rate of progress continues to increase, opening up immense opportunities for imaginative content providers.

Some are already developing multimedia features will one day pose serious competition for television and other conventional media. But as Charlie Mascari, DIGITAL business manager for network multimedia points out, "content providers need to be aware of the capabilities of their audience, given current bandwidth parameters. Clearly, a corporate Intranet provides more scope for leading-edge content than the mass consumer sector, where most users have modems with speeds of 28,800bps or less".

Higher transmission speeds in the form of ISDN, cable modems and other approaches are all coming, but it will take time for the consumer to catch up. That's why Web multimedia development is moving along two tracks, with most innovations being targeted at the 28,800bps end of the market. Some applications are specifically aimed at the higher bandwidth Intranets, but many that were developed for the low-end user are now being scaled up.

Animation is increasingly favoured by Web developers, as it provides more useful information than present-day mass media and flat-page formats. A good example is the AltaVista site, where employees on the company's Intranet can use multimedia tools to observe how a firewall works. This instantly makes the concept clear before they read the accompanying text.

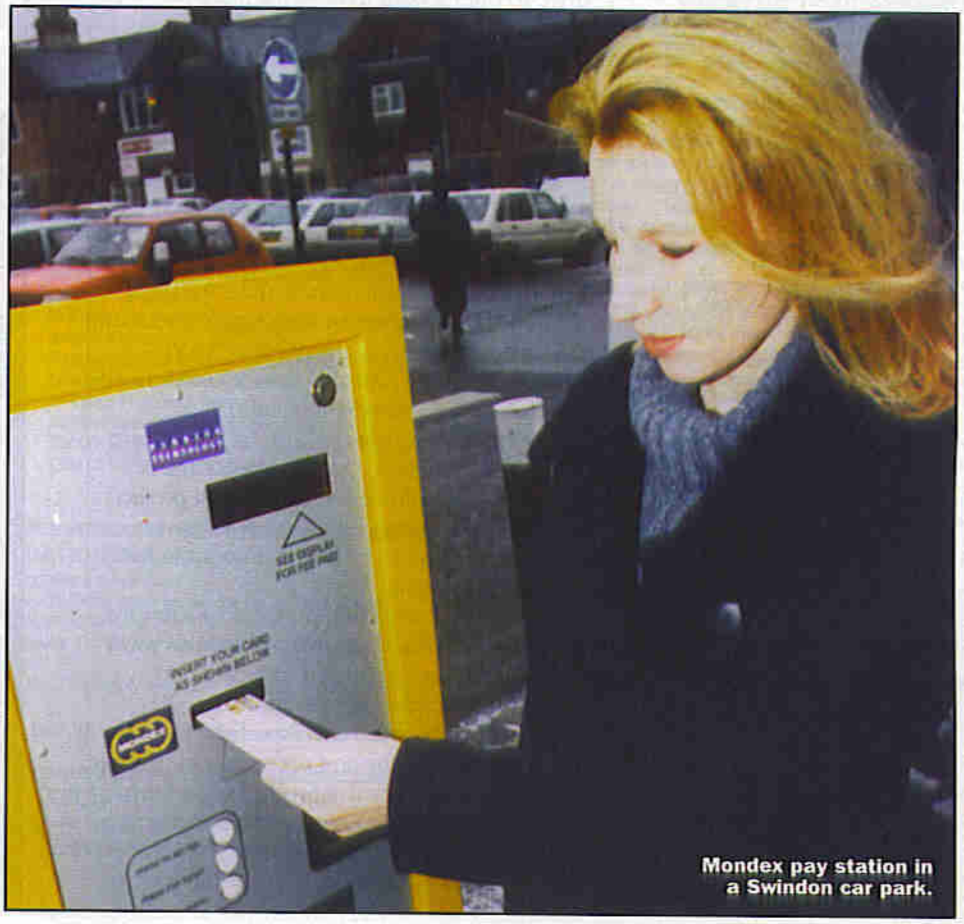
We're now seeing the emergence of a new breed of developer – the content creator – who delivers multimedia applications to sophisticated Web sites. These developers have links with television and film producers, as well as software development expertise, and they bring a fresh approach to multimedia, while working within the limitations of the bandwidth bottleneck.

Audio- and video-conferencing are already available to those who have the bandwidth and interactive virtual seminars with animated sequences are on the way. Also emerging is accessible television programming, which allows you to watch a programme on part of a screen while drilling down into Internet databases for related information.

The Conclusion

Electronic Commerce and Messaging is a fast-moving market and in order for it to continue to grow, the expansion and adoption of new technologies must continue unabated. Large multinational organisations (such as Shell and Unilever) act as early adopters. The Internet is being used, but not to its full potential. Companies are quite happy to use the Internet to advertise, or publish information. The security of messaging for trading is a prime concern.

As for EEMA itself, the organisation appears to have dropped its preoccupation with such matters as EDI X.300 routing and accepted the inevitable role that Internet will take in electronic messaging. Providing always, that security matters can be resolved.



Mondex pay station in a Swindon car park.

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.

November 1997

1 to 2 November. Radio Rally, Llandudno, North Wales. Tel: (01707) 659015.

2 November. Acorn World '97, Wembley Exhibition Centre, London. Tel: (0701) 0709 901.

3 November to 19 December. Amateur Radio Morse Workshop, Highbury College, Newbury. Tel: (01705) 383131.

4 November. Interconnect Technology, Institute of Physics, London. Tel: (0171) 287 4898.

4 November. EUROMILCOMP 97, Wembley Conference and Exhibition Centre, Tel: (01322) 660070.

4 November. Records Management Society of Great Britain, Central London, Tel: (01494) 488599.

4 to 5 November. Software in Sales and Marketing, Wembley Centre, London. Tel: (0181) 541 5040.

4 to 6 November. Computers in Manufacturing, National Exhibition Centre, Birmingham. Tel: (01932) 564 455.

4 to 6 November. Vision & Audio, Olympia, London. Tel: (0171) 244 6433.

5 to 8 November. Apple EXPO '97, Olympia, London. Tel: (0171) 388 2430.

12 to 13 November. Software Development and Web Development '97, Olympia, London. Tel: (0181) 541 5040.

18 November. Electronic Information Displays, Sandown Exhibitions Centre, Esher. Tel: (01822) 614671.

18 to 19 November. Workplace '97, Olympia, London. Tel: (0181) 910 7910.

18 to 19 November. Data Warehousing, Olympia, London. Tel: (0181) 879 3300.

18 to 19 November. Integrated Systems Solutions '97, Sandown Exhibition Centre, London. Tel: (01822) 614671.

18 to 20 November. Computer Graphics & Visual Communications Exhibition, Wembley Exhibition Centre, London. Tel: (0181) 995 3632.

19 November. System Builder, Sandown Exhibition Centre, Esher, Tel: (01822) 614671.

24 November. TMA30, TMA Ventures, Brighton. Tel: (01372) 361000.

26 November. Groupware and Workflow, Bloor Research, The Commonwealth Institute. Tel: (01908) 373311.

26 November. The BackOffice Magazine Conference, The Conference Forum, Aldgate, London. Tel: (0171) 600 9400.

December 1997

3 December. Modelling The Real World – Improving The Performance of IT Processes, Royal Horticultural Hall, London. Tel: (01635) 32338.

3 to 4 December. Digital Processing Data & Image Processing, Sandown Exhibition Centre, London. Tel: (0181) 547 3947.

5 to 7 December. Christmas Computer Show, Olympia, London. Tel: (0181) 568 8374.

6 December. RSGB Annual Meeting, London. Tel: (01707) 659015.

6 December. Computer Sale and Exhibition, NEC, Birmingham. Tel: (01691) 682432.

9 to 11 December. International Online Information Exhibition, Olympia, London. Tel: (01865) 388000.

January 1998

19 to 20 December. Computer Fair, North East Exhibition Centre, Manchester. Tel: (0161) 6268871.

18 January. Oldham Amateur Radio Club Mobile Rally, Elizabeth Hall, Civic Centre, West Street, Oldham, Lancashire. Tel: (01706) 846143.

28 to 29 January. Business Computer Systems Show, G-MEX Centre. Tel: (0161) 725 8016.

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?

Apple Expo '97 – The Multimedia Experience Revived

A new wave of optimism is expected to sweep the Apple Expo '97 in London next month, following Steve Job's rescue package announced early this summer.

Apple Expo running from 5-8th November at the Grand Hall, Olympia, is set to capture the imagination of Mac professionals and enthusiasts looking to sharpen their multimedia techniques, and upgrade related technologies. Visitors will be able to see at first hand the benefits and advancements taking place in this sector and take part in the numerous interactive feature areas, including the Multimedia Arena.

Leading companies such as Quark, Apple, Iomega, Adobe, MetaCreations and Macromedia will demonstrate latest products and upgrades, while also featuring extensively in the Hands-on Workshops and Keynote and Seminar programme.

Claris will offer the first UK viewing of Mac OS 8, providing visitors with an opportunity to test the enhanced ease-of-use, additional multimedia tools, Windows file compatibility and integrated Internet capabilities incorporated within it.

This year's Apple Expo also provides the first chance to see Iomega's revolutionary products, including Zip PLUS – the industry's first parallel drive to offer a path to SCSI for higher performance at higher speeds and with integrated multimedia and software; RecordIt – a digital recording software that enables audio recording and playback on PCs with sound quality comparable to a CD and Buz multimedia producer – the industry's most affordable audio/video and photo capture solution to bridge the gap between consumers, multimedia content and their PCs.

Quark Systems will demonstrate the preview release of QuarkXpress 4.0, the page layout and design tool used by many of today's top publishers. Quark will also show QuarkImmedia – a package which, in conjunction with QuarkXpress, provides publishers with a true cross-media solution. QuarkImmedia enables sophisticated multimedia and Internet projects that include pictures, text, sound, animation, movies and script to be built, without the need for a skilled programmer.

Macromedia, a leading provider of software tools for design and graphics, will showcase a full range of products used to create and compose animation, sound and video. Key products on show include Director 6.0 – the animation, authoring and presentation package; Authorware 4 Interactive Studio – a powerful tool for developing interactive information on Intranets and Flash 2.0 – enabling the creation of complex, powerful animations and interactive designs for the web.

Other innovations on show at Apple Expo '97 include MetaCreations' latest upgrade of Bryce – the 3D landscape generator, together with ArtDabbler – a revised version of Dabbler. Specialising in affordable yet powerful Macintosh software, Microspot will exhibit Version 2.5 of it's 3D World Animation Module, plus Designer add-on pack. Based on Apple's QuickDraw 3D architecture and using 3DMF as its file format, 3D World is an easy to use digital 3D sketching, design, modelling and animation programme.

Recognising the increasing sophistication of multimedia techniques and technologies, Apple Expo is upgrading sessions within one of its most popular feature areas – the Multimedia Arena. Whether the visitors interests lie in education, training, advertising or design, the comprehensive programme of free seminars will demonstrate how multimedia can impact on various application areas. Topics in the Arena – sponsored by Creative Technology – will range from 'Meeting in new worlds; 3D, VML and the rest' to 'Interactive schools and tomorrow's teacher'.

The free keynote and seminar programme has a wide range of multimedia-focused sessions which will offer visitors the opportunity to listen to some of the world's leading authorities on their chosen subjects. Speakers include the widely acclaimed and hugely charismatic Kai Krause, who on Thursday 6th November, will present his vision of design within a 'Pixels, Trixels, Voxels and Fun' keynote.

The Internet Arena, sponsored by Internet Magazine and organised by The Corps Business, with Internet access supplied by MacLine, will be offering free hour-long training sessions, six times a day, on 'Designing for the Internet' using Adobe's popular PageMill software. The sessions – available on a first come, first serve basis – will demonstrate how to structure a web page, linking pages, creating and applying text and graphics, making an animated GIF and do's and don'ts of web page design.

Co-ordinated by Direktek and in association with *Electronic Imaging* magazine, the Electronic Imaging Centre will present complete digital imaging solutions to Mac professionals and enthusiasts. Previously unseen leading-edge computer imaging technologies – including the world's first MPEG Digital Video Camera – will make their debut as top suppliers such as Adobe, CalComp, Hitachi, Polaroid, Linotype-Hell, QMS and Sony unveil the very latest image-capture, manipulation, printing and distribution product solutions.

The Development Pavilion, sponsored by Full Moon Software, will give visitors an insight into the development lifecycle. Also in the Development Pavilion – why the MacOS is the leading platform for Internet and multimedia: everything for digital imaging, photographic virtual reality, Internet/intranet, programming through to training and consultants. In addition, Mac enthusiasts will have an opportunity to preview Rhapsody and experience first hand its vast potential for the future.

The Publishing Centre, sponsored by Publishing and Pre-Press News, will provide visitors with a focus area in which to find Mac publishing solutions for traditional print and electronic publishing. The Centre will demonstrate the latest software innovations enabling design and page layout, Internet publishing and catalogue production on the Mac.

Hands-on Workshops, organised by The Corps Business and sponsored by Graphics International, are 2-hour sessions catering for all levels of ability and experience. These workshops will run from Wednesday through to Friday, focusing on skills ranging from Montaging in Photoshop 4 to QuarkXPress 4 for Power Users and Advanced Illustrator 7.

Visitors can pre-register for free entry to Apple Expo '97 by accessing the exhibition Web site at **www.apple-expo.com** or calling the pre-registration or using the hotline number, Tel: (0181) 240 5055. Entry on the door without pre-registration is £15.00.

Testing Times for HOME CINEMAS

by Nick Rose, OZAN

Installing your own Home Cinema can be fun; but to get the best from your expensive AV equipment, it's well worth investing in a serious piece of test kit

Isn't it just typical!

You spend night after night perfecting your home entertainment system, only to sit down to your favourite movie and find niggling problems!

"Why has the blue sky got patches of green in it?"
"The left and right sound channels are all mixed up!"
"The picture wasn't this grainy before I started playing around!"

Sounds familiar? Well, you could quickly solve most problems by using a small piece of TV test equipment. Then, if you need expert help you can show visiting engineers that your equipment really is in need of repair or alignment. Most importantly, if your equipment is brand new but faulty, you can take it back for an immediate replacement.

TELETESTS

The TELETEST-2 is a low cost, handheld test pattern generator. It produces 6 essential video test patterns and a 1kHz audio test tone. Powered from a 9Volt battery it has all the outputs you could possibly need; Composite Video, S-Video, RF Video / Audio and Line Out Audio.

First designed for TV repair-men, BBC and ITV broadcast engineers soon started using them. Now, more and more home cinema enthusiasts are relying on them to get the most out of their sophisticated AV equipment.

Finding a Quality Signal Source

But how will a TELETEST-2 help you? Well, most home cinema enthusiasts set up their systems using a video cassette, laser disc or an off air TV picture.

Unfortunately you do not know the quality of the source and just as you think you've got your adjustments right, the picture and sound changes.

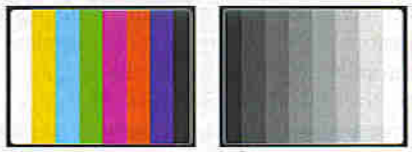
Perfect Picture, Every Time

A TELETEST-2 generates 6 quality video test patterns that are static. You can take as long as you like to get your system just right.

1. Setting up the colour:

The most commonly used pattern is the colour bars. Turn your TV on, plug in the TELETEST and adjust the colour control on the TV until the colour is not too pale or too bright.

Top Tip: *If the colour remains pale, the video cable you are using could be too long or of a poor quality.*



TELETEST-2
Video Patterns as seen on a TV
1. Colour Bars 2. Grey Scale

2. Brightness and Contrast:

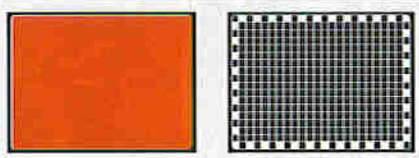
By using the grey scale pattern, you can ensure that all shades from black to white can be seen. When your TV is correctly aligned you should only just be able to see the first shade of grey on the pattern.

Top Tip: *If there is any hint of colour in the grey (eg the grey looks slightly blue) you should get an engineer to adjust the internal RGB levels.*

3. Colour Purity:

Magnets inside loudspeakers can cause distortions in the colour if they are too close to the TV. So, select the Red Purity pattern and move your speakers until the picture is pure red all over the screen.

Top Tip: *If the problem persists, do not worry: it's unlikely you'll need a new TV tube. Just ask your engineer to visit you with a "de-gausing" tool. This can often clear the problem in seconds.*



TELETEST-2
Video Patterns as seen on a TV
3. Red Purity 4. Cross-Hatch

4. Picture Alignment:

If straight lines on your picture look bent, or you can see flashing dots at the top of the screen, the chances are your TV is incorrectly aligned.

The Cross-Hatch pattern on the TELETEST-2 has a grid of vertical and horizontal lines to show up any faults; unless you are experienced with TVs you'll need an engineer to realign your TV set.

Top Tip: *Are the TV Station logos ever half hidden on your picture? This may means that your TV has been overscanned and you are missing up to 20% of the picture. The boxes around the edge of the Cross-Hatch pattern (castellations) will show you this.*

Perfect Sound, Every Time

With complex surround sound systems requiring 6 or more speakers, it is very easy to get wires twisted or plugged into the wrong sockets.

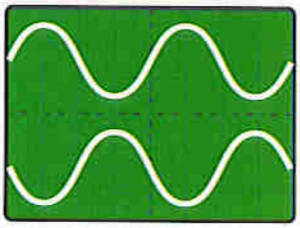
By using the audio generator on the TELETEST-2 you can have a pure signal to test out all parts of your sound system.

5. Sound Phase:

If an audio cable has had the pins soldered the wrong way around, or the speaker wire has been connected back to front, then the sound will be out of phase.

Look at the diagram below and you'll see that if the two signals were added together (your brain does this automatically), the "peaks" of the sound on the top oscilloscope trace will fill in the "troughs" of the sound on the bottom oscilloscope trace.

This can cancel out most of the original signal and mutes the output. It will then sound "tinny".



TELETEST-2 1kHz Audio Sine Wave as seen on an oscilloscope
5. Top trace shows the signal "in phase". The bottom trace shows how the signal would look "out of phase".

Such a simple mistake can often damage your sound equipment.

Top Tip: *By using the TELETEST 2 on both left and right channels you can quickly tell if the sound is out of phase by listening whilst changing the wiring.*

6. Left and Right:

The most common mistake is to connect the left channel into the right channel (or vica versa) at any one point in your sound system.

By connecting the TELETEST-2 to the first input in the audio chain means you can follow the signal and correct it where need be.

As the audio sine wave is at a constant level, you can look at the level meters on your equipment to help guide you through the connection process.

7. Correct Sound Balancing:

If you're lucky with the layout of your room, you'll be able to position all speakers at an equal distance from where the audience will be sitting and the sound will be in the centre of the room.

But in most cases it's not that easy, as even paintings and shelves can affect the sound balance.

As the TELETEST-2 produces a constant audio test signal, you can adjust the balance controls on your amplifiers until the sound level suits the room.

Top Tip: *If the sound is very low on one channel you may have a very poor cable with a high impedance. Try swapping it around with one you know that works to trace the problem.*

TELETEST PC (Top)
A handheld test pattern generator for PC and Multi-Media Monitors

TELETEST Tone (Right)
A handheld audio test tone generator for all audio equipment.

Conclusion

Installing Home Cinemas without a known source of quality audio and video test signals can be a hit and miss affair. Why pay a small fortune on a top of the range VCR, large screen TV and surround sound decoders only to be let down by a badly wired cable?

The TELETEST-2 can save hours of frustration and a small fortune in unnecessary repair charges.

COMPETITION

Win a TELETEST and accessories, worth over £200

To win a TELETEST of your choice, all you have to do is to tick the correct boxes and send your entry into:
TELETEST Competition, Electronics & Beyond, PO Box 777, Rayleigh, Essex, SS6 8LU.
Entries must be received by 5th December 1997. The first correct entry to be pulled out of the hat will be the winner.
All employees of Maplin Electronics and TELETEST are not eligible to enter. Multiple entries will be disqualified. Editors decision is final. Prize is not exchangeable for cash.

1. How many video test patterns does the TELETEST-2 produce?
a) 4 patterns ☐
b) 6 patterns ☐
c) 8 patterns ☐

2. What battery does the TELETEST-2 run from?
a) 9 Volt battery ☐
b) Four 1.5 Volt batteries ☐
c) A watch battery ☐

3. What is the frequency of the audio test tone?
a) 6kHz ☐
b) 3kHz ☐
c) 1kHz ☐

Should I win I would prefer the:
TELETEST-2 (for TVs, VCRs, Home Cinema) ☐
TELETEST PC
(for VGA and S-VGA computer monitors) ☐
TELETEST-Tone (for audio equipment) ☐

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WHAT'S IN A NAME

PART 10

Who 'Invented' Radar?

by Greg Grant

A very good question. In fact, one you could answer – and by no means inaccurately either – by replying 'anyone and everyone'. At the beginning of this series, we saw how Appleton contributed to Continuous Wave radar and Tuve and Breit to Pulse radar. So, let's begin our inquiry by getting our definitions sorted out and then look at the people involved in developing one of the few professions whose name is an acronym.

To 'invent' something is to 'create or devise (new ideas, machines, etc.)'.* It's a 15th century word, developed from the Latin 'invenire', meaning to find, or come upon. To 'contribute', on the other hand, is to 'supply (ideas, opinions, etc.) as part of a debate or discussion.** It's a 16th century development of the Latin 'contribuere', meaning to collect.

Hardly an Invention

Frankly, a great many contributions were made to the emergence of radar, but it could hardly be described as an invention per se. It was discovered to be an inherent characteristic of electromagnetic (EM) waves, and the man who made the discovery was, perhaps, the founding father of communications engineering: Heinrich Hertz.

In the course of his groundbreaking experiments to establish the validity of James Clerk Maxwell's equations, Hertz discovered that EM waves could be reflected by both mirrors and metallic surfaces.

By 1904, the first radar patent had been granted to the Dusseldorf-born engineer, Christian Hulsmeyer. His application described a technique for, as he put it, detecting distant metallic objects by electrical waves. He tested his creation – the 'Telemobiloscope' – on the Rhine by aiming the beam at another steamer, some 550m away. The reflection from the target vessel rang a bell on the receiving equipment. Hulsmeyer, however, was ahead of his time and its technology by some 30 years or so, in fact.

Yet the idea would not go away, and some twenty years later, the great Marconi, no less, advocated a system of ship detection by radio waves, in a speech to the Institute of Radio Engineers, in New York. At the same time, A. Hoyt Taylor – whom we've already met – and Leo Gifford of the United States (US) Naval Research Laboratory at Anacostia, began experimenting with a radar operating on 5m.

With their receiver set up in a motor car and the transmitter static in the laboratory, Taylor and Clifford shortly discovered that a wide variety of metallic structures – including passing cars – made the signal strength vary enormously.

When they drove their receiver to the other bank of the Potomac River, they rediscovered what Hulsmeyer had long known. A small vessel, the 'Dorchester', was heading down river and Taylor and Clifford noticed that 50 feet before it intersected the beam, the signal strength almost doubled. As the ship crossed the beam, the signal dropped to half its strength but, when the stern was 50 feet clear of the beam, the signal again doubled in value prior to returning to its normal level. Consequently, Taylor and Clifford suggested that this effect be used to detect enemy warships, regardless of weather conditions. The US Navy ignored the proposal.

In the following year, two engineers at Britain's Signals Experimental Establishment at Woolwich, W. A. Butement and P. E. Pollard, built a 50m pulsed radio system for ship detection.

Aircraft Detection

There matters rested until 1930, when another Briton, W. J. Brown, writing in the Proceedings of the Institute of Radio Engineers, suggested that radio waves could be used to estimate an aircraft's height above the ground. What was surprising about this suggestion was that it hadn't been aired before. Amateur radio

* *Collins English Dictionary: 3rd edition, 1991. Page 811.*
** *As above, Page 348.*

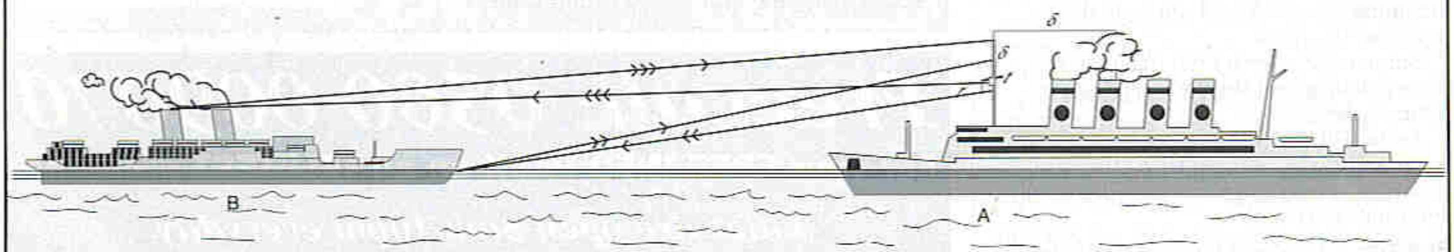

Figure 1. Hulsmeyer's 'Telemobiloscope' of 1904, from the first radar patent.

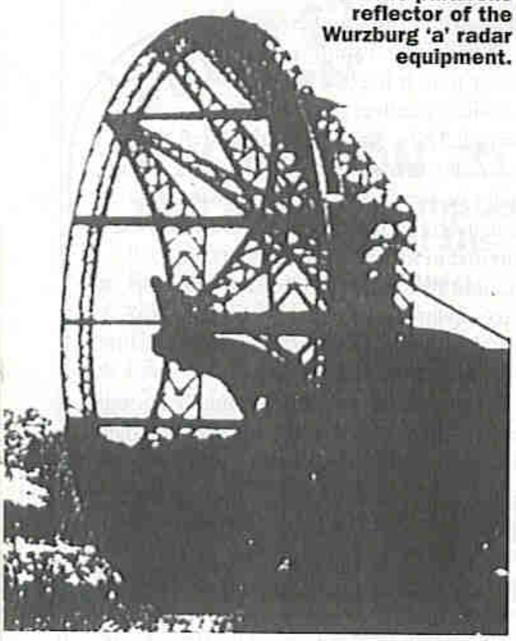

Photo 1. The parabolic reflector of the Wurzburg 'a' radar equipment.

enthusiasts, for example, had long known that aircraft passing overhead affected radio signals and the British Post Office had also noted that aircraft regularly disturbed its transmissions.

In 1934, the Americans revealed a 60MHz, Continuous Wave Interference radar, whilst both the British and Germans were becoming more involved in radar development, but for totally different reasons.

The German Navy's Signals Research Department was far advanced in developing underwater detection devices using pulse techniques. In the course of this work, the departmental head, Dr. Rudolf Kuhnold, realised that the same techniques could also be used for surface detection.

By the late autumn of 1934, Kuhnold had shown that his transmitter, developed around a new, high-power valve from Philips of Eindhoven, could detect surface ships at seven miles. More to the point, the fortuitous accident of an aircraft flying overhead in the course of the test trials, provided another unexpected application: air defence. Kuhnold had re-invented Hulsmeyer's 30-year old wheel!

In the following year, Kuhnold was calculating the target's distance from his transmitter by measuring the time taken between outgoing transmission and received reflection. Shortly afterwards, the German Navy had an operational radar set, working on 600MHz, capable of detecting other vessels at five miles and coastlines at 12 miles. By 1936, the Research Department had developed the 'Freya' radar with a range of 75 miles and the 'Seetakt' equipment, operating on 375MHz.

Two years later, the Germans revealed their new 'Wurzburg A', an excellent Telefunken product transmitting 8kW, and using the same parabolic reflector for transmission and reception. Operating on a frequency of 560MHz, it had a range of 25 miles and later developments would improve its accuracy to within 100m and half a degree!

The Dèath Ray!

The British, on the other hand, had through the popular press, been seized by the idea of a 'death ray.' Today, of course, such ideas appear the epitome of absurdity, but in the mid-1930s, they were taken seriously enough for even hard-boiled realists to ask if they were feasible. One such realist was the Director of Scientific Research at the Air Ministry, Dr. H. E. Wimperis.

Along with his deputy, A. P. Rowe, Wimperis had set up a three-man scientific committee to investigate this idea and one of the individuals requested to give evidence to it was the Head of the Radio Research station at Slough, Robert Watson-Watt.

A small, opinionated Scot with granny glasses, Watson-Watt had been a physics lecturer at University College Dundee, prior to entering the civil service as a research scientist at the National Physical Laboratory. He pointed out to the committee that a 'death ray' was impossible – the power required was, quite simply, astronomical – but added that he thought radio waves could be used to detect aircraft in flight.

He firmed up his ideas in a couple of memoranda in February, 1935, and tests began almost immediately using the British Broadcasting Corporation's (BBC's) shortwave transmitter at Daventry. The target was a Heyford bomber, flying at 3·6km. Transmitter and receiver separation was 8·04km and the range achieved about 12·875km.

Wimperis's committee – the Tizard Committee, called after the scientist who chaired it – were satisfied and recommended that work should continue along the lines of Watson-Watt's memos. The little Scot, with his assistant, A. F. Wilkins and five other physicists, spent the summer of 1935 at Bawdsey Manor, on a remote part of the Suffolk coast, developing practical equipment for aircraft detection. In the course of a few months, the team had created high-power, pulsed-modulation transmitters, as well as receivers capable of handling such signals and the necessary antennas.

By September 1935, Watson-Watt's team was achieving ranges of 160km and more, as well as measuring an aircraft's height above ground through the angle of arrival of the echo. By the spring of the following year, detection ranges had increased to 145km and the Air Ministry – suitably impressed – agreed to the construction of five radar stations on the East Coast.

Chain Home Stations

By September 1938, the majority of these units – known as Chain Home stations – were up and running. One of their earliest achievements was plotting the track of Prime Minister Neville Chamberlain's aircraft as it flew to Munich for the 'peace in our time' meeting with Adolf Hitler. Shortly afterwards, the stations were put on 24-hour operation.

The Chain Home system, however, had a snag: it couldn't detect low-flying aircraft. This problem was overcome by the development of the Chain Home Low (CHL) equipment, operating at 200MHz with a range of 80km. The British didn't stop there, however. They realised that information per se is useless unless processed in a usable manner. Consequently, they developed a fighter control system where the radar images were plotted on an operations map of the radar coverage area. This gave the Senior Fighter Controller and his staff an excellent overview of the enemy build-up and hence the impending battle, enabling him to deploy his own aircraft to maximum effect.

In France too, radar was under development. As early as 1934, Societe Francaise Radioelectrique scientists began looking into metric and decimetric techniques, the object being the saving of life at sea. In the following year, what was termed an 'Obstacle Detector' was installed on the liner 'Normandie'. It was decimetric and employed pulse techniques and a second model was installed at Le Havre, to control the port's traffic.

In the US meanwhile, L. A. Hyland, a friend of Hoyt Taylor, accidentally discovered that aircraft interfered with radio signals, whilst his colleague Leo Young developed a pulse system that gave the same results.

The US Navy, however, remained considerably underwhelmed and it took the persistent pushing of the Navy Laboratory's head, Robert Page, before the Service reluctantly parted with $100,000 for further

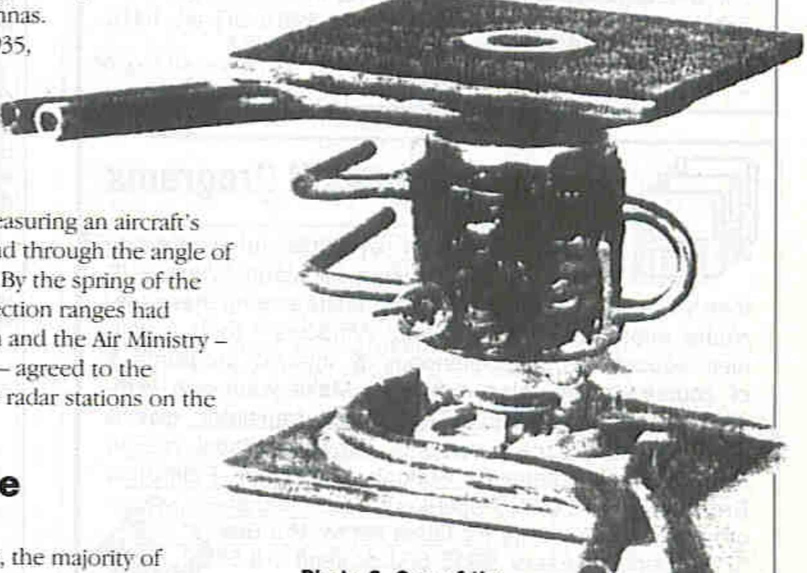

Photo 2. One of the earliest Cavity Magnetrons.

radar research. By 1938, two years after intensive laboratory work and demonstrations, the American Navy got around to fitting radar in a few of its warships.

In 1937, Birmingham University appointed a new Poynting Professor of Physics, Mark Oliphant. He was shortly joined by his first senior researcher, John Randall, who'd had considerable industrial experience in luminescence research with the General Electric Company (GEC). Also in the physics department at this time was a student called Harry Boot, working towards his BSc degree. The stage was set for the next major development in radar.

The Klystron

Oliphant was unusual in that he thought war was only a matter of a year or two away. He therefore felt that radar would have to progress beyond its present point and so, on a visit to Stanford University in America in the spring of 1939, he wasted no time in studying the newly invented Klystron.

The creation of the Varian brothers, Russell and Sigurd, the device first appeared in 1937, using an idea first put forward by a Stanford University physicist, William Hanson: the Cavity Resonator.

The Birmingham team initially thought that the klystron could, with further development, give microwave radiation at 10cm. This wavelength was important for many reasons such as, for example, far smaller antennas producing narrow beams, which wouldn't be neutralised by ground reflections. Another reason was that size was vital in an airborne context, both as regards antennas and equipment.

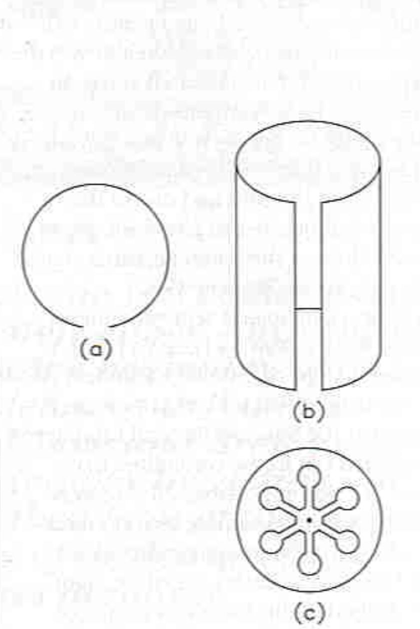

Figure 2. The cavity resonator, from (a) the Knockenkein Coil of Hertz to Randall's extension of it into a cylinder (b), to the final Cavity Magnetron (c).

The klystron rapidly proved to read better than it lived, the team deciding that it couldn't deliver a high enough power output. Then, Randall recalled that there was one other source of microwaves that might be worth looking at: the Knochenhaur Coil, used by Heinrich Hertz as a receiving antenna in his early experiments. Randall thought that you could expand the loop into a cylinder and the gap into a slot. You could then group several such slots around a centrally located cathode.

It sounded simple and, strangely enough, the first device was simple, cut from a block of copper in December, 1939. With a DC voltage applied between cathode and anode, the electron flow was in a direct path across the intervening space. When the device was placed in a magnetic field, however, the electrons followed a circular path, setting up oscillations in the slots in the copper block.

Power and Refinement

After a little more refinement, the prototype was ready for testing in February, 1940. To Randall and Boot's astonishment, the power output was some 400W! Randall's inspired back-to-the-future suggestion, indeed to the first name in communications engineering, had given radar a terrific impetus, one that continues to this day.

MPS
MAPLIN PROFESSIONAL

CATALOGUE PREVIEW

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E-mail: whatnet@cix.compulink.co.uk

Welcome to another mini preview of the new Maplin MPS catalogue, bringing you a selection of the newest and most popular products from Maplin MPS. You'll find some useful information on Video Accessories and Security Hints in this supplement. See our new catalogue for many thousands of electronics and associated products.

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In general prices are valid until 28th February 1998.
* Subject to availability.

VIDEO ACCESSORIES SELECTION GUIDE

AV LEADS

Phono-to-SCART and phono-to-phono leads can be used to connect a camcorder to a VCR when copying or editing. SCART leads, meanwhile, are intended for interconnecting VCRs, satellite receivers, laserdisc players and TV sets. Using SCART means better picture/sound quality - and stereo sound (if your equipment is stereo). S-video leads are intended for the interconnection of high-band equipment, such as Hi-8 camcorders and S-VHS video recorders.

LENS ADAPTORS

Various types are available. Some are designed to expand your camcorder's field of view, so that you can see more with panorama shots. Others increase the power of the zoom lens, so that you can see distant objects more clearly.

TRIPOD

These provide a stable platform for your camcorder. Using a tripod prevents wobbly pictures - the bugbear of home movies - particularly when the zoom lens is used.

CARRYING CASES

These are designed to protect your camcorder when in storage, or transit. They normally also hold batteries, tapes and other accessories.

VIDEO LIGHT

Camcorders give poor pictures when light levels are low. A video light, which has a high-power halogen bulb, provides an additional light source for illuminating your subject.

CAMCORDER MICROPHONES

An external microphone will reduce the rumblings picked up from the camcorder's mechanics. They generally offer a better sound quality too. Tie-clip microphones are intended for interview situations; other mikes, which clip onto the camcorder's accessory shoe, are intended for capturing the aural ambience of a shoot.

CAMCORDER BATTERIES

Maplin stock a range of replacement battery packs for most camcorders. If you need longer shooting times, or need to power a video light, choose one of the higher capacity versions.

BATTERY CHARGER/DISCHARGER

These treat your batteries better than the fast chargers supplied with most camcorders. These devices help to eliminate the 'memory effect associated with Ni-Cd cells, increasing the life of your camcorder battery packs.

COLOUR LCD TV MONITOR

Not all camcorders include an in-built colour screen - for those that don't, one of these devices allows you to playback recorded footage in colour, and check white balance prior to shooting. The TV tuner will allow you to catch up with your favourite TV programme when you're not at home.

EDIT CONTROLLER

These devices are designed to semi-automate editing the process. By operating its controls, you can decide the order in which you want your home movie segments assembled. The unit will then operate both VCR and camcorder, switching them into record, play, pause and search at the appropriate times. It requires a camcorder with an 'edit' socket, and a VCR with infra-red remote control.

COLOUR CORRECTOR

These units allow the individual red, green and blue levels of the video picture to be adjusted. Colour correctors are primarily designed to compensate for blue or red casts introduced by camcorder white-balance misadjustment, but they can also be used to creative effect with perfect footage. For example, a sepia tint gives the impression of vintage film, while a blue tint gives a cold atomsphere. Most colour correctors also have a video invert facility (for recording

stills from 35mm negatives using a camcorder), a split-screen function for monitoring the changes to a picture, and TV-like controls for colour, contrast and brightness adjustment.

VIDEO PROCESSOR AND AUDIO MIXER

A simpler version of the colour corrector, with adjustments for overall colour level, picture sharpness and fade. Some units include a stereo audio mixer, so that music, effects and commentary can be mixed into home movie soundtracks during the copying/editing stage.

TITLER

Add beginning, end and subtitles to your home-grown productions. High quality text, available in a number of font styles, sizes and colours, can be stored as 'pages' in memory. As the edit progresses, the pre-prepared title pages can be revealed at the touch of a button. Text can be made to scroll, flash and fade - giving a professional finish.

WIPE GENERATOR AND MIXER

If you've watched 1970s episodes of Top of the Pops, you will be familiar with the wipe, which makes all kind of interesting effects possible. Wipes reveal a coloured background, which progressively replaces areas of the picture under the user's control. Wipes can act from the centre of the picture (using a variety of shapes), or from the sides of the screen. With some units, the sharpness of the edge can be varied for effect, and the background colour changed.The more expensive units allow one video source to be wiped or dissolved (faded) into another. Such units also include other digital effects, such as mosaics and strobes. Another useful feature is chromakey, which is normally associated with putting weathermen against their computer-generated maps. An actor is placed against a coloured backdrop (normally blue, since it rarely occurs in the human body) - chromakey replaces all of this colour with the images from the second video source.

SECURITY HINTS – A GUIDE

Event Capture Recorder
ORDER CODE: 53256
£349.99

CARS

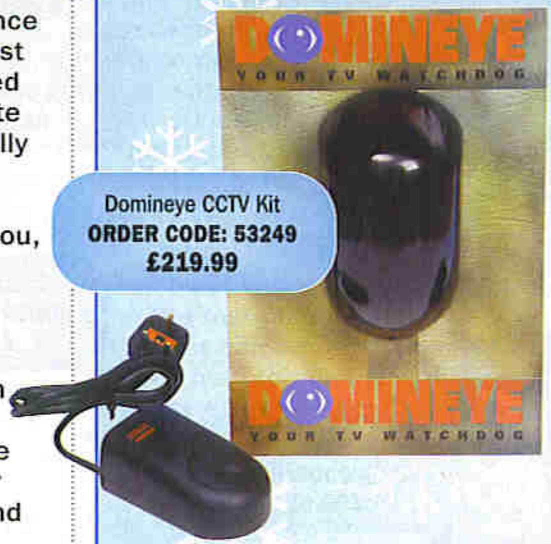
1. Lock your vehicle after parking it.
2. If your vehicle is equipped with a pull out stereo, remove it and lock it in the boot after parking the vehicle. If it has a detachable control panel, remove it.
3. Do not leave valuables, such as shopping and cellular phones, on view in your car when you are not in it.
4. Lock doors and close windows when travelling alone at night - this particularly applies to women drivers. Criminals could otherwise easily force entry into the vehicle when stationary.
5. Do not leave items like cellphones on the passenger seat - these can be grabbed by criminals as you wait in jams or at traffic lights.
6. Retract radio aerials when leaving the car, to prevent them from becoming a target for vandalism. Window-foil and automatic (motorised) aerials are available as an alternative to manually-retractable ones.
7. Fit a high-quality alarm or immobiliser. Not only will this deter theft, but it will also normally entitle you to a discount on your motor insurance. Inexpensive dummy alarms, typically flashing red LEDs, may deter thieves. They don't offer protection, however, and they certainly won't give you a discount on your insurance.

Modern car alarms, which attract attention by flashing lights and/or sounding a built-in piezo horn, can be hooked up to a variety of sensors. The motion sensor is triggered by the vibrations of a criminal trying to force open a boot or door. Door and switches are also triggered by forced entry. Ultrasonic sensors will detect breaking glass, and the presence of criminals within the car. Most alarms are armed and disarmed by using a coded keyfob remote control - some will automatically arm themselves when the last door has been closed. Don't forget to take your keys with you, though, or you'll be locked out!).Some will interface to central locking systems and electric windows, and will lock doors and close windows when armed. Many incorporate immobilisers - thieves won't be able to start the engine. Other car alarms will emit a bleep and flash hazard lamps just before disarming as you approach the vehicle and activate the keyfob remote - this can help you to locate your vehicle in a crowded car park.Alarms for motorcycles are also available from Maplin.

Smoke Alarm Test Match
ORDER CODE: 53247
£1.25

HOMES

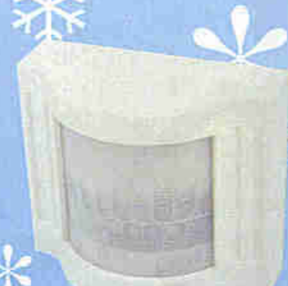
1. Close and lock all doors and windows when you leave the house. Hardware stores sell locks for securing windows. Padlock all gates that afford access to the rear of the property.
2. When going on holiday, inform neighbours so that they can keep an eye on the house in your absence. Don't forget to cancel the milk and newspapers - a build-up of these items will attract the attentions of criminals.
3. Leave a light on at night, to give the impression that you are in. Maplin sells light switches with a built-in timer that will switch on lighting during the appropriate time period. Plug-in time switches will allow desktop lights and other items to be switched on automatically. There are also switches that are inserted between a bayonet light fitting and the lamp bulb. Although most of these devices are based around the use of time switches, some others will switch on according to the ambient light level. This can be useful since you won't need to reset a timer's clock to BST or GMT.



Domineye CCTV Kit
ORDER CODE: 53249
£219.99

Smoke Detector Camera
ORDER CODE: 53257
£149.99

Programmable Security Light Switch
ORDER CODE: 53255
£22.99



Minature Infra-red Detector
ORDER CODE: 53246
£22.99

Kryptolok Cycle U-Lock
ORDER CODE: 53253
£14.99

Floodlight Security System
ORDER CODE: 53252
£15.99

Mini CCTV System
ORDER CODE: 53251
£199.99

Smoke ALarm Twin Pack
ORDER CODE: 53248
£8.99

AJ400 Burglar Alarm Kit
ORDER CODE: 53245
£54.99

4. Many modern TVs have built-in timers that will switch on the set at a preset period, thus giving the impression that there is activity in the building.

5. A security TV camera, mounted in the doorway, will allow you to check on callers before opening the door. Some systems will display the image from the camera on a standard TV set - others have dedicated black-and-white monitors. The camera could be fitted to other areas requiring monitoring, such as sheds, garages and out-houses. Many security cameras incorporate a microphone, so that you can hear the caller. A cheaper alternative is the fish-eye lens, which is mounted through a hole drilled into the front door.

6. If you want to speak to a caller before admitting them, a range of security intercoms are available. A caller presses a button, which activates a buzzer on an indoor unit. The noise alerts you to their presence; you can then then press a button to initiate conversation. Some security cameras provide intercom facilities.

7. Halogen security lamps, available in a variety of styles, are fitted to exterior walls. They include a passive infra-red (PIR) sensor that will activate when an intruder moves into close proximity to the beam. Their cover is thus blown. The sensitivity and range of the sensor can be adjusted to prevent false triggering by pets or people walking down the street.

160° Door Viewer
ORDER CODE: 53250
£1.99

Smaller, lower powered security lamps are ideal for installation at the front of the house, and are useful for providing automatic lighting when you arrive home in the dark with shopping. The higher-powered units are intended for use in rear gardens. They can also be used to provide evening lighting for social events, such as barbeques.

8. Install a good alarm. The easiest to set up are wireless alarms, in which the sensors communicate with a central control panel by means of radio waves. With wireless alarms, there's no need to run wires around the building. The more comprehensive alarms tend to be connected to sensors and exterior alarm boxes by means of wires, though. Sensors available include PIR types for detecting intruders in rooms, magnetic types that are triggered by the opening of a door or window, and conductive window foil that goes open-circuit when glass is broken.Be wary of the insurance benefits of a house alarm, though. If an insurance company can prove that you didn't arm the alarm, they can render all claims void - a sobering prospect, if many valuable items were stolen. Note that arming a house alarm is normally a much more involved process than the process required for a car alarm.

Ultra Sonic Immobiliser Alarm
ORDER CODE: 53254
£119.99

projects New Project

150W BIPOLAR POWER AMPLIFIER

PROJECT RATING 2

FEATURES:
- 175W RMS into 4Ω*
- 100W RMS into 8Ω*
- Classic Bipolar design throughout
- Wide frequency response 15Hz to 37kHz (-3dB)*
- Low distortion less than 0.1% at 1kHz*
- Full output at 1V RMS input*
- Operating voltage ±25V to ±50V DC

APPLICATIONS:
- PA Systems
- Disco equipment
- In Car Entertainment using PSU LP39N

*Quoted values measured using recommended PSU

Kit includes all components, PCB, heatsink, greaseless insulators, fixing hardware and full instructions. Pre-amp components and PSU not supplied.

150W BIPOLAR AMPLIFIER KIT LP33L £34.99
Construction details: 150W Bipolar Amplifier Kit leaflet XZ37S 50p
Issue 107 / November 1996 Electronics & beyond XD07H £2.25

AUDIO VIDEO MODULATOR

FEATURES:
- Simple construction. No alignment required
- Multiple inputs – SCART or BNC/Phono
- Silk-screened, pre-punched case
- Built in test signal for TV tuning
- Allows video equipment such as camcorders to be connected directly to the RF input of any TV
- Provides a SCART input to your TV (Composite video and audio only)
- Allows two videos to be linked without disconnecting the TV

APPLICATIONS:
- Low cost security monitoring using our range of CCD cameras

Kit includes all components, connectors, wire, PCB, box, and full instructions.

Requires +8V to +15V DC regulated mains adaptor 300mA minimum (not supplied).

PROJECT RATING 2

AUDIO VIDEO MODULATOR KIT LU35Q £34.99
Construction details: Audio Video Modulator leaflet XZ10L 80p
Issue 108 / December 1996 Electronics & beyond XD08J £2.25

ACTIVE TRANSFORMER DI BOX

FEATURES:
- Active design
- Battery or PSU operation
- Low battery and power on indicators
- 6.35mm (1/4in) jack inputs and XLR output
- Pre-punched silk-screened front and rear panels
- Sturdy and compact

IDEAL FOR:
- Matching unbalanced lines into balanced inputs
- Breaking earth loops
- Impedance matching

PROJECT RATING 1 Simple

Kit includes all components, connectors, wire, PCB, box, panel labels and full instructions. Requires PP3 battery or 9V mains adaptor (not supplied)

ACTIVE TRANSFORMER DI BOX KIT LU32K £29.99
Construction details: Active Transformer DI Box leaflet XV98G 50p
Issue 106 / October 1996 Electronics & beyond XD06G £2.25

ACTIVE SCART SPLITTER/SELECTOR

PROJECT RATING 2

FEATURES:
- SCART, Composite and S-Video compatible
- Separate phono audio outputs
- Split or source 2 ways
- Can be daisy chained for more outputs
- Easy to build and use
- Mains powered 230V AC 1.84W

IDEAL FOR:
- Connecting a single TV, VCR or cable/satellite unit to two other units
- Buffering of signals to reduce degradation
- Simple input selection of audio and video source

Kit includes all components, connectors, PSU, mains lead and plug, PCB, labelled box and full instructions. Connecting leads are dependant on use and not supplied.

ACTIVE SCART SPLITTER/SELECTOR KIT LU21X £34.99
Construction details: Active SCART Splitter/Selector leaflet XZ36P 80p
Issue 107 / November 1996 Electronics & beyond XD07H £2.25

These kits are:
- Supplied with high-quality fibre-glass PCBs – pre-tinned, with printed legend and solder resist
- Supplied with comprehensive instructions and a constructors' guide
- Covered by the Maplin Get-You-Working Service and 12-month warranty

Kits do not include tools or test equipment. Kits may require additional components or products, depending on application, please refer to construction details or contact the Maplin Technical Support Helpline (Tel: 01702 556001) if in doubt.

Kits from Maplin

AUDIO LEAD CHECKER KIT

– No home or professional studio should be without one!

FEATURES:

- Easily and clearly identifies interconnections on most types of audio cable
- Battery powered and portable
- Easy to build
- No setting up required
- EMC / CE Compliant

IDEAL FOR:

- PA/sound engineers
- Gigging Bands
- Home & professional studios
- Audio/Hi-Fi

PROJECT RATING 3 Average

Kit includes all components, PCB, box, box label, sockets, wire, etc., and full instructions. Requires Alkaline PP3 battery (not included in kit).

AUDIO LEAD CHECKER KIT LU26D £19.99
Construction details: Audio Lead Checker Leaflet XZ20W 80p
Issue 114 / June 1997 Electronics & Beyond XD14Q £2.25

1.5A VARIABLE VOLTAGE POSITIVE AND NEGATIVE REGULATED PSU KITS

NEW LOW PRICE!

PROJECT RATING 3 Average

FEATURES:

- Output reverse polarity and back-voltage protection
- Output voltage range: 1.25V to 37V (depending on input)
- LED power-on indication
- Variable output voltage
- Low noise
- Compact dimensions
- Easy to build
- Can be used with single, split and twin secondary transformers
- EMC / CE compliant

Kit includes all components, PCB, heatsink and full instructions. Mains transformer, other mains-side components and enclosure are dependant on users intended application and therefore not included in the kit.

VARIABLE POSITIVE PSU KIT LU86T £7.99
VARIABLE NEGATIVE PSU KIT LU87U £7.99
Construction details: Positive and Negative Variable PSU Leaflet XZ40T 50p
Issue 113 / May 1997 Electronics & Beyond XD13P £2.25

SIREN SOUND GENERATOR KITS

NEW LOW PRICE!

FEATURES:

- Easy to build – ideal beginners' project
- Three versions available
- Auto power-off for long battery life
- Low quiescent current (typically 1μA @ 3V)
- Wide supply voltage range: 2.4V to 24V
- Speaker or buzzer output drive
- Touch, switch contact or digital input to trigger siren
- Pulsed LED output
- Compact PCB
- EMC / CE Compliant

IDEAL FOR:

- Audible warning devices
- Sirens and alarms
- Children's toys

PROJECT RATING 1 Simple

Kit includes all components, PCB, LED, piezo sounder and full instructions. Enclosure, loudspeaker, switch/touch pads, battery, etc., are dependant on user's intended application and therefore not included in the kit.

CAR ALARM SIREN KIT LU85G £6.99 USA POLICE SIREN KIT LU88V £6.99
WAILING POLICE SIREN KIT LU89W £6.99
Construction details: Siren Sound Generator Leaflet XZ42V 50p
Issue 112 / April 1997 Electronics & Beyond XD12N £2.25

ELECTRONIC DICE KIT

NEW LOW PRICE!

FEATURES:

- Easy to build – ideal beginners' project
- Auto power-off for long battery life
- Low quiescent current (typically 1μA)
- 3V supply voltage (2 x 1.5V cells ideal)
- Touch, switch contact or digital input to 'roll' dice
- 'Rolling dice' sound effect
- Dice can be interlinked for games requiring more than one dice
- EMC / CE Compliant

Kit includes all components, PCB, LEDs, piezo sounder and full instructions. Enclosure, fixing hardware, switch/touch pads, battery, etc., are dependant on user's intended application and therefore not included in the kit.

ELECTRONIC DICE KIT LU78K £6.99
Construction details: Electronic Dice Leaflet XZ43W 50p
Issue 112 / April 1997 Electronics & Beyond XD12N £2.25

VIDEO DISTRIBUTION AMPLIFIER KIT

TOP SELLER!

FEATURES:

- Composite video input/output
- Four outputs as standard
- Units can be cascaded for multiple outputs
- Easy to build and use
- Compact dimensions
- Video gain (0dB to 8dB) control
- HF boost (0dB to 8dB) controls
- Wide bandwidth: 20Hz to 50MHz
- 75Ω or high impedance input
- 75Ω outputs
- Single +12V DC @ 50mA Supply
- EMC / CE Compliant

PROJECT RATING 1 Simple

IDEAL FOR:

- Video signal distribution
- Video dubbing/duplication
- CCTV/Security

Kit includes all components, PCB, potentiometers and full instructions. Enclosure, knobs, coaxial cable, connectors, etc., are dependant on user's intended application and therefore not included in the kit.

VIDEO DISTRIBUTION AMPLIFIER KIT LU79L £14.99
Construction details: Video Distribution Amplifier Leaflet XZ38R 50p
Issue 111 / March 1997 Electronics & Beyond XD11M £2.25

CONTINUITY TESTER KIT

PROJECT RATING 1 Simple

FEATURES:

- Easy to build – ideal beginners' project
- Audible continuity indication
- Can discriminate between semiconductor junctions and 'true short-circuits'
- Compact, lightweight and portable
- Battery powered
- No setting up required
- EMC / CE Compliant

NEW LOW PRICE!

IDEAL FOR:

- Tracing faults on PCBs
- Checking components
- Tracing wiring

Kit includes all components, PCB, box, box label, sockets, wire, speaker, test leads, etc., and full instructions. Requires Alkaline PP3 battery (not included in kit).

CONTINUITY TESTER KIT JA13P £14.99
Construction details: Continuity Tester Leaflet XZ39N 50p
Issue 111 / March 1997 Electronics & Beyond XD11M £2.25

ORDER NOW!

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Or Tel: 01702 554002 for details of your nearest Maplin or Mondo store.
Please quote **Priority Reference Code MA035** When ordering.

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MAPLIN

Internet Web Site: **http://www.maplin.co.uk**

TECHNOLOGY WATCH

with Martin Pipe

Flat-screen displays, which have been with us for some time now, were developed out of applicatory need. The conventional cathode ray tube (CRT), which has its roots in late 19th century technology, is bulky, heavy and requires high-voltage power supplies. It is simply not suitable for portable devices such as laptop computers and hand-held TVs. Sir Clive Sinclair designed a low-profile flat-screen display for use in a portable black and white TV set. Sinclair's tube was essentially a conventional monochrome CRT that used ingenious design techniques to minimise the profile of the tube.

Unfortunately, the Sinclair TV was never a commercial success, and its design seems to have disappeared without trace. Perhaps the mass-market need for colour was a major factor. Cambridge-based CDT, covered in a previous Technology Watch (and in an article in Issue 116 – Ed.), is working on a colour version of its light-emitting polymer (LEP) flat-panel display system. LEPs are cheap to manufacture, but are currently monochrome only. Presently, they're intended for devices like mobile phones and car radios.

The most successful flat-panel displays so far have been active matrix LCD panels, most of which have originated from Far Eastern companies. They can be found in everything from notebook PCs to high-end camcorders. Active matrix LCDs do have some disadvantages, however – they have a restricted viewing angle, image lag and a high unit cost (they're difficult to manufacture, and yields are poor). Indeed, they can account for a third or more of the notebook's total cost. What's more, there's a trade-off between colour depth and opacity. In other words, the greater the number of colours required, the more powerful the backlight needs to be.

Higher picture quality is available from plasma-addressed LCD (PALC) displays – albeit at a much higher price. This technology was used in Sony's Plasmatron – the first 'hang on the wall' telly. Unfortunately, the Plasmatron – which was demonstrated to the public at the Live '96 exhibition – sells for several thousand pounds. This sum will buy you a decent video projector capable of throwing an enormous image on a wall or screen. Plasma-based displays, which are also being developed by Fujitsu, Matsushita and Sharp, consume a lot of power – while they may be suitable for mains-powered TVs, they're a poor choice for portable computers.

At the present time, the good old shadowmask CRT gives the best price/performance ratio and is the technology of choice, provided that portability isn't an issue. All this could change if a new technology – known as ThinCRT – is adopted. ThinCRT, which is being developed by Californian company Candescent (**http://www.candescent.com**), promises to bring the CRT – and its performance advantages – into the 21st century. A 2·3in. diagonal colour prototype of the ThinCRT was demonstrated in early 1996. Larger types are currently being developed.

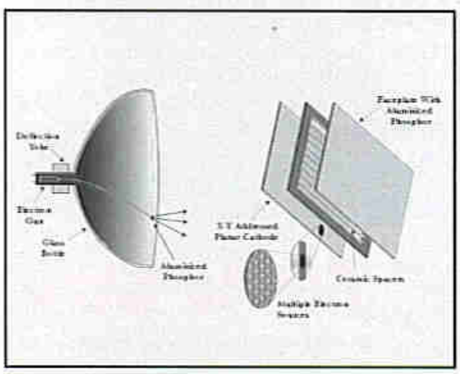
As with the conventional CRT, beams of electrons are fired from negatively-charged cathodes through an evacuated glass tube. The electrons strike phosphors at the front of the tube – the screen – causing them to glow and create a picture. While this basic principle is the same, the technologies and construction are radically different. The ThinCRT tube is a flat panel of 8mm thickness, and instead of the CRT's single large cathode, there are millions of microscopic electron emitters (nanoemitters) spread across the back of the tube in an addressable X/Y (row/column) matrix.

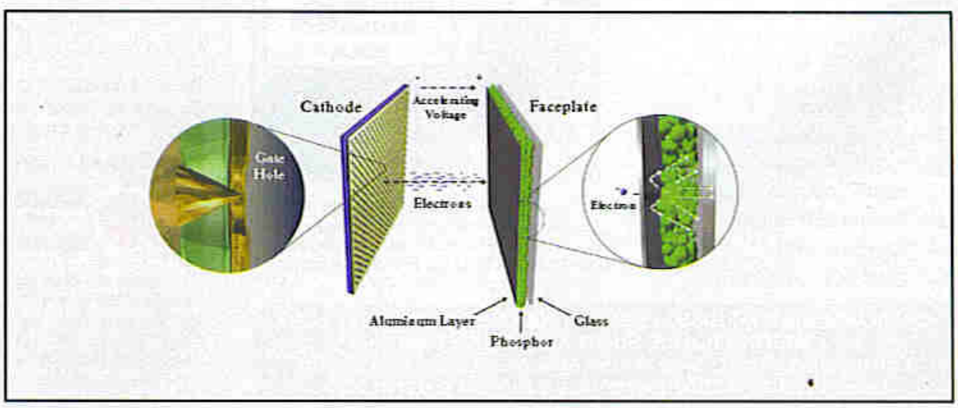
Each of these nanoemitters fires a small 'beamlet' of electrons towards the screen. Nanoemitters operate when a small voltage is applied to both row and column. They use a technology known as 'cold cathode', that consumes only a small fraction of the power used by the traditional CRT's heated cathode. According to Candescent, a notebook-sized screen will consume less than 2W of power. This is far less than a conventional CRT's 100W, and even less than today's active matrix LCD panels (particularly when the backlight is considered).

The screen's picture elements (pixels) are formed by depositing standard red, green, and blue TV phosphors on the screen, together with a thin aluminium layer to reflect coloured light towards the viewer. The layout of these sub-pixel phosphors corresponds to the layout of the nanoemitters on the back-mounted cathode assembly. A focusing grid is layered on the cathode, collimating electrons to strike the corresponding sub-pixel. Through this use of phosphors to emit light, ThinCRT has the wide viewing range as a conventional CRT screen.

Compare this with LCD-type screens. Away from an optimum viewing angle, images appear fainter and readability decreases. Although this does have some advantages – it means that the nosey person sitting next to you on the train is less likely to see what you're typing – it is annoying if you actually want a group of individuals to see the screen simultaneously. Multimedia presentations and regular TV are two examples where the wide viewing angle of ThinCRT will prove useful.

The ThinCRTs 5ms response time is ten times faster than that of an active matrix LCD panel, making it better suited to applications like full-motion video. Another video-friendly advantage of the ThinCRT over the active matrix LCD is its ability to deliver 24-bit colour and high resolution – demanded by high-quality multimedia applications – without brightness or power trade-offs. In active matrix LCDs, increasing





the resolution and/or colour depth reduces its efficiency. The backlight can be increased to compensate for this, but power consumption is increased and notebook battery life correspondingly reduced.

During the development of the ThinCRT, Candescent had to develop a new, proprietary ceramic material for use in the support structures that separate the back and front of the picture tube. These supports had to be strong enough to resist the atmospheric pressure bearing down on the tube – which could exceed 1,000psi on a 12in. display (the largest currently envisaged). At the same time, they had to be small enough to be invisible to the user, and electrically neutral to avoid deflecting the electron beams. Other innovations included a new photolithographic technique for fabricating billions of microscopic emitters across a glass substrate, and a mechanism that could precisely focus electron beamlets on their target phosphors, resisting the natural tendency of the electrons to repel each other and scatter.

Candescent will initially focus on the notebook computer market. Stanford Resources Inc. estimated this to be worth $6·5 billion in 1996, and predict that the figure will reach $10·3 billion by 2002. This computer focus isn't surprising when you look at the company's backers and partners, which include Hewlett-Packard and Compaq. Other backers include specialist companies in the fields of glass, thin-film technology, military systems and automated manufacture. Add to this, the various venture capitalists and it comes as no surprise to learn that Candescent has raised more than $230 million in total funding since its incorporation in 1991. This includes $56·7 million injected during mid-July of this year alone. Clearly, ThinCRT is now in a state where it has considerable commercial potential.

The company has its eyes on other small-screen markets. Candescent believes that desktop computers, personal digital assistants (PDAs), hand-held TVs and video phones could all benefit from ThinCRT. It estimates that ThinCRTs will have a 30-50% cost advantage over active matrix LCDs of comparable size – clearly a benefit in the highly competitive world of consumer electronics. The desktop computer market is an interesting one – indeed, you can purchase active-matrix LCD monitors as third-party products. These items, although expensive, are ideal for situations where desktop space is extremely limited.

ThinCRT Pixel

AMLCD Pixel

E-mail your comments or suggestions to Martin Pipe at whatnet@cix.compulink.co.uk.

RESEARCH NEWS

by Dr. Chris Lavers

New Photonic Crystal Waveguide

A revolutionary new form of optical waveguide has been developed in a collaboration between the School of Physics in Bath and the Optoelectronics Research Centre of Southampton University. The new photonic crystal fibre consists of a long fine silica fibre with a hexagonal array of air holes running down its length. A single missing air hole in the centre forms a pure silica region of higher effective refractive index in the middle. The unique optical properties of this waveguide allows the structure to guide a single optical mode whatever the wavelength used or the scale of the structure, quite unlike current fibre and planar waveguide devices. The reason for this unusual but useful behaviour is that the number of guided modes is independent of the scale of the structure but depends instead only on the size of the air holes present in the cladding material.

In practice, this means that the photonic crystal fibre will guide a single mode over the entire transmission range of silica (measured over the fibre's operational range from 337 to 1,580nm). The useful spectral range is limited ultimately by bend losses at both the short and the long wavelength cut-off edges. Furthermore, the photonic crystal fibre will only guide a single mode even if it is made with a core which is much larger than in conventional optical fibres, so it may be useful as a high-power fibre laser or amplifier as well as being on an easier (larger) scale for fabrication. Photo 1 shows a Scanning Electron Micrograph (SEM) of one of these new single-mode photonic crystal fibres made from silica.

So far, the Optics group headed by Professor Philip St-John Russell at the Bath School of Physics has only fabricated relatively short lengths of fibre, up to 10m in length. Dr Jonathan Knight, co-worker on this project, informs me that there is no reason why much longer lengths of fibre, perhaps hundreds of metres or even kilometres could not be made easily and cheaply, given that the main constituent of sand is basically pure silica. It is expected that the photonics crystal losses will be at least as good as in conventional optical fibres. The absence of any chemical dopants in the core or in the cladding means that the transmission characteristics and therefore, fibre performance, is limited only by those inherent in pure silica.

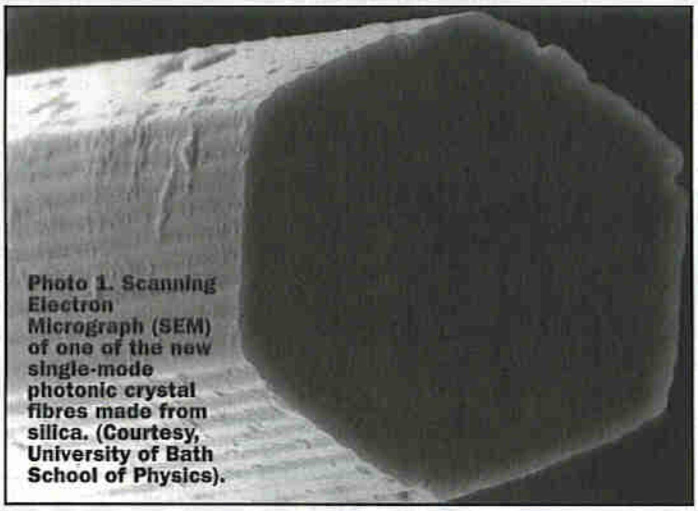


Photo 1. Scanning Electron Micrograph (SEM) of one of the new single-mode photonic crystal fibres made from silica. (Courtesy, University of Bath School of Physics).

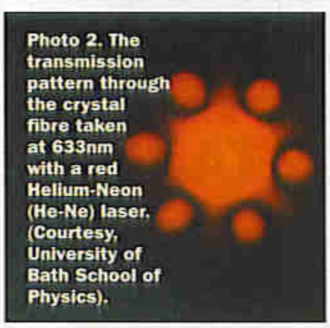


Photo 2. The transmission pattern through the crystal fibre taken at 633nm with a red Helium-Neon (He-Ne) laser. (Courtesy, University of Bath School of Physics).

Dr Knight has made crystal fibres down to about 15μm in diameter (still significantly larger than most single-mode or 'monomode' structures), with 50nm diameter air holes spaced by about 900nm. Photos 2 and 3 show respectively the transmission pattern through the crystal fibre taken at 633nm with a red Helium-Neon (He-Ne) laser, and the other, a composite of He-Ne and Argon ion green (528nm) performance. As can be seen, the air holes still guide a little light, although the guided light is spread out.

The photonic crystal fibre is currently fabricated at the ORC at Southampton University with assistance from the University of Bath. Design and characterisation of the fibre is carried out at the University of Bath. This optical development should have a significant impact in the delivery of intense single-mode laser light for both sensing, communications and clinical applications. It also offers the possibility that other materials, such as Germanium with different optical transmission properties, may be used when the optical processes involved in photonics crystals are better understood.

Neural Networks Help Control Damaged Aircraft

NASA has begun an experimental program to use neural network software to help control damaged planes and to help them land safely. This control software may eventually be used in many commercial industries to improve and extend equipment working life. Neural network software learns by observing pairs of related patterns in the 'real' world, and seeks to perform different tasks in response to different patterns. A neural network consists simply of many multiply connected processors (or nodes) using computational principles derived from the

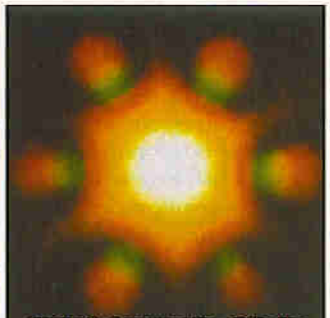


Photo 3. A composite of He-Ne and Argon ion green (528nm) performance. The air holes still guide a little light, although the guided light is spread out. (Courtesy, University of Bath School of Physics).

theory of how neurons operate in the human brain. Each node assigns a value to the analogue voltage input from each of connected neighbours. As these values change with time, the network can adjust and evolve the way in which it responds.

The new software is under joint development by McDonnell Douglas Corporation in St. Louis, Missouri, and NASA scientists at the Ames Research Center in Moffett Field, California. They hope that a damaged aircraft's computer will 'relearn' to fly and to land a plane safely after a major equipment failure or explosion on board. Existing aeroplane sensors can send speed, direction and force data to the network software. The aircraft's computer compares the pattern of what is happening to the aircraft with a pattern showing how the aircraft should fly. If there is a discrepancy, the neural network, which has learned the basis of aeronautics required for aircraft flight, will attempt to find a way to make the plane work with a new pattern.

Preliminary tests used an earlier version of the new software installed in a modified F-15 jet fighter. In the second phase, the collaborators will validate the software under very difficult simulated test conditions. After the simulation test, the software will be flight-tested in a specially modified F-15 called ACTIVE at NASA's Dryden Flight Research Center at Edwards Airforce Base in California in late 1997. Once neural network software is demonstrated to rapidly 'reteach' a crippled jet fighter to fly and to help pilots land it safely, then engineers will be significantly down the path to applying the software to operation in automobiles, factories and other less complicated systems to prevent the potentially catastrophic consequences of equipment failure.

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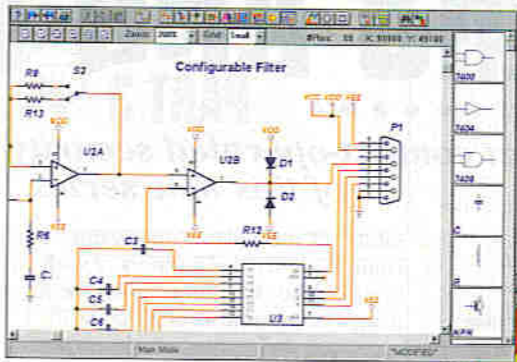

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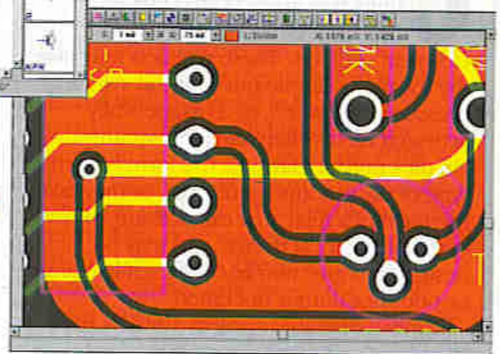

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MAPLIN modules TOP 20

Position This Month	Position Last Month	Stock Code	Description	Price Inc VAT	Catalogue Page
1	1	YU49	Clock Module	£4.69	728
2	15	YU05	Small Clock Module	£8.99	728
3	7	AM27	418MHz Tx	£13.99	770
4	11	AM28	418MHz Rx	£25.99	770
5	9	FS13	Counter Module	£9.99	755
6	10	WC20	UHF Modulator 6MHz	£10.99	791
7	3	FE33	Temperature Module	£9.99	753
8	-	YU07	Small Temp Mod Ext	£10.99	753
9	5	GW01	DVM Meter Module	£12.99	756
10	6	RJ89	W/Less Clock Module	£24.99	728
11	4	YT99	Temp Mod Wide Range	£13.99	754
12	-	MK68	EM2 MSF Rcvr Module	£16.99	727
13	2	FP64	Min/Max Temp Module	£11.99	754
14	13	AM11	Expansion Card Assm	£34.99	376
15	16	CK41	Touch Hybrid & Mstr	£23.49	954
16	12	LB97	Pre-Amp EQ2S	£12.49	709
17	-	NV10	TDGM622-1TimeDateVGM	£49.99	790
18	-	YU67	Alarm Clock Module	£4.99	728
19	-	LP85	RS232-Digtl ConvAssm	£19.99	724
20	-	NV08	418MHz AM Tx Module	£9.99	769

Over 100 modules available. Not all modules are supplied with data/instructions, however full technical data is available on request from Technical Sales. The descriptions above are necessarily short; please ensure that you know exactly what the module is and what it comprises before ordering by referring to the current maplin catalogue. Maplin Modules: Top 20: based on September 97 sales figures. All items subject to availability. Prices are subject to change. E&OE.

MAPLIN projects TOP 20 KITS

Position This Month	Position Last Month	Stock Code	Description	Price Inc VAT	Catalogue Page
1	2	LK63	Live Wire Det Kit	$6.99	785
2	3	LP56	Mosfet Amp Kit	$21.99	706
3	5	LP16	TDA7052 Kit	$6.99	703
4	1	LP98	SL6270 AGC Mic Amp	$10.99	709
5	4	LP30	1/300 Timer	$8.99	726
6	10	LP77	Lights On Reminder	$6.99	716
7	8	LK42	Car Batt Monitor	$12.99	714
8	6	LP69	L200 Kit	$7.99	762
9	11	LT34	555 Proto Card	$7.99	729
10	7	LU29	PIC 16C84 Programmer	$19.99	731
11	-	LM76	LM386 Kit	$4.99	703
12	-	LM55	TDA7000 MkII Kit	$24.99	765
13	-	LP14	Light Level Sw Kit	$7.99	752
14	16	LP66	Courtesy Light Extr	$4.99	716
15	-	LM99	Elec Die Kit	$14.99	751
16	12	LP03	TDA2822 Stro Pwr Amp	$10.99	703
17	20	LU79	Video Distrib Amp	$14.99	792
18	-	LT31	SSM 2017 Pre-Amp	$16.99	709
19	-	LP43	TDA1514 Power Amp	$19.99	705
20	19	LP28	Beginners AM Radio	$10.99	765

Over 200 kits available. All kits are supplied with full instructions. The descriptions above are necessarily short; please ensure that you know exactly what the kit is and what it comprises before ordering by referring to the current maplin catalogue. Maplin Projects: Top 20 Kits: based on September 97 sales figures. All items subject to availability. Prices are subject to change. E&OE.

Security Electronics

SYSTEMS AND CIRCUITS

PART 3

Ray Marston looks at contact-operated security circuits in the third episode of this new series.

Contact-operated security circuits are units that are activated by the opening or closing of a set of electrical contacts. These contacts may take the form of a simple push-button switch, a pressure-pad switch, or a magnetically activated reed switch, etc. The security circuit's output may take the form of some type of alarm-sound generator, or may take the form of a relay that can activate any external electrical device, and may be designed to give non-latching, self-latching, or one-shot output operation.

Contact-operated security systems have many practical applications in the home, in commercial buildings, and in industry. They can be used to attract attention when someone operates a push switch, or to give a warning when someone opens a door or treads on a pressure pad or tries to steal an item that is wired into a security loop, or to give some type of alarm or safety action when a piece of machinery moves beyond a preset limit and activates a microswitch, etc. A wide range of practical contact-operated security circuits are described in this article.

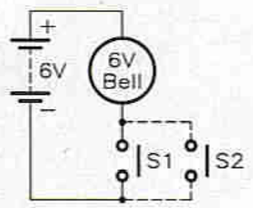
Bell and Relay-output Circuits

Close-to-Operate Circuits

The simplest type of contact-operated security circuit consists of an alarm bell (or a buzzer or electronic 'siren-sound' generator, etc.) wired in series with a normally-open (n.o.) close-to-operate switch, the combination being wired across a suitable battery supply, as shown in the basic 'doorbell' alarm circuit of Figure 1. Note that any desired number of n.o. switches can be wired in parallel, so that the alarm operates when any of these switches are closed. This type of circuit gives an inherently non-latching type of operation, and has the great advantage of drawing zero standby current from its supply battery.

A disadvantage of the basic Figure 1 circuit is that it passes the full 'alarm' current through the n.o. operating switches and their wiring, so the switches must be fairly robust types, and the wiring must be kept fairly short if excessive wiring voltage drops are to be avoided. This latter point is of particular importance in security applications in which the circuit is used with several widely separated n.o. switches. The solution to this problem is to activate the bell via a 'slave' device (which is fitted close to the bell but requires a fairly low input current), and to activate this slave device (and thus the bell) via the security switches. Figures 2 to 6 show a variety of such circuits, in which the slave device takes the form of a relay, a power transistor, or an SCR.

Figure 1. Simple doorbell type close-to-operate alarm circuit.



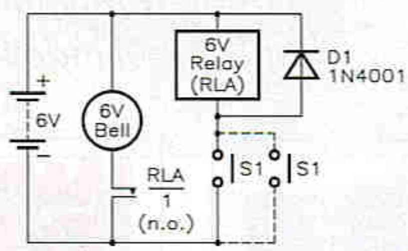


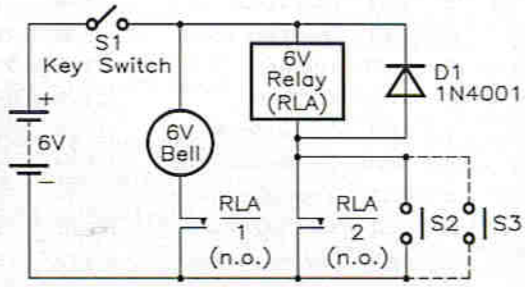
Figure 2. Relay-aided non-latching close-to-operate alarm.

Figure 2 shows a relay-aided version of the close-to-operate alarm circuit. Here, the parallel-connected n.o. switches are wired in series with the coil of a 6V relay (which typically draws an operating current of less than 100mA), and the relay contacts (which can typically switch currents of several amps) are wired in series with the alarm bell, and both combinations are wired across the same 6V supply. Thus, when the switches are open, the relay is off and its contacts are open, so the bell is off, but when any one or more of the switches is closed, the relay is driven on and its contacts close and activate the alarm bell. Note in the latter case, that the switches and their wiring pass a current equal to that of the relay coil; the switches can thus be fairly delicate ones, such as sensitive reed types, and the wiring can be reasonably long. Silicon diode D1 is wired across the relay's coil to protect the switches against damage from the coil's switch-off back emf.

The Figure 2 circuit gives a non-latching form of operation, in which the alarm operates only while one or more of the operating switches is closed. In most high-security applications, the circuit should be a self-latching type in which the relay and alarm automatically lock on as soon as any one of the n.o. switches is closed, and can only be deactivated via a security key. Figure 3 shows the above circuit modified to give this type of operation. Here, the relay has two sets of n.o. contacts, and one of these is wired in parallel with the n.o. switches so that the relay self-latches as soon as it is operated, and the entire circuit can be enabled or disabled/de-activated via key switch S1, which is wired in series with the battery supply line.

Circuits of this basic type are usually used in low-cost 'zone protection' applications, in which the 'zone' is a large room or shop floor, the S1 key switch is located outside of

Figure 3. Relay-aided self-latching close-to-operate security alarm.



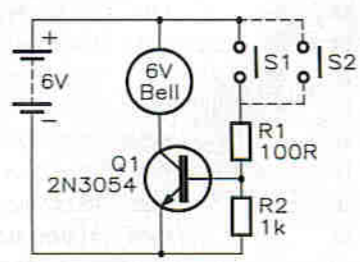


Figure 4. Transistor-aided non-latching close-to-operate alarm.

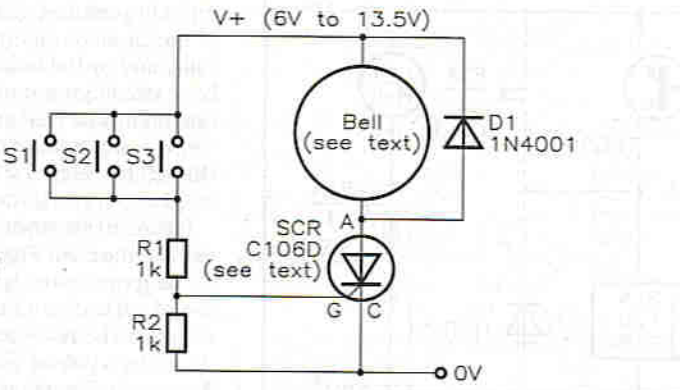


Figure 5. SCR-aided non-latching close-to-operate alarm.

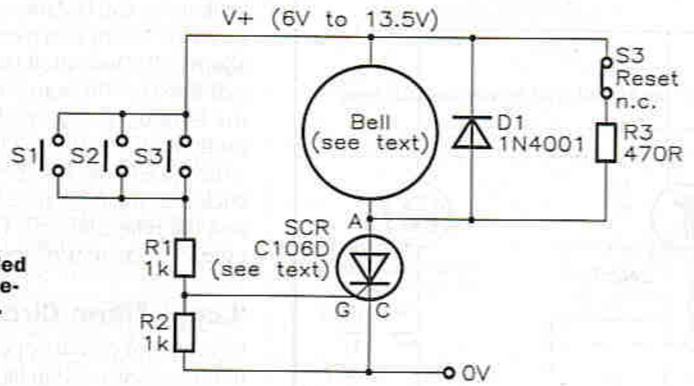


Figure 6. SCR-aided self-latching close-to-operate alarm.

the zone, and the n.o. trigger switches are hidden pressure-mat switches or door- or window-operated microswitches fitted within the protected zone.

An alternative solution to the Figure 1 switch-and-wiring 'current' problem – but which can only be used in non-latching applications – is shown in Figure 4, in which npn power transistor Q1 is used as the slave device. Resistor R1 ensured that – when any of the activating switches are closed – Q1's drive current is limited to less than 60mA, which (assuming that Q1 has a nominal current gain of at least ×25) enables the transistor to switch at least 1·5A through the alarm bell.

Another solution to the 'current' problem is to use an SCR (Silicon Controlled Rectifier) as the slave device, as shown in Figures 5 and 6. These circuits rely on the fact that ordinary electromagnetic alarm bells are self-interrupting solenoid devices that incorporate a self-activating on/off switch in series with the solenoid's supply line. This switch is normally closed, allowing current to reach the solenoid and throw out a striker that hits the bell dome and simultaneously opens the switch, thus breaking the current feed and causing the striker to fall back again until the switch closes again, at which point, the whole process starts to repeat, and so on; the bell's operating current is thus drawn in pulsed form.

In the Figure 5 circuit, the alarm bell is wired in series with an SCR that has its gate current derived from the positive supply line via current-limiting resistor R1 and via the parallel-connected n.o. security switches, which (when R1 has a value of 1kΩ) pass operating currents of only a few milliamps. When all the switches are open, the SCR and alarm bell are off, but when any one of the switches is closed, it feeds gate current to the SCR via R1, so the SCR turns on and activates the bell. Note in this design, that since the bell is a self-interrupting device, the circuit effectively gives a non-latching type of operation in which the SCR and bell only operate while one or more of the switches are closed.

Figure 6 shows how the above circuit can be modified to give self-latching operation. SCRs are inherently self-latching devices that, once they have been initially turned on, remain on until their anode current falls below a 'minimum holding' value, at which point, the SCR unlatches and turns off. In the Figure 5 circuit, the SCR thus automatically unlatches each time the alarm bell self-interrupts, but in the modified Figure 6 design, the bell is shunted via R3, which is wired in series with n.c. switch S4, which ensure that the SCR's anode current does not fall below the C106's minimum holding current value when the bell self-interrupts, thus providing the circuit with a self-latching action.

Note that the C106 SCR used in the Figure 5 and 6 circuits has an anode current rating of only 2A, so the alarm bell must be selected with this point in mind. Alternatively, SCRs with higher current ratings can be used in place of the C106, but this modification will probably necessitate changes in the R1 & R3 values of the circuits. Also, note in these SCR circuits that – to compensate for the SCR's typical 1V anode-to-cathode volt drop – the supply voltage must be at least 1V greater than the nominal operating voltage of the alarm bell.

Open-to-operate Circuits

A major weakness of the Figure 1 to 6 circuits is that they do not give a 'failsafe' form of operation, and give no indication of a fault condition if a break occurs in the contact-switch wiring. This snag is overcome in circuits that are designed to be activated via normally-closed (n.c.) switches, and a basic circuit of this type is shown in Figure 7.

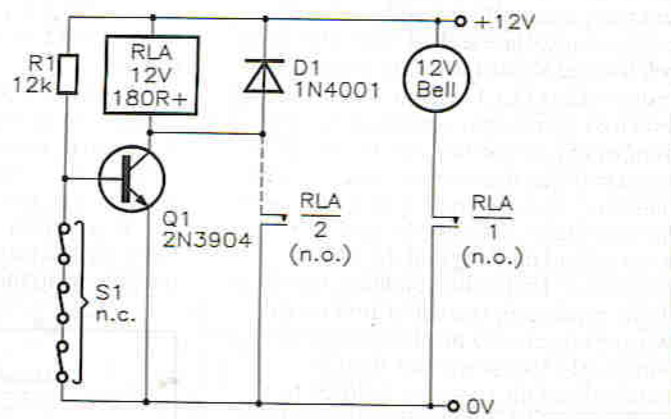


Figure 7. Simple open-to-operate alarm draws a 1mA standby current.

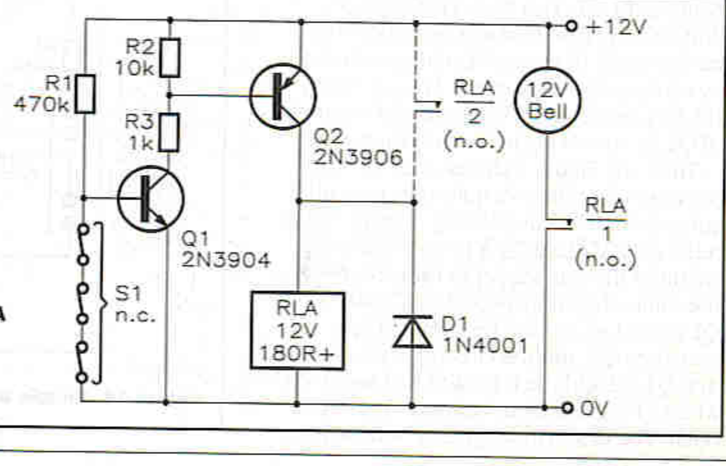
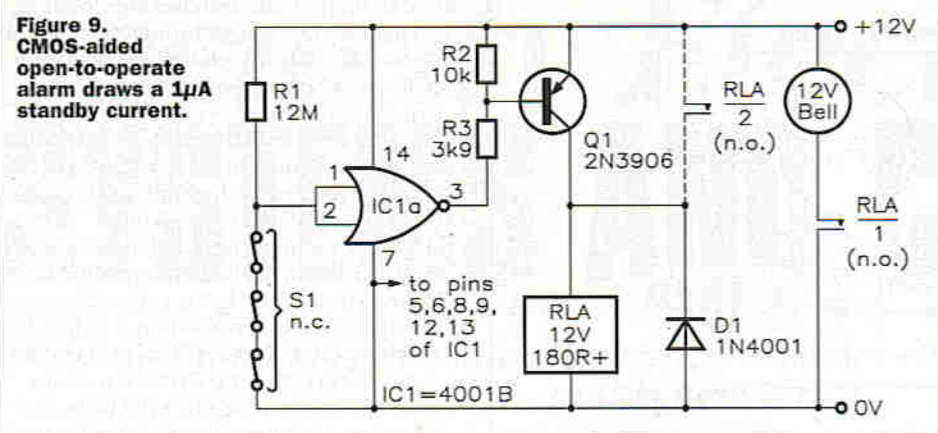


Figure 8. Improved open-to-operate alarm draws a 25μA standby current.

Figure 9. CMOS-aided open-to-operate alarm draws a 1μA standby current.



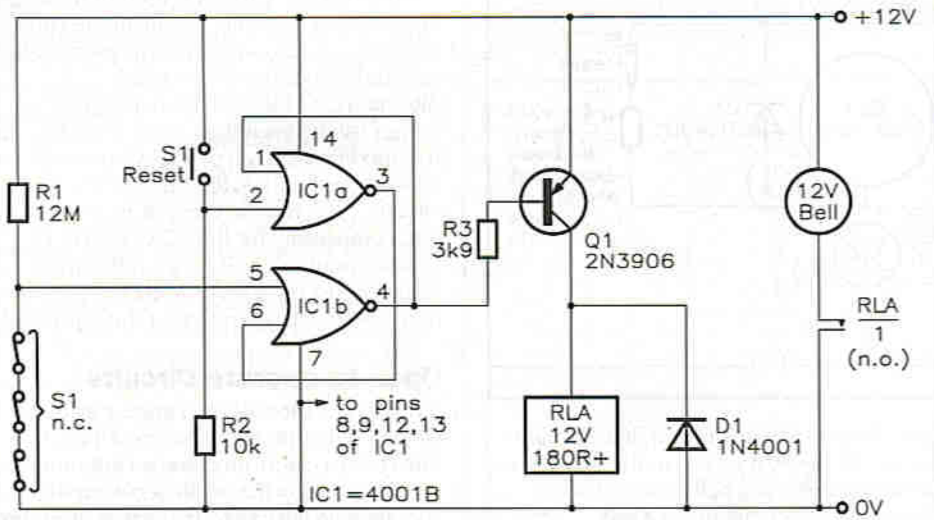


Figure 10. Self-latching CMOS-aided alarm draws a 1μA standby current.

In Figure 7, the coil of a 12V relay is wired in series with the collector of transistor Q1, and bias resistor R1 is wired between the positive supply line and Q1 base. The alarm bell is wired across the supply lines via n.o. relay contacts RLA/1, and n.c. operating switch S1 (which may consist of any desired number of n.c. switches wired in series) is wired between the base and emitter of the transistor. Thus, when S1 is closed, it shorts the base and emitter of Q1 together, so Q1 is cut off and the relay and the bell are inoperative. Under this condition, the circuit draws a quiescent current of 1mA via R1. When S1 opens or a break occurs in its wiring, Q1's base-to-emitter short is removed and the transistor is driven to saturation via R1, thus turning the relay on and activating the alarm bell via relay contacts RLA/1. This basic circuit gives a non-latching type of alarm operation, but can be made to give self-latching operation by wiring a spare set of n.o. relay contacts (RLA/2) between the collector and emitter of Q1, as shown dotted in the diagram.

Thus, the Figure 7 circuit gives fail-safe operation, but draws a quiescent or standby current of 1mA. This standby current can be reduced to a mere 25μA by modifying the circuit in the way shown in Figure 8. Here, the value of R1 is increased to 470kΩ, and Q1 is used to activate the relay via pnp transistor Q2, and the circuit's action is such that Q1-Q2 and the relay and bell are all off when S1 is closed, but turn on when S1 is open. The basic circuit gives a non-latching form of operation, but can be made self-latching by wiring a spare set of n.o. relay contacts (RLA/2) between the collector and emitter of Q2, as shown dotted in the diagram.

If desired, the standby current of the Figure 8 circuit can be reduced to a mere 1μA or so by using an inverter-connected CMOS gate in place of Q1, as shown in Figure 9. The gate used here is taken from a 4001B quad 2-input NOR gate IC, and the three unused gates are disabled by shorting their inputs to the 0V line, as shown in the diagram. The used gate has a near-infinite input impedance, and the standby current of the circuit is determined mainly by the R1 value and by the leakage current of Q1. The basic circuit gives a non-latching form of operation, but can be made self-latching by wiring a spare set of n.o. relay contacts (RLA/2) between the collector and emitter of Q1, as shown dotted in the diagram.

Figure 10 shows an alternative way of making the basic Figure 8 circuit give self-latching operation, without resorting to the use of a spare set of n.o. relay contacts. In this case, the relay-driving transistor (Q1) is driven by a pair of 4001B CMOS NOR gates that are configured as a bistable multivibrator and has an output that goes low and self-latches if S1 is briefly opened or its leads are broken. As the bistable output goes low, it turns Q1 on, thus activating the relay and alarm bell. Once the bistable has latched the bell into the 'on' state, it can be reset into the standby or 'off' mode by closing S1 and momentarily operating RESET switch S2, at which point, the bistable's output latches back into the high state and turns off Q1 and the relay and bell. The circuit draws a quiescent current of about 1μA.

'Loop' Alarm Circuits

One type of contact-operated alarm circuit that is widely used in large shops and stores (and also in domestic garages and garden sheds) is the so-called 'loop' alarm, in which a long length of wire is run out from the alarm unit, is looped through a whole string of 'to be protected' items in such a way that none of them can be removed without cutting or removing the wire, and is then looped back to the alarm unit again, to complete a closed electrical circuit. The alarm sounds instantly if an attempt is made to steal any of the protected items by cutting the wire loop, i.e., by effectively opening its 'contacts'. Figure 11 shows the circuit of a simple battery-powered unit of this type.

The simple Figure 11 loop alarm circuit is a modified version of the self-latching CMOS-aided Figure 9 circuit, with its series-connected S1 security switches replaced by a number of series-connected wire 'loops' that – when key-operated switch S1 is

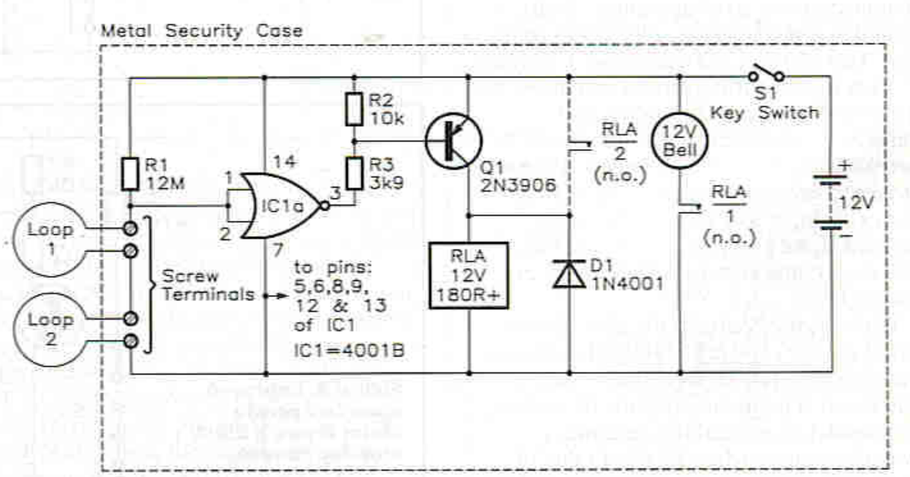


Figure 11. Simple self-latching loop alarm circuit.

closed – activate the self-latching alarm if any part of the loop wiring becomes open circuit. In the diagram, only two loops are shown, but in practice, any desired number of loops can be used. The entire circuit (except the loops) is housed inside a metal security case, and the loops are connected to screw terminals on the main circuit board via grommet holes in the side of the case; unwanted loops can be replaced by short circuits connected between the appropriate screw terminals. The entire circuit can be turned on and off via key switch, S1.

Figure 12 shows an improved version of the Figure 11 self-latching loop alarm circuit. The first points to note about this version of the circuit are that an LED is connected across the relay coil via R4 and thus illuminates and gives a visual indication whenever the relay is turned on, and that the circuit's +12V power feed is controlled via 4-way key switch S1 and diodes D2 & D3. When S1 is in position '1', the entire circuit is turned off. When S1 is in position '2', the main part of the circuit (including the LED indicator) is active but the alarm bell and self-latching facility are disabled; this TEST (non-latch) position is meant to be used when testing the loop wiring. When S1 is in the position '3' TEST (latching) position, all of the circuit except the bell is enabled. When S1 is in the position '4' ON position, the entire circuit (including the alarm bell) is enabled, and the circuit gives normal 'security' operation.

The final point to note about the Figure 12 circuit is that n.c. anti-tamper switch S2 is wired in series with the loop network and (when S1 is set to the ON position) activates the self-latching alarm if it (S2) takes up an 'open' state. S2 is actually an ordinary n.o. tactile 'keypad' switch with a short coil-spring bonded vertically to its touch-pad, and is fixed to the main circuit board in such a way that the switch is held in the closed n.c. position (via the spring) when the circuit's security case is closed, but opens (thus sounding the alarm) if the case is opened while the alarm system is still turned on. Anti-tamper switches of this basic type are quite easy to make from readily available components; Figure 13 illustrates the basic method of construction.

Before leaving this section of the article, note that the various relay-output circuits shown in Figures 2, 3, and 7 to 11 can, if desired, be used to activate any type of electrical or electronic alarm or system via their n.o. relay contacts when the relay is triggered in response to an input contact-switching action, and are thus not restricted to use with alarm bells only.

Siren-sound Security Circuits

Contact-operated security circuits can easily be designed to produce electronically generated 'siren' alarm sounds in piezoelectric 'sounders' or in electromagnetic loudspeakers. Such systems can be made to produce a variety of sounds, at a variety of power levels, and may be designed around various types of semiconductor device. All siren-sound generators take the basic form shown in Figure 14, and consist of a siren waveform generator, an output driver, and an electro-acoustic transducer.

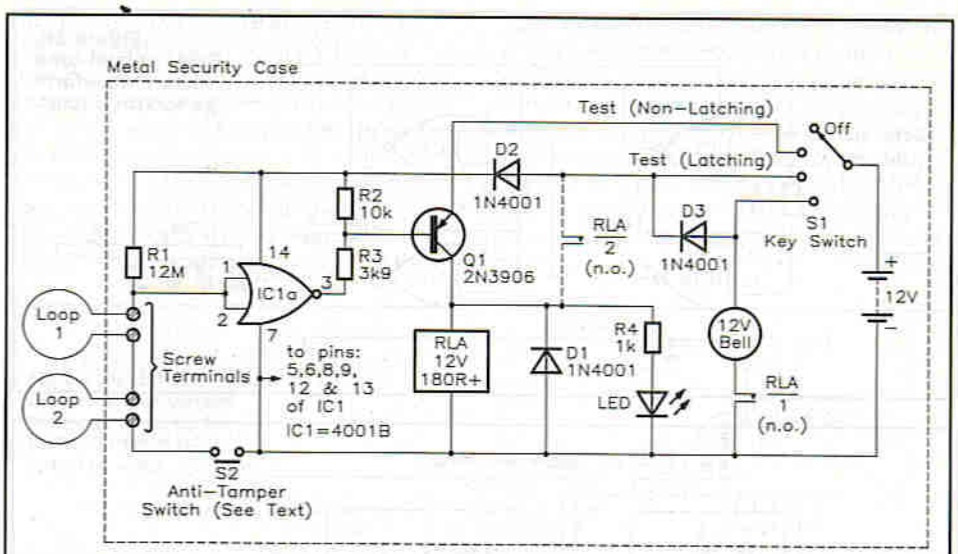


Figure 12. Improved version of the self-latching loop alarm.

Figure 14. Basic elements of a siren-sound generator.

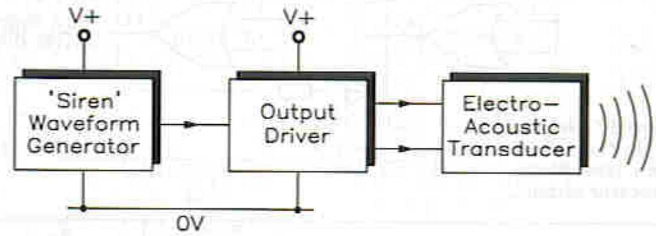
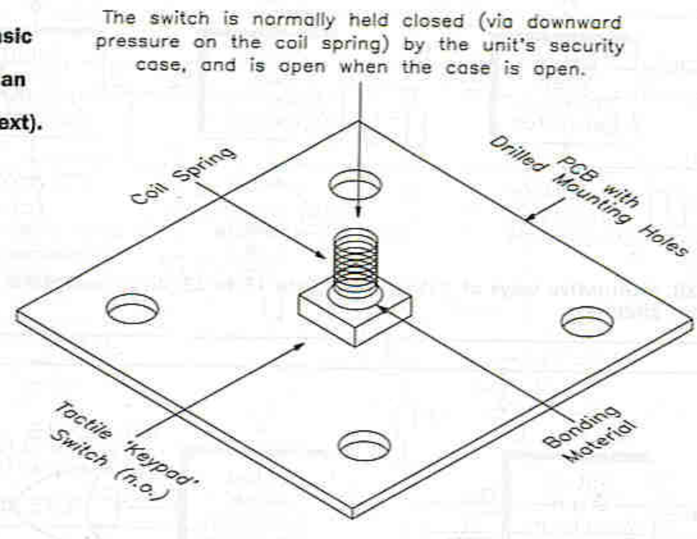


Figure 13. Basic way of constructing an anti-tamper switch (see text).



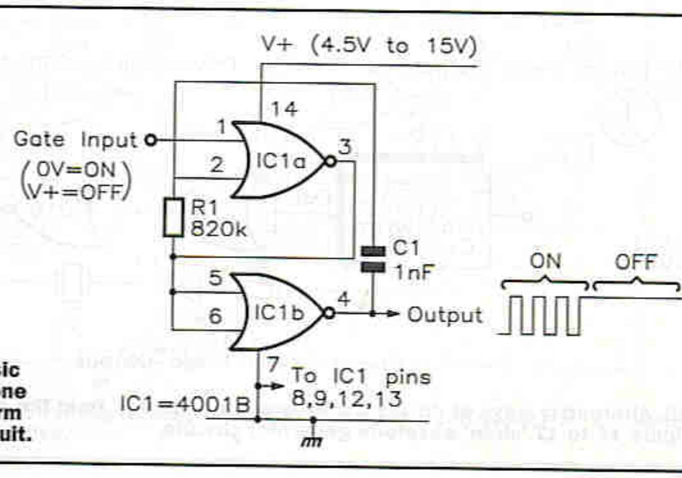


Figure 15. Basic 800Hz monotone 'siren' waveform generator circuit.

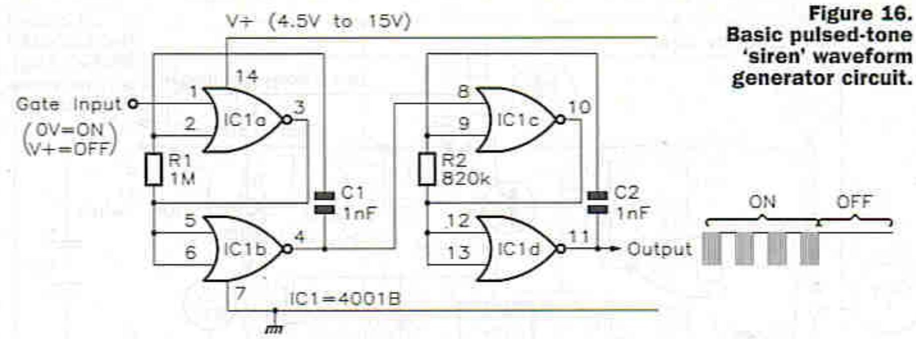


Figure 16. Basic pulsed-tone 'siren' waveform generator circuit.

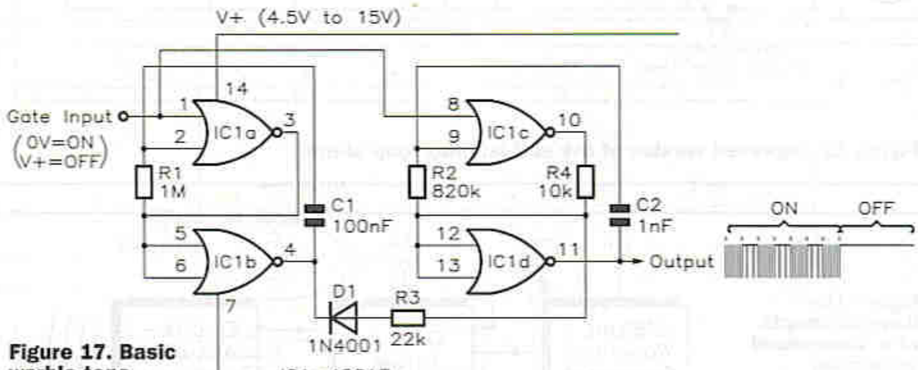


Figure 17. Basic warble-tone 'siren' waveform generator circuit.

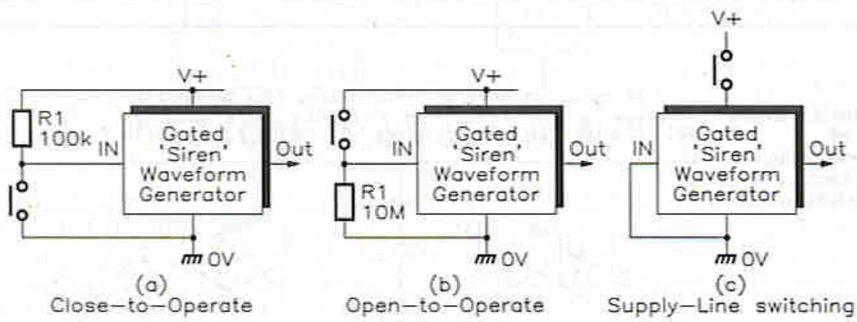


Figure 18. Alternative ways of gating the Figure 15 to 17 'siren' waveform generator circuits.

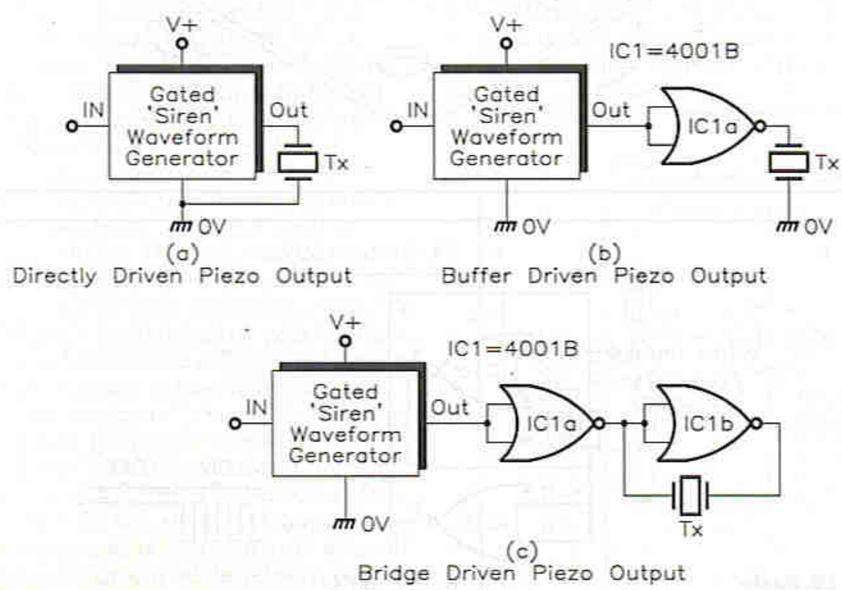


Figure 19. Alternative ways of driving a piezoelectric 'sounder' from the outputs of the Figure 15 to 17 'siren' waveform generator circuits.

One of the cheapest and most useful semiconductor devices for use in this type of application is the CMOS 4001B quad 2-input NOR gate IC, which draws near-zero standby current, has an ultra-high input impedance, can operate over a wide range of supply-rail voltages, and can be used in a variety of waveform generating applications. The rest of this article shows various ways of using one or two 4001B ICs and a few other components to make a variety of contact-operated siren-sound security circuits.

Figures 15 to 17 show three different ways of using 4001B ICs to make practical siren waveform generator circuits. Figure 15 shows the basic circuit of a simple gated 800Hz (monotone) siren waveform generator. Here, two of the gates of a 4001B IC are connected as a gated 800Hz astable multivibrator, and the IC's two remaining gates are disabled by wiring their inputs to ground. The action of this astable is such that it is inoperative, with its pin-4 output terminal locked high (at V+) when its pin-1 input terminal is high (at V+), but acts as a squarewave generator when its input pin is low (at 0V); the generator can thus be gated on and off via the pin-1 input terminal, and produces its output signal on pin-4. The astable's operating frequency is controlled by the R1 and C1 values.

Figure 16 shows a single 4001B IC used to make a gated pulsed-tone waveform generator. Here, the two left-hand gates of the IC are wired as a gated low-frequency (about 6Hz) astable squarewave generator, and the two right-hand gates are wired as a gated 800Hz astable that is gated via the 6Hz astable. The action of this circuit is such that it is inoperative, with its pin-11 output terminal locked high (at the positive supply rail voltage) when its pin-1 input terminal is high, but becomes active and produces a pulsed-tone output on pin-11 when its input pin is low (at 0V). This generator can thus be gated on and off via the pin-1 input terminal, and when gated on, produces an 800Hz tone that is gated on and off at a 6Hz rate. The operating frequency of the 6Hz astable is controlled by R1-C1, and that of the 800Hz astable is controlled by R2-C2.

Figure 17 shows how the Figure 16 circuit can be modified so that it produces a warble-tone alarm signal. These two circuits are basically similar, but in the latter case, the 6Hz astable is used to modulate the frequency of the right-hand astable (rather than to simply pulse it on and off), thus causing the generated tone to switch alternately between 600Hz and 450Hz at a 6Hz rate. Note that the pin-1 and pin-8 gate terminals of the two astables are tied together, and both astables are thus activated by the pin-1 'gate' input signal; the circuit is inoperative, with its pin-11 output terminal locked high (at V+) when the pin-1 input terminal is high, but becomes active and produces a warble-tone output on pin-11 when the input pin is low (at 0V). The operating frequency of this circuit's 6Hz astable is controlled by R1-C1, the centre frequency of the right-hand astable is controlled by R2-C2, and the 'warble-tone' swing of the right-hand astable is controlled via D1-R3.

Note that each of the Figure 15 to 17 gated waveform generator circuits are inactive (with their output terminal locked high) when their pin-1 input terminal is high (at V+), but can be gated on by pulling pin-1 low (to 0V). Each of these circuits can thus be gated on and off by using any of the three input connections shown in Figure 18. Thus, they can be gated on by closing an n.o. switch by using the input connections shown in (a), or by opening an n.c. switch by using the input connections shown in (b), or can be gated on or off by making or breaking the supply line connection by using the input connections shown in (c). In cases (a) and (b), the circuit draws a typical standby current of only 1μA or so when in the 'off' state.

If the Figure 15 to 17 gated waveform generator circuits are to be used in alarm-sound applications where fairly low acoustic output powers are required, these can be obtained by feeding the circuit's output to a low-cost piezo sounder in any of the three basic ways shown in Figure 19. Thus, in (a) the sounder is driven directly from the generator's output, and in (b), it is driven via a 4001B gate that is used as a simple inverting buffer; in both cases, the rms 'alarm' voltage applied across the piezo load equals 50% of the V+ value. In (c), the sounder is driven in the 'bridge' mode via two series-connected 4001B inverters that apply anti-phase signals to the two sides of the piezo load, causing the piezo load to 'see' a squarewave drive voltage with a peak-to-peak value equal to double the V+ value, and an rms 'alarm' signal voltage that equals the V+ value. The (c) circuit thus gives four times more acoustic output power than either of the (a) or (b) circuits.

If the Figures 15 to 17 gated waveform generator circuits (which each have an output that is locked high when the generator is gated off) are to be used in alarm-sound applications where fairly high acoustic output powers are required, these can be obtained by feeding the astable's output to inexpensive 'low-fi' or horn-type loudspeakers (these have an electro-acoustic power conversion efficiency that is typically some twenty to forty times greater than a normal Hi-Fi speaker) via one or other of the simple direct-coupled 'driver' circuits shown in Figures 20 to 22.

Thus, the simple Figure 20 driver circuit is designed to pump a maximum of only few hundred milliwatts of audio power into a cheap 64Ω speaker. When the siren waveform generator is gated off, its output is high and Q1 is thus cut off, but when the generator is gated on, its output drives Q1 on and off and causes it to feed power to the 64Ω speaker. The output power depends on the supply rail voltage, and has a value of about 520mW at 12V, or 120mW at 6V, when feeding a 64Ω speaker load. Note that, since Q1 is used as a simple power switch in this application, very little power is lost across the 2N3906 transistor, but its current rating (200mA maximum) may be exceeded if the circuit is used with a supply value greater than 12V.

The Figure 21 driver circuit can pump a maximum of 6·6W of audio power into an 8Ω speaker load, or 3·3 watts into a 16Ω load. Here, both transistors are cut off when the waveform generator is gated off, but are switched on and off in sympathy with the siren waveform when the generator is gated on. Note in this circuit, that the positive power supply rail is fed directly to the output driver, but is fed to the waveform generator via decoupling network R1-C1, that voltage divider R2-R3 ensures that the output stages are not driven on until the generator's output voltage falls at least 1·9V below the supply rail value, and that diode D1 is used to damp the speaker's back-emf when driver Q2 switches off.

Finally, the Figure 22 driver circuit can pump a maximum of 13·2W into a 4Ω speaker load when powered from a 15V supply. Here, all three transistors are cut off when the waveform generator is cut off, but are switched on and off in sympathy with the siren waveform when the generator is gated on.

Thus, Figures 15 to 17 show three alternative 'siren' waveform generator circuits that can – when used in practical contact-operated security circuits – each be gated in any of three basic ways and be used in conjunction with any of six basic types of acoustic output driver circuit, thus offering a total of 54 different circuit combinations. Figure 23, for example, shows how the Figure 17, 18(a) and 20 circuits can be combined to make a warble-tone alarm-call generator that can be activated by closing an n.o. switch and which can pump 520mW into a 64Ω speaker load when operated from a 12V supply.

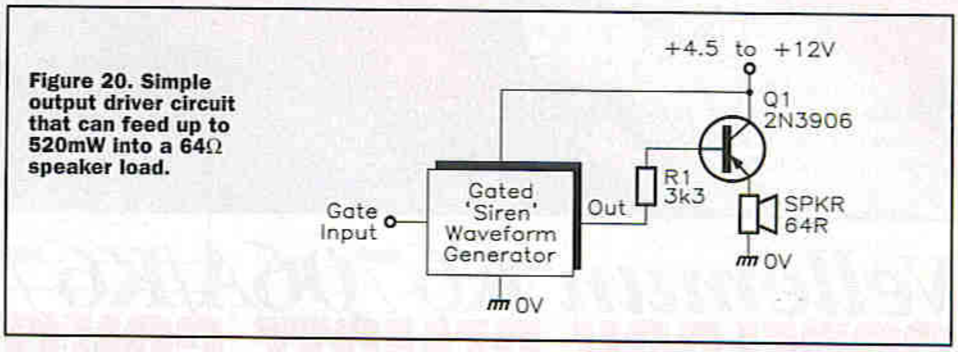


Figure 20. Simple output driver circuit that can feed up to 520mW into a 64Ω speaker load.

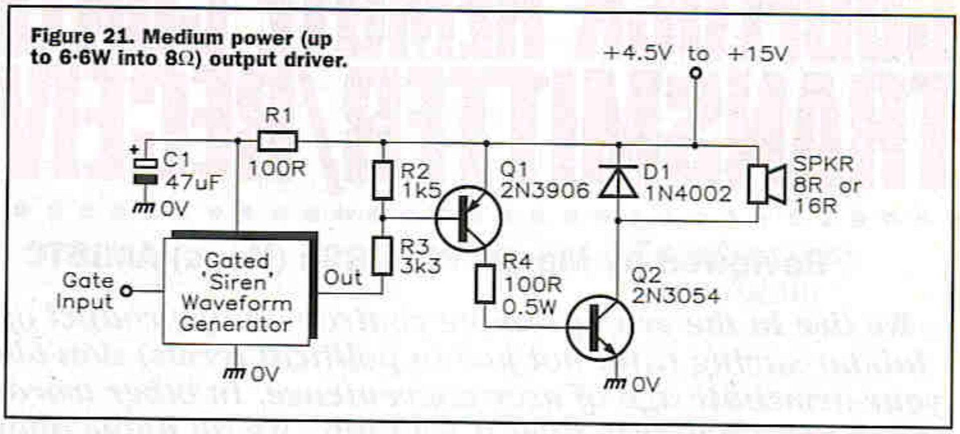


Figure 21. Medium power (up to 6·6W into 8Ω) output driver.

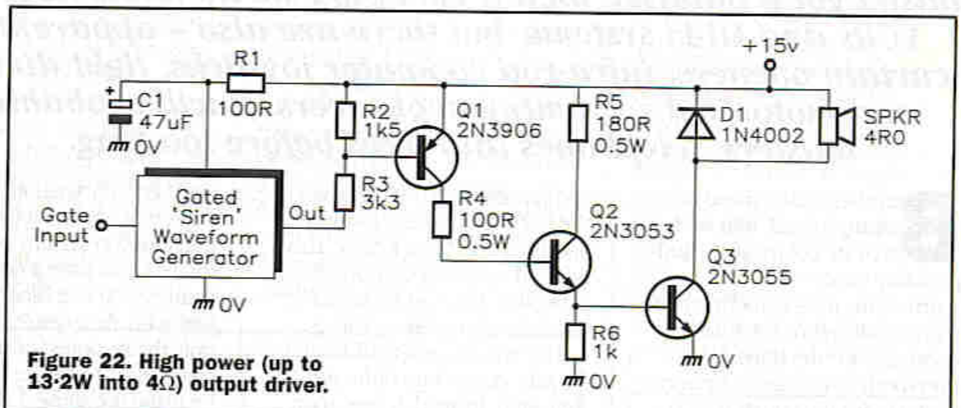


Figure 22. High power (up to 13·2W into 4Ω) output driver.

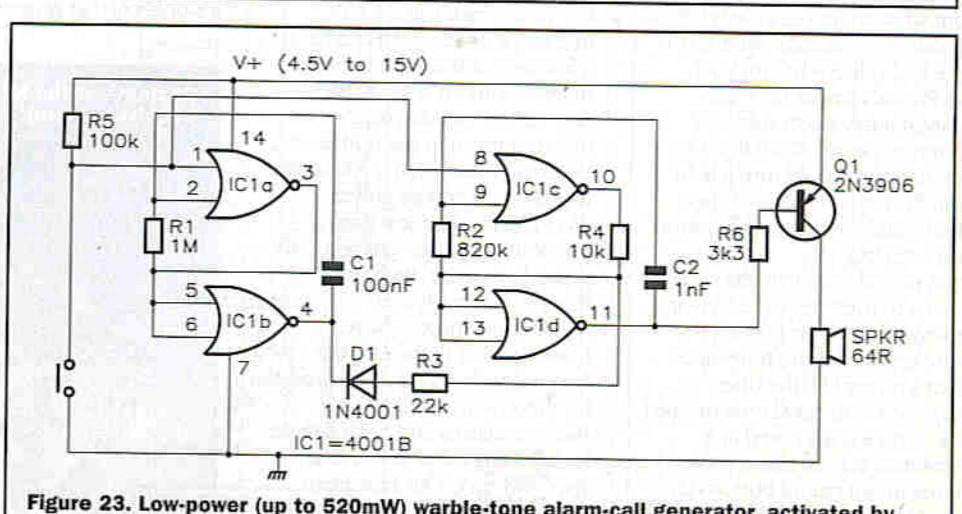


Figure 23. Low-power (up to 520mW) warble-tone alarm-call generator, activated by closing a n.o. switch.

The remote control transmitter in use.

Velleman K6706A/K6707

CODELOCK REMOTE CONTROL TRANSMITTER/RECEIVER

Reviewed by Martin Pipe BSc (Hons) AMISTC

We live in the era of remote control – a by-product of the labour-saving (and not just in political terms) don't-leave-your-armchair age of user convenience. In other words, If it hasn't got a handset, then it isn't hip'. We all know about TVs, VCRs and Hi-Fi systems, but there are also – apparently – curtain openers, infra-red computer joysticks, light dimmers and motorised swimming-pool covers. It will probably be toasters, telephones and trees before too long. . .

But then again, there is plenty of stuff that isn't remote controllable, and probably never will be (particularly if it's something that you already own). Yet, there's a good case for the opposite. Everybody associates the remote control with the couch potato – but what about the elderly? What about the disabled? What about the bed-ridden? Life for such individuals would be made considerably easier through remote control. Wouldn't it be a boon if they could turn a light out from the comfort of their bed simply by pressing a button on a keyfob!

A pair of Velleman kits could come to their rescue, and help many others. The K6706A is a tiny keyfob remote transmitter that's rather like the ones supplied with car alarms (indeed, the device is also used in a Velleman vehicle alarm project). It features a pair of buttons that could be used to activate various functions, such as the switching off or on of lights. The companion K6707 kit receives the signal from the transmitter, and uses it to drive a relay. This isolated switched output, which is rated at 10A, can be used for all kinds of interesting things.

The system, unlike VCRs and TV sets, doesn't use infra-red signalling. Instead, it uses ultra low-power radio, at a UHF frequency of 433·92MHz. The advantage of this is a better range – you can operate the remote from a completely different room in the house. Velleman claims that a 30m range is possible. The low-power 433·92MHz telemetry band is, out of interest, deregulated – it's possible to use it, without licence, in the UK and continental Europe. Note, however, that in the UK, the frequency should only be used for automotive applications (such as alarms and central door locks) – any other uses are at your own risk. Our European readers can, however, use it for more general applications.

To give your transmitter/receiver combination a high degree of addressability, a coded transmission system is used. Indeed, you have a choice of nearly 9,000 combinations to play with. As a result, there is only the remotest of remote chances that your neighbour will be using the same code, and so it's unlikely that remotely switching your kettle on will trigger his car alarm. Velleman claim that a range of 30m is attainable.

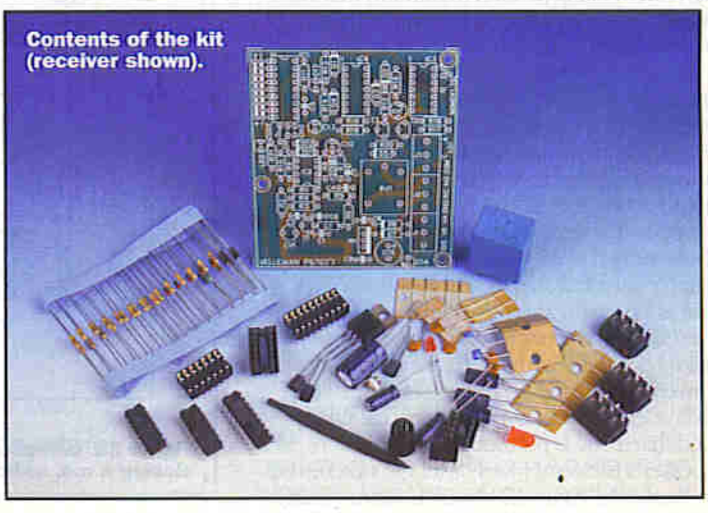
A single keyfob can be used to operate two receivers, which can be set to respond to a keypress from SW1 (Channel 1), and SW2 (Channel 2). One channel could, for example, open a garage door while the other could turn on the light. If the garage door is metal, the receivers might have to be mounted outside in a weatherproof box – unfortunately, the aerial is on the receiver PCB and a metal garage door might do a good job of shielding the transmitter's signals, thus affecting the range of the system.

How Does it Work?

In both transmitter and receiver kits is an encoder/decoder (or 'codelock') IC, the CMOS-fabricated UM3758-120A from UMC. Whenever one of the buttons on the transmitter (see Figure 1) is pressed, this chip yields a serial 12-bit code (see Figure 2). This code is used to modulate an 433·92MHz oscillator, based around T1 and X1 (the latter is a SAW resonator). The code is set via 12 pins on the chip. They can be left floating, or tied to the supply voltage or ground – in other words, it's tri-state.

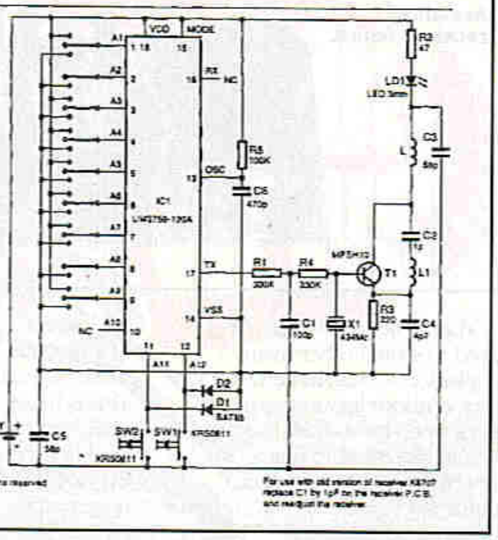
As a result, there are a possible 531,441 code combinations (3^{12}) to choose from. Unfortunately, these Velleman kits don't give you access to all such codes. One code-setting pin is left unconnected, while others are wired so that they can operate in only two of the possible three states. There's nothing to stop you from carrying out modifications to the PCBs if you really do need more choice.

On both transmitter and receiver, seven of the 12 code pins (A1, A3 to A7, and A9) are accessible and 'tri-stateable'. The



Contents of the kit (receiver shown).

Figure 1. Transmitter circuit diagram.



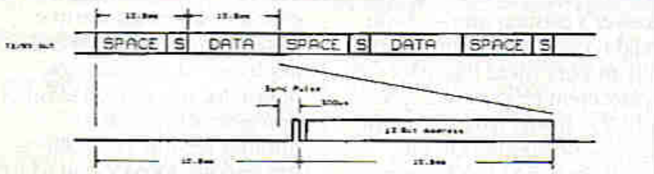


Figure 2. Format of transmitted code.

PCB has a series of tin-plated tracks and holes that will accept wire jumpers for such a purpose. Because of the way the circuit board has been designed – there's no hole in the PCB at the appropriate point – a further two code-setting pins (A2 and A8) can be only be grounded or left floating. In other words, the option of a third state (supply voltage) has been deliberately eliminated. Exactly why Velleman has done this is a mystery. Perhaps it's been done to ensure compatiblity with other kits in their range.

Two more of the code pins (A11, A12) are wired to the keyfob's pair of push-buttons (SW2 & SW1, respectively), and as such, are capable of working in two states (ground or floating). Since the push-buttons are momentary-action, these pins will be floating most of the time. Grounding them operates the transmitter and sends the code; interestingly, a pair of diodes (D1 & D2) ensure that the UM3758's clock oscillator only operates when one of the two buttons are pressed, thus conserving power (note that the chip is permanently connected to the tiny 12V battery). The final available code-setting pin, A10, is also left floating. The upshot of all this is that you have a total of 8,748 combinations to play with. Nevertheless, it's still enough for most applications.

The same type of chip is employed by the receiver, the circuit of which can be found in Figure 3. To make the circuit designer's life easier, the UMC3758 can operate in either encode or decode mode, depending on the voltage applied to one of the pins. No prizes for guessing how it's wired in the receiver! The signal is retrieved by an extremely simple TRF (Tuned Radio Frequency) radio receiver, and processed by op-amps A1 and A2 to ensure the correct logic levels.

Interestingly, the receiving aerial, shown as L2 on the circuit diagram, is formed by a PCB track. For this reason, the receiver circuit board should not be mounted in a metal box, as this would act as an effective Faraday cage and prevent pickup of the transmitter's signals. A plastic box (such as Maplin's LH21X) is, therefore, mandatory. L2 also forms part of the receiver's tuned circuit – which can be adjusted by parallel-connected trimmer CV1.

The processed signal is fed into the UMC3758 (IC1 in the circuit diagram). At this point, there's also an LED that blinks whenever a datastream from the keyfob is being received – a distinct help when setting up the receiver. On the receiver is a series of jumpers identical to those found on the transmitter. If the received code matches the one set through these jumpers, then a logic-level output is raised by the chip. A link, which corresponds to code-setting pins A11 and A12 and hence the transmitter's push buttons, can be set on the PCB. It is important to wire this link according to the push button that you would like to operate your equipment. Through this provision, two channels can be set up if a pair of receivers are employed.

The output from IC1 is active-low. It is then inverted by a Schmitt inverter (one of six in IC4), and fed into a circuit based around a pair of D-type flip-flops (both in IC3, a 4013). This part of the design is designed to provide the kit with even greater flexibility. You can choose whether you want the output to toggle – i.e., change state until the keyfob button is pressed again – or a momentary action, in which the output is active for as long as the button is pressed.

Another link on the receiver PCB determines which mode is selected; in my experience, the toggle' action is rather more useful.The logic-level output from the flip-flops drives the relay, via transistor T2. The relay is a single-pole changeover type, and all its contacts are brought out to a series of screw terminals on the receiver PCB. A final part of the circuit drives an LED that indicates the state of the relay. When the relay is energised, the light blinks (courtesy of spare Schmitt inverter N5 and associated components).

Construction Time Again

Building the two kits won't pose much of a problem to the seasoned constructor, and indeed, the entire job shouldn't take much longer than a couple of hours. The Velleman PCBs are of excellent quality, with nice clear legends. For ease of construction, Velleman has resisted the march towards surface-mount, although the transmitter would be a good candidate for its employment. For now, though, everything's through-hole. It's good to see IC sockets, although you should consider soldering the chips straight to the board if your project is to end up in a hostile

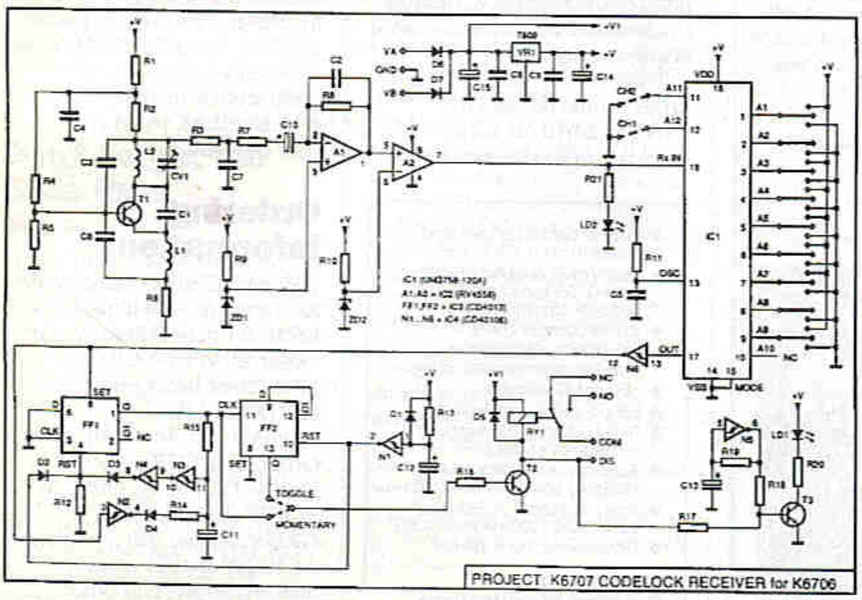


Figure 3. Circuit diagram of receiver.

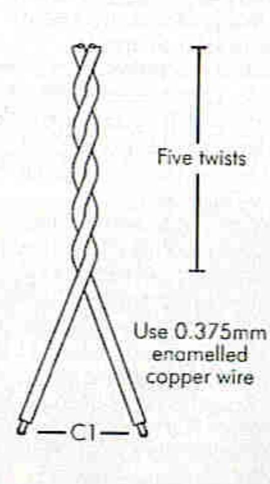
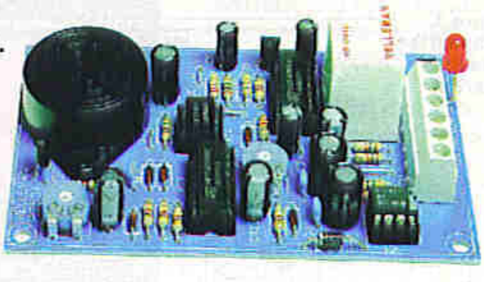


Figure 4. Making the transmitter's 1pF capacitor.

View inside the assembled remote control transmitter.



Assemled receiver board.

environment. Don't forget to set up the wire links that correspond to the code and receiver channel you want to use.

One of the ceramic capacitors supplied with the transmitter, C1, has a value of 100pF – and this is indeed the correct value if the transmitter is to be used with certain Velleman kits. For compatibility with the K6707 receiver, C1 has to be replaced by a 1pF capacitor – that's right, 1pF! Seeing as capacitors of so low a value aren't commercially available, you'll have to make your own. This can be done by twisting two pieces of enamelled copper wire together, as shown in Figure 4.

There are some caveats, however. For a start, there's an annoying need to make and fit the fiddly wire links that set codes on both transmitter and receiver. Velleman should have designed the PCB tracks so that solder bridges could be used instead – as it is, they're too far apart. The second point concerns the receiver's use of a section of PCB track as the aerial. An external aerial input would have been much better. The receiver could then be built into a screened enclosure and protected from unwanted noise and other nasties (such as stray capacitance, which could affect the receiver's tuned circuit). With an external aerial, the effective range of the system would be improved as well.

Once built and checked, it's time to set it all up. The transmitter is powered by a tiny GP23A 12V alkaline lighter battery, which mates with blades soldered to the circuit board and held in place by the snap-fit case. The receiver has rectification, smoothing and regulation on the circuit board, and can be powered by a 9V centre-tapped mains transformer (such as Maplin's YN15R). As an alternative, a DC power source capable of supplying between 12 and 16V at 100mA can be used.

To set up the receiver, the relevant button on the transmitter is held down while adjusting CV2 on the receiver – a plastic trim tool is supplied for the purpose. LED LD2 should begin to flash as the receiver goes into alignment. To maximise the range, fine tuning of CV2 is necessary – you might need to get somebody to help you here. There is an alternative, if the receiver is configured for toggle operation. You can try tweaking the trimmer slightly, moving away and activating the transmitter. If the LD1 has changed state, the transmitter has successfully talked to the transmitter. If it hasn't, try tweaking it the other way slightly. By repeating this procedure, and moving progressively further away from the receiver, adjustment for maximum range can be achieved.

What Can You Do With It?

An obvious use is a remote-controlled light switch. Most wall-mounting light switches are single-pole changeover types, and so substitution is an easy task. It is important to take the appropriate safety precautions when working with mains electricity, such as shutting off the power and removing the fuse that feeds the lighting circuit you're working with. It is also highly important to build the receiver into a well-insulated plastic case, and to hide any exposed mains wiring. If you're in any doubt as to what you're doing, consult a qualified electrician.

- Easy to build – no coils to be made!
- Two channels
- Fixed 433·92MHz transmitter frequency
- Operates in conjunction with the K6707 code lock receiver
- SAW resonator
- Approved design (report BLC/96-0452 according to I-ETS 300 220)
- 8,748 possible codes
- Range of the transmitter/ receiver: approximately 30m
- LED on/off and battery indication
- Key-chain housing
- Power supply: GP23A 12V lighter battery
- Dimensions (WHD): 35 × 15 × 57mm

Table 1. Transmitter specifications.

This project could also be used to switch other mains appliances – such as kettles, TV sets, outdoor lighting, garage door openers and the like. We would recommend that a double-pole relay, of contact rating appropriate to the current being switched. is used. This relay could be switched by the receiver's existing one – or you could replace the existing relay with another (note that your replacement must have a 12V coil). You would have to mount the relay on another circuit board, since the track pattern and through-holes on the receiver PCB won't accommodate a different type.

Not all of the fun centres around mains voltages, though. Older Hi-Fi, and the stuff pitched at the audiophile market, dispenses with gimmickry such as remote controls. But why should you suffer inconvenience for your music? The receiver module associated with a universal remote control device could interrupt the audio between pre-amp and power-amp, thus muting the audio when the phone starts ringing. I successfully tried this with my elderly integrated Pioneer amp (which has rear-mounted links to separate pre-amp and power amp). For stereo systems, however, a DPST relay is needed – remember that the device fitted to the receiver is a simple single-way (i.e., mono) changeover type.

Then, there's security. This project could be used to remotely-arm a car alarm. Shielding of the receiver by the car bodywork isn't as much of a problem as you would think, at least, at close-range. This is because at the low wavelengths involved, signals could propagate through gaps in the bodywork. A bigger disadvantage is the financial aspect – the combined price of the kits represents a significant chunk of a new car alarm's price. You could, however, implement a remote panic button for use with an existing domestic alarm system. Another security possibility is the remote door-lock, in which your old-fashioned key is replaced by an electronic version. Here, the receiver drives an electromechanical door-release, such as Maplin's 12V YU89V.

- Easy to build – no coils to be made!
- Operates in conjunction with the K6706 two channel codelock transmitter
- 8,748 possible codes
- Range of the transmitter/ receiver: approximately 30m
- LED on/off indication
- LED receiving level indicator
- Relay output: 10A, toggle or momentary contact
- Separate output to switch Velleman car alarm on or off
- Power supply: 2 × 9VAC, or 12-16VDC (100mA maximum)
- Dimensions: 76 × 84mm

Table 2. Receiver specifications.

Conclusion

These two kits work well, although I couldn't get the full 30m range – probably something to with the cluttered nature of my home. They are flexible, and can be put to a range of uses – at least, if you live in Europe. Unfortunately, legal use of the 433·92MHz band in the UK is restricted to automotive applications. But then again, the power levels involved are in the sub-milliwatt region, and the transmitter will be operated in short bursts. The risk of causing interference to other radio users, and attracting the interest of the DTI's Radio Investigation Service, is hence very low. Nevertheless if you, as a UK reader, choose to use these kits for anything that isn't vehicle-related, you do so at your own risk.

Ordering Information

K6706A 2 Channel Transmitter Kit. Order As: VF84F (£14.99)
K6707 2 Channel Receiver Kit. Order As: VF66W (£20.99)
MB2 Plastic Box. Order As: LH21X (£2.34)
250mA 9-0-9V Transformer. Order As: YN15R (£4.99)
Electric Door Lock. Order As: YU89W (£16.99)
GP23A Alkaline Battery. Order As: JG91Y (£0.99)
Spacers, screws and other hardware: As Required.

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

Ready, Steady, Go!

Dear Sir,

Since using a BBC computer in 1985 to measure and record temperature and input signals with relative ease, I thought of doing something similar with an IBM compatible computer. For many years, I tried in vain to obtain information about interfacing until I came across your magazine in our local library. In a short while, I read through all the back copies and was favourably impressed with the contents. I also came across the article 'Programmable Centronic 24-line Input/Output Card' in the March 1997 issue which gave me all the information I tried for so long to obtain, including the required commands needed to program in BASIC. I subsequently satisfied the long-standing need I had to interface a computer to traffic signal lights in order to measure how long the different lights were on without resorting to the tedious and inaccurate use of a stopwatch. In my search for information about the parallel port, I learnt that this port is apparently switchable from output to input in the latest PCs available. Can someone perhaps provide details on this aspect? I since subscribed to your excellent magazine through your local agents in Somerset West and really enjoy receiving your magazine on a regular basis. Some time ago, I learnt about the Dallas Semiconductor Corporation 1620 Digital Thermometer IC and saw a demonstration where it is used to measure temperature by connecting it to the parallel port of a computer. Dallas also has a 1820 Digital Thermometer IC of which a number could be connected together using only 2 wires to measure temperatures in various locations. Unfortunately, neither the manuals or the local supplier could give me information as to how this is done and how a BASIC or CLIPPER program can be written to accomplish this. It will be much appreciated it if an article could perhaps be published in your magazine about this. I am sure many of your readers will find this a useful project. I also read your articles about PICs with much interest. As I am familiar with programming PLCs, I wonder why the developer of these devices did not make it as easy to program them as programming PLCs using ladder diagrams?

L. D. M. de Wet. Pr.Eng., Boksburg, South Africa, e-mail: ldmdewet@ilink.nis.

Good to hear you enjoy our magazine and find it a useful source of information. I trust you obtained the local highway authority's permission before hooking up your PC to their traffic lights! Perhaps a knowledgable reader may be able to help out with Mr de Wet's queries?

Don't Forget the Slide Rule

Dear Sir,

A point that is missing from every article or book I have ever read on VHF/UHF Yagi aerial arrays reflects a lesson I learnt as an Aircraft Wireless Mechanic in 1952-53 when serving at the New Zealand Farm outpost of RAF Boscombe Devon, on Salisbury Plain; that there are three adjustments for maximum sensitivity of signal reception: rotational and horizontal (aka alt-azimuth) and nodal distance of the main dipole along the straight line between the transmitter and the aerial. The number of elements required for maximum signal strength is a less important factor than that the distance between the dipole and the furthest director element should not be less than 1·414 times the longest wavelength of the received band, while a slide-adjustment in the direction of the transmitter should not be less than 0·707 times the same wavelength, given that the correct alt-azimuth settings are already fixed. This critical pair of adjustments can often result in there being no need for an aerial amplifier since it can result in as much as 30dB extra gain over a poor installation – a point that most aerial erectors seem ignorant of appreciating, as are nearly all journalists.

Bert Martin (NIMROD), Verwood, Dorset.

In this issue, A. Fairbrace, of Crawley, W. Sussex, wins the Star Letter Award of a Maplin £5 Gift Token for raising the dust covers on the finer points of valve amplifiers.

£5 MAPLIN GIFT VOUCHER

Star Letter

Dear Sir,

As a serious home constructor in the field of electronics, I would like to air some points of view regarding the subject of valve amplifiers, i.e., kits bought from Hi-Fi stores or home-built. I have recently completed my second valve amplifier. The first was a stereo Class A, and uses EL84 output valves which gives 3-4W per channel output. The unit is Midi-size and has a dust-cover used only when the amp is not in use. I designed this amp mainly to play CDs (see Photo 1). The results of this first project were so impressive that one year later, I decided to design and build a second amp, this time, a Class B type with separate power supply, which makes the hum almost zero, I'm happy to say (see Photo 2). This amp is stereo ultra-linear push-pull, using 6L6s as output valves, giving 15-20W output per channel. This was an old 1960 circuit which I modified and brought up to date. It now sits in our lounge working beautifully driving two floor type loudspeakers, and is used mainly for playing CDs. The results of this second amp are much greater in terms of sound quality and power, and was worth all the hard work. Fine, you may think, but then other home constructors have been known to do great things. However, due to these two projects, I have learnt a great deal, not just technically. Points I'd like to raise are:

1. When valve amplifier projects appear in magazines, 9 times out of 10, they are Class B designs. In my opinion, there should also be some Class A versions – simpler and cheaper to construct.

2. The majority of valve amplifier kits sold in catalogues, magazines and Hi-Fi shops are overpriced. For example, on my Class B amp, I used the best components throughout and also had the transformer boxes made for me; the top of the amp is copper and everything I used was new, yet I still didn't come near some of the prices charged for kits! It was these prices that made me decide to design and construct my own.

3. In my opinion, you do not need tone controls when playing a CD through a valve amp, which in turn rules out a preamp and keeps the power amp simple. To be fair though, it is a matter of taste.

4. In my opinion, a good valve amp kit for the home constructor would have good looks (professional finish with a dust cover), simple construction, fair price, be Stereo Class A (to begin with), and compact size.

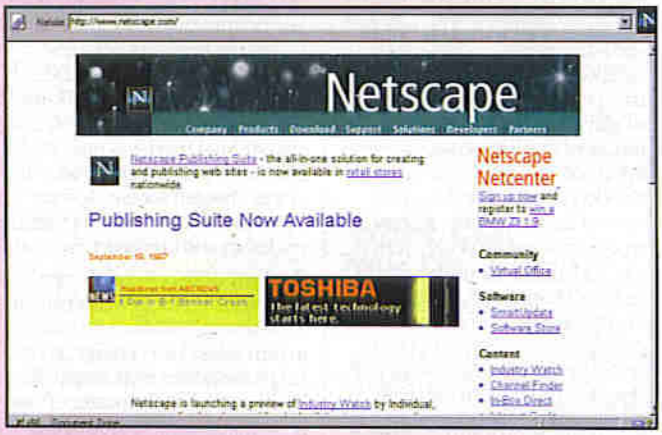
I would be interested to see other readers' responses to these points.

If these amplifiers sound as good as they look, we can imagine that they must be a real treat to listen to! It must be satisfying being able to construct your own Hi-Fi valve amps for less than they cost in kit or ready-built form too; this isn't usually the case with many electronic appliances in this age of mass production and cut-price foreign imported goods.

New Web Design Software

While the majority of the pages on the World Wide Web are designed on just a handful of programs (Adobe PageMill, Claris Home Page, SoftQuad HoTMetaL Pro together are used for well over 80% of Web pages), it's interesting to see that new programs are still being developed. UK company, SoftPress Systems' new Web design program, Freeway, has just been announced. A design program in the true sense, it's Macintosh-only, and a 30-day trial copy of Freeway can be downloaded from SoftPress' Website at http://www.softpress.com. While Freeway's release came too late for us to look at the program this month, we'll be taking a look in next month's issue. Features include the ability to use graphics in original formats, anti-aliased type, character and paragraph level styles, professional typographical controls and many others. If it performs as well as it sounds, this will be a PageMill-killer.

Netscape Revamps Web Site



Netscape has turned its existing Web site at www.netscape.com into a NetCenter, offering registered users the ability to create Web pages for private discussion groups and to automatically receive updates to Netscape software.

The company hopes its reincarnation will spark more traffic, and generate more advertising revenue and transaction fees. Competitors such as Yahoo!, Excite and Microsoft are also beefing up the free services on their Web sites, but Netscape hopes to exploit its high concentration of corporate users.

Microsoft Jump-Starts Web TV

Microsoft at www.microsoft.com has unveiled a beefed-up version of its WebTV system for surfing the Internet via the television. The company's new technology is based on an innovative chip that combines the capabilities of a TV tuner, a cable modem and a high-speed PC modem all into one low-cost unit.

The new boxes will enable WebTV to develop content that combines both television programming and Web sites in a seamless mix, using an improved program guide called Explore.

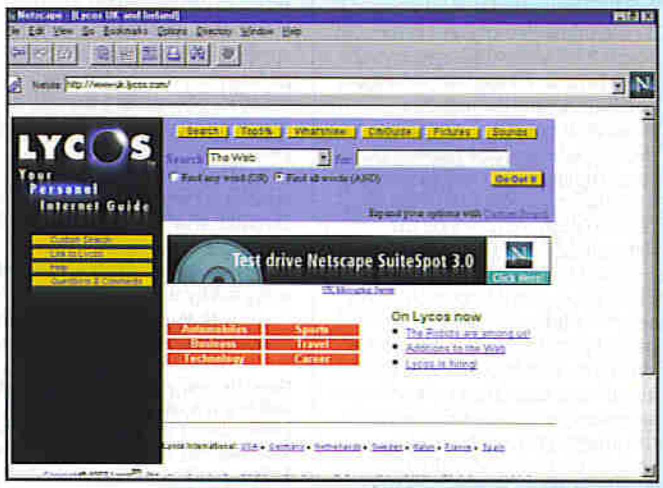
Patent to be Issued for Lycos' Spider Technology

Personal Internet Guide, Lycos, has secured a patent for its pioneering spider technology, invented at the Carnegie Mellon University. Under the terms of the patent, Lycos at www.lycos.com, has the exclusive rights to this technology. The patent acknowledges the proprietary nature of the Lycos spider currently in use indexing the Web.

Spider technology enables Web users to gather targeted information from the world's estimated 30 million different Web sites, and their hundreds of millions of subsidiary pages. Spiders are the cornerstone of today's search, directory and indexing products deployed throughout the Web.

Dubbed Lycos, from the Latin for wolf spider, the service quickly grew in popularity as the increasing numbers of Web users found a growing need for an efficient and effective way to find Web-based information for their research and recreation.

Spiders are widely recognised as one of the key technologies, which have made the Internet's vast resources accessible to end users by collecting and organising information into searchable databases.



Contemporary Art Exhibits Goes Online

Documenta, one of the world's leading contemporary art events, is held every five years in Kassel, Germany. For the first time, this year's exhibition features art on the Internet as a platform.

The artists post their projects on the Net themselves and develop these further during the exhibition period. Internet users from around the world can view and influence the works of art as well as interact with artists and visitors.

The newly created Web site at www.documenta.de sports its own distinctive look and feel, dominated by the colours red and black, and by navigational symbols. Both German and English versions are available. Sixteen projects are currently available on the site, among them, a self-writing Web site, which has no addresses. Individual visitors to the Web site leave behind traces that expand into paths and routes. The total number of visits forms the structure.

Another Internet project consists of elements such as words and film assembled by visitors of the documenta Web site. Contributions are filtered through a neuronal net.

Web On the Move

Users of Apple MessagePad personal digital assistants who use the Internet, or are considering doing so from their pocket computers, should try out Lunetech's LunaSuite Pro 2.1 beta that's available for free download from `http://newton.lunatech.com/Beta/Products/LunaSuite/Pro/`. LunaSuite is a full-featured Web browser plus e-mail package for the MessagePad that surpasses anything else yet available. For example, it positively leapfrogs the features and abilities of the Web browser and e-mail packages supplied by default with the latest MessagePad 2000 PDA. Essentially, it turns the MessagePad into a complete portable communications device and, if you've a GSM mobile telephone, you can access the Internet from literally anywhere with the benefit that it's totally integrated into the Newton operating system within the MessagePad, such that addresses, mail and so on are accessed directly from internal Newton features. As it's supplied in a Newton package form, the download can be to Macintosh or Windows-based computers via a conventional computer Web browser, then the package can be forwarded to the MessagePad using either computer's Newton Connection Utilities application.

Online Gaming Market Growing Up

The online gaming market is beginning to mature and attract investment from growth funds rather than venture capitalists. E-Pub Limited, which hosts the free-to-play Cosmo's Conundrum trivia quiz on its Web site at www.uk.oasisgames.com has won new backing of over £3 million from London-based investors including John Govett & Company and ICE Securities, as well as Euroventures, which backed the company's start up.

E-Pub founder and managing director, Michael Simon, said "The fact that we have now attracted investors anticipating imminent growth, rather than venture capitalists, is a sure sign that our market is beginning to mature. We were turning a profit within four months of our launch in August 1996 and have already signed up over 30,000 registered players."

According to Simon, games are proven tools for building traffic, usage and online communities, delivering precisely profiled audiences to advertisers and sponsors.

But E-Pub's views contradict the findings of a study published this month by Forrester Research at **www.forrester.com.** The study claims that the future of the Web definitely does not lie in the subscription-based model. Even online gaming, which was touted as the exception to the rule, has fallen far short of expectations.

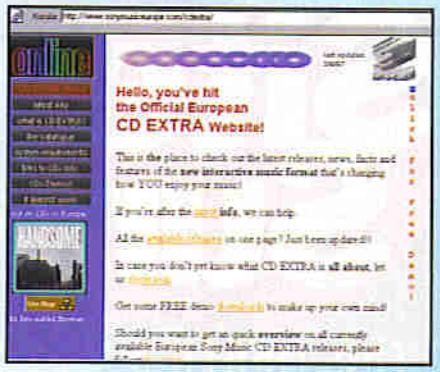
The Forrester study estimates the number of paying subscribers to Internet gaming services at around 600,000. That number is expected to double by 2001, but even so, Forrester claims that the growth rate is too slow to sustain the industry.

Interactive Compact Disk

To bring fans closer to their favourite artists, Sony Music has taken advantage of multimedia and Internet technologies to offer all of these media in one Compact Disk. CD-EXTRA at www.sonymusiceurope.com/cdextra is Sony Music's exciting new technology for combining music, videos, album artwork and band information on a single CD.

The CD EXTRA offers consumers a full audio album when played on a CD player and an interactive experience when used as a CD-ROM in a Personal Computer – all at the price of a normal CD. Sony Music has taken this technology one step further with the help of IBM by including an Internet package, with direct access to a particular band's homepage.

Sony Music's new CD EXTRAs offer fans the music they love along with multimedia content and a free Internet access kit provided by IBM.



By inserting the CD into their PCs, and after a couple of mouse clicks, fans can sign up to the Internet and are brought directly to the artist's web site, from where they can surf the Internet.

The CD and Web sites offer a unique multimedia experience, including exclusive interviews, video clips, fan club information, letting fans interact with their favourite bands right on the desktop.

The first artists to take advantage of this new medium to strengthen their relationship with their fans are Big Soul at www.sonymusic.fr/Bigsoul and Jean-Michel Jarre at www.jeanmicheljarre.com.

The Electric Net

It's obvious really, but all this talk of cable telephone networks, ISDN, microwave links and so on, depends on new networks having to be set up between users. Often, this means digging up roads and pavements to create the new network and get it to the user. Yet, a network already exists between users that can provide all the communications necessary, without the resultant hassle and mess of new ones. The existing network is the electricity supply, and recent work has succeeded in developing a way of allowing computer data to travel over the network at the same time as electricity, such that – wait for this – users can be cheaply and permanently connected to the Internet (yes, that's right, you read correctly – permanently!) at data rates of up to 1M-bps. Of course, every item of good news is usually followed by an item of bad news.

The bad news, however (if you can call it bad), is that rates vary with the number of users connected to the Internet via the network. However, even at its lowest speed, the network will provide Internet access ten times current bottom-end ISDN rates! Some bad news, huh? The technology has been developed by Nortel, and will initially be used by NorWeb Communications, water and power utility company in the North West of England. NorWeb hopes to have trials commencing in the second quarter of next year to customers in Manchester. Essentially, each substation in the electricity network will be capable of supporting about 200 installations, and each computer connected requires an internal adaptor card costing around £200. Nortel's plans are that audio, video, videoconferencing and voice will be provided along the data link. BT, eat your heart out!

AOL Combines with CompuServe Following WorldCom Shake-out

WorldCom, has announced its intention to acquire CompuServe for a cool $1·2 billion. But that is only the start of the story. WorldCom is hanging onto CompuServe's network infrastructure, but has given American Online (AOL) CompuServe's customer base, while purchasing AOL's network services division for $175 million in cash.

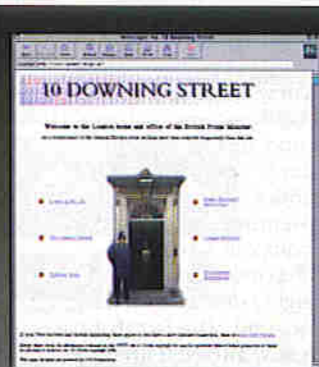
So, what does this mean for AOL and CompuServe users? For a start, it means that WorldCom will operate both the AOL and CompuServe network infrastructure. Beyond this, the implications of the deal for users have yet to be confirmed. Early signs are that AOL and CompuServe online services will continue to operate as separate entities – in Europe, at least.

Speaking to Electronics and Beyond as the deal was announced, Jerry Roest, CompuServe's European vice-president said, "We will continue to operate as a separate brand, focused on meeting the needs of the professional consumer at work and at home".

Through its UUNET subsidiary, WorldCom at www.worldcom.com already holds a leading position in the global Internet market, and the transactions announced today further strengthen and broaden that position – particularly with respect to its value-added product and services portfolio.

Site Survey

The month's destinations



Selling England by the Byte

Many companies are beginning to use the World Wide Web as sales showrooms. Some do very well at it, too. Dell Computers, for example, is said to be earning $1 million a day (yes, that's right, each and every day – weekends included) selling its computers over the Web. One of the latest to try out selling off the Web is our very own Scotts of Stow, whose Website opened for business recently. Scotts of Stow catalogues, often full of its traditional dark green household goods, should be familiar to many readers, and the Website at: **http://www.scottsofstow.co.uk** is worth a visit, if only to see the very stylish design. You're not, of course, obligated to purchase.

Way Cool

Make sure this site's on your Web browser's bookmark list, and make sure you check out the site every day. The Cool Site of the Day at: **http://cool.infi.net** is updated, err . . . daily, with links to at least one new site that's guaranteed to be stylish. What makes cool? Well, they say beauty's in the eye of the beholder, so what's cool for one is probably another's poison. Find out for yourself.

Off With His Head!

Historically based Websites are always a bonus, particularly when they're in the UK. The Tower of London's at: **http://www.tower-of-london.com** is one such site. There's lots of information on linked pages, relating to visiting the Tower (for short stays, we hope) and enough about its history to be of direct use for schools.

Number 10

While you're on your virtual visit to the Tower of London, make a whole daytrip of it and pop along to Downing Street, at: **http://www.number-10.gov.uk.** You can tour the house, read the Queen's speech, sign the visitors' book, read the PM's biographies, check out Cabinet ministers, and find Government departments. All-in-all, a nice introduction to the workings of our Parliament.

ELECTRONICS and Beyond

in the pipeline

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

Issue 121 on sale Friday 5th December

AVR: The Project

The second in our series of AVR microcontroller-based applications.

Time/Date Stamp

Put a time and a date to it with this punctual project.

Touch Hybrid Relay Board

Another application for touch hybrid security technology.

PLUS Douglas Clarkson provides us with a Cold Fusion Update, just in time for winter!

The final part of Information Economy from Stephen Waddington looks at problems of information overload.

In Part 4 of Security Electronics Systems and Circuits, Ray Marston looks at visible light optoelectronic security circuits.

Rob Sperring scales the dizzy heights of Technology in the Mountains.

George Pickworth continues his article on Communicating Through Water.

Reg Miles inspects the latest developments in printing technology.

Keith Brindley reviews Apple Palmtops.

In Part 11 of What's in a Name?, Greg Grant uncovers the mysteries of piezoelectricity.

ADVERTISERS' INDEX

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:

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.

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.

Average. Some skill in construction or more extensive setting-up required.

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

Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

Ordering Information

Kits, components and products stocked at Maplin can be easily obtained in a number of ways: ❶ Visit your local Maplin store, where you will find a wide range of electronic products. If you do not know where your nearest store is, telephone (01702) 554002. To avoid disappointment when intending to purchase products from a Maplin store, customers are advised to check availability before travelling any distance; ❷ Write your order on the form printed in this issue and send it to Maplin Electronics PLC, P.O. Box 777, Rayleigh, Essex, SS6 8LU. Payment can be made using Cheque, Postal Order, or Credit Card; ❸ Telephone your order, call the Maplin Electronics Credit Card Hotline on (01702) 554000; ❹ If you have a personal computer equipped with a MODEM, dial up Maplin's 24-hour on-line database and ordering service, CashTel. CashTel supports 300-, 1200- and 2400-baud MODEMs using CCITT tones. The format is 8 data bits, 1 stop bit, no parity, full duplex with Xon/Xoff handshaking. All existing customers with a Maplin customer number can access the system by simply dialling (01702) 552941. If you do not have a customer number, telephone (01702) 554002 and we will happily issue you with one. Payment can be made by credit card; ❺ If you have a tone dial (DTMF) telephone or a pocket tone dialler, you can access our computer system and place your orders directly onto the Maplin computer 24 hours a day by simply dialling (01702) 556751. You will need a Maplin customer number and a personal identification number (PIN) to access the system; ❻ Overseas customers can place orders through Maplin Export, P.O. Box 777, Rayleigh, Essex SS6 8LU, England; telephone +44 1702 554000 Ext. 376, 327 or 351; Fax +44 1702 554001. Full details of all the methods of ordering from Maplin can be found in the current Maplin Catalogue.

Internet

You can contact Maplin Electronics via e-mail at <recipient>@maplin.co.uk or visit the Maplin web site at http://www.maplin.co.uk.

Prices

Prices of products and services available from Maplin shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%). Prices are valid until 3rd December 1997 (errors and omissions excluded). Prices shown do not include mail order postage and handling charges. Please add £2.95 to all UK orders under £30.00. Orders over £30.00 and MPS Account Holding customers are exempt from carriage charges.

Technical Enquires

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics and Beyond*, the Technical Sales Dept. may be able to help. You can obtain help in several ways; ❶ Over the phone, telephone (01702) 556001 between 9.00am and 5.30pm Monday to Friday, except public holidays; ❷ By sending a facsimile, Fax (01702) 554001; ❸ Or by writing to Technical Sales, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Don't forget to include a stamped self-addressed envelope if you want a written reply! Technical Sales are unable to answer enquires relating to third-party products or components which are not stocked by Maplin.

Maplin 'Get You Working' Service

If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini-Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service return the complete kit to: Returns Department, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Enclose a cheque or Postal Order for the servicing cost (minimum £17) as indicated in the current Maplin Catalogue. If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost, plus parts.

Circuit MAKER

by Dr G. L. Manning G4GLM

LED Map-reading Torch

Powering an LED in series with a dropper resistor isn't original, but the present application requires some thought and optimisation. Whilst on the return leg of a long car journey, at night on unlit roads, I found map-reading quite hard. Torchlight was difficult to control and the driver complained of dazzle. The bright light meant that my night vision wasn't at its best for picking out roadsigns and the whole exercise was wasteful of batteries. Even a red filter over an incandescent bulb is not ideal, giving poor colour rendition when reading road atlases and Ordnance maps. It is also questionable whether the red light really does not detract from night vision.

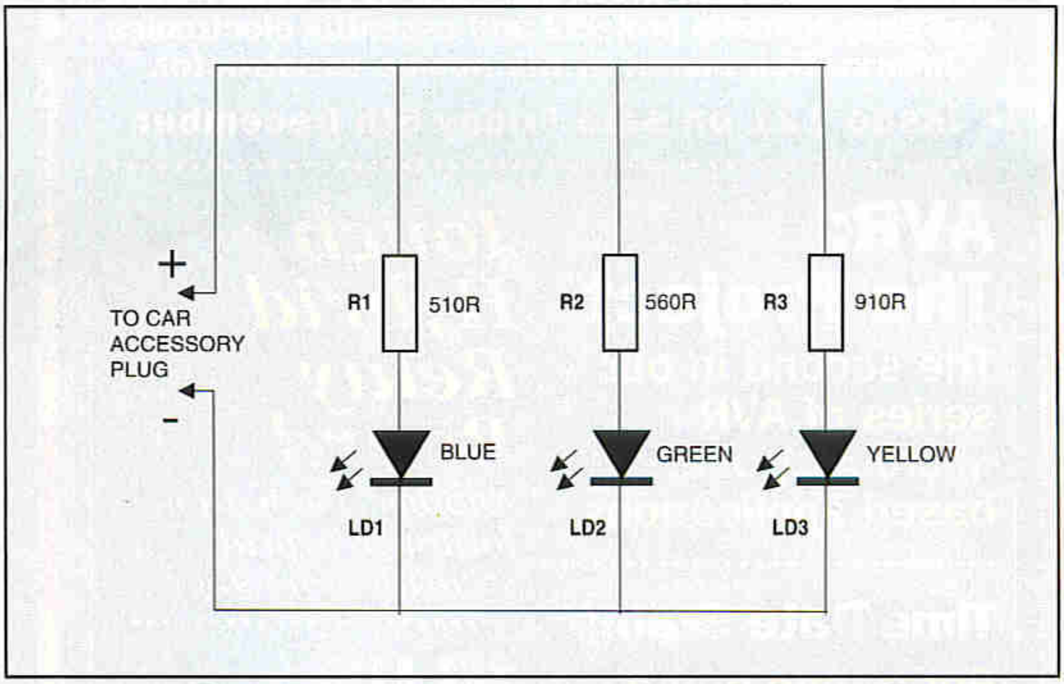
My design optimises the use of LEDs as a light source that the navigator can safely leave on throughout the journey without either dazzling the driver, reducing night vision, wasting batteries or burning out bulbs; the unit is powered from the vehicle's cigarette lighter socket. It was not possible to produce a pool of white light by aiming red, green and blue LEDs onto the map, since the colours are not sufficiently pure. However, colour rendition is still good enough to read a map easily. In fact, yellow LEDs pick out red A-road markings adequately and so there is no red LED in the final design.

Construction is by a 'freestyle' method. Although the LEDs could perhaps be mounted in some sort of box, I found this clumsy. The dropper resistors are soldered hard against their LED with the shortest intervening lead. Heatshrink sleeving is then applied to cover the resistor. Each LED is fitted with the appropriate size of clip. The three LED sub-assemblies are then mounted on a lump of 'Blu-Tack' (from stationers such as W. H. Smith) which has previously been moulded into a slightly conical shape. Apply 13·8V to the LEDs via test leads and darken the room. Aiming the light at white paper, press the LEDs into the Blu-Tack until their pools of light coincide about 3cm away. Perfect overlap is neither possible nor necessary. Seal the LEDs in position with plenty of epoxy resin.

The wiring must be well insulated and plenty of heatshrink will help here. Finally, solder a length of twinflex to the assembly and terminate with a car cigarette lighter plug. Wrap the assembly with self-amalgamating tape for strength and insulation. A sleeve of black plastic is now wrapped around the assembly so as to recess the LEDs themselves in a manner resembling the lens hood on a camera. Black PVC adhesive insulating tape binds the hood to the assembly. Finish off with an outer tube of 'race pack' heatshrink sleeving.

Even at this stage, there were visible gaps between the LEDs. I filled these with 'Milliput' compound (from model shops) and painted this with Humbrol model enamel paint (colour 33, matt black).

On road testing, there were no reflections in the windscreen and no dazzle. The driver is aware of a faint pool of light in the vicinity of the navigator, but this light is less obtrusive than that from the car's instrument panel. The navigator can pick out features local to the current map position. This light enables the route to be followed and the position updated, but it is not intended to illuminate a large area of the map for planning purposes. This should be done before embarking! The resistors are within their power ratings but the unit does become noticeably warm after an hour. There is no on/off switch; just rest the lamp face-down on the map to occult the light, or pull out the cigarette lighter plug. Current consumption is less than 40mA.



LED MAP-READING LIGHT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1	510Ω	1	(M510R)
R2	560Ω	1	(M560R)
R3	910Ω	1	(M910R)
SEMICONDUCTORS			
LD1	3mm Blue LED	1	(JA19V)
LD2	10mm Green LED	1	(UK26D)
LD3	10mm Yellow LED	1	(UK27E)
MISCELLANEOUS			
	Cigarette Lighter Plug	1	(HW12N)
	3mm LED Clip	1	(YY39N)
	10mm LED Clip	2	(UK17T)
	Twin Syringe Epoxy	1	(BA11M)
	4·6mm Black PVC Tape	1 Reel	(FT20W)
	Self-amalgamating Tape	1 Reel	(KW29G)
	Twin-core Flex	As Req.	(XR39N)
	Heatshrink Sleeving	As Req.	(XS11M)
	Blu-Tack	As Req.	
	Milliput	As Req.	
	Humbrol Matt 33 Paint	1 Tin	