THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

October 1996 No. 106 £2.25

Britain's favourite monthly magazine for electronics

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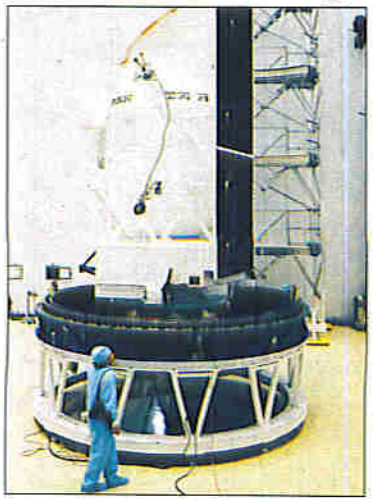
A great future

The Set-Top Box Network Computers

GranadaLand TV Theme Park

Infrared Space Observatory



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WIN TICKETS TO THE GRANADA STUDIOS TOUR
See page 20

EXTRA 16 PAGE SUPPLEMENT
See inside for your pull-out supplement featuring the latest products from the new Maplin MPS Catalogue.

Projects for you to make... SuperScan MkII ◆ Active DI Box ◆ Model Train Sounds

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October 1996 Vol. 15 No. 106

Projects

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Welcome to ELECTRONICS and Beyond

Welcome to a special edition of *Electronics and Beyond*. As our new name suggests, the magazine will be looking forward to the new technologies and associated products to emerge in the market place. The huge variety of products you'll see within these pages will be of interest to the technically aware consumer.

We shall be highlighting the methods and techniques that Maplin MPS product is being used in industrial applications.

There's an extra 16 pages this month in the centre which features a variety of new products from the new Maplin MPS catalogue. If you spend over £50 inc VAT from the products featured here you'll receive a Casio calculator absolutely free with your order.

Many of you will perhaps be reading the magazine for the first time. We hope you like what you see and will be tempted to seek out next months edition of *Electronics and Beyond* from your newsagent, local Maplin shop or by subscription. The temptation is even greater when we tell you that we are giving away a £5 voucher with the next issue to spend either in our shops or to use on product purchased by mail order. Whichever way you look at it, *Electronics and Beyond* represents great value for money.

Robin Hall, Editor

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Photo Retouching

If your summer holiday photos aren't quite up to scratch, you should get hold of a copy of the latest version of PaintShop Pro, the photo-editing and graphics package from Digital Workshop.

The upgrade adds more sophisticated photo-editing features, paper textures, gradient fills, drop shadows and multiple selections. There's also a seamless texture option and a buttonise effect for creating graphics for web pages.

Paintshop Pro 4 for Windows '95 is available from today on floppy disk or CD-ROM at around £60. Upgrades are available from earlier versions.

Contact: Digital Workshop, Tel: (01295) 258335.

Toshiba Takes Lead with Industry's Fastest Memory

Toshiba will soon begin shipping a more advanced type of dynamic random access memory (DRAM) chip. The new chips, which have a capacity of 64M-bit, feature Extended Data Out (EDO), which means faster access.

The chips are Toshiba's second generation devices, and boast the world's fastest access speed, of 40ns. Power consumption is also low, with the devices requiring just 3·3V at a current of 100mA. The chips are produced using 0·35μm production technology, and have an EDO cycle time of 16ns.

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

Contact: Toshiba, Tel: (0171) 242 7295.

Manufacturers want Video Conferencing

A new survey commissioned by Fellows Independent Research on behalf of PictureTel, revealed that 50% of manufacturing companies in the UK are planning to implement videoconferencing within their organisation in the future.

Almost two thirds of the respondents who had plans to introduce videoconferencing quoted savings on travel time as the prime reason. Faster decision making and savings on travel costs were also given as a reason by over half of the respondents.

For further details, check: `http://www.picturetel.com`.

Contact: PictureTel, Tel: (01753) 673000.

Turn your Colour Printer into a Photocopier

SOFTcopy, from Colourgraph, claims to turn your colour printer into a colour photocopier. Combined with a scanner, the application simulates a colour photocopier-style control panel on the PC screen. From the control panel, it is possible to change the colour balance and brightness or zoom in or out on areas of a document.

SOFTcopy is available in Windows 3.1 and Windows '95 format, priced £50.

Contact: Colourgraph, Tel: (01734) 819435.

NEWS BYTES

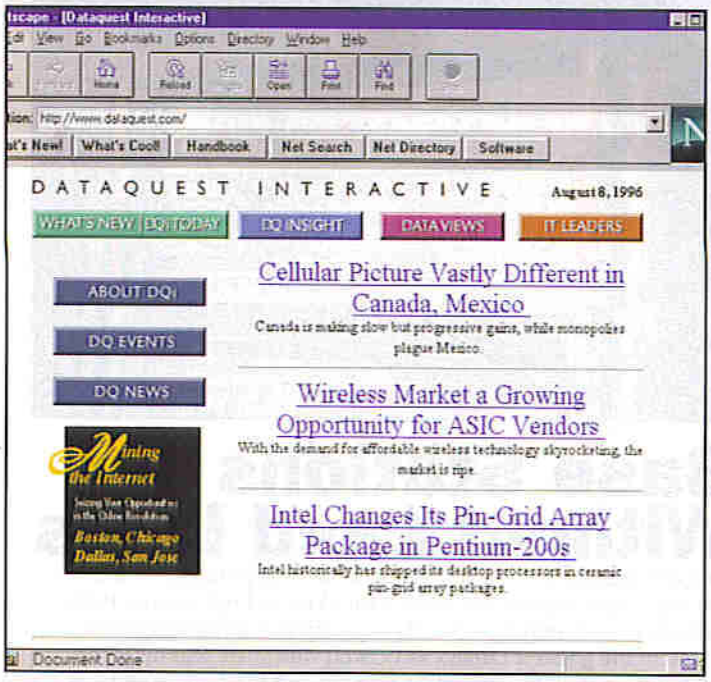
PC Multimedia Growth Doubles

The worldwide multimedia desktop PC market more than doubled last year, to more than 20·8 million machines from 10·3 million in 1994, according to Dataquest. Dataquest said gains in PCs with multimedia features – combining sound, graphics, animation and video – were 44% in Europe, 35% in the US, and almost 400% in Asia.

Apple Computer led the multimedia PC vendor in the world in 1995 for the third consecutive year, with sales growing 67·4% to 3·93 million units. However, Apple, which is scrambling to survive by focusing its business, saw its market share fall to 18·8% from 22·9% in 1994.

Packard Bell, which agreed last week to merge its PC operations with NEC, was a distant second with sales rising 526% to 3 million, followed by Compaq, gaining 57·5% to 1·93 million.

For further details, check: `http://www.dataquest.com`.



Zero Energy

Sending a bit from one computer to another requires energy, right? Perhaps not, according to a paper published by IBM's Rolf Landauer. At a time when the technological limits of computing are challenged daily, the paper continues a long chain of investigations at IBM Research, exploring the energy limitations of computation, measurement, and communication.

A conceptual proposal designed to provoke continued innovation in reducing energy consumption in a networked world, Landauer's paper questions the assumption that there is some minimal amount of energy required to send a bit – the smallest unit of information handled by a computer, represented by a 1 or 0 – from one point to another.

"My message is that the energy and matter used in sending information need not be thrown away at the receiving end – they can, in principle, be recycled", said Landauer. "While the examples in my paper are artificial, they are meant to stimulate more realistic inventions that make better use of the energy used in everyday computing".

A copy of the Landauer's paper can be downloaded at: `http://www.ibm.com`.

Contact: IBM Research, Tel: (+1) 914 945 3584.

CD-ROM Acceleration

A new CD-ROM utility claims to reduce CD-ROM access time by as much as 90%. SpeedyROM, a 32-bit utility from Quarterdeck, incorporates a caching algorithm to intelligently determine the most frequently-used information and cache this to memory or hard disk.

Retailing at £35, Quarterdeck claim SpeedyROM will smooth out graphics and audio for twin-speed CD-ROM applications. Benchmark tests show gains ranging from 11 to 92% for second and subsequent passes on a CD-ROM with SpeedyROM active.

For further details, and to download a trail version of SpeedyROM, check: `http://www.quarterdeck.com`.

Contact: Quarterdeck, Tel: (01245) 491190.

PCs in Europe Cost a Third More

A new report from IDG Group says that PC prices in Europe average 34% higher than the US for the same machine. Regardless of this, IDG claim sales are expected to continue to rise, with an anticipated 6·4 million units sold this year, up from 5·4 million last year.

For further details, check: `http://www.idg.com` or `http://www.idg.co.uk`.

Contact: IDG, Tel: (0171) 831 9252.

Compaq Cuts Memory Prices

Compaq has dramatically reduced the price of its memory upgrade options for desktop, server and portable systems. The move reflects falling world-wide memory prices.

Price cuts across the range are typically between 40 and 55%, with a 4M-byte memory module for desktop systems being reduced by 55% from £145 to £65. An 8M-byte memory module now costs £135, a reduction of 47%, or £145 for an 8M-byte EDO RAM kit, a reduction of 47%.

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

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

Freephone Nightmare

A wrong number in a computer manual has caused headaches and a huge phone bill for a small educational toy distributor. Compaq printed the free phone number for Play 'n' Learn Sales in manuals as the help line for a WordPerfect program that is installed on its Presario 7100 machines.

As a result, dozens of calls a day came into the family-run Play 'n Learn, sometimes through the night, from people who have a question about the program WordPerfect Works.

"On top of the nuisance of it, we're losing business because our lines get tied up and our customers can't get through", said owner Kathleen Henn. She is suing Compaq earlier this week, seeking payment for the more than $6,000 in erroneous calls to her company's freephone line.

International Radio Amateur Certification

The Radio Communications agency has launched a new scheme for UK radio amateurs who wish to operate abroad for periods of over three months. The new ruling will make obtaining a foreign amateur radio license a relatively simple procedure.

Countries that have implemented the appropriate CEPT Recommendation will issue, on request, mutually recognised HARECs to those who have passed a relevant national examination.

In the UK, Class B HARECs will be issued to anyone who has passed the Radio Amateurs' Examination (RAE) and Class A HARECs will be issued to anyone who has passed the RAE 12 words per minute Morse test.

Contact: Radio Authority, Tel: (0171) 211 0211.

Small Business Initiative

BT and Microsoft are to jointly market a range of computer networking and online services to small- and medium-sized businesses, using BT's direct sales channel and a number of Microsoft accredited resellers.

The two companies believe that by combining their respective networking and software expertise with the support and integration skills of solution providers, smaller businesses will benefit from a single point of contact for all their business needs.

Companies with between 10 to 50 PCs that are either looking to implement a networked computer system for the first time, or considering upgrading their existing network, will be targeted initially.

Contact: BT, Tel: (0171) 356 5369.

NEWS BYTES

Crashproof PC

A new piece of software from POW Distribution promises to debug the configuration of a PC, to avert system crashes. Power Utilities runs hundreds of tests automatically, seeking out problems before the user is even aware of them, and offers appropriate fixes.

Power Utilities contains all the tools necessary to resolve hardware problems, diagnose software conflicts, tune Windows for maximum performance and make hardware installation trouble-free.

The package cleans configuration files, repairing or removing performance-robbing entries and invalid lines. It repairs invalid and outdated entries in the Start Menu and spots potential problems in folders, shortcuts and group files, fixing them before they become a real problem.

Power Utilities also cleans disk space by removing files and space-wasting remnants, which POW Distribution claim even uninstall programs miss.

Power Utilities is available in Windows 3.x and Windows '95 versions from POW Distribution, at around £55.

Contact: POW Distribution, Tel: (01202) 716726.

Price Cut Strategy to Boost Pentium Sales

Intel has changed its price-cutting strategy on Pentium processors in a bid to entice PC manufacturers to buy chips sooner, so they can satisfy pre-Christmas demand. According to Intel, the move is designed to create a more stable price and ordering environment during the key final calendar quarter, which is the most important selling season of the year.

Intel said it intends to aggressively cut prices on certain Pentium chips in August and withdraw price cuts scheduled for November. Industry analysts said the August price cuts would also help Intel compete with new microprocessors from rival Advanced Micro Devices (AMD).

For further details, check: `http://www.intel.com`.

Contact: Intel, Tel: (01793) 403000.

LG Semicon to Invest in UK Plant

South Korea's LG Semicon is to build its first offshore semiconductor plants in Livingstone, Scotland, later this year. LG Semicon chairman, Koo Ja-Hak, said it intends to go ahead with a wholly-owned plant, making 15,000 12in. wafers a month, mainly for 256M-byte DRAMs.

For further details, check: `http://www.lg.co.kr`.

Base Stations Without Land Lines

A recent relaxation in the legislation governing privately owned two-way radio-systems has opened the door to huge savings in the installation and running costs of remote base station equipment.

One of the greatest outlays associated with such systems is the link between the office-based equipment and the remote aerial or mast site, which is normally stipulated by the licensing authority as a land line.

There is now a cost-effective alternative to this expensive type of installation and monthly line rental. Following amendments in legislation from the Radiocommunications Authority, a new technique called Reverse Frequency Working (RFW) replaces the landline link with a simple radio loop.

Diplomat Communications is the first company to bring a product to market which embraces the new RFW technique.

Critics of the system claim it will place an even greater burden on the already cramped radio frequency spectrum.

Contact: Diplomat Communications, Tel: (01256) 381 656.

High Level Integration from Texas Instruments

125 million transistors – that's roughly the total number of transistors found in a high-end personal computer, including the CPU, memory, motherboard chips, modem, sound card and hard disk. Now, it's also the number of transistors that Texas Instruments (TI) can pack onto a single chip using their newly announced 0·18μm TI Timeline Technology. Current fabrication techniques typically work to 0·5μm geometries.

"This dramatic order of magnitude increase in transistor availability will create a new systems and applications domain that will revolutionise the electronics industry", said Rich Templeton, senior vice president for TI Semiconductor Group.

According to Templeton, the ability to compress 125 million transistors into a single device will be especially valuable in the convergence of high-end computer and communication systems, enabling new levels of multimedia interoperability and wireless connectivity. Overall system performance will be significantly increased through integration and silicon performance.

For further details, check: `http://www.ti.com`.

Contact: Texas Instruments, Tel: (01604) 633147.

Mobile Computing Guide

Portable Add-ons has published a free guide to mobile computing, designed to answer some of the most fundamental questions facing the mobile computer user. The booklet provides practical advice when travelling, giving information on issues such as choosing the right equipment for your needs, getting your modem to work over foreign phone lines, and connecting to the Internet.

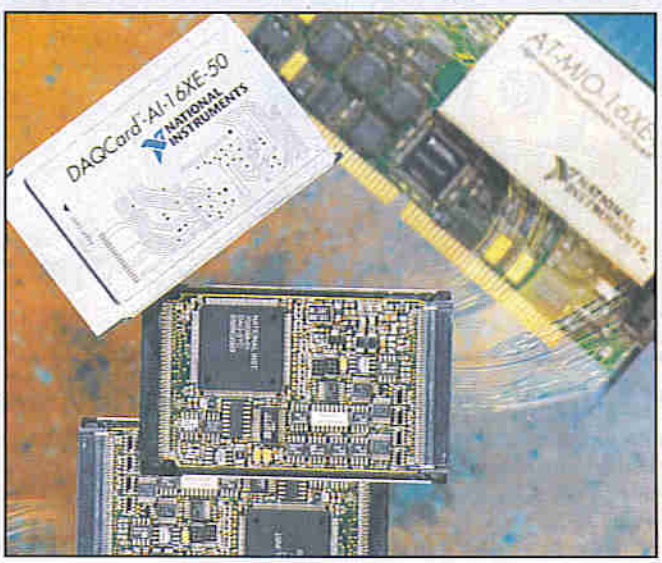
Contact: Portable Add-ons, Tel: (01483) 241333.

Instrumentation Class Data Acquisition

A set of PC Cards from National Instruments can transform a PC into a sophisticated data collection tool. The DAQCard-AI-16E-4 and DAQCard-AI-16XE-50 analogue-to-digital data entry card pack the same functionality found on the company's full-size boards into a PCMCIA format. Meanwhile, the DAQCard-516 is the lowest cost 16-bit multi-function I/O card available on the market.

For further details, check: `http://www.natinst.com`.

Contact: National Instruments, Tel: (01635) 572400.



PSION Spins Out Software Licencing Company

Learning from Microsoft's business model, palmtop specialist Psion has formed a new company, Psion Software, to encourage and assist other companies in bringing products to market such as palmtops, sub-notebooks, smartphones, intelligent terminals and mobile web-browsers using Psion's previously proprietary technologies.

Psion claim that operating systems and applications designed for hand-held computers are fundamentally different from PC platforms. They have to start immediately, be power and memory efficient and never lose the user's data. They have to be responsive and bug-free and offer deep functionality in small code size, whilst appearing intuitive to novice and power users alike.

With thirteen years experience developing such expertise and with over two million units sold, Psion is making its platforms available to licencees. Over the past eighteen months, the company has formed strategic partnerships with Advanced RISC Machines (ARM), Cirrus Logic and Digital Semiconductor.

Mark Gretton, Psion Software Marketing Director explains, "We have been building an alliance of partner companies to provide ROM-based computing solutions for a wide range of products. With ARM, we specified a highly integrated 'PDA on a chip', the ARM7100 targeting high-end palmtops".

"With mass-market volumes in mind, we partnered Cirrus Logic to make the device available to any palmtop manufacturer. If licencees need supercomputing power in a palmtop, we are working with Digital on a StrongARM design", added Gretton.

Contact: Psion, Tel: (0171) 208 1800.

Distillery Saved from Closure After Fire

It was a nightmare scenario for the Scottish distillers, Inver House. The ancient whisky distillery, in operation for over 100 years and the whisky provider for over 300 customers world-wide, was potentially lost forever.

The distillery, based near Greenock, Scotland, went up in flames only days after a brand new wing had been built and cabling laid down for new IT systems.

The morning after the fire, management began to realise the potential consequences to their business. The fire had destroyed many of the systems needed to run the operation, including IT systems, office systems and some vital data storage. The business had basically ground to a halt overnight.

Ann Geddes, IT manager for the distillery said, "Overnight, it seemed the business had collapsed. We called IBM's Business Recovery Services (BRS) and they took the panic out of the situation. Once IBM had been alerted, they were with us within hours. They quickly set up recovery machines in port-a-cabins close to the site, and managed to retrieve the majority of the data - crucial to the continuation of our business".

IBM's Business Recovery Service provided on-site support for all IT systems, fully recovering data that was thought lost. Within hours, an action plan was in place and replacement equipment was despatched. Just two days after the outbreak of the fire, BRS experts were able to enter the building.

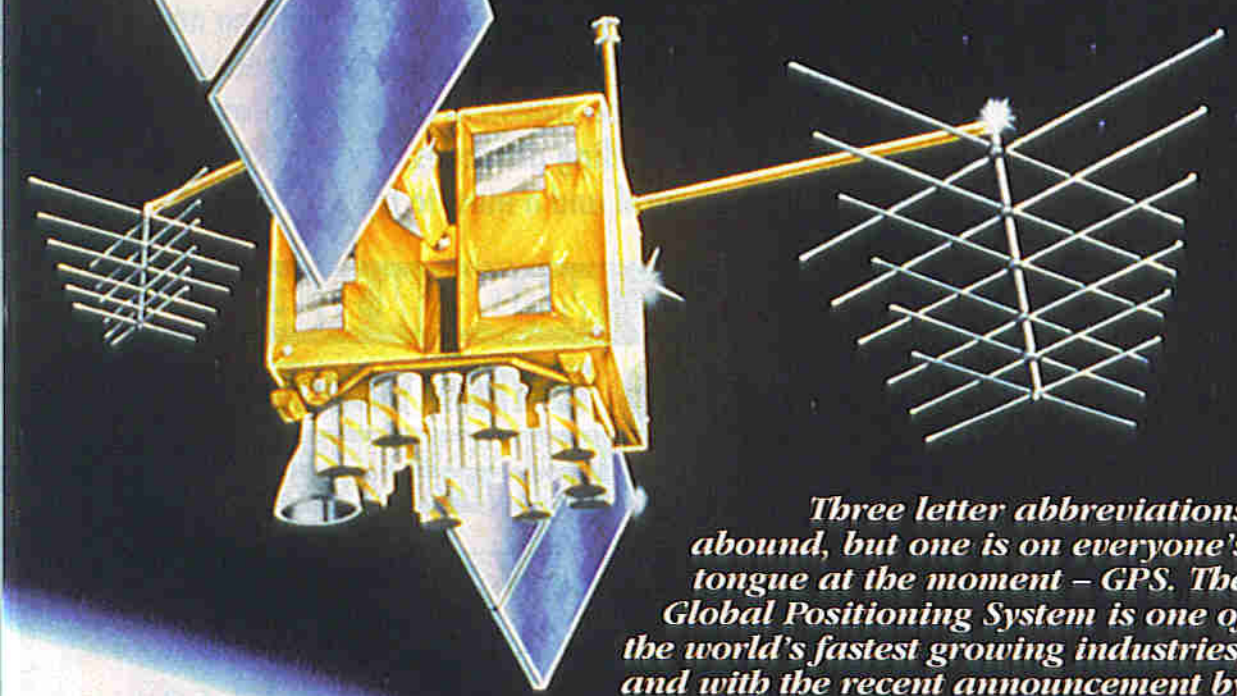
Bill Broadley, BRS Scotland said, "Once we had entered the building, we were able to recover the rest of the data and download it all onto new disks – all without any risk of contamination. This meant little of the Inver House vital data was lost".

For further details, check: `http://www.ibm.com`. Contact: IBM, Tel: (0181) 818 4000.

The futu

Prices for GPS receivers have plummeted. When Magellan introduced the world's first commercial hand-held GPS receiver seven years ago, the price was around £2,000. Today's most recent models sell now for just £200. This makes the price drops experienced in the computer industry look less than significant. Low-cost core module GPS receivers, which can be integrated into computer and communication systems, enable designers to include a positioning device into a wide variety of products we use everyday. Not only will your palmtop computer be able to schedule your life for you and calculate your tax return, but it will also tell you where to go.

The concept of the Global Positioning System was first conceived in the 1960s, when people were considering new uses for satellites. Like most major developments in technology, it started with humble beginnings as a bolt-on goody. The idea was quickly taken up in earnest in the 1970s by the US Department of Defence. The US government saw the potential for a world-wide navigation system for military applications and started to invest some $12 billion to develop and launch the present constellation of 24 satellites.



Three letter abbreviations abound, but one is on everyone's tongue at the moment – GPS. The Global Positioning System is one of the world's fastest growing industries, and with the recent announcement by the US White House which ensures free use of the Global Positioning System for anyone, anywhere in the world, this market looks set to explode. Whatever your walk of life, GPS will know where you are and where you are going.

re of GPS

by Mark Luffingham

The intention was to provide a world-wide navigation system for US forces, without enabling everyone else to also benefit from Uncle Sam's generosity. The US Government's solution to this problem was to have two coded signals, L1 and L2, transmitted from the satellites, as Photo 1 indicates. The L1 frequency contains the civilian access code. This provides Standard Positioning Service (SPS) with an accuracy of around 25m rms for world-wide civilian use. The military code is broadcast on both L1 and L2 frequency, resulting in the Precise Positioning Service (PPS) of less than 8m.

Photo 1. GPS navigation signals.

Photo 2. The new low-cost Magellan GPS 2000 puts satellite technology into the hands of everyone.

However, to a wary US Government, even positioning to 25m seemed a little too accurate when in the hands of their enemies, and so they devised a method of intermittently interfering with the Standard Positioning Service. This Selective Availability (SA) interference inserts random errors into the data transmitted from the satellites, resulting in 95% probability of about 100m accuracy. However, the recent Presidential Decision Directive announced by the White House states that within 10 years, SA will be removed and some sources claim this is more likely to happen within the next two to three years.

For many new and potential users of GPS, this SA interference was just that, and it didn't take long for engineers and scientists to think of a way to overcome the random errors to achieve accuracy of less than 5m. This technique is known as Differential GPS. It involves placing one GPS receiver at a surveyed and known position. The position information from that receiver, calculated against its known position, is used to show the corrections needed for the position data transmitted by the satellites. This corrected information is then transmitted to a Differential Beacon Receiver which, when connected to a Differential-ready GPS receiver, will provide accuracy in the order of 5m.

GPS used in conflict

It was the Gulf War which really brought GPS to the forefront of modern technology. Companies such as Magellan had started designing and building hand-held GPS products in the late 1980s. The company's first product, the NAV 1000, was a single-channel sequential unit with a 30s update, and was available in May 1989.

By 1990, the company had developed the NAV 1000M – a receiver designed specifically for military use and which cost $3,500. As Saddam Hussain and his troops marched into Kuwait in August of that year, the future success of GPS was sealed. Everyone wanted this fantastic bit of technology, which would help them navigate their way in the aptly named, featureless Desert Storm. Demand was such that companies like Magellan were effectively prevented by the US Government from manufacturing receivers for other than military purposes. Even so, there were not enough GPS receivers to go around and the troops quickly started buying up the civilian models. The huge number of civilian receivers used in Desert Storm resulted in the US Government switching off Selective Availability at the very time when it was designed to be used!

This ability to know your precise position, anywhere in the world, 24 hours a day was widely reported by the media covering the Gulf conflict, and the term 'Magellan' became almost generic. To those navigating at sea and in the air though, the concept of GPS was not so much considered to be in the space age but essential. Navigators have been used to looking to the skies for clues to their whereabouts for years. Existing navigation systems such as Decca and Loran had drawbacks in that they were not available world-wide.

By early 1992, the Global Positioning System receiver was becoming the in-thing to have on board your yacht or in your cockpit as you took to the skies. Prices were dropping with the NAV 5000 marine version from Magellan costing less than £1,000. As the price of receivers dropped, Magellan led the way into new market areas launching products including the Trailblazer, a hand-held GPS receiver designed specifically for the land-based outdoor user. However, it was not until 1996, with the launch of the ultra-low cost GPS 2000 from Magellan that GPS receivers really became the accessory of the year – see Photo 2.

Retailing at under £200, the GPS 2000 suddenly became affordable and desirable. Skiers took to the slopes – GPS in one hand and piste guide in the other, to track their routes and store their favourite alpine restaurants as a landmark. Suddenly, walkers, cyclists, fishermen, off-road drivers, campers, hot-air balloonists and even pot-holers were turning to the accuracy, information and reassurance provided by satellite technology – see Photo 3.

More than just a position

For pilots, the GPS products started to add extra useful features which would tell them more than just where they are, where they want to go to, and which way to get there. Databases of all the airports and landing strips over 1,600ft. long in the world are included in aviation products such as the SkyBlazer XL. The hand-held GPS receiver can help pilots with their flights by providing fuel planning information, glide slope and winds aloft calculations. In the case of an emergency, the database will provide full details on the nearest airfield, as well as its bearing and distance, and useful information including the facilities and the call frequencies for approach, tower and ground control.

In its aviation product line, Magellan saw the need to provide more detailed mapping information, combined with the data available from a GPS receiver. The company

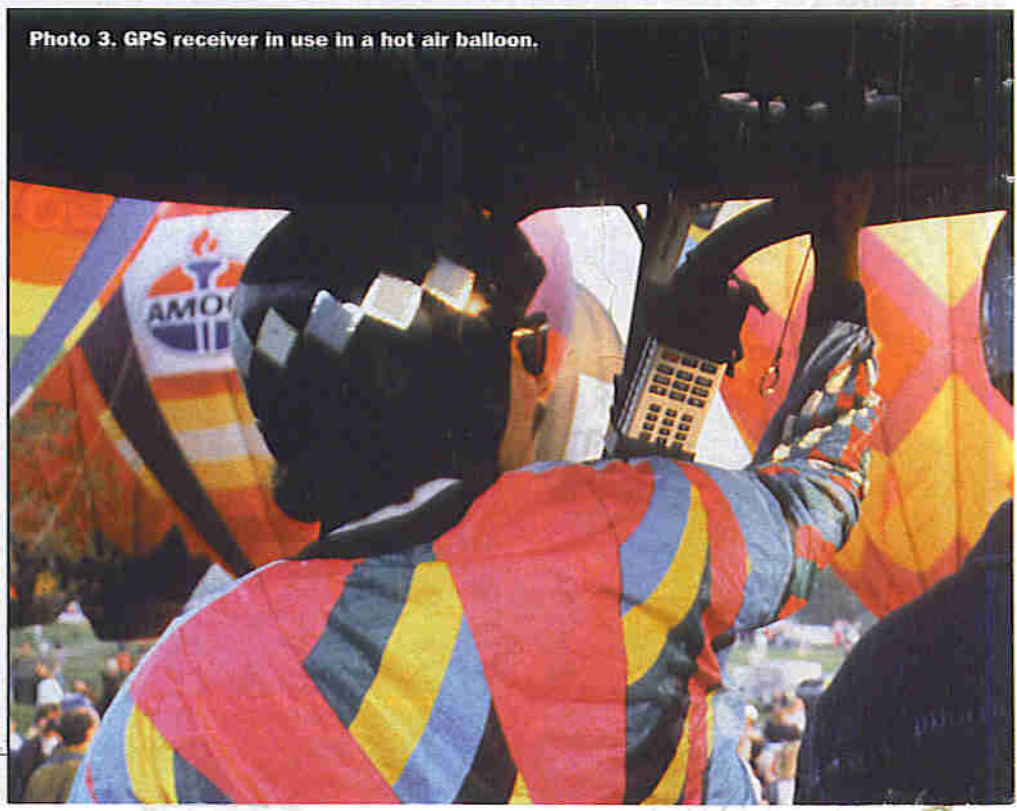


Photo 3. GPS receiver in use in a hot air balloon.

developed a knee board, which overlaid your GPS position onto a moving map of the terrain below. Known as the EC-10X, it enables pilots to plot their route prior to takeoff and overlay the actual path taken and its GPS positions on a moving map of the area. Airspace information, together with navaids and major land features such as roads and railways, are all displayed on the knee-mounted moving map, together with the real-time position of the aircraft, provided from the GPS. Pilots can even zoom in and out on the detailed data. In a situation such as a search and rescue mission, this type of real-time data is invaluable at watch changes. The EC-10X was launched at the International Air Show at Farnborough in 1994, to an interested audience of both civil and military pilots.

Avionics technology has also benefited from the developments of GPS, linked to aircraft communications systems to provide an affordable answer to the increasing need for air traffic management systems. Magellan's CNS-12 combines a 12-channel GPS receiver with an integrated VHF Aircraft Communications Addressing and Reporting System (ACARS).

Integrating GPS

Meanwhile, the benefits of GPS were spreading to other market sectors. Surveyors, developers, ecologists and environmentalists soon started to find novel and inventive uses for this technology. Specific product ranges were developed for GIS applications and data logging, which requires sub-1m accuracy, as well as the facility to post process data on computers back in the office.

GPS is even being used to help protect the environment against oil spillage at sea. A Magellan core module has been incorporated in the 'Oil Tracker', an oil spill tracking buoy. Linked via radio telemetry with a central station, the buoy provides information on the speed and direction of the oil slick. This information is downloaded to a computer modelling programme which projects the rate of dispersion and direction of flow, so protection resources can be applied in a timely and effective manner.

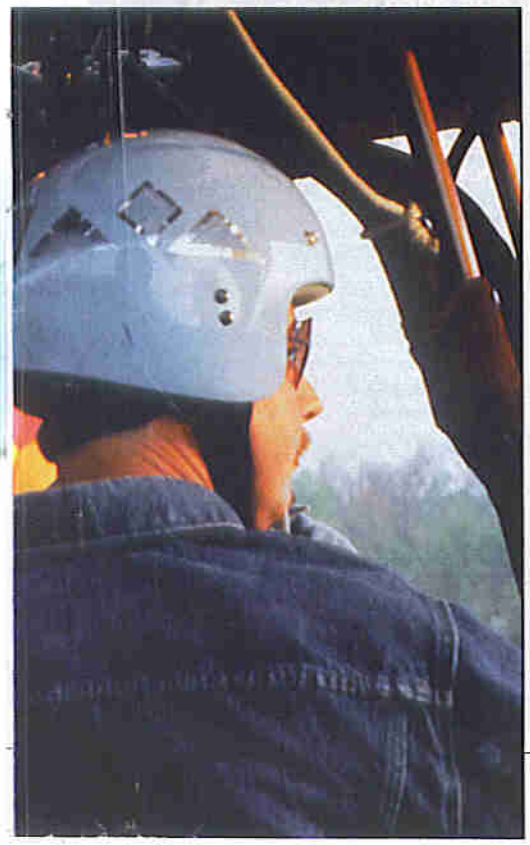


Photo 4. Magellan satellite navigator protects Gothenburg Taxi drivers.

Vehicle location and tracking has always been seen as a major use of GPS technology. Yet this development has been initially slower to come to fruition than other uses of GPS, because of the necessity of combining a known position identified from a GPS to the ability to economically broadcast that position to a control room. Design engineers and systems manufacturers have developed solutions to this by using two-way radios and cellular telephones.

The ability to know a vehicle's precise location from a GPS receiver is also helping to protect drivers, passengers and goods being transported. In Gothenburg, for example, a city which is not renowned for its levels of violence on the streets, taxis are being fitted with an emergency button linked to a GPS receiver – see Photo 4. Mathias Westholm, marketing director at Gothenburg Taxi, explains that robberies and assaults have increased dramatically over the last year. Now, each taxi is being fitted with a GPS receiver and an emergency button. When activated, the taxi's position is automatically relayed to the police, who can then track the vehicle's progress and assess the best tactic to apprehend the villains.

Nerosecond accuracy

Another major benefit of the GPS system is not its ability to tell you where you are, but to indicate precise time. In order to calculate your position, the GPS satellite has to know the exact time between the signal being transmitted 11,000 miles away and it being accepted by the GPS receiver on the Earth. The time and distance measurements from a total of four satellites give a three-dimensional position fix. So, for example, if the GPS receiver's clock disagrees with a satellite's time signal by one thousandth of a second, the resulting position could be off by a distance of 186 miles – not really acceptable.

The solution is to have four atomic clocks on board each satellite. This gives timekeeping accuracy which can be measured in nanoseconds – billionths of a second, and these clocks will only lose one second in about 70,000 years. The absolute accuracy is around 50-100ns, but this is before the US Government implemented the Selective Availability interference for civilian users, which is initiated by clock dithering. With SA, the accuracy is usually between 100 and 300ns. However, by viewing the same satellite from two different sites remotely stationed from each other, this error can be almost entirely eliminated, producing incredible timing accuracy.

Engineers have been quick to see the benefits of using a relatively low-cost GPS core module to replace extremely high-cost timers and clocks. With the long term stability of a GPS receiver, many scientists are turning to it as a method of driving and disciplining a low-cost oscillator. One example of this is where America telecommunications giant, AT&T, used GPS-referenced timing to bring Hawaii into synchronisation with the rest of the national network. The results were so successful that today, all of AT&T's telephone system is timed by clocks referenced to and monitored by GPS. Other applications include the cellular phone networks, which also use GPS to time synchronised digitised data packets.

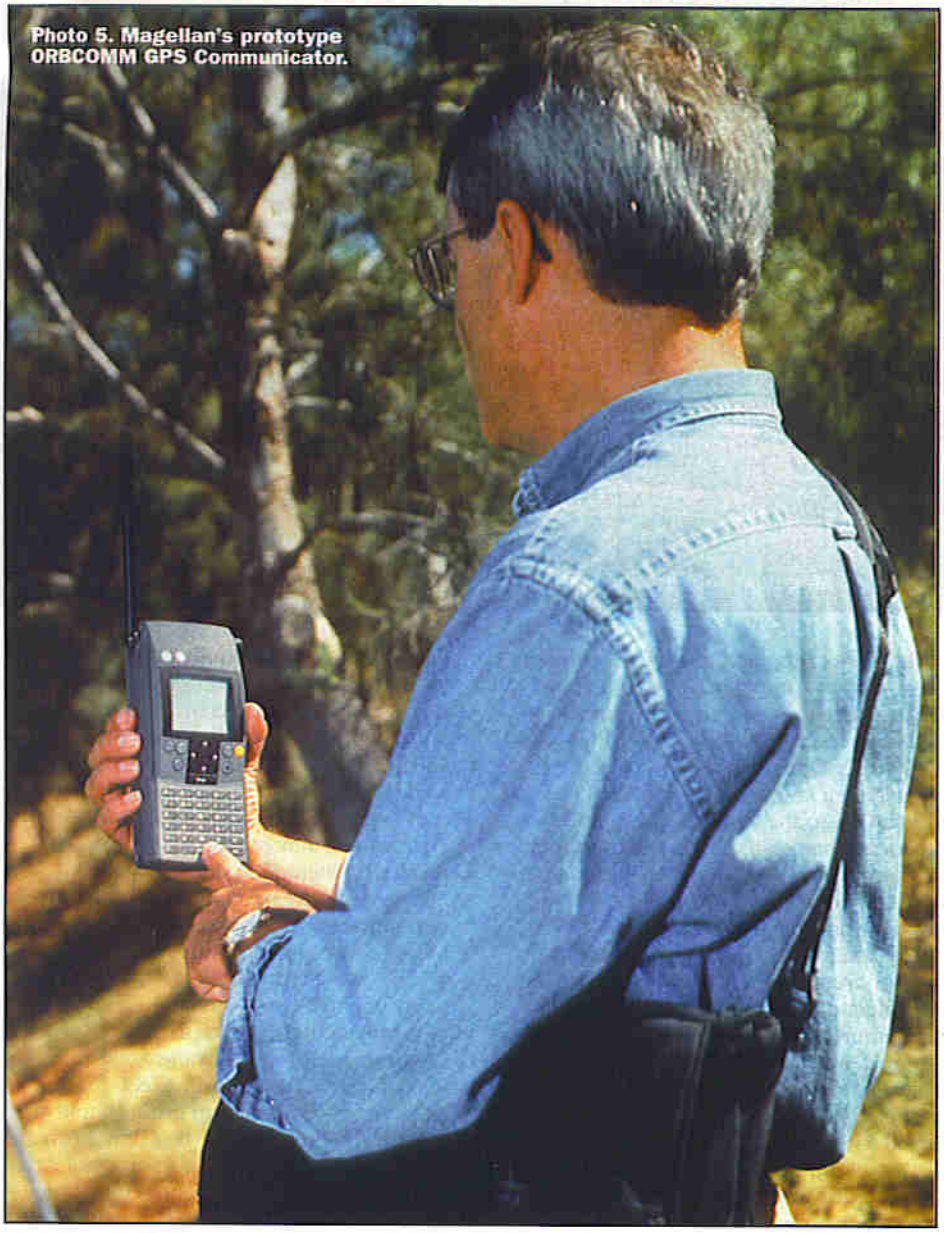


Photo 5. Magellan's prototype ORBCOMM GPS Communicator.

While GPS has become invaluable as a stand-alone positioning device, the majority of users require the ability to integrate their position information with other systems. Interfaces are available on most models of GPS receivers, enabling them to link and download to CD ROMs, computers and mapping systems.

The next Space Race

Yet, the real future of GPS technology lies in the ability to combine a positioning device with a world-wide communication solution – and it won't come as any surprise to learn that steps are already being taken to provide the answer. The new space race is on for the first company to provide a truly global satellite communications system – and GPS manufacturers are in the field already.

Magellan's parent company, Orbital Sciences Corporation, based in Dulles, Virginia, has developed the ORBCOMM system. ORBCOMM uses a network of satellites to provide low cost world-wide two-way digital message capabilities, with data communications and a geo-positioning service. This works by using narrow band VHF frequencies between 137 and 150MHz, and a UHF uplink in the 400MHz range.

The satellites are in a low-Earth-orbit system and ORBCOMM currently has two operational satellites in orbit at 775km above the Earth. These will increase to 36 by the end of 1999. The satellites, just the size of an average suitcase, are launched into space from an Orbital Sciences Pegasus rocket. This is mounted aboard a specially outfitted Lockheed L1011 aircraft, from where the rocket is launched, greatly reducing the cost of launch.

The plan is for ORBCOMM to become the world's first low-cost, global messaging and data communications service. Data communications and messages will be sent from the hand-held ORBCOMM communications receiver/transmitter (shown in Photo 5) to the nearest ORBCOMM satellite. This is then downlinked through a gateway Earth station, from where the message or data is routed to another hand-held stand-alone ORBCOMM communicator, or sent through the Internet or via terrestrial links to personal computers and other communications devices.

This facility to communicate to and from anywhere in the world, combined with the ability to know your position anywhere in the world, opens up a whole host of possibilities. Emergency services, for example, could accept distress calls and immediately identify the precise position of the person or vehicle in question. Vehicle tracking, fleet management and asset management system designers are waiting for this type of low cost communication and positioning facility to solve their problems. You'll even get more accurate weather forecasts, thanks to remote environmental monitoring schemes such as one currently being used. This utilises an unmanned buoy which automatically collects and sends weather information to its control room as part of the forecasting system. Automated data and position information can be sent and received from a single device and downloaded straight into a computer system to show position and messages on a digitised mapping system.

GPS finds its place

Sounds too much like the latest scene from a James Bond film – well, you could be right. But before long, there won't be many people who cannot claim that GPS has a direct involvement in their life, whether it is from knowing exactly when to expect the next bus at the bus stop or sending a message across the world.

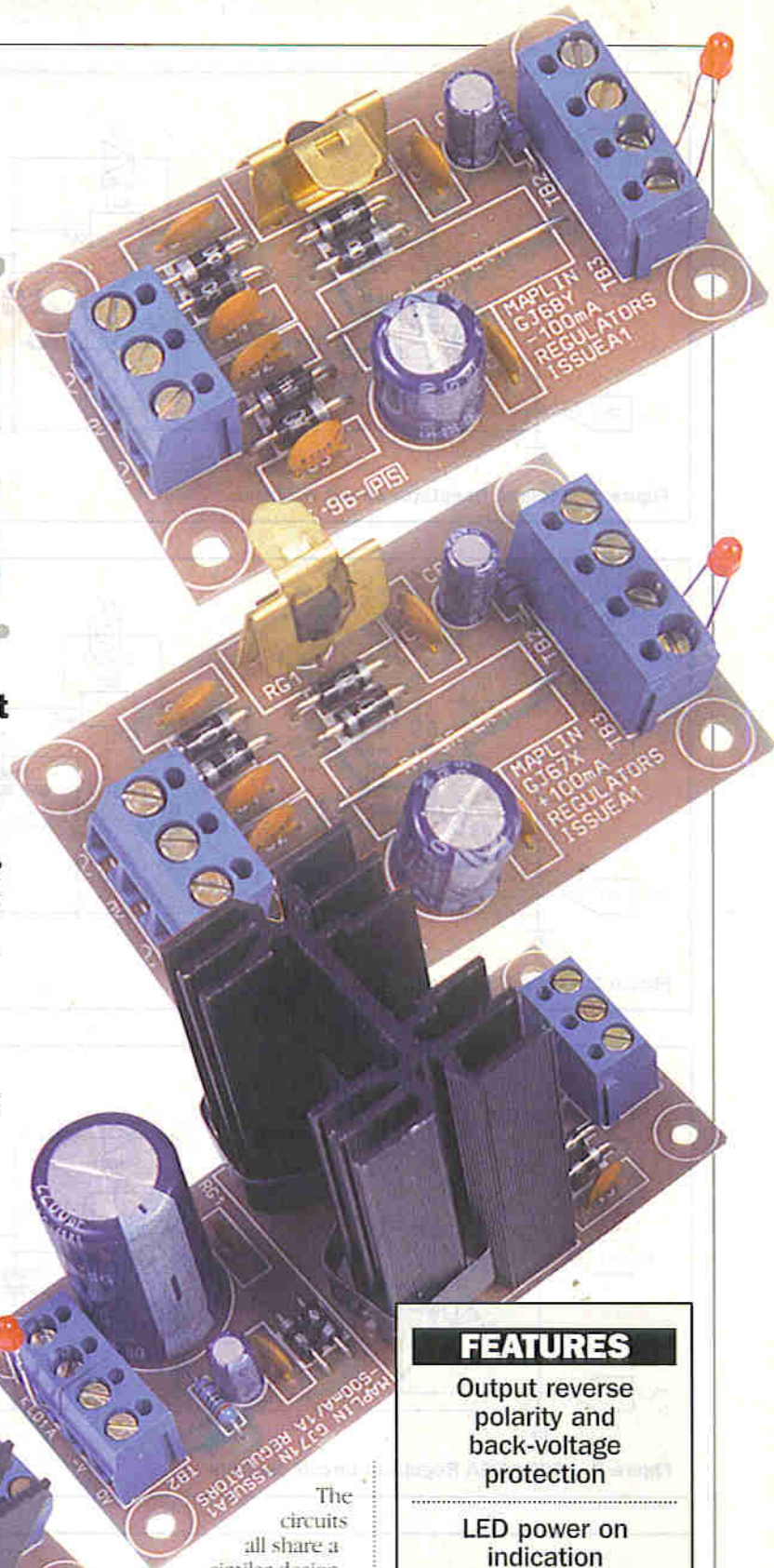
Mark Luffingham is the European Sales Director of Magellan Systems Corporation, based at Waterlooville in Hampshire. From its headquarters in San Dimas, California, Magellan Systems Corporation has led the world in the development of GPS products and applications. The company currently has over 30 different GPS products and is expanding into new world-wide communications and positioning system products.

PROJECT

Regulator KITS

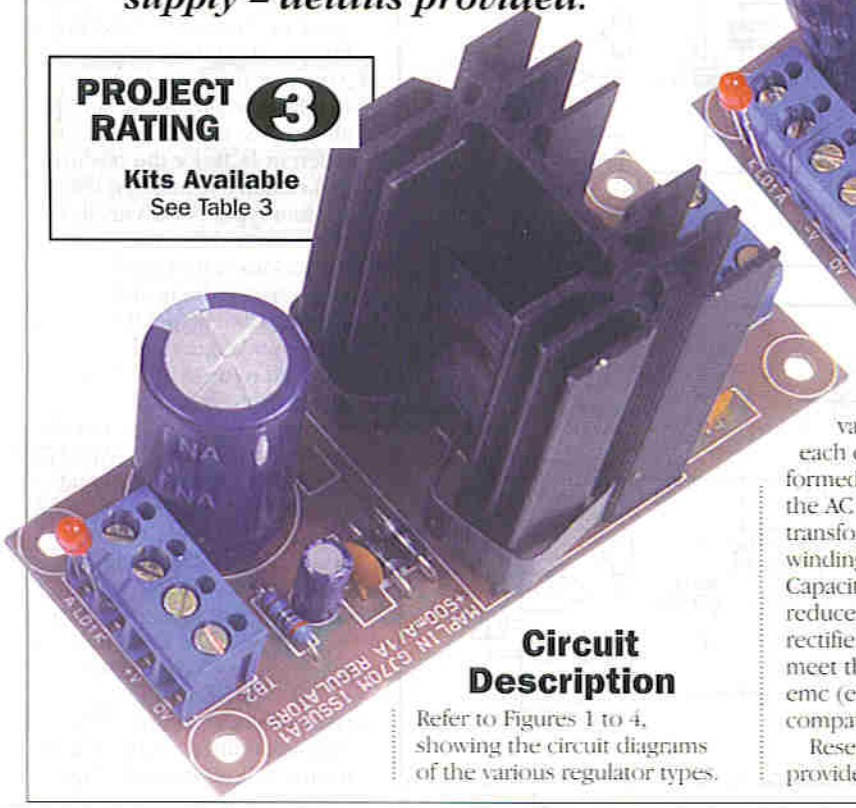
Design by Alan Williamson
Text by Alan Williamson and Maurice Hunt

This article describes a versatile range of compact, easy to build and use fixed voltage, positive- and negative-rail regulator kits. They are available in three current-supplying capacities, of 100mA, 500mA and 1A, and of various voltage ratings. The regulators can be used in any applications requiring a DC power supply stage capable of supplying a smooth and steady voltage level, and the positive- and negative-rail regulators may be combined as necessary, to create a dual-rail supply – details provided.



PROJECT RATING 3

Kits Available
See Table 3



Circuit Description

Refer to Figures 1 to 4, showing the circuit diagrams of the various regulator types.

The circuits all share a similar design, the only differences being in component values and polarities. In each case, a bridge rectifier is formed from D1-4, to convert the AC voltage from the transformer secondary winding into a DC level. Capacitors C1-4 serve to reduce noise from the bridge rectifier diodes, to help meet the compulsory emc (electromagnetic compatibility) requirements.

Reservoir capacitor, C5, provides low-frequency

FEATURES

- Output reverse polarity and back-voltage protection
- LED power on indication
- Low noise
- Compact dimensions

APPLICATIONS

- DC power supplies
- Op-amp circuits
- Logic circuits

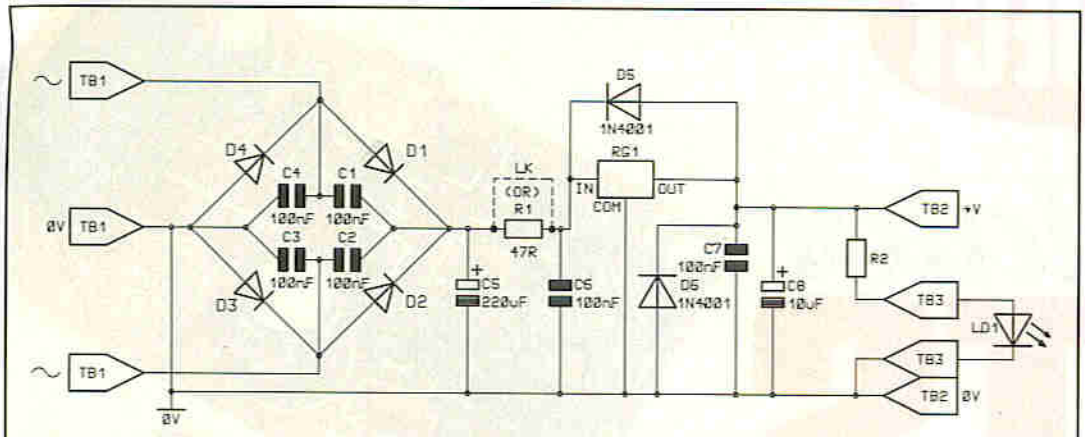


Figure 1. +100mA Regulator circuit diagram.

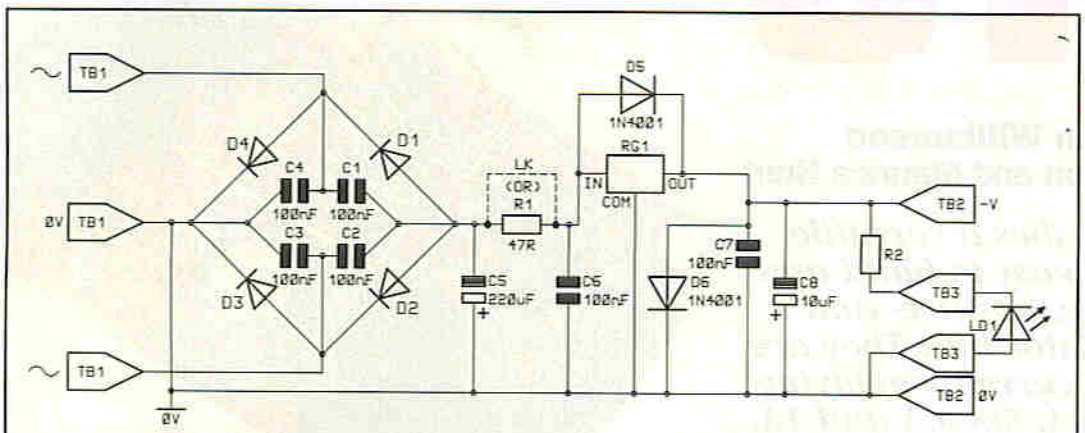


Figure 2. –100mA Regulator circuit diagram.

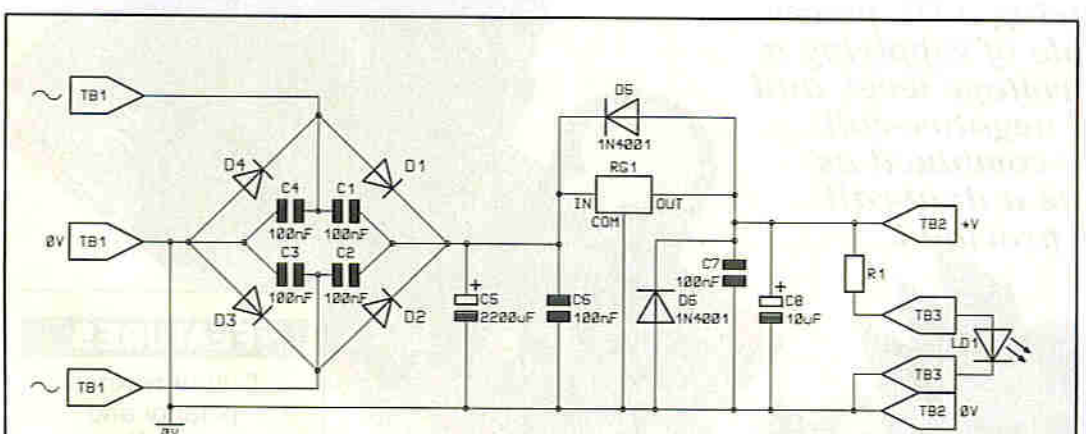


Figure 3. +500mA/1A Regulator circuit diagram.

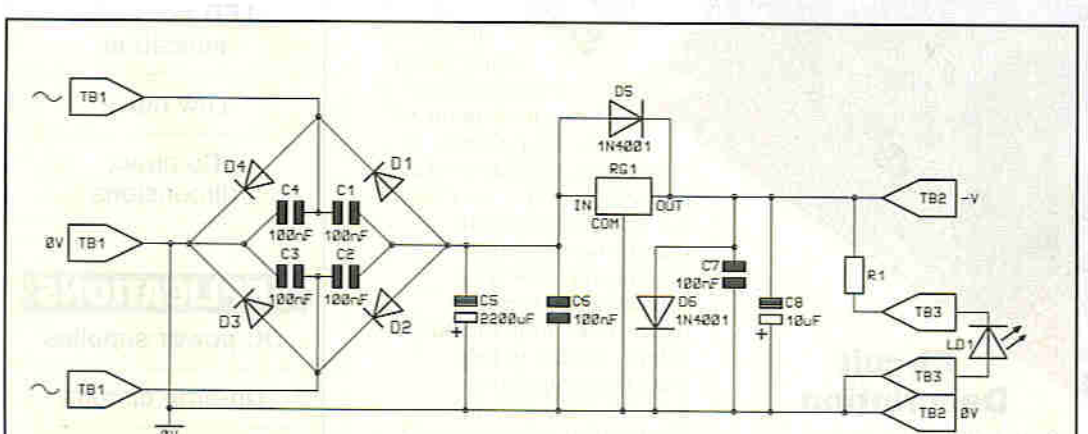


Figure 4. –500mA/1A Regulator circuit diagram.

decoupling of the DC supply, and C6, high-frequency decoupling. Resistor R1 is only fitted on the ±15V 100mA regulators, to reduce excess power dissipation of the regulator. RG1 is the voltage regulator employed to govern the output voltage at the required current. Diode D5 is connected in reverse-bias between the RG1's input and output terminals, and protects the regulator if a voltage (of the same polarity) is applied to the output terminals (i.e. from a circuit with a large supply capacitance, for example). D6, conversely, protects the regulator if a voltage of reverse polarity is fed into the output terminals.

C8 provides low-frequency decoupling of the output, while C7 is used for high-frequency decoupling of same. LED LD1 is used to indicate that power is present at the output terminals, and also to provide the required minimum load; if an LED is not required, an equivalent resistive load (minimum 5mA) MUST be fitted in its place. This is particularly important on the negative-rail regulators, to prevent floating of the output voltage. Do NOT alter the resistor value to allow the use of a low-current LED for LD1, since it will not sufficiently load the output.

PCB Construction

Refer to Table 1 if building the 100mA regulators, and Table 2 for the 500mA/1A versions, for details on the components used for a particular regulator – beware of subtle differences! Note that the 500mA/1A regulators share identical PCBs, although in all cases, there are different PCBs for the positive and negative regulators; there are four types of PCB in all. The main visible difference between the various completed boards is in the size of the heatsinks – obviously, the higher the current rating, the larger the heatsink required to dissipate the higher temperature generated. The 100mA regulators have a small clip-on brass heatsink (Type 92F – 36°C/W*), while the 500mA and 1A regulators have a far more substantial aluminium vaned heatsink, that for the 1A regulators (Type BW50-2 – 5·8°C/W) being around 10mm higher than the Type BW38-2 (7·2°C/W) heatsink used on the 500mA regulators.

* This value of thermal resistance applies only if the heatsink is fitted to the PCB by means of both its solder lugs.

In all cases, assemble the boards in order of ascending component size, commencing with the wire links (if applicable), but do not fit C5 or the voltage regulator RG1 yet.

Ensure that polarised components (i.e., diodes, electrolytic capacitors and LED) are fitted the correct way round, in accordance with the PCB legend/wiring diagram.

Heatsink Fitting

For the 100mA Regulators, a small brass clip-on heatsink is clipped onto voltage regulator RG1, and soldered to the PCB by means of its two solder tags. It is important to solder it to the board, to provide adequate heat dissipation.

For the 500mA/1A Regulators, a large vaned aluminium heatsink is used. This should be soldered to the PCB by means of its two posts, BEFORE fitting the regulator. The procedure then is to ensure that the surfaces are clean prior to placing the semiconductor insulator pad between the regulator's metal back and the heatsink. Next, with the regulator in place with its leads in the appropriate PCB holes, affix the clip, by pushing it on at the front, having placed it at the correct height (to match that of the regulator body – NOT the metal tab). Do NOT attempt to slide the clip on along the length of the heatsink. If, for any reason, the clip needs to be removed, use thin-nose pliers to gently release its ends from the heatsink, and lift it away.

Having fitted the heatsink, proceed to fit reservoir capacitor, C5, ensuring correct polarity.

With the board fully assembled, check your work carefully for misplaced components, solder whiskers, bridges or dry joints, then clean excess flux off the board using a suitable solvent.

Kit Order Code	Voltage	Regulator	Transformer (250mA)	PCB	R1	R2
95155	–15V	79L15 (WQ87U)	12-0-12V (YN16S)	95181	47Ω 3W (W47R)	1k3 (M1K3)
95156	–12V	79L12 (WQ86T)	9-0-9V (YN15R)	95181	LINK	1k (M1K)
95157	–5V	79L05 (WQ85G)	6-0-6V (YN14Q)	95181	LINK	270Ω (M270R)
95158	+5V	78L05 (QL26D)	6-0-6V (YN14Q)	95180	LINK	270Ω (M270R)
95160	+12V	78L12 (WQ77J)	9-0-9V (YN15R)	95180	LINK	1k (M1K)
95161	+15V	78L15 (QL27E)	12-0-12V (YN16S)	95180	47Ω 3W (W47R)	1k3 (M1K3)

DO NOT connect transformer centre tap. Inclusion of an LED is necessary for minimum load. Resistors are 0·6W 1% Metal Film (unless stated).

Table 1. Fixed voltage regulators, ±5V to ±15V, 100mA.

COMMON PARTS LIST FOR 100mA REGULATORS

CAPACITORS			
C1-4,6,7	100nF 50V Ceramic Disc	6	(BX03D)
C5	220µF 35V Radial Electrolytic	1	(AT60Q)
C8	10µF 63V Radial Electrolytic	1	(AT77J)
SEMICONDUCTORS			
D1-6	1N4001	6	(QL73Q)
LD1	3mm Red LED	1	(CZ22Y)
MISCELLANEOUS			
FS1	50mA Time Delay Glass Fuse	1	(CZ85G)
TB1	3-way 5mm PCB-mounting Terminal Block	1	(JY94C)
TB2,3	2-way 5mm PCB-mounting Terminal Block	2	(JY92A)
	Heatsink Type 92F	1	(HQ79L)
	Instruction Leaflet	1	(XZ31J)
	Constructors' Guide	1	(XH79L)

Assembled board dimensions (WDH): 60 × 36 × 17mm

Kit	Voltage	Current	Regulator	Transformer	PCB	R1	C5	FS1	Heatsink
95163	–15V	500mA	79M15 (WQ90X)	9-0/9-0V 12VA (series) (WB11M)	95184	(M1K3)	1,000µF 35V (AT63T)	50mA (CZ85G)	(AX84F)
95164	–12V	500mA	79M12 (WQ89W)	9-0/9-0V 12VA (series) (WB11M)	95184	(M1K)	1,000µF 35V (AT63T)	50mA (CZ85G)	(AX84F)
95165	–5V	500mA	79M05 (WQ88V)	6-0/6-0V 12VA (series) (WB06G)	95184	(M270R)	1,000µF 35V (AT63T)	50mA (CZ85G)	(AX84F)
95166	+5V	500mA	78M05 (QL28F)	6-0/6-0V 12VA (series) (WB06G)	95183	(M270R)	1,000µF 35V (AT63T)	50mA (CZ85G)	(AX84F)
95167	+12V	500mA	78M12 (QL29G)	9-0/9-0V 12VA (series) (WB11M)	95183	(M1K)	1,000µF 35V (AT63T)	50mA (CZ85G)	(AX84F)
95168	+15V	500mA	78M15 (QL30H)	9-0/9-0V 12VA (series) (WB11M)	95183	(M1K3)	1,000µF 35V (AT63T)	50mA (CZ85G)	(AX84F)
95169	–24V	1A	7924 (AV15R)	12-0/12-0V 25VA (series) (WB25C)	95184	(M2K2)	2,200µF 50V (AT72P)	125mA (CZ88V)	(AX85G)
95170	–15V	1A	7915 (QL36P)	9-0/9-0V 25VA (series) (QL36P)	95184	(M1K3)	2,200µF 35V (AT64U)	125mA (CZ88V)	(AX85G)
95171	–12V	1A	7912 (WQ93B)	15-0/15-0V 25VA (parallel) (DH27E)	95184	(M1K)	2,200µF 35V (AT64U)	125mA (CZ88V)	(AX85G)
95172	–8V	1A	7908 (AW76H)	6-0/6-0V 12VA (series) (DH27E)	95184	(M560R)	2,200µF 35V (AT64U)	100mA (CZ86T)	(AX85G)
95173	–5V	1A	7905 (WQ92A)	9-0/9-0V 12VA (parallel) (WB11M)	95184	(M270R)	2,200µF 35V (AT64U)	100mA (CZ86T)	(AX85G)
95174	+5V	1A	7805 (QL28F)	9-0/9-0V 12VA (parallel) (WB11M)	95183	(M270R)	2,200µF 35V (AT64U)	100mA (CZ86T)	(AX85G)
95175	+6V	1A	7806 (AW69A)	9-0/9-0V 12VA (parallel) (WB11M)	95183	(M390R)	2,200µF 35V (AT64U)	100mA (CZ86T)	(AX85G)
95176	+8V	1A	7808 (AW70M)	6-0/6-0V 12VA (series) (YJ50E)	95183	(M560R)	2,200µF 35V (AT64U)	100mA (CZ86T)	(AX85G)
95177	+12V	1A	7812 (QL32K)	15-0/15-0V 25VA (parallel) (DH27E)	95183	(M1K)	2,200µF 35V (AT64U)	125mA (CZ88V)	(AX85G)
95178	+15V	1A	7815 (QL33L)	9-0/9-0V 25VA (series) (DH26D)	95183	(M1K3)	2,200µF 35V (AT64U)	125mA (CZ88V)	(AX85G)
95179	+24V	1A	7824 (AV11M)	12-0/12-0V 25VA (series) (WB25C)	95183	(M2K2)	2,200µF 50V (AT72P)	125mA (CZ88V)	(AX85G)

Fuse FS1 is a Time Delay glass type. Inclusion of an LED is necessary for minimum load. Resistors are 0·6W 1% Metal Film (Unless Stated).

Table 2. Fixed voltage regulators, ±5V to ±24V, 500mA/1A.

COMMON PARTS LIST FOR 500mA/1A REGULATORS

CAPACITORS			
C1-4,6,7	100nF 50V Ceramic Disc	6	(BX03D)
C8	10µF 63V Radial Electrolytic	1	(AT77J)
SEMICONDUCTORS			
D1-6	1N4001	6	(QL73Q)
LD1	3mm Red LED	1	(CZ22Y)
MISCELLANEOUS			
TB1	3-way 5mm PCB-mounting Terminal Block	1	(JY94C)
TB2,3	2-way 5mm PCB-mounting Terminal Block	2	(JY92A)
	Heatsink Clip	1	(AX86T)
	TO218 Semiconductor Insulator Pad	1	(UL74R)
	Instruction Leaflet	1	(XZ32K)
	Constructors' Guide	1	(XH79L)

Assembled board dimensions (WDH): 84 × 36 × 42mm (500mA Regulator)
84 × 36 × 54mm (1A Regulator)

Important Safety Note

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

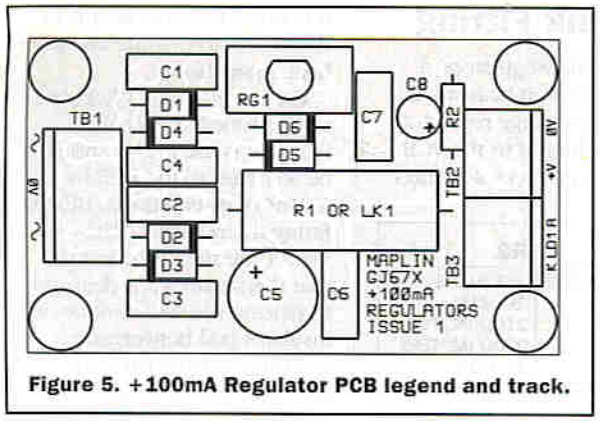


Figure 5. +100mA Regulator PCB legend and track.

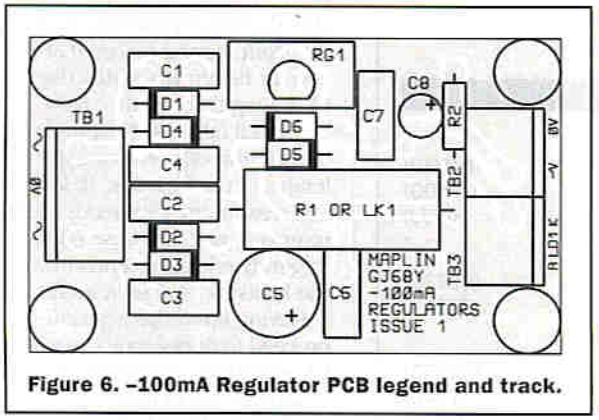


Figure 6. –100mA Regulator PCB legend and track.

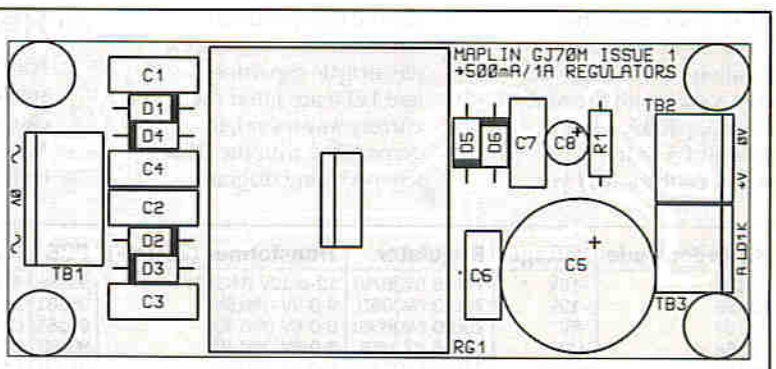


Figure 7. +500mA/1A Regulator PCB legend and track.

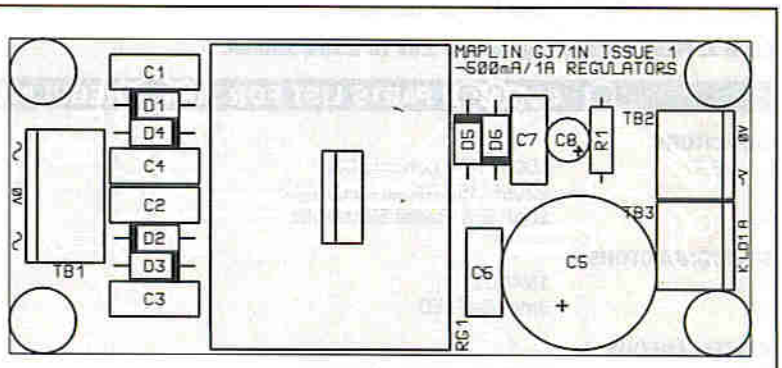


Figure 8. –500mA/1A Regulator PCB legend and track.

Testing and Use

Refer to Figures 9 to 15, showing the various wiring configurations possible with these Regulator Kits. Take care to select the correct type of transformer for the particular regulator(s) being used, and to ensure that they are correctly wired as per the relevant diagrams. Using the specified transformer and heatsink enables the regulators to provide the full stated output current up to a temperature of 70°C, i.e. 45°C above an ambient temperature of 25°C.

If boxing the regulators, ensure that sufficient ventilation is provided for the heatsink(s). It is ESSENTIAL that the transformer is properly housed, and that the mains wiring connections are adequately insulated. Remember to carry out any mains wiring in accordance with the safety warning printed in this article.

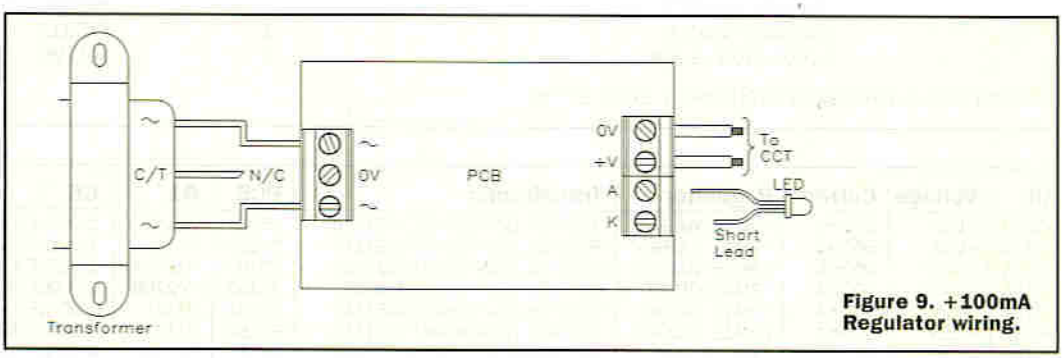


Figure 9. +100mA Regulator wiring.

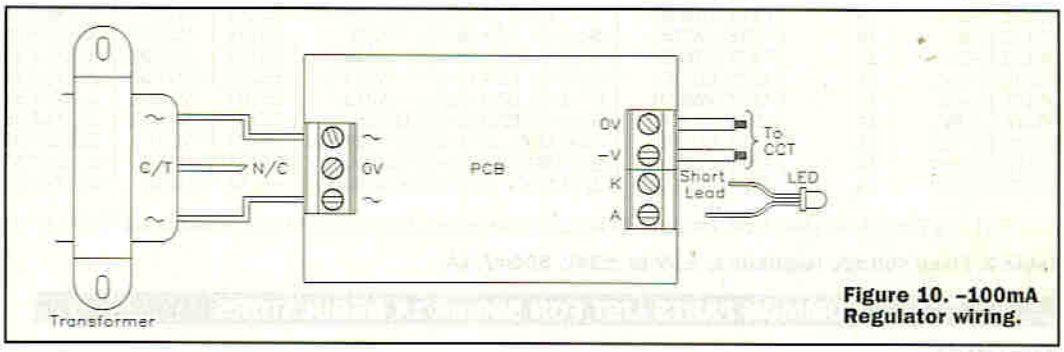


Figure 10. –100mA Regulator wiring.

Order Code	Description	Price	Order Code	Description	Price
95155	–15V 100mA Regulator	£5.99	95169	–24V 1A Regulator	£8.99
95156	–12V 100mA Regulator	£5.99	95170	–15V 1A Regulator	£8.99
95157	–5V 100mA Regulator	£5.99	95171	–12V 1A Regulator	£8.99
95158	+5V 100mA Regulator	£5.99	95172	–8V 1A Regulator	£8.99
95160	+12V 100mA Regulator	£5.99	95173	–5V 1A Regulator	£8.99
95161	+15V 100mA Regulator	£5.99	95174	+5V 1A Regulator	£8.99
95163	–15V 500mA Regulator	£7.99	95175	+6V 1A Regulator	£8.99
95164	–12V 500mA Regulator	£7.99	95176	+8V 1A Regulator	£8.99
95165	–5V 500mA Regulator	£7.99	95177	+12V 1A Regulator	£8.99
95166	+5V 500mA Regulator	£7.99	95178	+15V 1A Regulator	£8.99
95167	+12V 500mA Regulator	£7.99	95179	+24V 1A Regulator	£8.99
95168	+15V 500mA Regulator	£7.99			

Table 3. Kits available from Maplin.

The above items (Tables 1 and 2) are available as kits, which offers a saving over buying the parts separately.

Regulator Kits 95155, 95161 Price £5.99
Regulator Kits 95163, 95168 Price £7.99
Regulator Kits 95169, 95179 Price £8.99

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996/97 Maplin Catalogue.

Regulator PCBs* **95180, 95181 Price £2.29**
Regulator PCBs* **95183, 95184 Price £2.49**

* See Tables 1 and 2

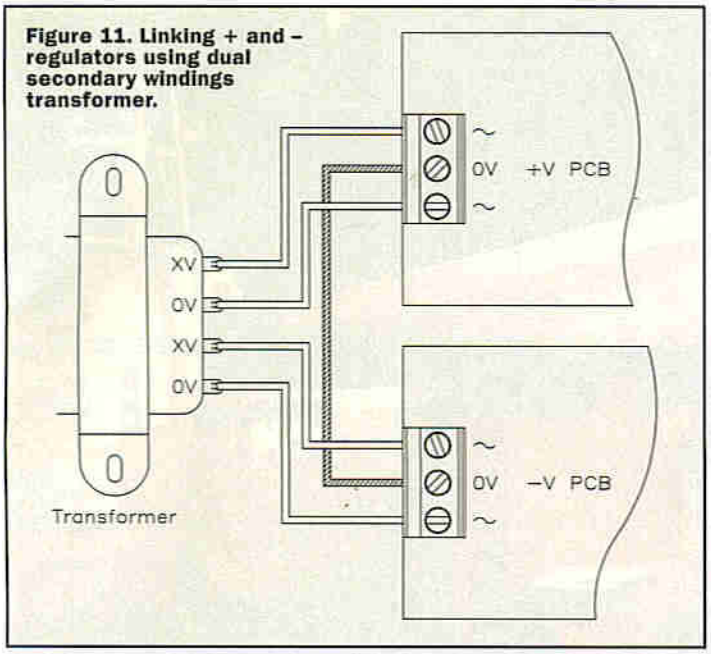


Figure 11. Linking + and – regulators using dual secondary windings transformer.

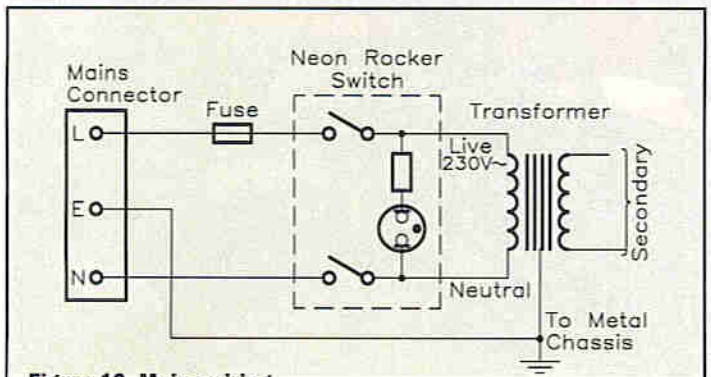


Figure 12. Mains wiring.

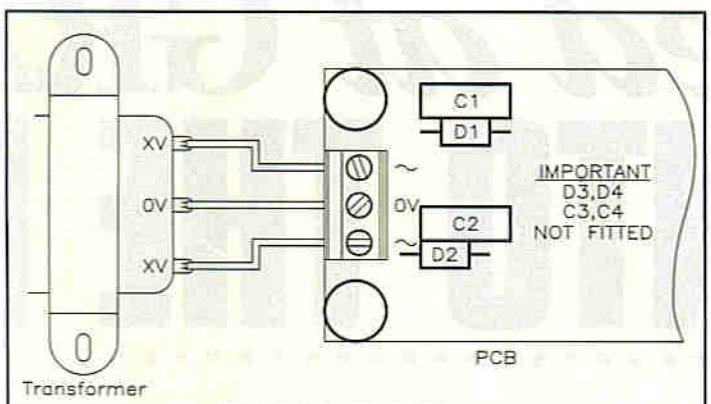


Figure 13. Regulator centre tap wiring.

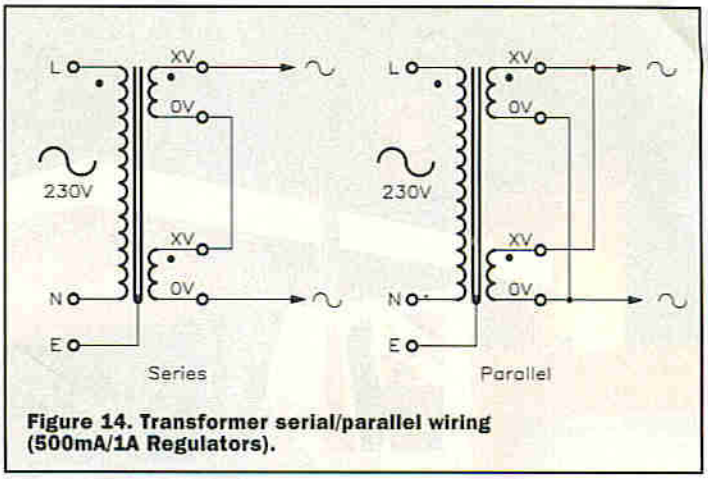


Figure 14. Transformer serial/parallel wiring (500mA/1A Regulators).

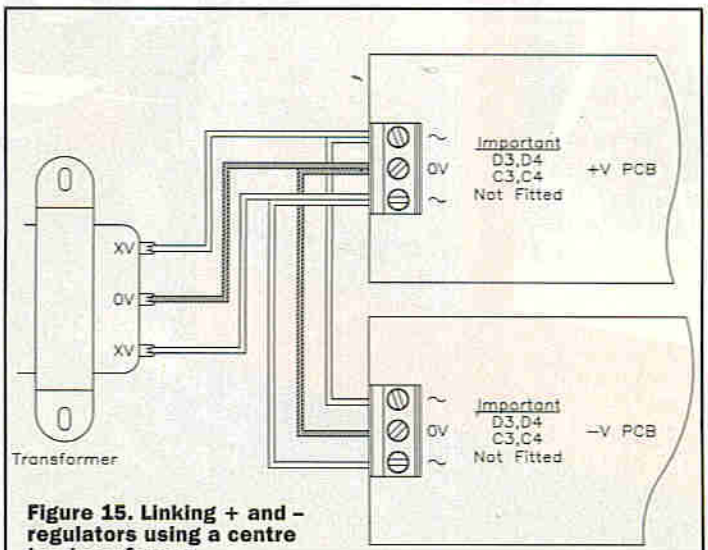
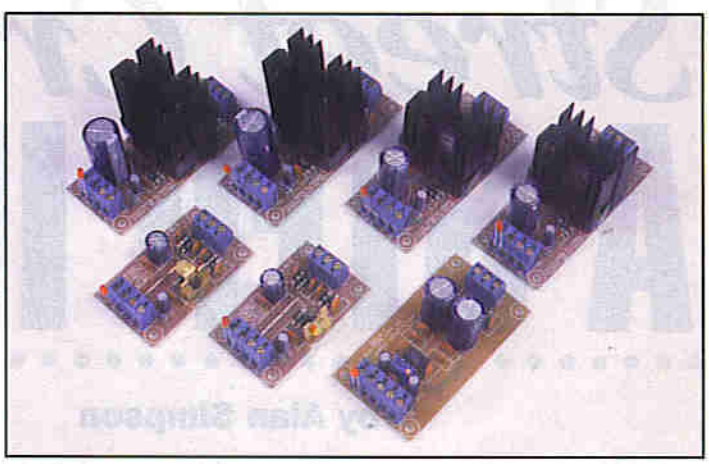


Figure 15. Linking + and – regulators using a centre tap transformer.

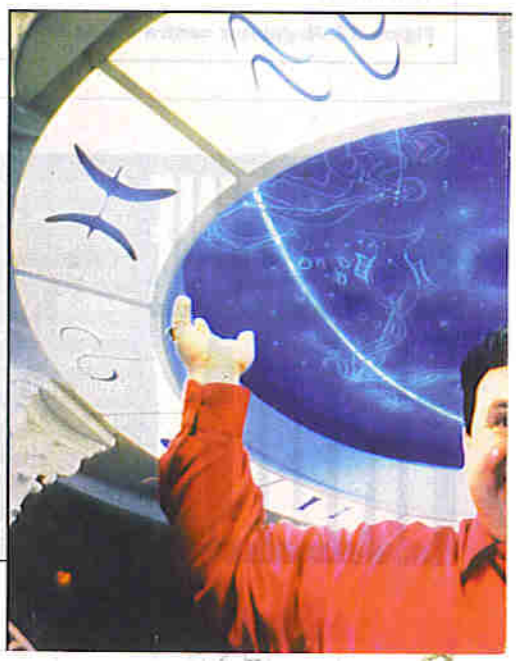


Street Cred at GRA

A STEP INTO THE F

by Alan Simpson

Billed as Europe's No 1 film and TV theme park, The Granada Studios Tour is certainly 'something else'. Since **Electronics** ***last visited the Manchester complex back in April 1990 when a highlight was a trip on the Coronation Street tram (since deleted from the tour) the Granada Tour has moved more resolutely high tech. Guaranteed to produce admiring comments – "Ah, the wonder of GranadaLand – It's all part of the great technology revolution". However, take care. A visit is not only a route to the information superhighway net but a stroll down memory lane within brushing distance of the Ena Sharples hairnet.***



NADA UTURE

The £8.5 million Granada Studios Tour opened for business in 1988. Since then a further £12 million has been spent in extending the facilities and £5 million for this year. To date, over 4,000,000 people have visited Granada Studios, including over 50,000 coach parties and 9,500 school groups. With the average visitor stay being in the region of five or six hours, the attraction is genuinely a full day out.

As Maurice Kelly, Granada Entertainments & Hotels Deputy Managing Director says, the overall aim is to attract a younger element into the Centre. So to mark the 40th Anniversary of the Granada TV franchise, the organisation undertook some Mystic Meg research and came up with the fact that the biggest challenge facing us all is the convergence of technology". "Nowhere was anyone addressing this requirement – certainly not today's museums and trade shows". "And with schools demanding a futuristic high tech showcase (partly to meet their structured General National Vocational Qualification studies) the Granada Futurevision attraction was developed". "At this stage, Granada sought a high tech funding partner and alighted on ICL, a company which was doing its best to distance itself from being an equipment manufacturer to that of providing technological solutions". "In fact the ICL/Fujitsu has proved an excellent combination, showcasing not just their own products but where relevant, other suppliers futuristic ideas".

With interactive workstations, plasma screens, two-way televisions and video phones, 'Futurevision – This is Tomorrow' brings together the wonderful world of computers and communications convergence. But before you embark on your tour into the future, beware. Try to avoid mornings where simply huge numbers of school children (both local and international), do a spot of converging of their own and dominate the proceedings.

Tour Offers the Taste of Things to Come

Some 45 years after predicting the development of satellites, science fiction guru Arthur C Clarke (2001 – A Space Odyssey) was on hand to open the Futurevision exhibition. Well not exactly on hand, but via a satellite link to his base in Sri Lanka. He was apparently 95% certain that the world stood on the brink of a breakthrough in power sources which would rid the world of energy pollution and give us all the power we need. While experiments a few years ago had been dismissed as 'bilge' he felt that there was increasing evidence that new technology would change the world as we know it. The best advice he could offer people about the future was "don't panic!"

As a hitchhikers' guide to the world of futuristic high tech, the tour may offer many surprises, but few panics for the anticipated million visitors a year. Highlights of the tour include virtual reality classrooms wired to the Internet, and pictures the home of the future with wafer-thin plasma television sets hung on the walls and a sound system like a giant spider wrapped around the armchair. Also in a Coronation Street mock-up, you can glimpse a future where you can argue with the TV, meet holograms of colleagues and friends, and hold a video conference with your local friendly bank manager.

The 1,000 square metre walk-through project is the most ambitious yet seen in the UK. It is the year 2056. We can have meetings with holograms of our fiends, video conference with our office, buy everything we need from the comfort of our home. Education is not just for kids and takes place in a virtual universe which makes learning fast and fun. Just as well because the pace of life is so frantic that grown-ups need regular updates just to keep on top of the latest developments. Offices are largely a thing of the past. Increasing congestion and pollution has made commuting to work a distant memory.

TV Past and Present

Visitors to the attraction will be guided around by @net., the attraction's very own Miss Superhighway and a visitor from the future. Under her caustic eye, guests first take a look at state-of-the-art television – and contrast it with contemporary coverage from the dawn of television such as the Queen's Coronation in 1953. "You know re-runs of Cracker still look pretty good in 2056 - that Robbie Coltrane a bit of a cult in my day!" says @net. "And I just saw a replay of that amazing Cup Final from 2001. But, of course, you don't know about that yet." Interestingly, at the time of the writer's visit, the old black and white TV set had a "not working" sign attached. Quite clearly, not a Granada rental TV set.

Moving swiftly from the present to the future, the next area showcases interactive television. In 2056 viewers can chose how programmes develop and end – they can even argue with their TV! Among the visions of the future is a new concept for democracy with local and national issues decided by viewers' votes.

In case visitors were unaware of vital facts, a prominent sign states that in September 1925, TV was invented by John Logie Baird. The next highlight occurred in 1960 when the first episode of Coronation Street was screened. 1989 saw the arrival in the skies of Sky, and BSB satellite services. Meanwhile 1996 sees a demonstration from Japan of the Plasmavision TV monitor. Just 6cm in depth and with a 140 degree viewing angle, the hanging-on-the-wall set employs a pair of parallel electrodes sealed in multi-layered glass units filled with neon and xenon gases. Ultra violet light is created by an electrical discharge within the glass. This excites a series of phosphor dots (pixels) on the inner surface of the glass which glows with the different colours.

Yep. We are all agreed that together with High Definition TV (HTV), the familiar CRT (cathode ray tube) days are numbered.

Hopefully HTV of the future will not still be showing pictures of John Major entering Downing Street, Hugh Grant or the National Lottery as is the case on the tour.

Into the Web

Somehow surfing the net in Manchester does not have quite the same allure as surfing the net in Hawaii. 'Into the Web' guides visitors into the world of cyberspace where everything you have ever wanted to know about everything is at your fingertips. Housed inside a 7m diameter dome, 'Into the Web' shows visitors the origins of the World Wide Web as well as how it works, and pushes aside the jargon to cut to the heart of what the Internet offers surfers of the future. Bugs had also struck some of the Cyber terminals with 'Out of Order' signs being prominently displayed. Apparently TV of the future will learn your preference in programmes.

One intrepid visitor has a short list of footballer Paul Gascoigne, Manchester United and Bay Watch. At least he scored one out of three in my preference list too. You can't beat the net so why not join it, is the theme.

The Virtual Classroom

As @net. comments: "Education is a funny business back in your time. All that chalk and talk and kids sitting in classrooms, in the 21st Century, learning is for life." Society is moving so fast that people's knowledge and skills have to be updated regularly. Demonstrations in the Virtual Classroom include remote learning, network connections and virtual reality 'walk through environments'. In my time however, distance learning was called sitting in the back row.

Stay Mobile

"You really make hard work of work in the 20th century" comments @net. "People actually travel thousands of miles to meet each other!" Visitors can experience video-conferencing for themselves, while other demonstrations include voice-reactive and digitally-created on-screen environments.

The Electronic High Street

One of the more startling demonstrations here is the future of shopping for clothes with customised fashion shows showing how customers will look in the articles they choose – thereby ridding at a stroke one of the major obstacles to shopping from your armchair. Further glimpses of the future include cross-store price comparisons, on-screen video catalogues and food ordered and delivered to the door. Naturally, all payment is electronic and if money becomes a problem a chat with the bank manager is just a video-conference away.

The Home of the Future

This is a place where domestic computers have replaced drudgery. Lights, heating and even re-ordering food is done automatically in the year 2056. For @net. and most of her friends it is the very centre of her life. Homes will become fully wired-up sites for education, work, shopping and, of course, having fun with the very latest technology. Exhibits here include plasma screen wafer thin televisions, video projection, wrap around sound systems for individual 'better than real life' quality and the latest in games stations. Interactive TV games shows, movies-on-demand and 3-D sound and vision will play their part in making sure home really is where the heart is. Mind you, with wall-to-wall tv screens, there will be little scope for mirrors and pictures in these smart homes.

Smart in fact could well be the theme of the Futurevision world. Similarly your personal doorman is a smart camera, programmed to accept your instructions by phone while you are on your way home. And no more fumbling with keys when you arrive at your front door. You are recognised and the front door automatically opens, lights switch on and heating adjusted as you check your tv monitor for messages.

The Office of the Future

It does not take a future visionary to suggest that the next few years will see enormous change in the shape and look of the conventional office. Workers will no longer have their own private desk but will log-on to a workstation each day. 'Hot Desking' as it is called, will make use of cordless phones and will use a filing cabinet on wheels we are told. I have news for the designers. This practice of desk sharing has been in operation for some six years, possibly longer especially in the major consultancy firms.

The danger is that most youthful visitors will leave Futurevision convinced that the future is available at the touch of a button. There is no doubt that future generations will laugh at our present primitive levels of technology. It dosn't take Mystic Meg to forecast that before long, computers will be as powerful as the human brain. In fact Professor Cochrane from BT's Martlesham research laboratories forecasts that early in the next century, computers will be over 1,000 times faster than they are now. Right now, every six month period sees technology power doubling while size and costs halve. By 2056, our generation could be labelled the 'Information Technology Flintstone age'.

To sum up, Futurevision (as the organisers admit) may not offer an accurate vision of the year 2056 (who can tell what the future holds?) but it does give an insight into the powerful forces that are shaping the world we will all live in. Far from being a dry and dusty or even catering for the needs of techno-freaks, Futurevision is presented with much flair and imagination.

The Word on the Street

While it may be all high tech 'beam me into the future' displays at Futurevision, life goes on in the rest of Granadaland. New attractions this year include Cracker, billed as the most gritty, real-life drama ever presented on British television. Cracker at the show, is the inspiration for a genuine interactive presentation where the audience actually influences the outcome of a dramatised investigation. Live sets with actors and audio-visual presentations are housed in a 300-seater theatre.

Aliens is also a new show. It is the latest exciting ride which is guaranteed to chill the spine of even the most battle hardened space warrior. So what else is on offer. Well some six shows and ten experiences ranging from a fascinating backstage and soundstage tour, and a visit to Coronation Street itself. This is not to be confused with a visit to the Houses of Parliament which has mysteriously been moved to Baker Street. It's fun. It's fast. It's a great day out. Electronics has no less than 20 sets of family (two adults, 2 children) tickets to give away. So what are you waiting for. Experience Futurevision for yourself. Win our easy-to-enter competition, and you could be strutting The Street.

Granada Studios Tour

Granada Studios, Water Street, Manchester. Open every day (except Mondays) from 9.45am. Last entry is 4.00pm. £12.99 for Adults. £8.99 for Children. Children under 5 admitted free. Tel: (0161) 832 9090.

GRANADA · STUDIOS · TOUR ·

The Award Winning

INTO THE FUTURE WITH GRANADA

Exclusive Competition

Electronics and Beyond ***have no less than 20 family sets of tickets (worth over £42 a set) to give away to lucky winners of our exclusive competition. Each set allows 2 adults and 2 children full access to all the heady delights of*** **THE GRANADA STUDIOS TOUR** ***including the futuristic, newly opened Futurevision experience.***

How to enter

All you have to do to enter, is complete the coupon, correctly answering the four questions, or send your answers on a postcard of back of a sealed-down envelope. Don't delay – all entries must be received by 30th September 1996. Send your entry, remembering to include your name and address, and if possible, your day-time telepone number, to the address printed on the coupon.

Please note that employees of Maplin Electronics, associated companies and family members are not eligible to enter. In addition, multiple entries will be disqualified. The prizes will be awarded to the first all-correct entries drawn. The editor's decision will be final. Prizes are not exchangeable for cash. Any related travel costs will not be met by the publication or the contest promoters.

GRANADA STUDIOS TOUR

Answer all the questions below, ticking one box for each question.

1. Is The Granada Studios Tour in?
- ☐ Northern Norway.
- ☐ Northern Spain.
- ☐ Northern England.

2. Which of the following programmes is associated with Granada TV?
- ☐ Coronation Street.
- ☐ The BBC Newsnight.
- ☐ Come Dancing.

3. The Granada Futurevision experience is?
- ☐ Michelle Pfeiffer transmitted in 3-D.
- ☐ A hi-tech experience into the future.
- ☐ A marquee where you can meet Mystic Meg.

4. What is the Information Highway?
- ☐ The convergence of computers and communications.
- ☐ The parking lot at your local library.
- ☐ The road where Bill Gates lives.

Name _____

Address _____

_____

_____

_____ ***Postcode*** _____

Daytime Telephone Number _____

No purchase necessary.
Entries on a postcard, back of a sealed-down envelope or photocopies will be accepted.

ELECTRONICS and Beyond

Send your entry to
Granada Studios Tour Competition, The Editor, *Electronics and Beyond*, P.O. Box 3, Rayleigh, Essex SS6 8LR.

PROJECT

SuperScan MK II

Uses Surface Mount Technology

Design by Chris Barlow G8LVK
Text by Chris Barlow and Maurice Hunt

Superscan MkII is an improved, easier to build and more-compact version of the acclaimed Superscan Active Aerial. This is an advanced design of HF/VHF and UHF Wideband Active Aerial, using sophisticated surface-mount technology and microstrip PCB design to provide optimum signal reception strength across a very wide bandwidth, making it perfect for use with scanning receivers having an external aerial input connector. Unlock the hidden potential of your radio receiver!

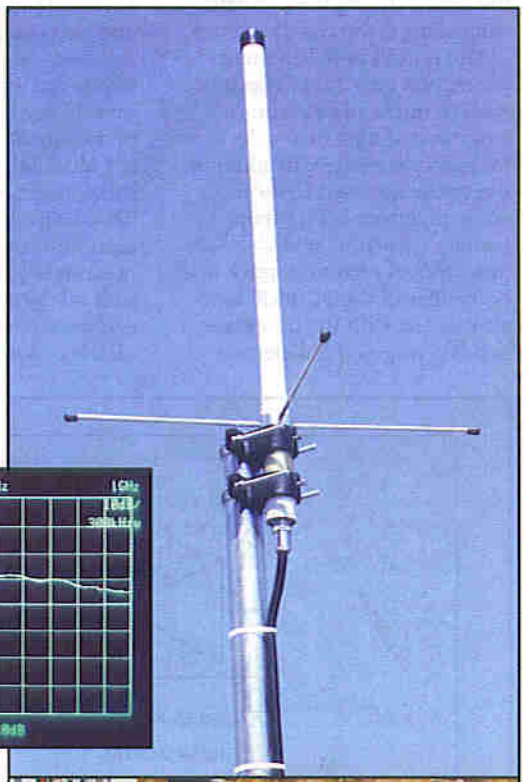
FEATURES

- Indoor or outdoor use
- Wideband HF/VHF/UHF preamplifier
- Low power consumption
- High gain
- Power supply through coaxial cable
- Uses Surface Mount Technology

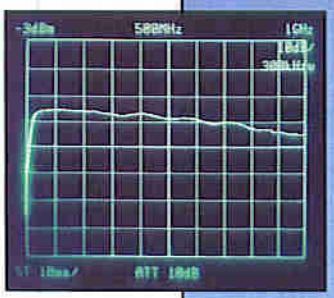
APPLICATIONS

- Ideal for scanning receivers
- VHF and UHF Aircraft bands
- VHF Marine band
- HF/VHF/UHF Amateur Radio bands
- VHF Taxi band

The assembled SuperScan MKII Aerial.



Preamplifier frequency response as shown on a spectrum analyser.



Typical receiving set-up.

PROJECT RATING 2

Kit Available
Order as 95136
Price £49.99

Ready-assembled
Order as AM37S
Price £79.99

The original Super Scan aerial (LT27E) made its debut in the May 1995 issue (No.89) of *Electronics*, and from its initial launch, it has proved to be an extremely popular kit. However, just about anything can be redesigned and improved. The new Super Scan aerial uses the same surface mount technology as the original, but has the following improvements;

- No more visits to your local DIY shop for plastic waste pipes, the aerial housing is pre-manufactured and included in the kit.
- No more fiddly wire aerial elements to thread up, the aerial elements are etched into the PCB.
- No more drilling of the PSU Interface box, this too is pre-manufactured and included in the kit.
- Smaller size, lighter construction, higher performance, and easier build all go to make the new Super Scan MKII even better value for money.

SPECIFICATION

Aerial Specification

Power supply:	+9V to +14V DC
Supply current:	17mA (@ +12V DC)
Frequency range:	1MHz to 2,000MHz (2GHz)
Gain:	19dB (maximum)
Impedance:	50Ω
Connector:	N type
Length:	75cm
Weight:	0·25kg
Mast clamp:	51mm (2in.) Maximum diameter mast

PSU Interface Specification

Power supply:	+9V to +14V DC
RF Insertion loss:	–1dB at 500kHz and 1,000MHz (1GHz)
Input/Output Impedance:	50Ω
DC Connector:	2·5mm DC Power
RF Connectors:	N / BNC

Although the small antennas usually fitted to scanners and other receivers are adequate for local reception of strong signals, for long distance (DX) or weaker signal reception, an external aerial, mounted as high as possible and preferably outdoors, is required. With the ever-increasing frequency range coverage of modern VHF/UHF scanners, a very broadband aerial is needed to enable the receiver's full potential to be realised. The Superscan MkII Active Aerial enables you to extract the best possible performance and hence, value, from your receiver, and will provide far superior reception than the standard-fitment 'rubber duck' type aerial found on most scanners.

Additionally, the interconnecting cable linking the aerial to the scanner must have low-loss signal characteristics if the advantages of using an external aerial are to be obtained. All cables will have some losses, which increase with feeder length and frequency. To compensate for this requires the aerial to incorporate signal gain; passively, this can be achieved by increasing the number of elements, reducing bandwidth and making the aerial directional – features not desirable in a scanner aerial system. A well-designed active aerial system solves all these problems, by using a wideband masthead signal amplifier to boost the incoming signals without the need for a directional aerial. The DC voltage used to power this amplifier is fed up through the centre core of the coaxial cable, which is introduced by using a PSU Interface at the receiver end.

The aerial described in this article features a weatherproof plastic housing, ideal for outdoor use, but equally suited for use indoors, and is compact enough to be unobtrusive when attached to a building or wall.

If you don't have the time or tools to build the kit, then the ready-made version (AM37S) is for you, and includes the following items:

- The Super Scan aerial and PSU Interface
- 230V AC Mains to +12V DC power supply
- Ready-made coaxial cables
- Two coaxial plug adaptors (N-type and PL259)
- Cable tie pack
- Installation guide

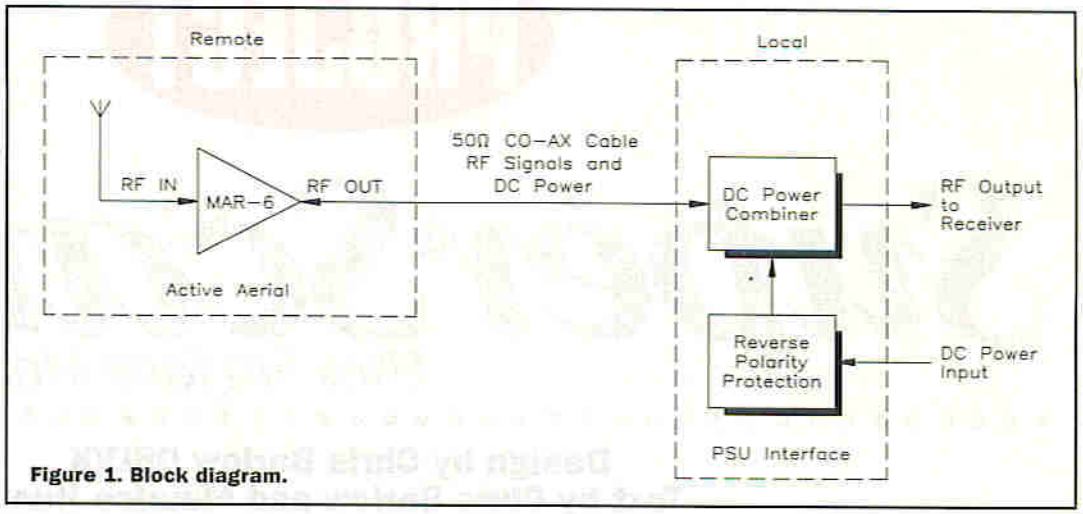


Figure 1. Block diagram.

Circuit Description

In addition to the system block diagram detailed in Figure 1, the circuit diagrams of both the aerial and the PSU Interface unit are shown in Figure 2. These should be of assistance in following the circuit description, or with faultfinding in the completed unit.

The passive aerial elements are etched into the PCB as a pattern tracks of differing lengths, resulting in a wider frequency coverage. In addition, the tracks are used to form some phantom components, namely, capacitors and inductors. A section of track on both sides of the PCB will form a capacitor, with the fibreglass board acting as the dielectric. A spiral track will act as an inductor and when combined with a phantom capacitor, will form a series or parallel tuned circuit.

There is only one active component used in this part of the circuit, a MAR-6 RF amplifier integrated circuit, IC1, shown in Figure 3. This component is a Surface Mount Device (SMD) and because of its small size, any stray capacitive or inductive effects are minimised, thus maximising the performance of the circuit. The MAR-6 is a Monolithic Microwave Integrated Circuit (MMIC). This device is used as a 50Ω input/output amplifier with low noise and high gain characteristics, with an upper frequency response in excess of 2,000MHz (2GHz) – see inset header photo on page 21. The signal input is on pin 1 and its output is on pin 3, with pins 2 and 4 used as ground returns.

The RF signals picked up by the aerial tracks are connected to pin 1 of IC1 and the amplified output appears on pin 3. This is connected to a track used to provide a 50Ω output line and the DC power input to the MAR-6. The end of this track is attached to an N-type coaxial chassis socket, SK1. The centre conductor of the coaxial cable carries both the positive voltage required to power the circuit and the amplified output signal of the aerial. The ground connection of SK1 is returned to the PCB through the metal end block at the base of the PCB assembly.

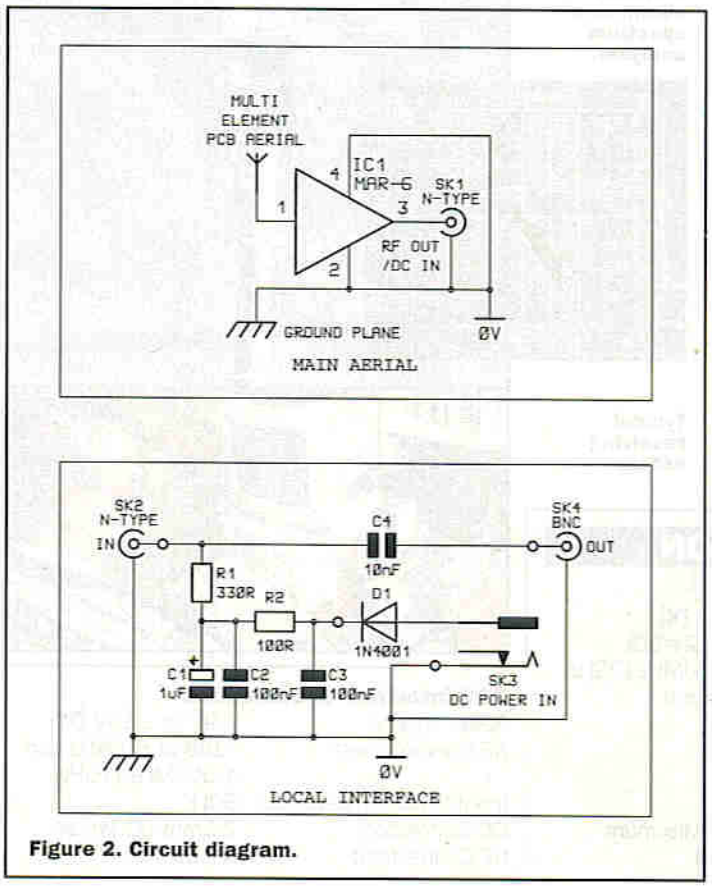


Figure 2. Circuit diagram.

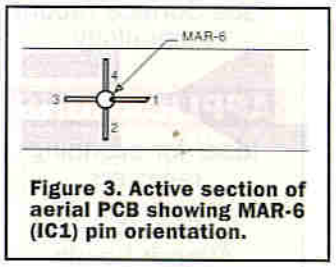


Figure 3. Active section of aerial PCB showing MAR-6 (IC1) pin orientation.

The active aerial is powered from the PSU Interface circuit, which splits off the amplified received RF signals to the radio receiver's aerial input. The external power supply required by the system is applied to SK3, with the positive voltage on its centre pin. This supply must be within the range of 9 to 14V and to prevent any damage caused by reverse polarity connection, diode D1 is used. D1 only conducts when the positive supply voltage is applied to its anode, allowing the DC power to pass to the rest of the circuit.

Capacitors C1, C2, C3 and resistor R2 provide the main RF decoupling for the +V supply rail. This is combined with the incoming received RF signals

on the centre pin of the second N-type socket SK2 via R1. The RF signals are AC coupled via C4 to the BNC output socket SK4.

Aerial PCB Construction

Before the SMD component, IC1, is soldered onto the board, the PCB must first be prepared. This is achieved by soldering two pieces of brass angle strip to the ground plane tracks, as per Figure 4.

The following steps should be carried out to ensure correct installation of these strips, as they provide both mechanical and electrical stability.

1. Using a small hacksaw, cut two pieces of brass angle from the length provided in the kit. The first should be 110mm and the second 40mm.
2. Using a small flat needle file, or some fine abrasive paper, remove any brass swarf from the ends of each strip.
3. Using a polishing block (HX04E), or some fine abrasive paper, remove any tarnish from the surface of the brass.
4. Lay the aerial PCB (component side up) on a heat resistant surface.
5. Position the longer 110mm strip between the PCB markers and over the central 50Ω output track.
6. Using a 25 to 50W or butane/gas type soldering iron (fitted with a large bit), solder down each side of the brass angle strip, bonding it to the ground plane tracks of the PCB.
7. When cooled, turn over the PCB and position the shorter 40mm brass strip over the hole at IC1 and at the end of the ground plane track. Solder down each side to bond it to the PCB.

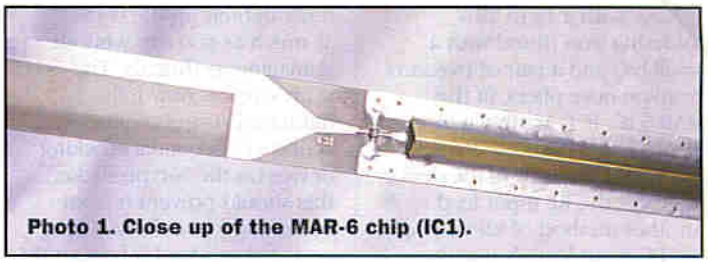


Photo 1. Close up of the MAR-6 chip (IC1).

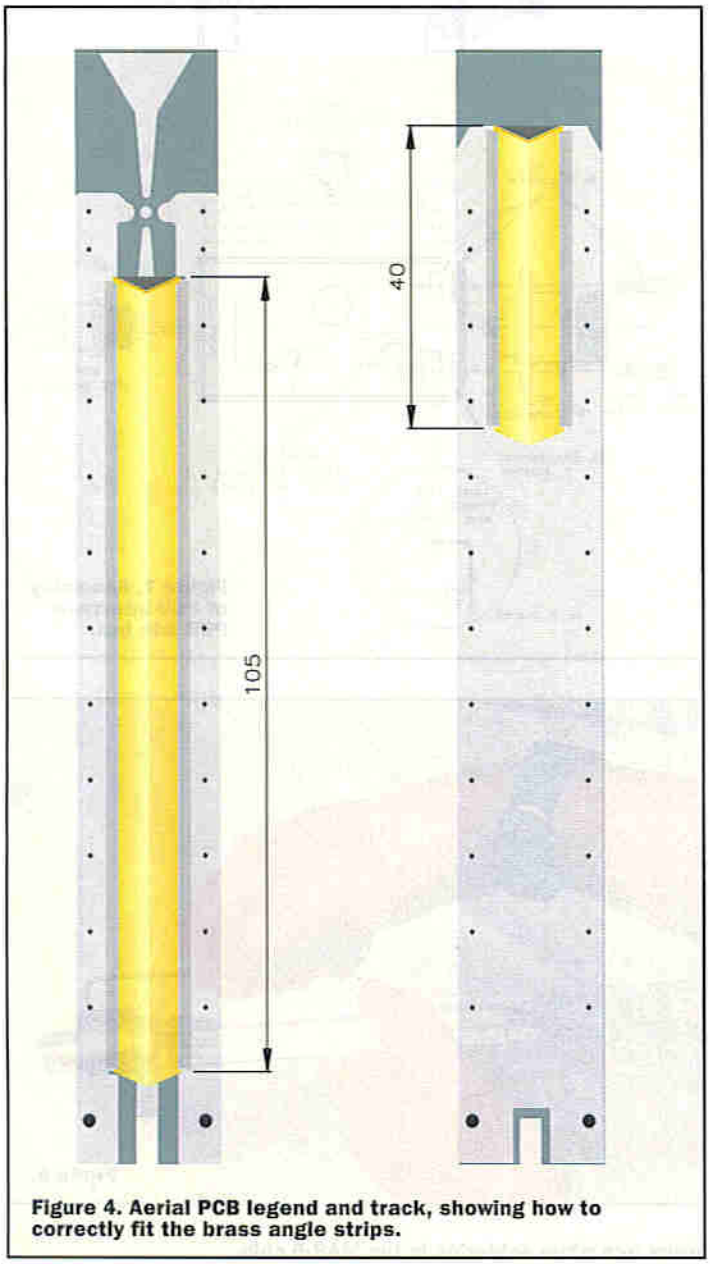


Figure 4. Aerial PCB legend and track, showing how to correctly fit the brass angle strips.

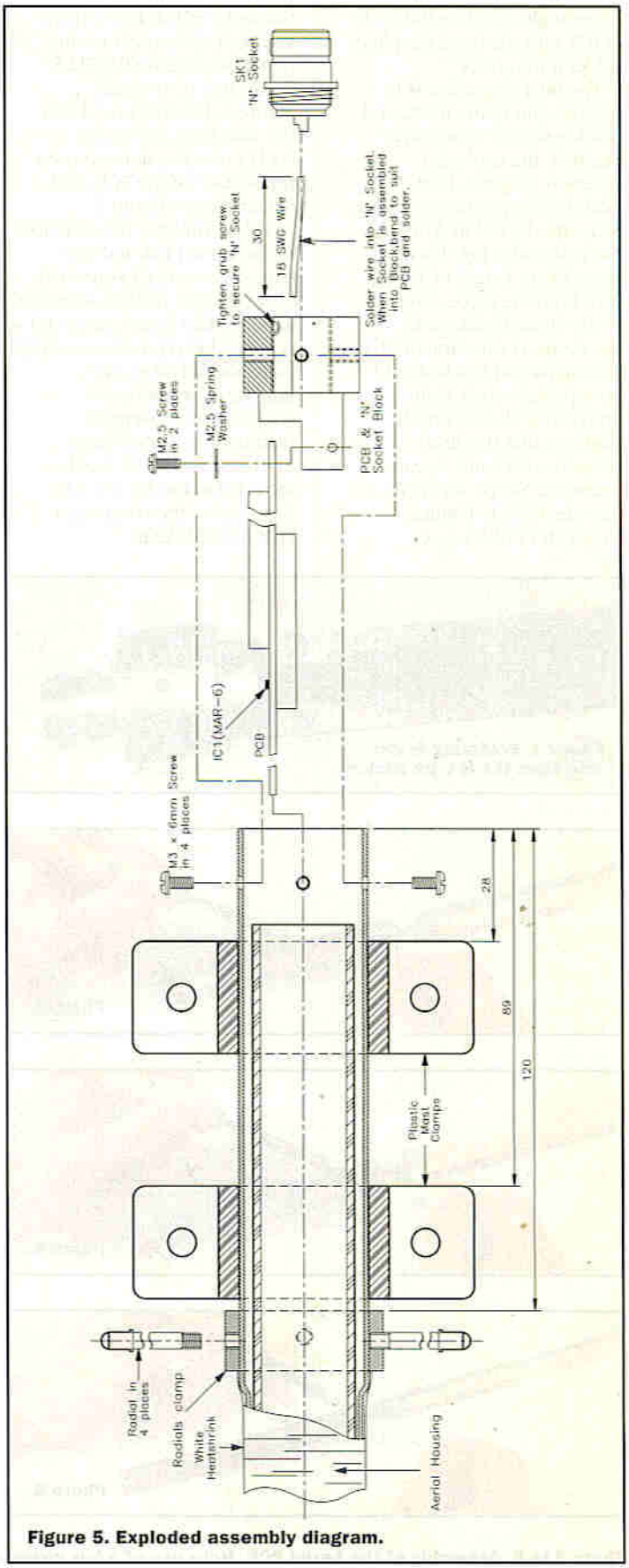


Figure 5. Exploded assembly diagram.

Next, with a 15 to 18W soldering iron (fitted with a small bit) and a pair of tweezers or snipe-nose pliers, fit the MAR-6 IC, IC1, as shown in Figure 3 and Photo 1. A white marker on the body of the device indicates the RF input lead. Another method of identifying the RF input lead, is that the end of the lead is cut off at an acute angle. Holding the body of IC1 with the tweezers/pliers, solder it into place.

The final procedure is to prepare and fit the metal end block assembly, as shown in Figure 5, the exploded assembly diagram. First, take the N-type chassis socket, SK1, and discard its fixing nut and solder tag. Then cut a 30mm length of 18swg wire from the piece supplied in the kit and solder it to the centre connection of SK1. The metal end block should be supplied with a 3mm grub screw already fitted. Ensuring that this grub screw is sufficiently released, screw the N-type socket into the metal block. Using a large pair of pliers, you must tighten up the socket as much as you can without damaging its threads. The grub screw is now fully tightened (using an allen-key), acting as a secondary locking device on the N-type socket; this should prevent it from becoming loose if the N plug on the down lead is frequently removed. Ensuring that the aerial PCB is the correct way round, secure it to the metal block using the M2·5 hardware, as shown in Figure 5. Finally, bend down the wire from the N-type socket into the slot and onto the surface of the PCB, and solder it – see Photo 2.

This completes the assembly of the aerial PCB, and you should now check your work very carefully, making sure that all the solder joints are sound – no dry (dull/crystalline-looking) joints should be present. Further information on soldering and assembly techniques can be found in the Constructors' Guide included in the kit. Photos 3 to 6 show the completed PCB in clear detail.

Photo 2. Soldering in the wire from the N-type socket.

Photo 3.

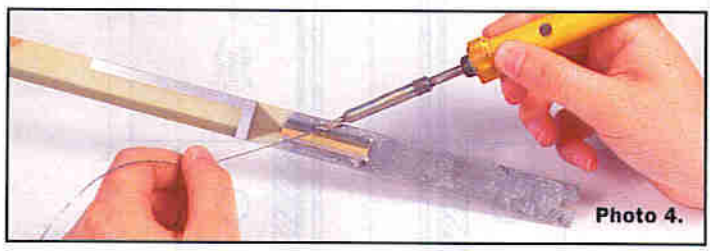


Photo 4.

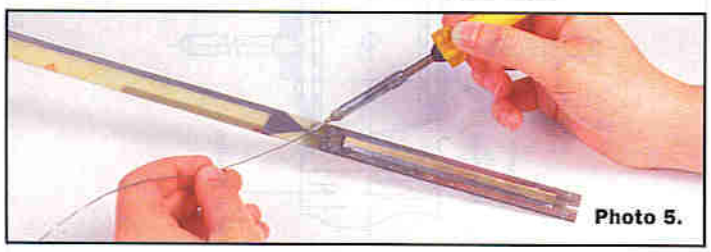


Photo 5.

Aerial PSU Interface PCB Construction

Refer to Figure 6, showing the PSU Interface PCB legend and track. The majority of the components used in the PSU Interface are surface-mount devices (SMDs), apart from D1, a standard silicon diode, which is the reverse polarity protection device on SK3. DO NOT fit D1 until it is called for in the final assembly stage.

A sequence of photographs show how to typically mount the SMDs, by first wetting one of the components' pads with solder as shown in Photo 7a (see page 26), holding components in position with tweezers, re-flowing the solder to wet the component as shown in Photo 7b, and then making the opposite joint of the component, as shown in Photo 7c. The completed PSU Interface PCB is shown in Photos 7d & 7e.

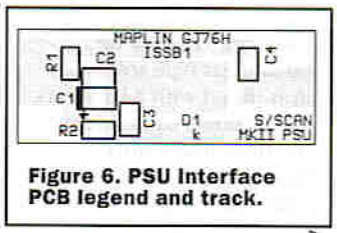


Figure 6. PSU Interface PCB legend and track.

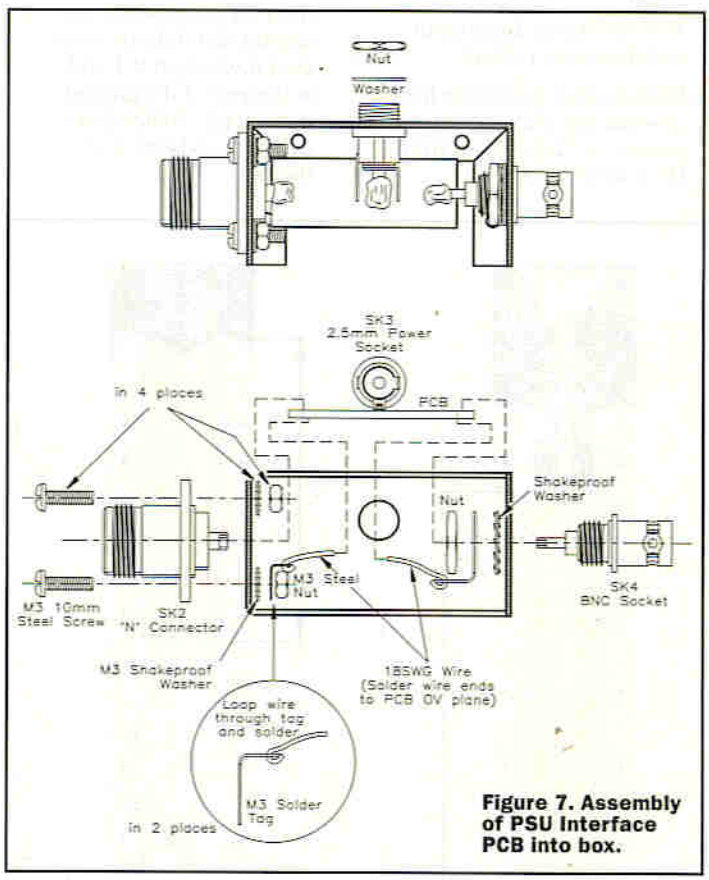


Figure 7. Assembly of PSU Interface PCB into box.

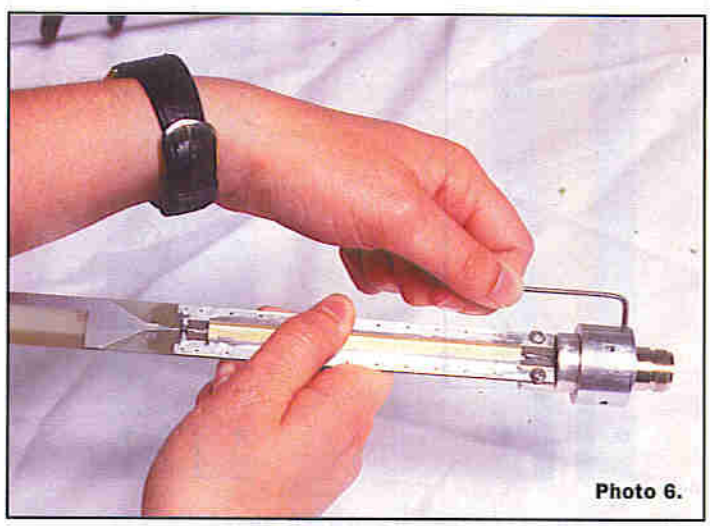


Photo 6.

Photo 3 to 6. Assembly of the Aerial PCB. Note use of a low power soldering iron when soldering in the MAR-6 chip.

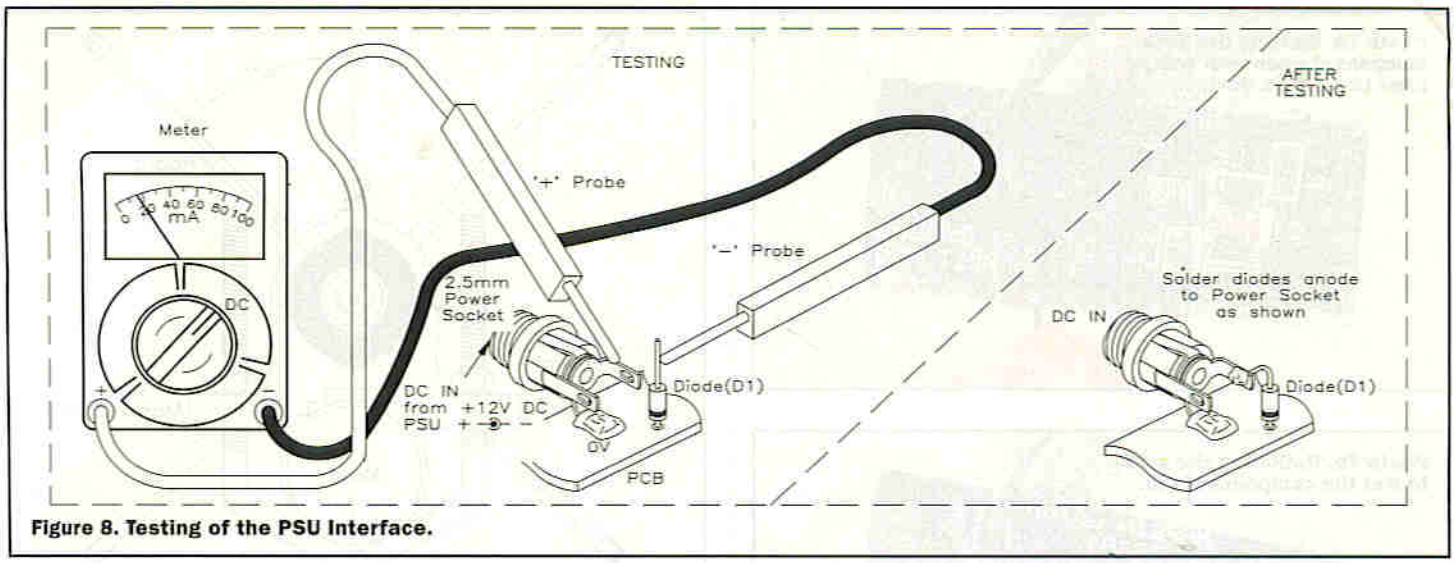


Figure 8. Testing of the PSU Interface.

Aerial PSU Interface Assembly

The three sockets are mounted onto the PSU Interface box in their correct locations, with the relevant hardware, see Figure 7.
The N-type aerial socket, SK2, is fixed using four M3 × 10mm bolts, four shakeproof washers and four M3 nuts. In addition, two M3 solder tags are fitted at the locations shown. The BNC receiver socket, SK4, is a single hole fixing type; ensure that its solder tag is at the position shown. The 2·5mm DC power input socket, SK3, is also a single hole fixing type, and its tags must be positioned as shown in the diagram. Make certain that all the hardware is fully tightened up and the solder tags are in their correct positions.

Position and solder into place the PSU Interface PCB assembly, as shown in Figure 7. The centre pin of the N-type socket, SK2, should be soldered to the large pad near to the SMD resistor, R1. The centre pin of the BNC socket, SK4, should be soldered to the large pad near to the SMD capacitor, C4. The middle tag of the 2·5mm socket, SK3, goes to the large ground pad at the centre of the PCB. Using three 15mm lengths of the 18swg wire supplied in the kit, prepare and solder them to the three solder tags on the sockets, as also shown in Figure 7. Bend down the wires onto the surface of the ground plane track on the PCB and solder them into place.

Finally, fit the 1N4001 diode, D1, so its cathode (K), or banded end is soldered to the PCB – see Figure 8. DO NOT connect or solder its anode lead to the DC power input socket, SK3, until instructed to do so during the testing procedure.

Testing Procedure and Final Assembly of the Aerial and PSU Interface

Before you commence the testing procedure, you must first prepare two RF coax connecting cables. You will need a lead from the output of the PSU Interface to the aerial input of your receiver. On one end, you must fit a 50Ω BNC plug (HH17T) and at the other, a suitable connector for your scanner. This is usually another 50Ω BNC plug, as it keeps the lead as standard as possible and if required, an adaptor is used to obtain the correct connection, N, PL259, TNC, etc. The type of cable must be 50Ω RF coax and be cut to a length to suit your requirements (100mm to 1m). Remember, connecting cables have losses which increase with length and frequency, so make the lead only as long as you need it. With the second lead, you have the option of making a short temporary test cable, or preparing the main aerial down lead if you know its final length requirement. Depending on its length and the upper frequency of your receiver, you should consider the choices of coax cable and N-plug shown in Table 1.

The initial DC testing procedure can be undertaken using the minimum amount of test equipment. You will need a multimeter and a power supply capable of providing a regulated +12V DC at up to 300mA – see Figure 8. All the following readings are taken from the prototype using a digital multimeter, some of the readings you obtain may vary slightly depending upon the type of meter used.

When testing the aerial, it has to be pre-tested outside the aerial housing before the final assembly, but the first part to be tested is the PSU Interface.

The first test is for any short circuits. Assuming that the PSU Interface is built up in its box, but without the lid fitted, you should obtain resistance measurements before applying power to the unit.

Using a multimeter on the ohms range and applying the test probes either way around, you should see the following readings;

1. Metal box to anode of D1 = open circuit (> 20MΩ).
2. Centre pin of N socket to box = open circuit.
3. Centre pin of BNC socket to box = open circuit.
4. Centre pin of N to centre pin of BNC = open circuit.
5. Body of N socket to body of BNC socket = short circuit (< 0·3Ω)

Coax	Length	Frequency	N-plug
RG58 (XR19V)	3m	2,000MHz	N-050 (FJ77J)
RG58 (XR19V)	10m	1,000MHz	N-050 (FJ77J)
RG58 (XR19V)	20m	500MHz	N-050 (FJ77J)
UR67 (XR63T)	10m	2,000MHz	N-011 (FJ78K)
UR67 (XR63T)	30m	1,000MHz	N-011 (FJ78K)
UR67 (XR63T)	60m	500MHz	N-011 (FJ78K)

Table 1. Choosing appropriate coax cable and N-plugs.

We now carry out similar tests on the actual active aerial on the N-type socket SK1 at the base of the aerial PCB assembly;

1. Body of N socket to metal end block = short circuit.
2. Centre pin of N socket to body of N socket = approximately 1k2.

Using the N to N coax cable, connect it between SK1 on the aerial and SK2 on the PSU Interface. Set your multimeter to read DC current. Next, apply power (+12V DC) to SK3, connect your multimeter's test probes to the anode of D1 and the centre tag of SK3 – see inset of Figure 8. When powered up you should observe a current reading of approximately 17mA. Power down the unit and remove the meter, then solder the anode lead of D1 to SK3 as shown in Figure 8. Set your multimeter to read DC Volts. Connect the negative test probe to the metal box and positive to the centre pin of the N socket SK2. When powered up you should observe a reading of approximately 3·6V DC, move the positive probe to the centre pin of the BNC socket SK4. No DC voltage should be present on this socket, however if you are using a high input impedance meter you may get a small floating reading. If the unit passed all its DC tests you can fit the lid on the box and connect the BNC to BNC coax cable to SK4.

The only way of testing the radio reception of the aerial is to either connect it to a spectrum analyser or failing that, to a wide range scanner receiver. Tune to something that you would normally pick up on the whip aerial on the scanner, and when you change over to the Super Scan MKII it should be of

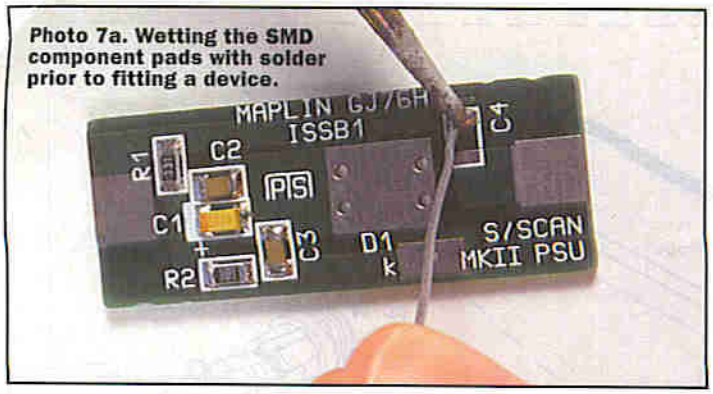


Photo 7a. Wetting the SMD component pads with solder prior to fitting a device.

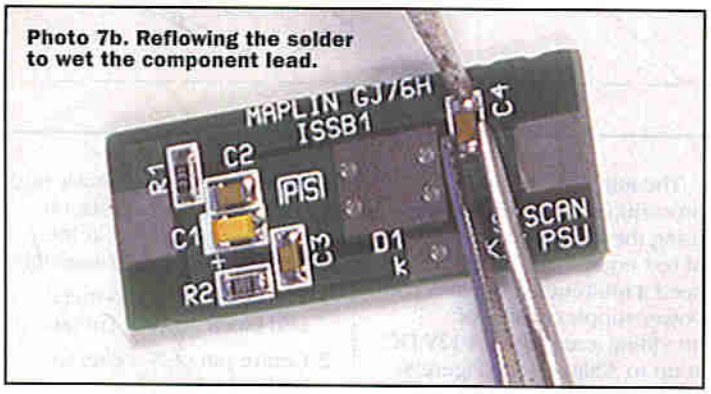


Photo 7b. Reflowing the solder to wet the component lead.

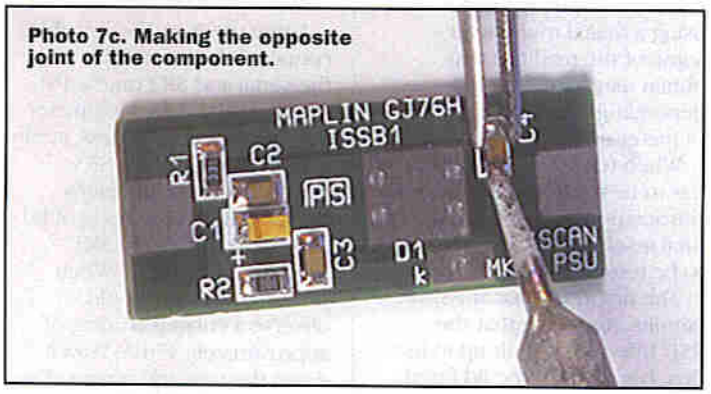


Photo 7c. Making the opposite joint of the component.

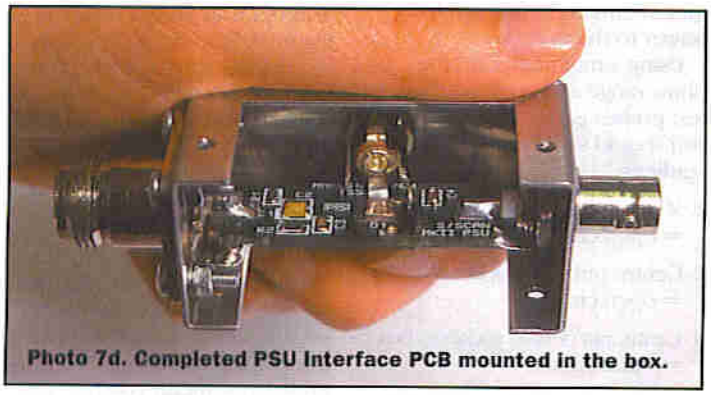


Photo 7d. Completed PSU Interface PCB mounted in the box.

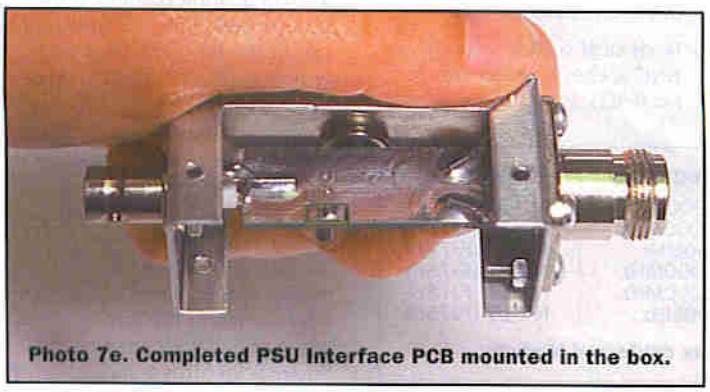


Photo 7e. Completed PSU Interface PCB mounted in the box.

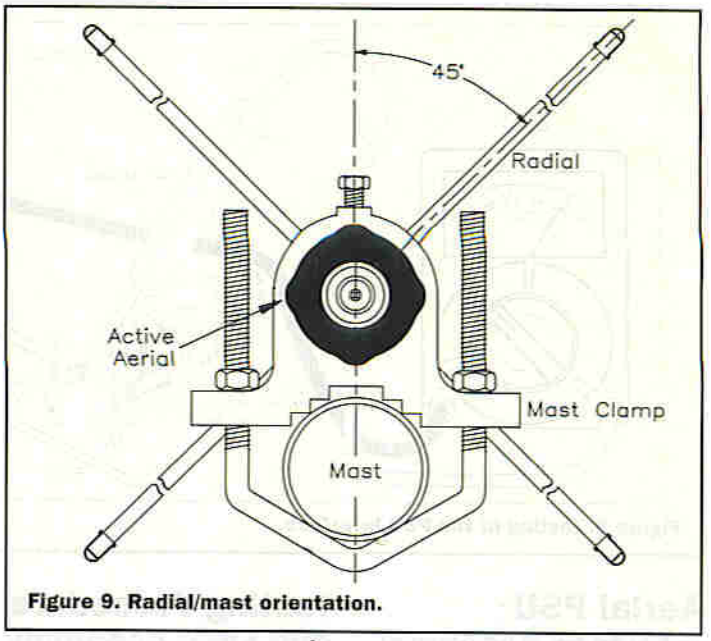


Figure 9. Radial/mast orientation.

a relatively similar strength, or stronger. Power down the unit and disconnect the N cable from the aerial, this completes the testing procedure.

Assemble the aerial housing with the groundplane radials and mast clamps as shown in Figure 9. NOTE that the groundplane radials are at 45° to the mast clamps and ensure that the spacing between the components are as shown in Figure 5.

Slide the aerial PCB assembly into the housing, see Photo 8. Rotate the N socket until all the M3 tapped holes in the metal end block align with the holes in the housing. Using the four M3 by 6mm bolts, secure the end block. The bolts should be tightened in turn to ensure the end block is held centrally in the aerial housing. This can be adjusted by looking at the width of the slight gap between the end block and the housing.

Before fitting the heat-shrink material, make sure that the four M3 bolts are fully tightened. When using a screwdriver, it is possible to leave a sharp edge on the head of the bolt, if heat-shrink is then applied over these, as it shrinks, it will puncture and tear. So, after tightening, make absolutely sure that the bolt heads are smooth; if not, use a piece of emery paper or a file to smooth off any rough edges.

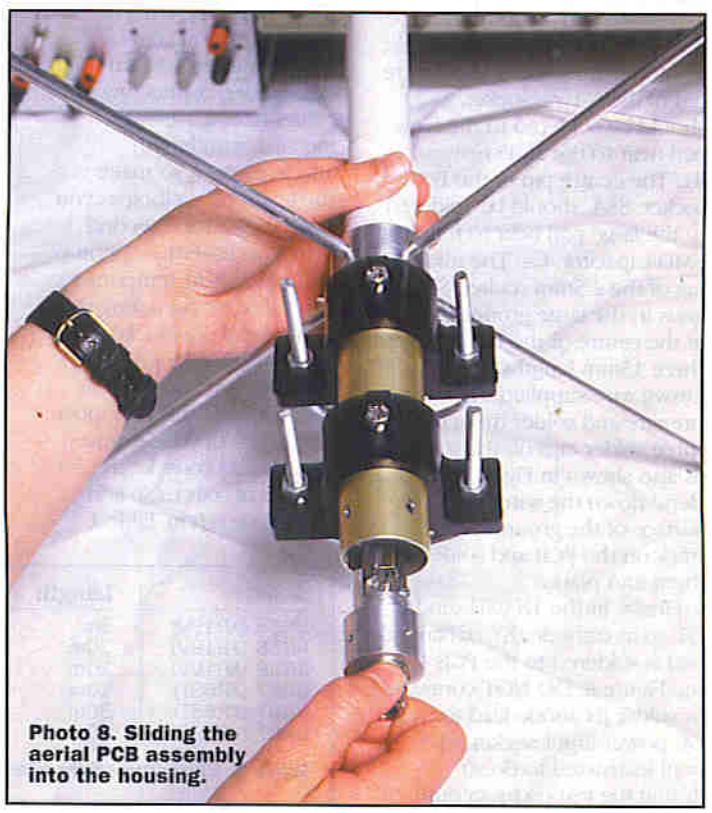


Photo 8. Sliding the aerial PCB assembly into the housing.

Figure 10. Labels (separate into four sections). Shown at 85%.

Fit the heat-shrink sleeving over the base of the aerial as shown in Photo 9, making sure that it covers the four M3 bolt heads and the end if the metal tube. Do not overheat the heat-shrink material, it only needs to mould itself over the aerial; excessive heat will weaken it and cause it to split.

If a proper heat-gun is not available, then either a heat-gun of the paint stripping variety (the heat from which is very strong) or an efficient hairdryer at its maximum setting will suffice. After the heat-shrink sleeving has cooled, trim off any excess from the end of the aerial base, see Photo 10. Additional long-term protection against the elements can be provided by smearing silicone sealant between the metal end block and the base of the tube, see Photo 11.

Finally, to finish off the project, the sticky label supplied with the kit (which is printed in four parts – see Figure 10) has to be cut up with a pair of scissors and fitted to the aerial and PSU Interface, see Photos showing the completed units. The top right-hand portion of the label can be used to identify the downlead as being for the Superscan MkII aerial, to avoid confusion with other coax leads that may be nearby.

This completes the assembly of the project, and you should now check all the work you have done and give the aerial one last receiver test before installing the system.

Aerial Installation

The aerial installation is straightforward and follows normal practice for small aerials. First, select a location on your building, preferably away from power and telephone lines, etc., that might interfere with reception. With safety in mind when climbing ladders, make sure that the base of the ladder will not slide about. Next, install a wall mounting bracket (XQ53H), or chimney lashing kit (XQ57M), as required. Then attach the Super Scan MKII to a suitable length of aluminium tubing (XQ62S) to act as the support mast, see Figure 11.

Refer to the system wiring diagram shown in Figure 12 when wiring in the Superscan MkII aerial and its PSU Interface unit. Connect the prepared coax to the N-type socket at the base of the aerial and secure the cable to the mast using cable ties or insulation tape. Next, fit the mast assembly to the bracket and tighten up the clamps. A good tip is to lightly grease the threads and the nuts on both clamps, as this will make it easier to undo in the future. Run the coax down the wall to the required receiving location (fixed in position by clips) and if necessary, drill a hole into the building.

The coax is connected to the aerial PSU Interface by means of another N-type plug, and a coax connection with BNC plugs on each end runs to the scanner receiver. Finally, connect the regulated PSU (set to 12V) with centre pin positive on the 2·5mm plug to the aerial PSU Interface.

Using the Super Scan MKII

There are, generally, two main categories of scanning receivers – portable hand-held and desktop models. Both these types include scanners that are FM/AM only, and others which cover modes such as SSB and CW. The earlier and cheaper type of scanning receiver did not have full coverage of the HF/VHF/UHF spectrum, the gaps in the frequency ranges being dependent on the type and make of scanner. A modern top-of-the-range scanning receiver can now have a frequency coverage from virtually 0kHz to in excess of 2,000MHz (2GHz), and most will receive NFM, WFM, AM, USB, LSB and CW.

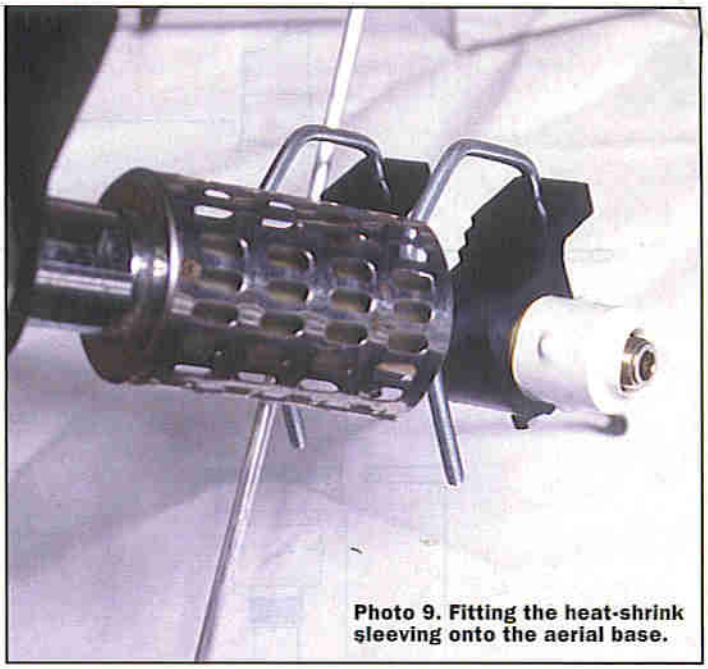


Photo 9. Fitting the heat-shrink sleeving onto the aerial base.

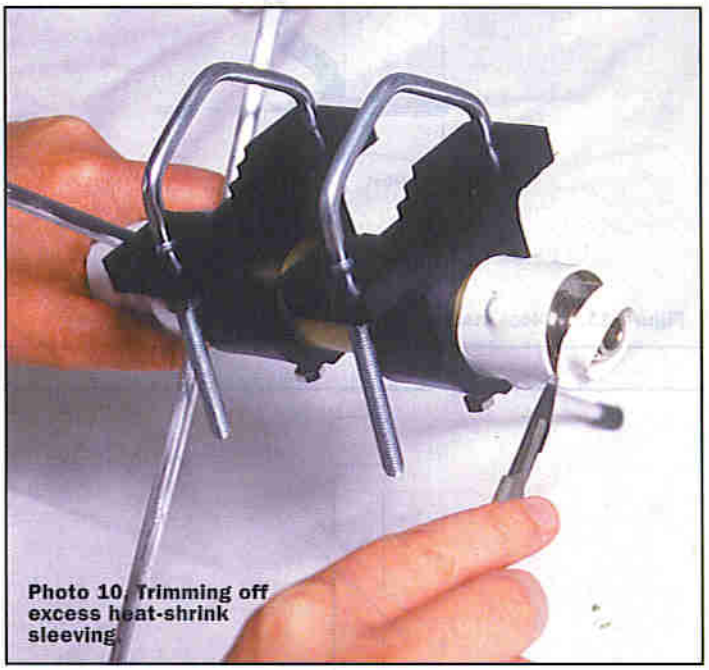


Photo 10. Trimming off excess heat-shrink sleeving

Photo 11. Extra protection against the elements can be acheived by smearing silicone sealant between the metal block and the base of the tube.

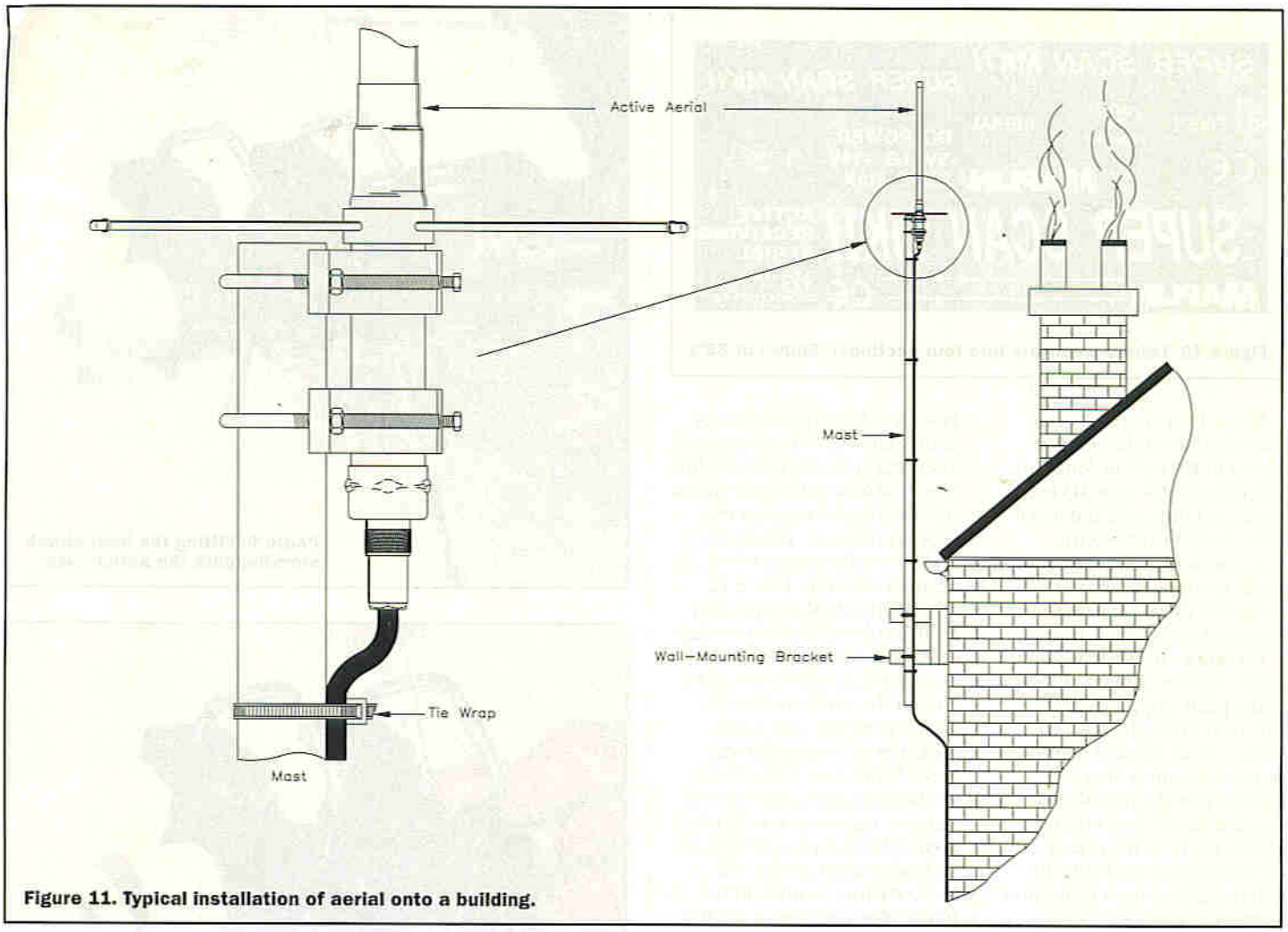


Figure 11. Typical installation of aerial onto a building.

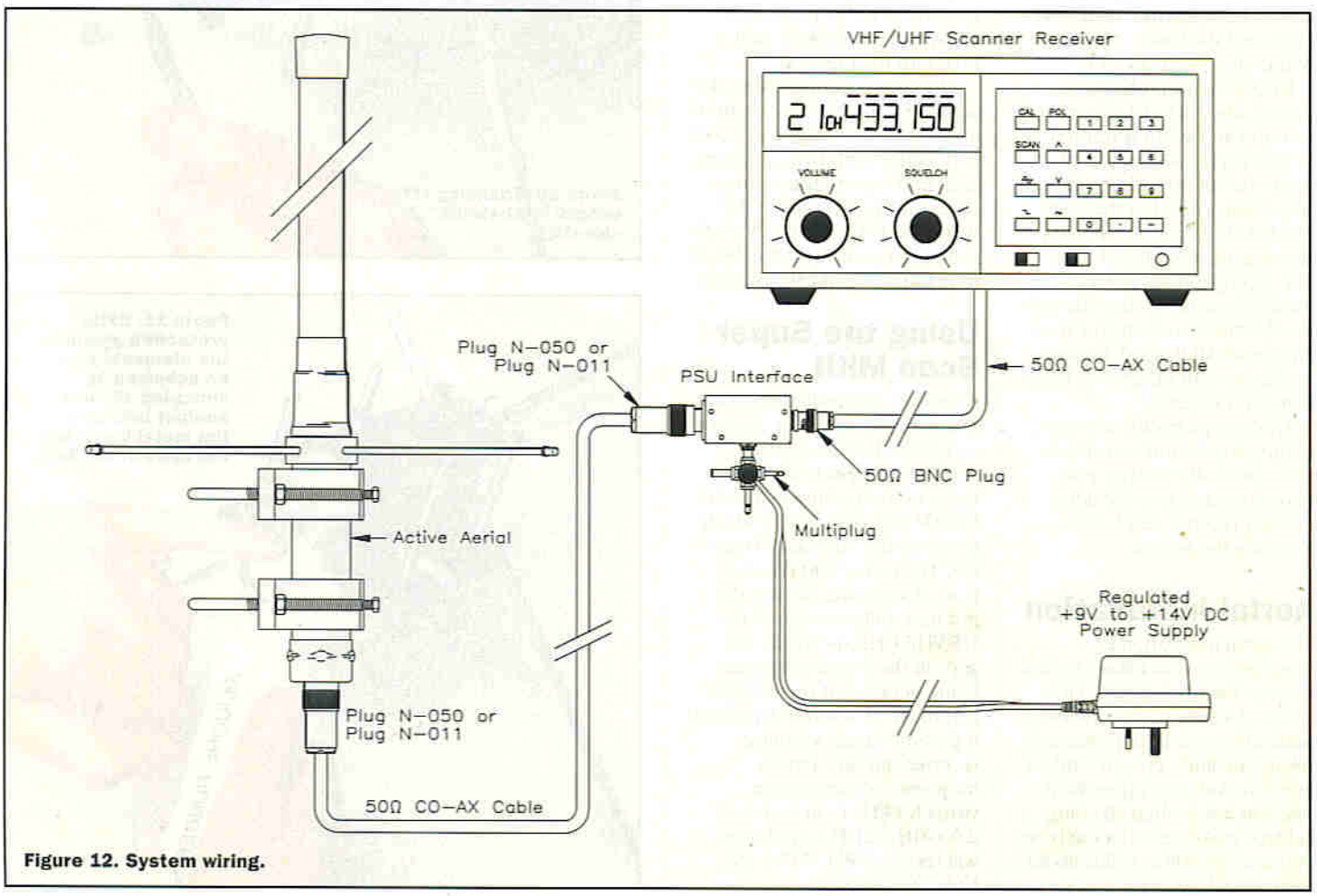
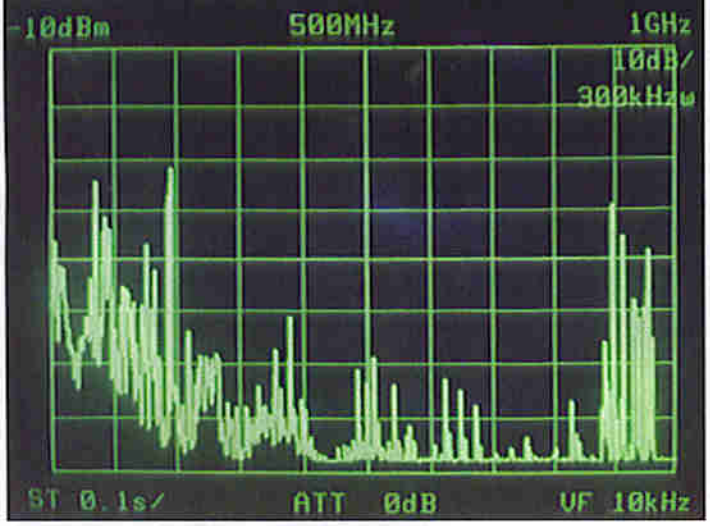


Figure 12. System wiring.

Photo 12. Frequency scan showing the greatly varying strengths of radio signals being received.



Over such a large frequency range there are many radio signals at greatly varying strengths, see Photo 12. All radio receivers can be overloaded by strong local RF signals, resulting in distorted or scrambled reception. To over come this problem most receivers employ some form of Automatic Gain Control (AGC). However, extremely strong RF signals can fall outside the range of the AGC circuit and require additional attenuation. This can take the form of a manual variable RF gain control, or switched RF attenuator. Nearly all scanners are fitted with a –10dB attenuator switch, please refer to your scanners operation manual.

The completed Superscan MkII project and a selection of current typical scanners and scanner books are shown in Photo 13. There are a number of books dedicated to the scanner enthusiast, some of which are not always appreciated by the authorities. Responsible scanning must be the order of the day, as hefty fines and confiscation of equipment can be the result of insensitive listening and divulging of classified information to third parties.

Further Reading

Short Wave International Frequency Handbook, Bill Laver (Order Code WT73Q)
Scanning Secrets, Mark Francis and Bill Laver (Order Code YE84F)
Scanner 3 – Putting Scanners into Practice, Peter Rouse GU1DKD (Order Code WP47B)
An Introduction to Scanners and Scanning, I. D. Poole (Order Code WZ62S)
The VHF/UHF Scanning Frequency Guide, Bill Laver (Order Code WT70M)

PROJECT PARTS LIST

RESISTORS			
R1	330Ω Surface-mount	1 Pkt	(DJ09K)
R2	100Ω Surface-mount	1 Pkt	(DJ07H)
CAPACITORS			
C1	1µF Surface-mount Ceramic	1 Pkt	(DK22Y)
C2,3	100nF Surface-mount Ceramic	2 Pkt	(DJ00A)
C4	10nF Surface-mount Ceramic	1 Pkt	(DH97F)
SEMICONDUCTORS			
D1	1N4001	1	(QL73Q)
IC1	MAR-6	1	(DK24B)
MISCELLANEOUS			
SK1	N-type Chassis Socket	1	(FJ79L)
SK2	N-type Square Chassis Socket	1	(FJ80B)
SK3	2·5mm Panel-mounted Power Socket	1	(JK10L)
SK4	50Ω Round BNC Socket	1	(HH18U)
	6·4 × 6·4 × 305mm Brass Angle	1	(HZ65V)
	Aerial Housing	1	(GA37S)
	PSU Box	1	(GA38R)
	M3 10mm Steel Screw	1 Pkt	(JY22Y)
	M3 Steel Nut	1 Pkt	(JD61R)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M3 Solder Tag	1 Pkt	(LR64U)
	M3 6mm Steel Screw	1 Pkt	(JY21X)
	M2·5 6mm Steel Screw	1 Pkt	(JY29G)
	M2·5 Spring Washer	1 Pkt	(JD97F)
	18swg 1·25mm Tinned Copper Wire	1 Reel	(BL12N)
	Lay-flat Heat-shrink Tubing Type CHT57	1m	(BA05F)
	PCB	1	(GJ66W)
	PSU PCB	1	(GJ76H)
	Label	1	(KV21X)
	Instruction Leaflet	1	(XZ27E)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
	Low Capacitance Screened Cable	As Req.	(XR19V)
	UR67 RF Cable	As Req.	(XR63T)
	N-type Plug N-050	2	(FJ77J)
	N-type Plug N-011	2	(FJ78K)
	50Ω BNC Plug	2	(HH17T)
	N-type Male to BNC Adaptor	1	(FJ82D)
	UHF Male to BNC Female Adaptor	1	(YW05F)
	AC Adaptor Regulated	1	(YB23A)
	Tie-wrap	As Req.	(FE00A)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.
The above items (excluding optional) are available as a kit, which offers a saving over buying the parts separately.
Order As 95136 (Superscan MkII Aerial) Price £49.99

Please note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue.

Superscan MkII Aerial PCB **Order As 95137 Price £15.99**
Superscan MkII PSU PCB **Order As 95204 Price £2.49**
Superscan MkII Label **Order As 95138 Price £3.99**
Superscan MkII Aerial Housing **Order As 95205 Price £24.99**
Superscan MkII PSU Box **Order As 95206 Price £3.99**

With infrared astronomy, however, there are additional reasons for wishing to establish observations from space. Firstly there is the fact that the earth's atmosphere strongly absorbs infrared radiation over critical bands. Secondly there is the ease of maintaining observational systems at ultra low temperatures in order to be able to detect signals from 'dark', i.e. low temperature objects.

It is not perhaps appreciated what specific demands are made on systems to detect, image and analyse infrared radiation from very weak sources. This has a considerable bearing on the design and function of ISO.

All objects at a given temperature radiate electromagnetic radiation with a characteristic wavelength content. The exact shape of the radiation curve (intensity as a function of wavelength is given by Planck's Law).

Figure 1 shows some characteristic curves for objects at 150K, 125K and 100K, equivalent to −123C, −148C and −173C. Planck's Law picks up two important factors. As the temperature of the radiating body falls the peak of radiation shifts to longer wavelengths and the total amount of radiation also falls. As the temperature rises above 150K, the height of the peak increases very rapidly.

By using appropriate filters with an infrared detector, the wavelength emission characteristic of an object can be measured and the temperature of the source calculated.

Figure 2 shows how the value of the radiated wavelength increases as the temperature of the radiating body falls. (The vertical dotted line is the lower limit on temperature for bodies to be detected by ISO.)

Thus an optical telescope at say 20°C (293° Kelvin) will be emitting a broad spectrum of radiation with a peak at around 10 microns. However, the relative amount at a green optical wavelength will be some 6×10^{-30} less than the radiative peak at 10 microns. Thus optical telescopes do not have any interference from passive radiating surfaces at room temperature. As the telescope is designed to detect longer

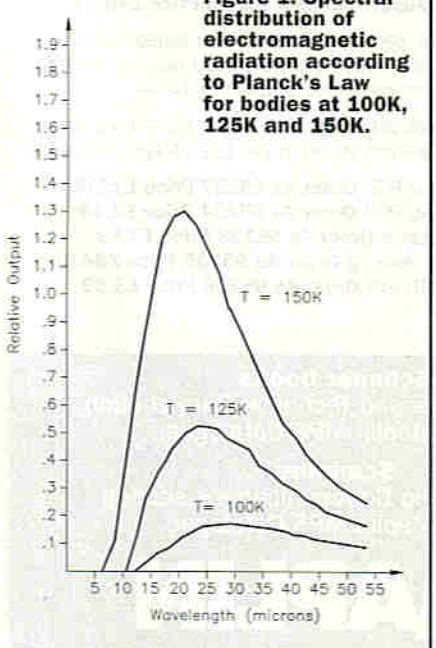
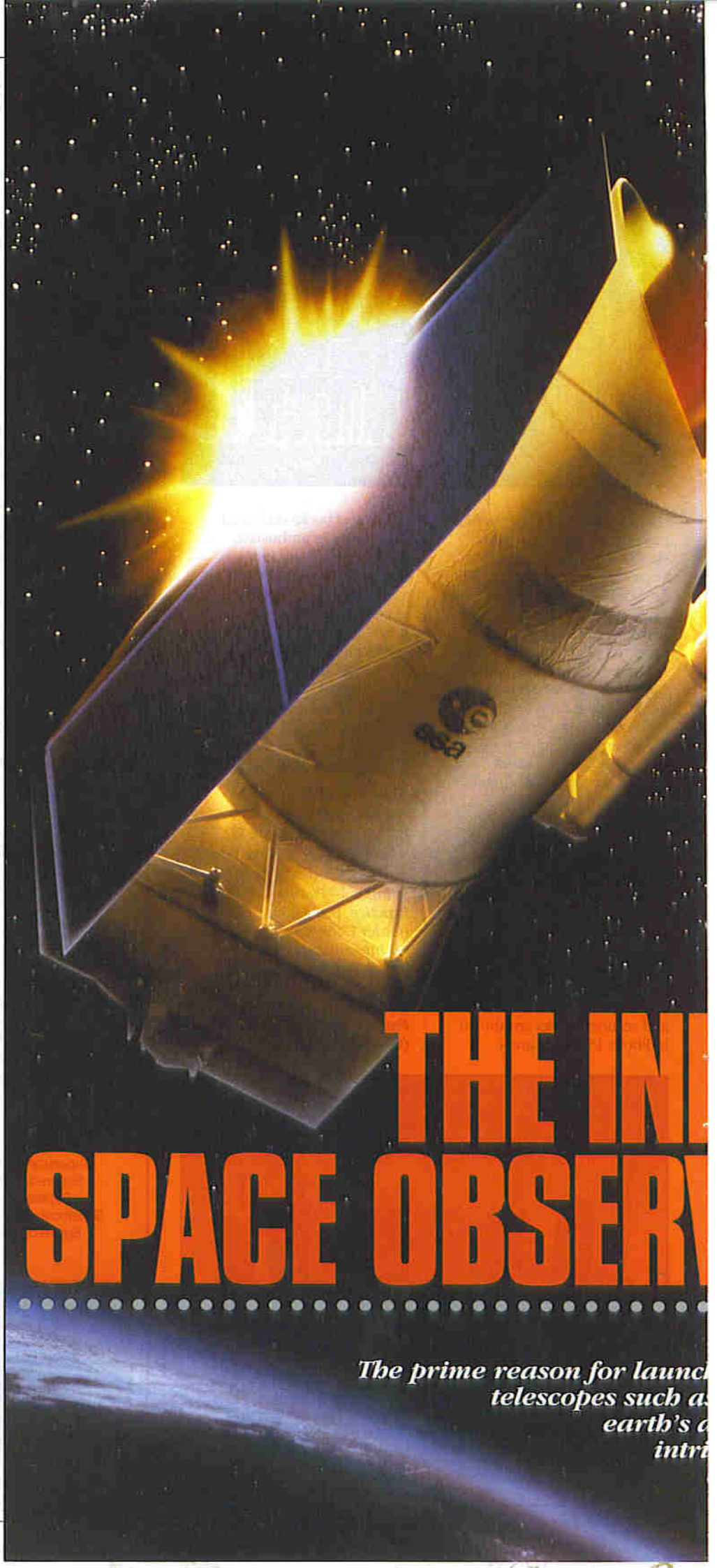


Figure 1. Spectral distribution of electromagnetic radiation according to Planck's Law for bodies at 100K, 125K and 150K.



THE INF
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ISO
FRARED
VATORY

by Douglas Clarkson

bing state of the art optical
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caused by instability in the
earth's atmosphere.

and longer wavelengths, radiations emitted from the telescope structures at ambient temperatures begin to interfere with the incoming signals. It is a signal to noise issue. In practice optimised results can be achieved by maintaining the telescope and detection systems close to the temperature of liquid helium, around 2K or –271C.

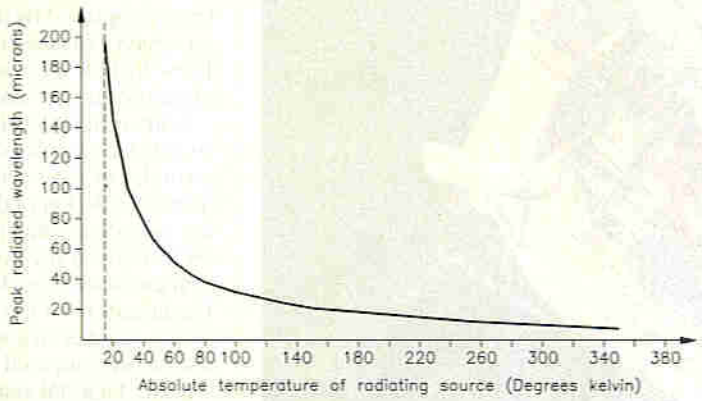

Figure 2. Variation of 'peak' wavelength at which most infrared radiation is radiated as a funcition of absolute temperature.

The IRAS Mission

The first space mission to observe the universe in the infrared spectrum was made by IRAS (Infrared Astronomical Satellite). This was a highly successful UK/Dutch/US mission launched in 1983 which catalogued the sky for some ten months before its cryogenic system became depleted. This represented a significant advance for infrared astronomy. This mission made extensive measurements in four main bands between 8 microns and 120 microns. IRAS catalogued a total of 250,000 infrared sources and until the launch of ISO has been the main reference source for all infrared astronomy. Soon after its successful completion, the decision was made for ESA to go ahead with the Infrared Space Observatory (ISO) mission.

differentiated pixels have subsequently been seen in considerably more details by ISO. IRAS's sky survey has, however, been invaluable in the planning of the observing time of ISO. To date, UK based astronomers have secured around 20% of the observational time of the ISO mission. Some 1,000 astronomers around the world are now actively engaged in the ISO programme.

ISO represents a significant advance on the IRAS specification with regard for example to length of mission, range of spectral sensitivities and angular resolution. The region between 120 microns to 250 microns until ISO has been entirely unexplored. Compared with IRAS, the availability of more advanced technology of ISO provides a thousand fold increase in sensitivity and a resolution ten times higher.

All About ISO

Figure 3 indicates the general design of ISO. While some spacecraft are too complex to describe, ISO is relatively simple in design. A top sunshade prevents sunlight from entering the observational port. Light entering the observational aperture is first reflected from the primary mirror and then onto the secondary mirror where in turn it is reflected to the sensor arrays. The telescope is a so called Ritchey-Chretien type with an aperture of 20cms and a focal length of 9m. The design of the telescope allows the system to detect an ice-cold object the size of a human being 100km away. ISO can detect infrared radiation from objects at temperatures as low as 15K (–258C).

The quality of images is in part due to the excellence of its gold coated quartz mirror. The finish required for the centrepiece of the observatory is such that if its 60cm diameter were artificially expanded to the size of the Earth's diameter, the residual bumps and dips of the reflecting surface would be no more than one metre up or down.

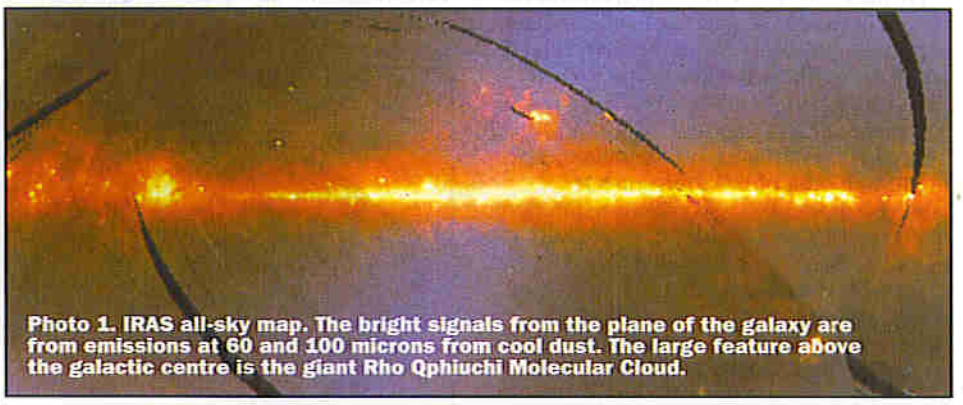

Photo 1. IRAS all-sky map. The bright signals from the plane of the galaxy are from emissions at 60 and 100 microns from cool dust. The large feature above the galactic centre is the giant Rho Qphiuchi Molecular Cloud.

Rutherford Appleton Laboratory CLRC.

Photo 1 shows an IRAS composite all-sky image. The bright signals from the plane of the galaxy are from emissions at 60 and 100 microns from cool dust. The large feature above the galactic centre is the giant Rho Ophiuchi Molecular Cloud. The black stripes are areas not explored by IRAS during its mission. Many of the sources emanate from regions where visible light is absorbed by dust and gas clouds. Many of the features which IRAS identified by a few

The helium tank is cylindrical in shape and extends around the side of the satellite. An array of solar panels provides around 600W of power for on board instruments. By using liquid helium on ISO, detectors are cooled down as far as 2K and telescope structures down as far as 3K. The total radiation varies as the fourth power of absolute temperature (Stefan's Law). Thus the reduction in emissions between 293K (room temperature) and 3K is some

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Figure 3. General design of ISO.

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1 in 100 million. The cooling effect on the ISO craft is achieved by gradual expansion of the helium reservoir of some 2,300 litres capacity. With a target life of 18 months, present indications suggest that the cooling systems will remain viable for some 24 months. In terms of the efficiency of the craft's thermal insulation, if it were filled with boiling water it would take some six years to drop to ambient temperature.

Figure 5 shows ISO during preparation for blast off in French Guyana close to its successful launch on the 17th of November 1995 aboard an Ariane 44P launch vehicle. The mass of ISO at launch was 2,400kg with the craft some 3·5m in diameter and 5·3m long. The cryostat cover of ISO was successfully ejected in the 10th orbit of ISO's mission. On present estimates ISO will continue to function till November 1997. The total budget for ISO is estimated at ECU 650 million.

A total of 35 highly specialised firms have been involved in the development of the project. One of the major contractors for the project was Daimler-Benz – responsible for the Payload module incorporating the large cryostat system. The principal contractor for the launch system including the Ariane rocket was Aerospatiale.

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Orbit Definition

The orbit of ISO is shown in Figure 4. At the point of closest approach (perigee) ISO is some 1,000km above the earth. At its furthest distance (apogee) the craft is some 70,000km distant. The orbit is designed to maximise the amount of time the telescope remains beyond the extent of the earth's Van Allen radiation belts. Interference from trapped electrons and protons reduces somewhat the sensitivity of ISO's instruments. ISO was initially placed in a circular orbit round the earth. On board hydrazine thrusters subsequently were used to move ISO into its elliptical orbit. The orbital period is 24 hours, of which some 16 hours can be used for observational activity. The orbit is inclined at some 5 degrees to the equator. ISO can observe an object continuously for up to 10 hours.

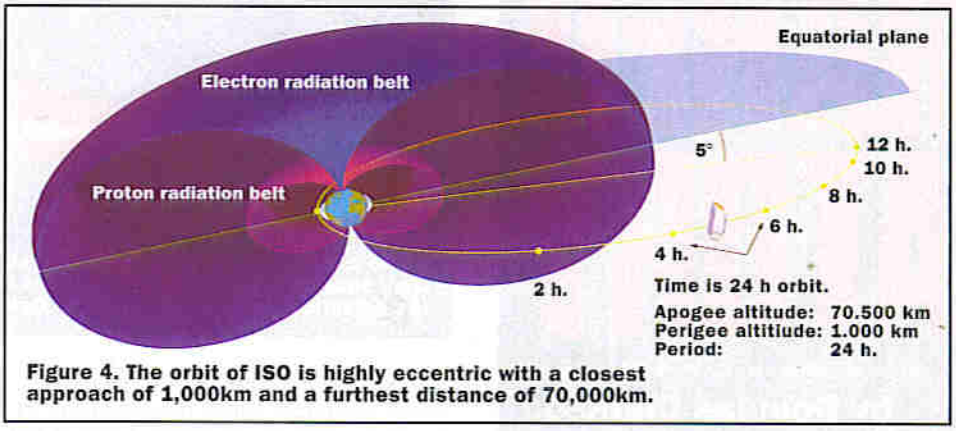

Figure 4. The orbit of ISO is highly eccentric with a closest approach of 1,000km and a furthest distance of 70,000km.

Mission Control

The main terrestrial contact point for ISO is at Villafranca near Madrid. Direct contact can be established for up to 14 hours per day. Additional linkages are available via a ground station at Goldstone in California. In exchange for such ground control links, US and Japanese observers receive allocation of 30 minutes observation time per day. It is estimated that Villafranca station will receive 170M-bytes of data per day and at least 90 billion bytes during its mission. Data links operate at 32k-bits second.

The Scientific Instruments

Images captured by the telescope can be presented to a range of scientific instruments. These include a camera, an imaging photopolarimeter and two spectrometers.

Four separate levels of magnification of ISOCAM are provided –1·5, 3, 6 and 12 arc seconds per pixel which defines also the spatial resolution of the observations. The wavelength sensitivity of the camera is from 2·5 to 18 microns. Two channels of detector array are available, each with 32 × 32 elements. The images from the ISO camera system therefore reflect a lower level of image resolution compared with optical detectors.

In the ISOCAM system, some 20 filters can be used to select regions of the infrared spectrum for study. The size of images able to be observed corresponds to 1/1200 to 1/150 times the full diameter of the moon. ISOCAM was developed by Service d'Astrophysique de Saclay, France.

The IMAGING photopolarimeter (ISOPHOT) is in some ways the most complex instrument. This unit comprises a separate spectrometer in range 2·5 to 12 microns, a far infrared camera detecting in range 50 to 240 microns and a multi-band multi aperture photopolarimeter in range 3 to 125 microns.

In ISOPHOT a range of 15 apertures and 25 spectral filters and polarisers allow selection of infrared spectra for observation. The detector system incorporates novel pre-amplifiers which can detect ultra low level signals in the range from one pico watt (10 to power –12) to one atto watt (10 raised to power –18). Also, the sensing electronics can operate at power levels as low as 5mW. Indeed the low power consumption of the electronics is an important aspect of the system design since it is essential that heat taken up by the on board cooling system is minimised.

The ISOPHOT device has the most far ranging wavelength coverage and is able to detect objects not even detected previously by the IRAS mission. ISOPHOT was developed chiefly at the Max Planck Institute in Germany.

The short wave spectrometer (SWS), analyses wavelengths between 2·5 and 45 microns while the long wave spectrometer

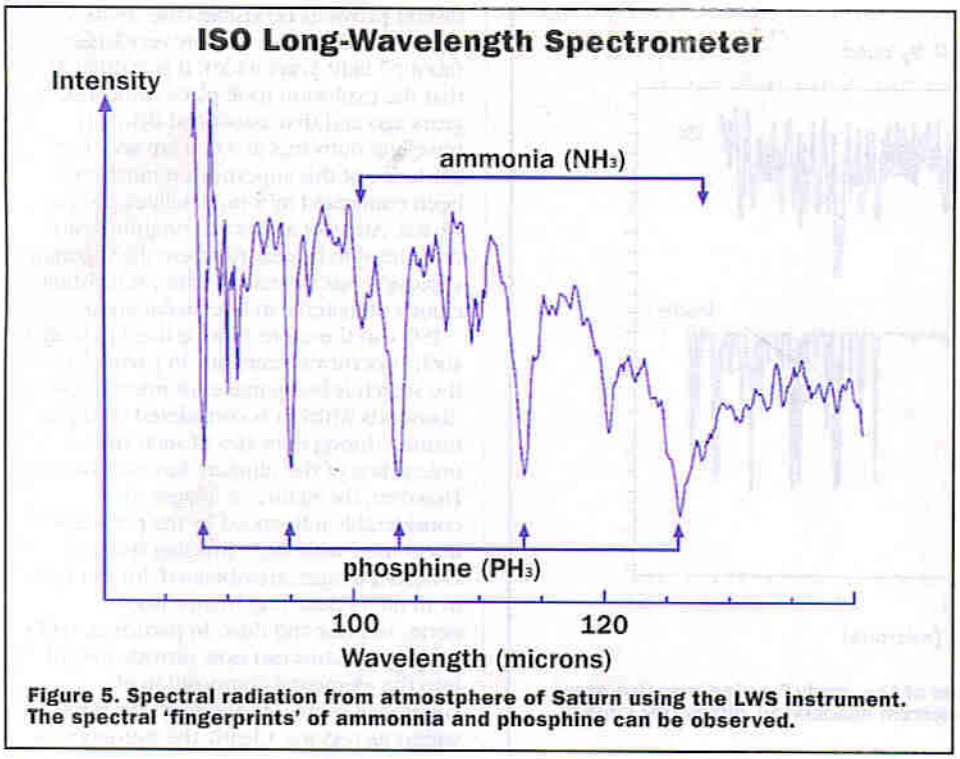

Figure 5. Spectral radiation from atmostphere of Saturn using the LWS instrument. The spectral 'fingerprints' of ammonnia and phosphine can be observed.

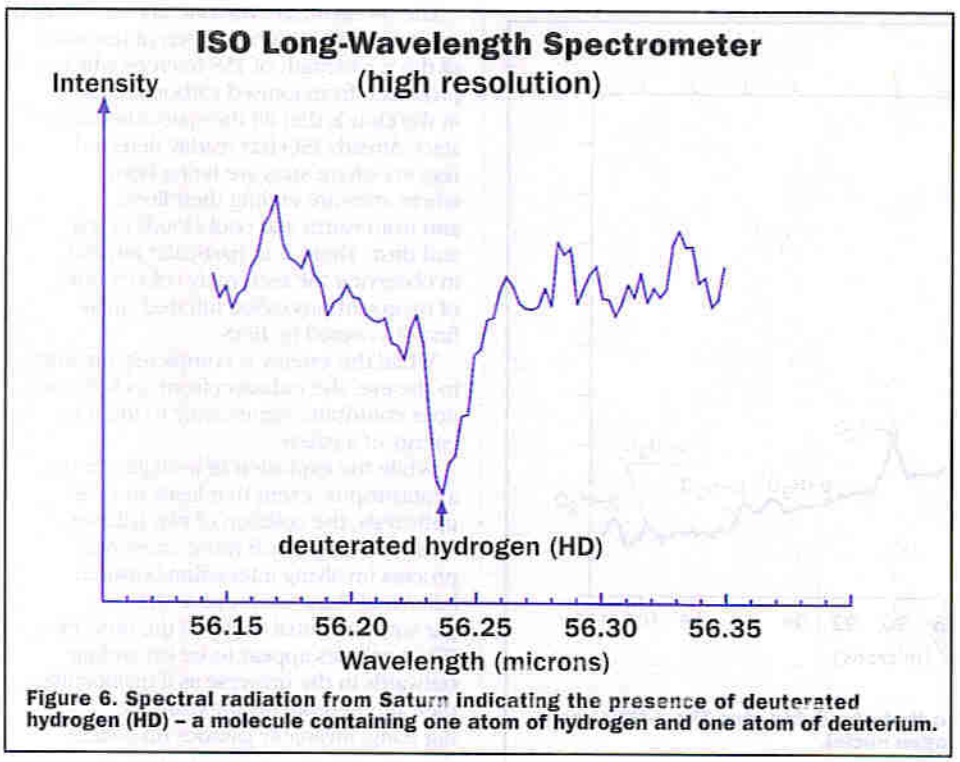

Figure 6. Spectral radiation from Saturn indicating the presence of deuterated hydrogen (HD) – a molecule containing one atom of hydrogen and one atom of deuterium.

(LWS) analyses between 45 and 180 microns. SWS was developed by the Groningen Laboratory for Space Research in the Netherlands and LWS by Queen Mary and West London College.

Scientific Objectives

While there is obviously much interest in objects such as stars that shine brightly and can be more readily observed due to the relative abundance of light that they emit, it is in observing cool objects between 15K and 300K that new and highly significant discoveries of astronomy are likely to be made.

Our own solar system provides significant opportunities to analyse the spectral radiation from planets such as Jupiter, Saturn, Neptune and Uranus in order to determine the relative abundance of for example hydrogen and deuterium.

It is anticipated that ISO will be able to analyse emissions of cometary heads on the outskirts of the solar system to determine analysis of their material before modification takes place by solar heating.

On a note of cosmology, the search for 'dark' or 'invisible' matter continues in order to try to identify in what form the known 'missing' physical mass of the universe exists. Matter may, for example, be present in the form of 'brown dwarves' that have never entered a nuclear burning phase. ISO is likely to be able to detect these objects and provide information of their chemical composition. There is also the possibility that the bulk of the dark matter in the universe exists as a halo of cold matter extending far outside the bounds of each galaxy. The determination of the amount of matter in the universe is a fundamental factor in determining theories of cosmology. Thus if the universe is 'open' it will continue expanding for ever. If it is closed it will eventually collapse upon itself.

Of particular interest to the ISO mission is Titan, Saturn's intriguing moon which has a dense atmosphere. ESA's Huygens probe is due to land on Titan in the year 2004.

ISO is in particular looking at features in astronomy which could give insight into the formation of planets around star systems. ISO will be able to detect features corresponding to disks of dust and gas which are thought to have given rise to systems such as the solar system. The data that ISO finds could significantly alter our perceptions on the number of possible planetary systems in our own galaxy.

First Observations

Figure 5 indicates using data from the long wavelength spectrometer the spectral fingerprints of ammonia and phosphine in the atmosphere of Saturn. Similarly Figure 6 indicates the existence of so called deuterated hydrogen (HD) where an atom of hydrogen (one proton) becomes bonded to an atom of deuterium (one proton and one neutron). The determination of the relative abundances of these two isotopes provides clues about processes of evolution of planetary systems from the times of their earliest existence.

One of the major discoveries of ISO has been to detect water in the universe to be much more widespread than previously thought.

Thus in the depths of outer space water is detected in the form of ice collected on dust grains. Also, in the birth of new stars, characteristic lines of water vapour are detected as heat within the collecting mass is radiated into space. Thus water can help the embryonic star shed heat and thus consolidate faster. Figure 7a (upper section) shows part of the spectrum of the newly forming massive star GL 2591. This matches well the predicted spectrum associated with water vapour (lower section).

Also, water vapour is detected in the material surrounding dying stars as the spectra of W Hydrae in Figure 7b indicates. The o-H2O and p-H2O refers to alternative orientations of hydrogen nuclei.

It is interesting to reflect that water is thus formed out of the material of 'universal' hydrogen and from oxygen that has been created from the process of fusion within the heart of stars. Water is therefore generally more abundant in the universe than had first thought. This may have significance within the solar system. There may, for example, be more water vapour locked within the frozen surface of Mars and particularly on the moons of Jupiter and Saturn.

Optical observations are often made difficult by clouds of dust and gas. The infrared camera system of ISO has been able to as it were fill in the gaps in optical observations made so far in astronomy.

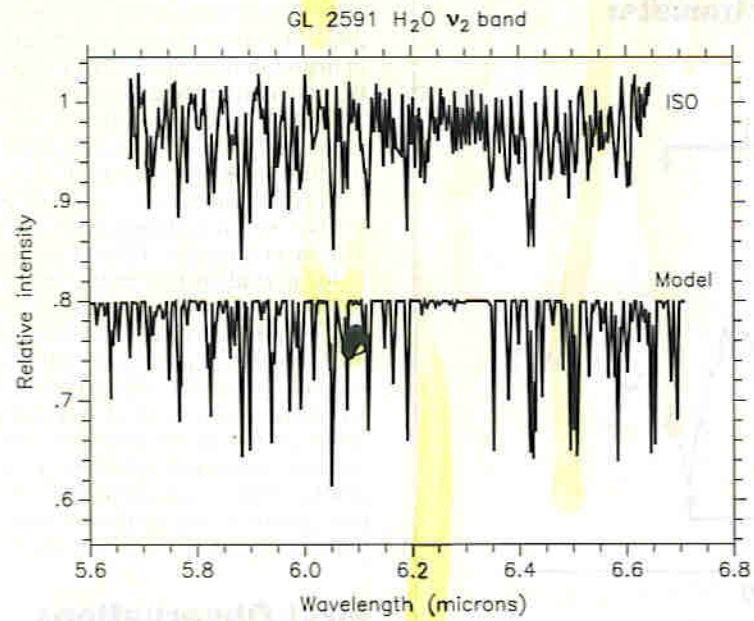

Figure 7a. (Upper section) Part of the spectrum of the newly forming massive star GL 2591 which matches well the predicted spectrum associated with water vapour (lower section).

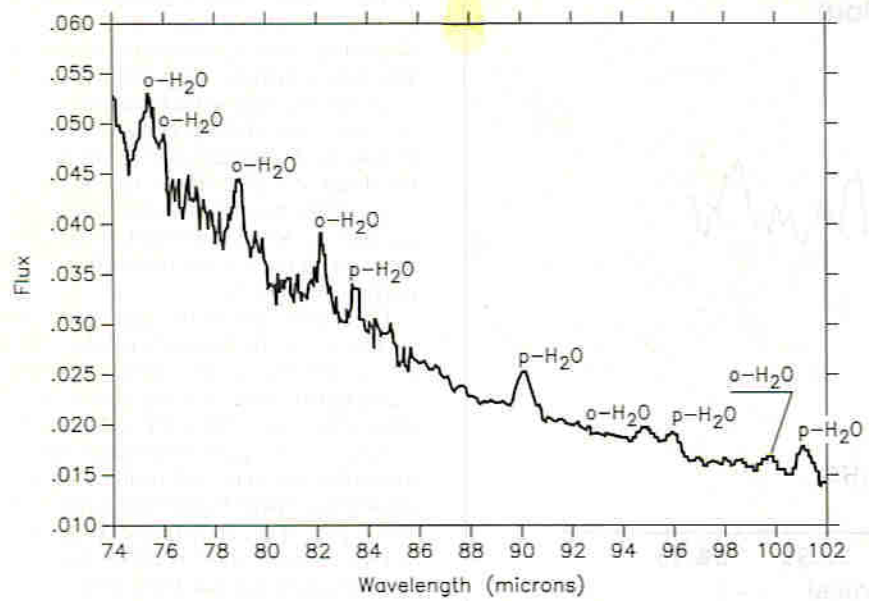

Figure 7b. Spectra of W Hydrae – thought to be that of a dying star. The o-H2O and p-H2O refers to alternative orientations of hydrogen nuclei.

The object M51 or NGC5194 was the first object described as a spiral galaxy. Its ISO image is shown in Photo 2. The bright spots in the spiral arms are identified as warm dust clouds identified by the 15 micron filter used in the exposure. There are also regions of star formation on either side of the central nucleus.

The companion galaxy in the top centre is NGC 5195 and its infrared image is somewhat smaller than its optical image. This is because star formation is limited to regions closer to its galactic nucleus.

The ISO photometer has been able to identify supernova remnants of MSH 11-54 as indicated in Photo 4. This object in the Southern Cross constellation some 10,000 light years distant provides no visible clues of its existence. The object is now very large (about 7 light years wide). It is estimated that the explosion took place some 1,000 years ago and that associated debris is travelling outwards at 3,000 km/sec. The existence of this supernova remnant has been confirmed by x-ray satellites such as Exosat. Areas of additional brightness are considered to be regions where the supernova explosion has interacted with pre-existing clouds of material in interstellar space.

ISO can therefore now be used to image such supernova remnants. In particular the search is being made for microscopic diamonds which it is considered could be formed during episodes of such violent unleashing of the ultimate forces of nature. However, the nature of images, is considerably influenced by the particular filters used with ISO's imaging systems. Different images are obtained, for example, from filters detecting hydrocarbons, neon, sulphur and dust. In particular, ISO's imaging systems can now provide insight into the elemental composition of supernova remnants and how this varies within its regions. Clearly the astronomers are enjoying themselves.

Life on earth, as everyone knows, is based on carbon. Studies have been undertaken of the wavelength of 158 microns which is produced from ionised carbon atoms in the clouds that fill the spaces between stars. Already ISO has readily detected regions where stars are being born, where stars are ending their lives, and from warm and cool clouds of gas and dust. There is in particular interest in observing the extremely cold clouds of hydrocarbons called infrared cirrus first discovered by IRAS.

While this energy is completely invisible to the eye, the radiation from such regions does contribute significantly to the total energy of a galaxy.

While the explosion of a single star is a catastrophic event that leads to violet upheavals, the collision of two galaxies must rank as a much more awesome process involving interaction between billions of stars. Such events are on a par with the initial origin of the universe. While galaxies appear to be expanding outwards in the universe as if maintaining their momentum arising from the Big Bang, invariably galaxies do collide. Photo 5 indicates an image taken by

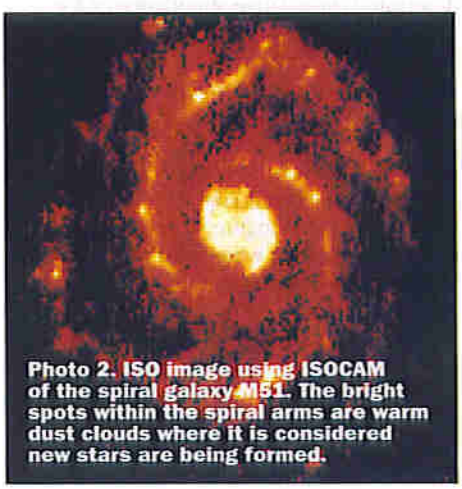

Photo 2. ISO image using ISOCAM of the spiral galaxy M51. The bright spots within the spiral arms are warm dust clouds where it is considered new stars are being formed.

Photo 4. ISOPHOT image of the supernova remnants of object MSH 11-54 in the Southern Cross constellation. ISO can detect the large area of remnants ejected by the supernova explosion some 1,000 years ago.

ISO on its ISOCAM system at 15 microns wavelength in the constellation of Corvus (the Crow) at a distance of some 60 million light years. Clouds of gas and dust in the galaxies NGC 4038 and NGC 4039 have crashed together and provoked starmaking events called starbursts. In the lower galaxy (NGC 4039), an extended bright region with a hot spot at its right side marks the overlap of the disks of the two spiral galaxies. This is where the collision is fiercest and star making most rapid.

ISO's camera has also observed merging galaxies 230 million light years away in a feature known as Arp 220. The very high infrared emissions are, however, limited to a very small region, suggesting the existence of a black hole. The spectral details of dust in galaxies can be measured using ISO's photometer system. In the NGC 6090 galaxy, for example, an estimated temperature of 23K was measured.

Planetary Nebula

In the planetary nebula phase of a star it is considered that with fuel supply dwindling the star 'fertilises' the surrounding space with an array of chemical elements. Figure 8 indicates the ISO Short Wavelength Spectrometer (2·5 to 45 microns) data for NGC 6543 lying about 3,000 light years away in the constellation of Draco (the Dragon). The peaks indicate the principal elements present in the expelled clouds of material. To go one stage better, images can be produced which allow ISO to 'see' particular elements. Photos 6a, 6b and 6c indicate the relative spatial distributions of Sulphur (10·5 microns), Neon (12·8 microns) and warm dust (15 microns).

The Birthplace of Comets

There is intense interest in understanding better the conditions in deep space where for example water ice and hydrocarbons are thought to accrete around small silicate particles. This process through time is thought to give rise to comets. Astronomers have anticipated keenly the first spectral data from cold star forming regions. Figure 9 which shows the short wavelength spectrum of the star forming region Capheus A. This confirms the existence of water ice, silicates and simple carbon compounds. Astronomers are 'over the moon' with such excellent data.

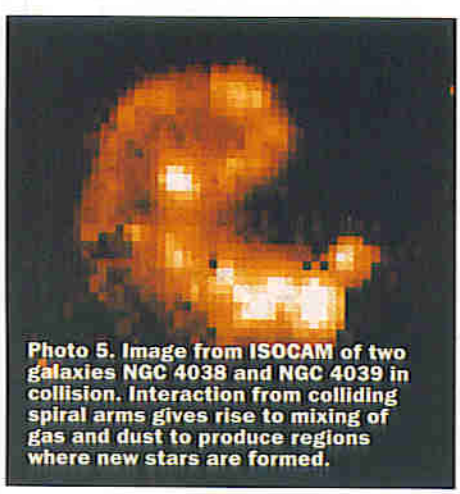

Photo 5. Image from ISOCAM of two galaxies NGC 4038 and NGC 4039 in collision. Interaction from colliding spiral arms gives rise to mixing of gas and dust to produce regions where new stars are formed.

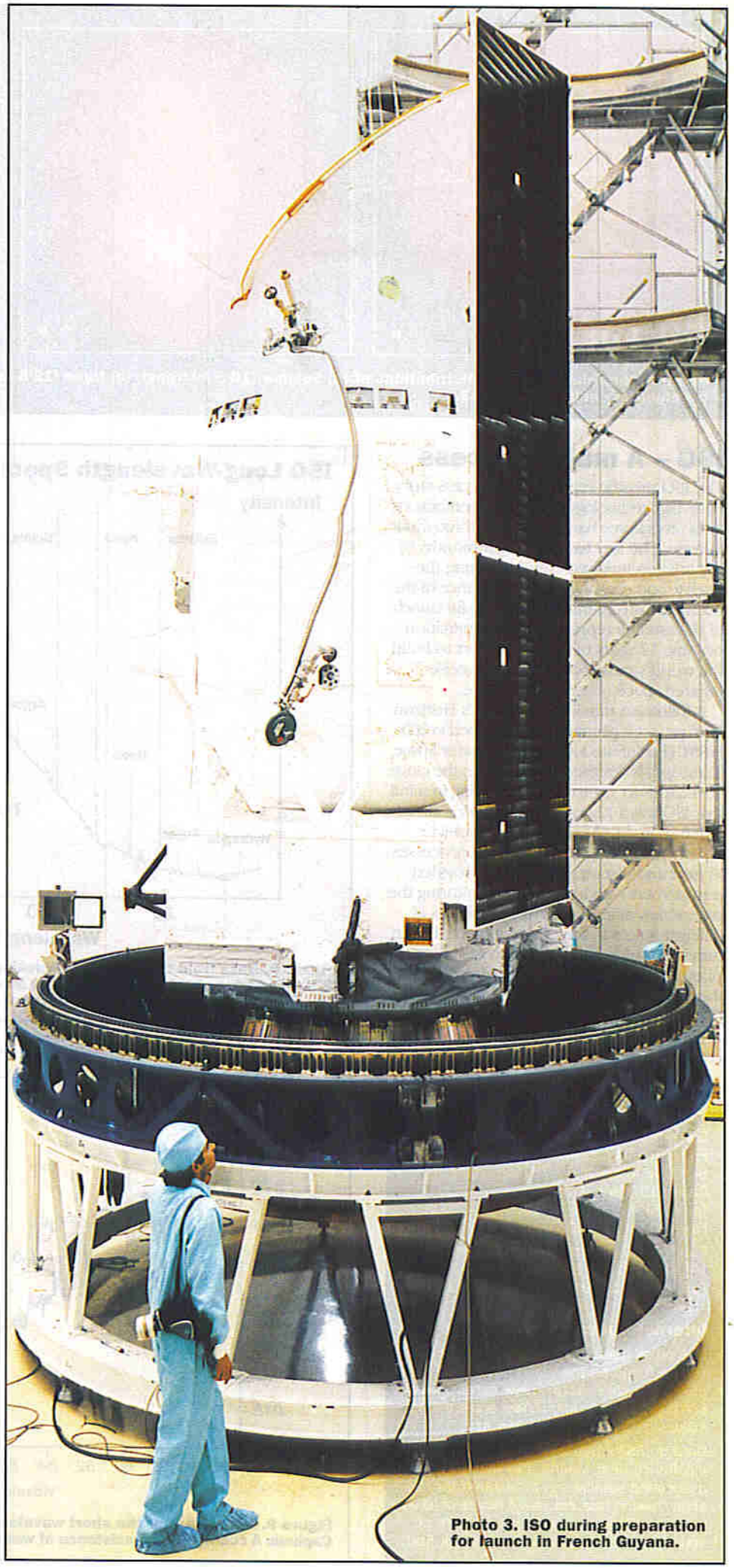

Photo 3. ISO during preparation for launch in French Guyana.

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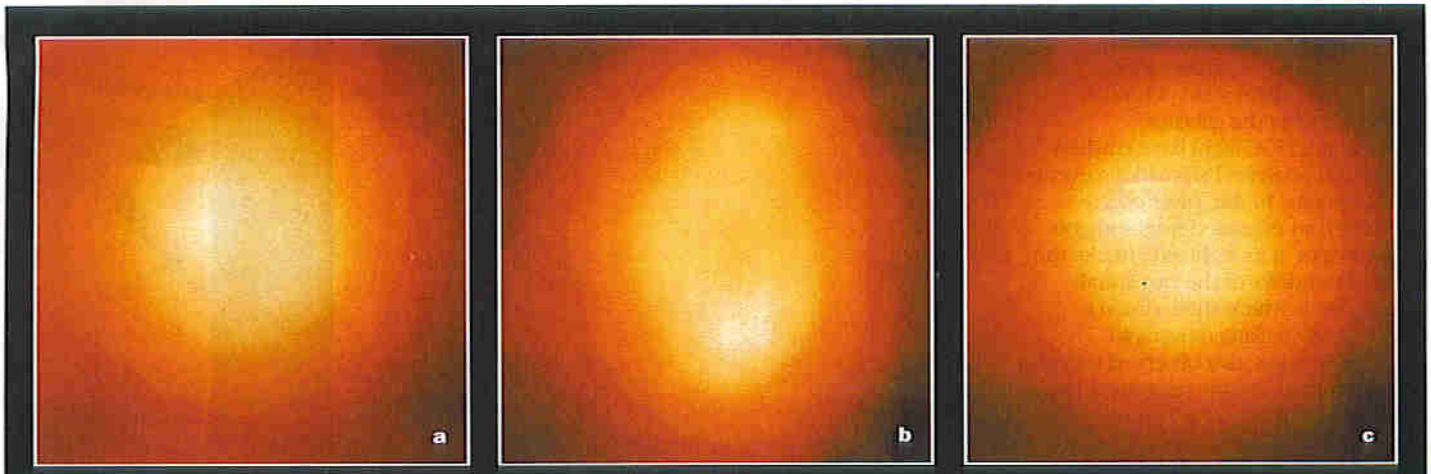


ESA/CEA SACLAY AND ISOCAM CONSORTIUM

Photo 6. The relative spatial distributions of (a) Sulphur (10·5 microns), (b) Neon (12·8 microns) and (c) warm dust (15 microns) for planetary nebula NGC 6543.

ISO – A major success

The ISO mission represents a success story for its high technology industries. Contributions to its programme have come from throughout Europe. The first two and a half months of the mission involved commissioning the satellite and verifying the performance of the scientific instruments. The successful launch of the satellite represents the culmination of some 12 years of intensive effort to build the world's most powerful and precise infrared space observatory to date.

A follow-on mission under ESA's Horizon 2000 project is planned to be launched in 2006. FIRST (Far Infrared and Submillimeter Space Telescope) is designed to function in the range 70 microns to 1,000 microns. Bearing in mind that ISO was a 12 year project, work is already in hand on developing this new vehicle.

The monitoring of star making processes in near and distant galaxies has provided astronomers with a means of monitoring the rate of new star production in galaxies at different stages in their development. This in turn will provide new insight into the processes of evolution within the Milky Way and how the conditions for life came into being within the solar system. ISO could therefore reveal an entirely new understanding of the potential conditions for 'Life in the Universe'.

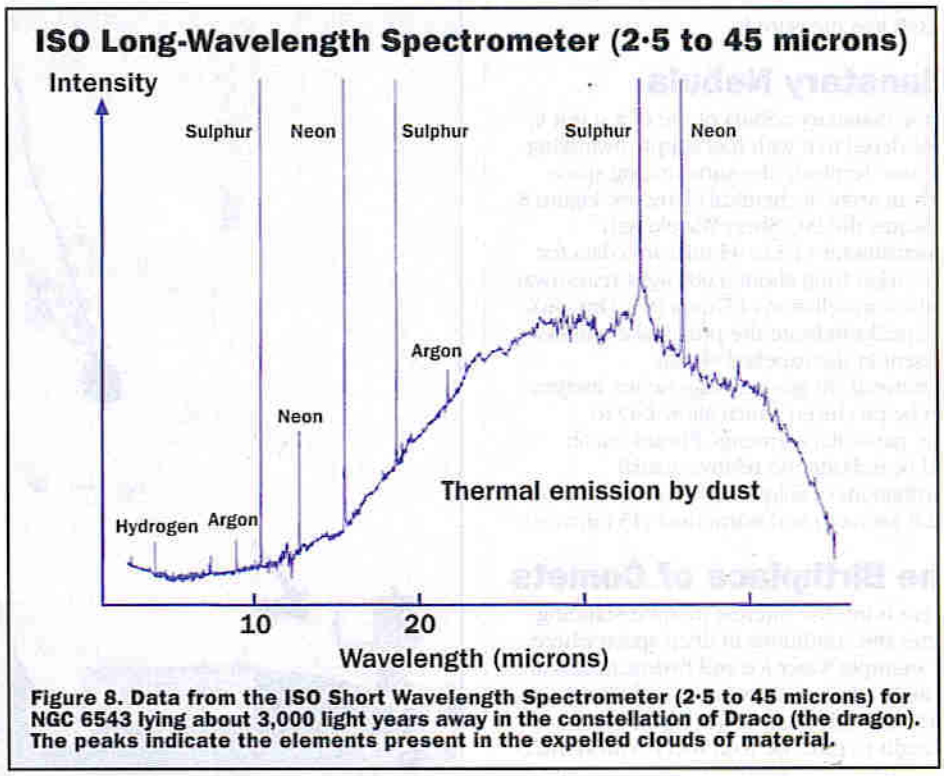
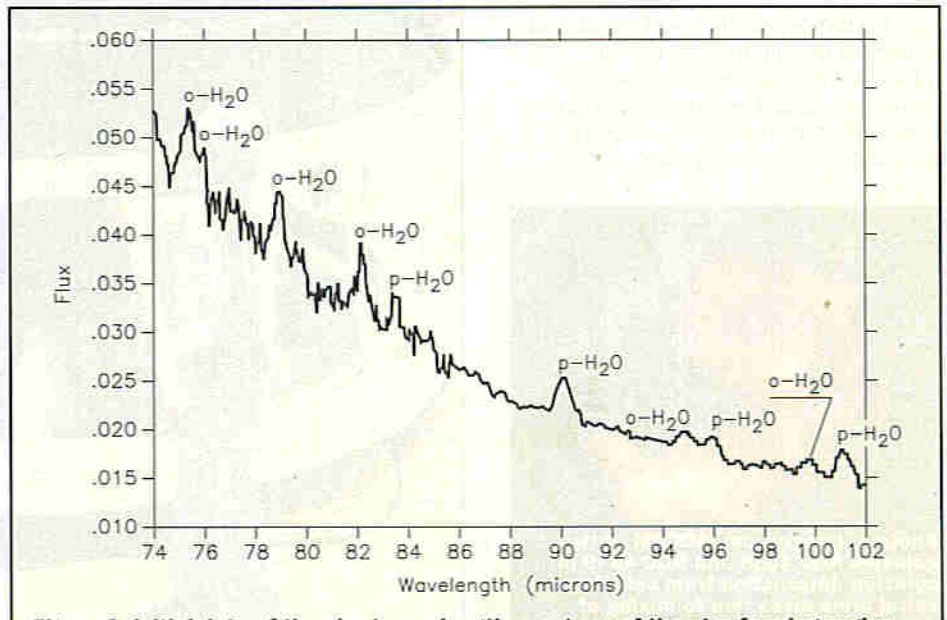


Figure 8. Data from the ISO Short Wavelength Spectrometer (2·5 to 45 microns) for NGC 6543 lying about 3,000 light years away in the constellation of Draco (the dragon). The peaks indicate the elements present in the expelled clouds of material.



ESA/SWS Consortium

Figure 9. Initial data of the short wavelength spectrum of the star forming region Capheus A confirming the existence of wata ice, silicates and simple carbon compounds.

Points of Contact

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Internet Sources

ESA press releases and other information can be found on the World Wide Web.
ESA home page: `http://www.estec.esa.nl`
ESA press releases: `http://www.ersin.esa.it/htdocs.tidc/Press/press95b.html`

Data on ESA's Satellite tracking station at Villafranca near Madrid (ISO station) and associated satellites is available from: `http://www.vilspa.esa.es-`. A picture of S106 taken by IRAS is available as a gif file at: `http://ast.star.rl.ac.uk/isouk/isouk.html`.

MAPLIN
The World of ELECTRONICS AND BEYOND

By Sandy Black, Managing Director, Maplin Electronics Group PLC

As one of the UK's leading retailers and distributors of components, accessories and equipment, Maplin Electronics brings you the "World of Electronics and Beyond".

Experience

The company was founded in 1972, at a time when there were numerous other companies in the market offering electronic components and equipment to the general public. However, most stocked government or industrial surplus items which, while cheap, were inconsistent in both quality and availability.

Maplin offered a different service – brand new and high quality components for the home, the hobbyist and small industrial user, available from stock. Today, it still has that same customer base, plus major clients including many of the UK's best-known companies and institutions, such as British Telecom and the Ministry of Defence, who have appreciated the high service levels and product ranges offered.

In addition to the leisure enthusiast and business user, Maplin supplies many schools, colleges, universities and industrial educational establishments. It also sells to over 50 other countries, either directly or through appointed distributors.

In December 1994, Maplin was acquired by Saltire Plc, which is listed on the London Stock Exchange. Saltire has a number of other electronics distribution companies in the UK and Continental Europe, and has been able to identify areas where benefits can be gained by sharing resources and best practice. Plans are in hand to open more Maplin Catalogue stores and Mondo superstores in major urban areas.

Product Ranges

At the heart of the business is the Maplin MPS Professional catalogue, which includes details of more than 17,000 products lines, as well as technical advice and tips. The broad range of national and exclusive brand products covers:

- Specialist components, test and measurement equipment
- Cables, tools and electromechanical products
- Sound and vision products
- Hobbies, kits and education products
- Computer accessories and networking products
- General electrical and security products

Sourcing, Buying and Packaging

The company has extensive operations in the Far East, with its own buying offices in Taiwan (Maplin Taiwan), Hong Kong and China (Nikkai Hong Kong), where staff are involved in the sourcing, buying, quality control and shipping of products, and a packaging operation in the Philippines, called Cubipaq.

Maplin's nationwide distribution centre at Wombwell, West Yorkshire.

Maplin Catalogue Stores

Maplin has a chain of Maplin catalogue stores and Maplin Mondo catalogue superstores in large towns throughout the UK and managed from the National Distribution Centre near Barnsley. The stores stock the vast majority of products listed in the Maplin MPS Professional catalogue and offer a unique home or business delivery services.

Through this network of stores, Maplin is able to provide high quality technical advice on a local basis. Stores also incorporate Maplin MPS Trade Centres, offering specialist services to our corporate account customers.

Maplin MPS Professional Mail Order

Maplin operates a thriving mail order business, trading on its strengths of quality products and same-day despatch service. At one end of the spectrum, this is a high service level, broadband electronics distributor competing with some of the world's leading distribution companies. At the other end of the spectrum, most of the UK's electronics enthusiasts have appreciated the convenience and value of dealing with a company which is able to cater for their needs as well as the more specialist needs of larger corporate customers.

Details of more than 300,000 recent Maplin MPS mail order customers are held on a direct marketing database at Hadleigh, and from time to time, they receive mailings containing details of new and innovative items in the Maplin range. This most valuable database forms the heart of the direct marketing communications programmes. From this data, it has also been possible to identify areas in the UK where new Maplin stores could be located.

Maplin's catalogue operations underwent considerable changes in 1996 as part of a series of moves aimed at preparing the company for the 21st century. The long-established distinctions between types of technically qualified customer were set aside

Inside the Mondo Superstore at Leeds.

The Maplin telesales team.

and for the first time, all Maplin's customers were given access to its entire product range through the Maplin MPS Professional Catalogue.

Previously, industrial and institutional customers had received a twice-yearly catalogue published by Maplin Professional Supplies (MPS, a separate marketing arm of the company, while hobbyists and other customers had received their own Maplin technical catalogue, published every September.

From September 1996, a single full-colour catalogue, containing complete information of all the company's product lines, was made available to all. Over 230,000 copies of the catalogue are printed, making it the

Maplin Technical Enquiries department based at Hadleigh, Essex.

most widely available in the UK. Updated twice a year, a large proportion of the catalogues are sold in the high street through the WH Smith and John Menzies retail chains.

Maplin Discoveries – Consumer Home Shopping

In recent years, Maplin has been successful in bringing specially developed consumer items to the retail market. Advertising campaigns in the national press have also raised public awareness of Maplin's stores and the company's name.

One result of this is that a nationally distributed direct home shopping catalogue, Maplin Discoveries, has been launched, bringing new and technically advanced products to the general consumer market. Mass circulation of these catalogues ensures maximum exposure not only of this offer, but for other Maplin services and stores.

Ordering, Distribution and Systems

The 20,000ft.2 Maplin House at Hadleigh, Essex, not only serves as Maplin's administrative headquarters, but is also the heart of the company's mail order operations. Telephone and mail orders are processed using sophisticated computer facilities developed within Maplin. As a result, the company can offer its customers a fast and efficient service with guaranteed same-day despatch for orders placed within business hours.

Order details received at Hadleigh are transmitted immediately – in data form via a private kilostream link – to the 90,000ft.² National Distribution Centre at Wombwell, near Barnsley, South Yorkshire, where they are printed and prepared for despatch. The main computer system also handles supplies to stores, stock control and purchase ordering.

Buying programs supply data for the buyers and stores staff, and buyers have a desktop system for comprehensive data interrogation. A complete EPOS system operates within the stores and stock replenishment orders are automatically transmitted to the National Distribution Centre.

Technical Support and After-sales Service

Maplin employs some 500 full-time staff and a significant number of part-time staff, providing customer service of the highest quality. In 1991, it was awarded ISO 9002 distributor accreditation, which not only guarantees quality and reliability, but has opened the way to being able to supply major companies and government departments in the UK and throughout Europe.

A free technical help line service is available to all customers, and more personal technical advice can be provided in each of the catalogue stores nationwide. All products are fully tested and evaluated by Maplin's own test laboratories for compliance with all the latest European safety and other regulations before being accepted into the Maplin catalogues.

If any product should fail to satisfy the customer's expectations, Maplin offers a 'no quibble' seven-day money back guarantee, together with a one-year repair or refund service in the unlikely event that any product is faulty.

Maplin Publications

Electronics and Beyond, which celebrated its 100th issue in 1996, is the UK's best-selling specialist monthly electronics publication. The magazine has been redesigned and relaunched in 1996, and keeps readers in touch with the latest developments in electronicsand the newest products in the Maplin range.

Complete kits of parts and equipment are made available so that readers can buy components knowing that all the parts are exactly as required for the design. These kits are also used by schools and colleges for practical experience in their electronics courses.

The magazine is just one element of a range of Maplin publications which also includes specialist electronics handbooks and guides available though the Maplin MPS Professional Catalogue direct or in store.

Maplin International

As well as expending its UK operations, Maplin, in collaboration with sister companies in the Saltire group, is making inroads into other European markets. It has opened the first of a series of Mondo stores in Romania, and plans to bring the "World of Electronics and Beyond" to customers on the Continent by developing more stores and catalogue businesses.

FREE BOOK GIVE-AWAY

Eraser, a new blockbuster action-thriller from Warner Bros. staring Arnold Schwarzenegger, James Caan, James Coburn and Vanessa Williams is on nationwide release in the UK from 23rd August. Signet publish the novel by Robert Tine, based on the screenplay by Tony Puryear and Walon Green on 29th August and Electronics and Beyond have fifteen copies to give-away.

Erase against time

His name is John Kruger. His nickname is Eraser. If you are a threatened government witness, he erases your old identity and gives you a new one. If you try and get your hands on one of those witnesses, he will make you vanish in a different way.

But now he is protecting the wrong witness from the wrong people, and both he and the beautiful woman in his hands are to be eradicated. But Eraser is not about to disappear – not when he has so little time to stop the ultimate act of terror and so much rubbing-out to do.

Eraser is published on 29th August 1996, priced at £5.99. Available from all good book retailers or from Penguin Direct, Tel: (0181) 899 4036 (£1.50 will be charged for postage and packing and this service is only available in the UK).

Please note that employees of Maplin Electronics, associated companies and family members are not eligible to enter. In addition, multiple entries will be disqualified. The prizes will be awarded to the first fifteen entries drawn.

ERASER BOOK DRAW

Fifteen lucky Electronics and Beyond *readers need not pay a penny for a copy of* Eraser. *The first fifteen readers whose names are drawn from the Editor's hat(!) on 23rd September will have a copy delivered to their home.*

Name _____

Address _____

_____

_____

_____ *Postcode*

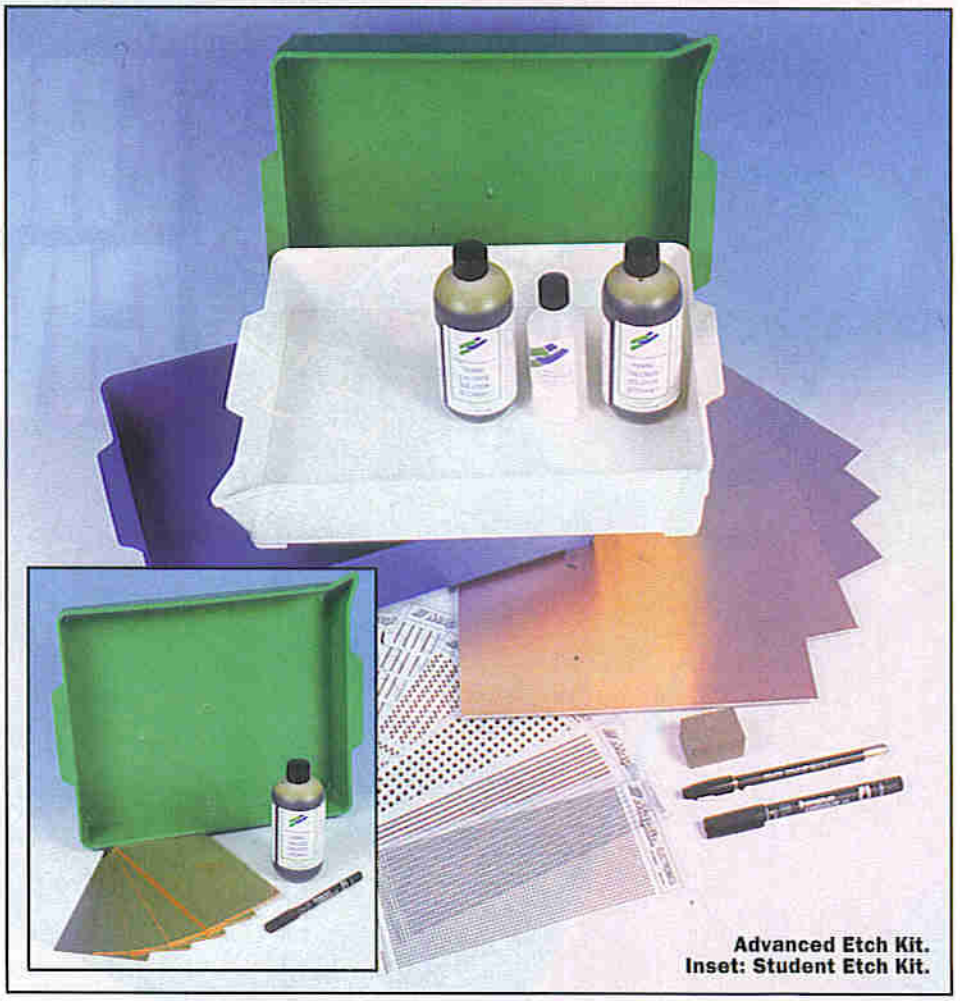
Daytime Telephone Number _____

No purchase necessary. Entries on a postcard, back of a sealed-down envelope or photocopies will be accepted.

ELECTRONICS and Beyond

Send your entry to Eraser Free Book Draw,
The Editor, *Electronics and Beyond*, P.O. Box 3, Rayleigh, Essex SS6 8LR.

Two kits are now available from Maplin which enable simple, basic PCB designs to be created quickly and efficiently.



Advanced Etch Kit. Inset: Student Etch Kit.

PCB ETCHING KITS

Review by P. Woollcott

The two kits, Order Codes GT07H and GT08J, provide the basic ingredients to allow a simple PCB to be created by anyone from a beginner, student, serious amateur or professional, wishing to test out a PCB design both quickly and effectively.

The GT07H is the simpler of the two kits, containing only four main parts, which allow the constructor to create boards in basically a 'freehand' style.

The GT08J kit contains more parts, including a 'drafting transfer' pack, allows the constructor to create a more professional-looking PCB design layout. In essence, both kits take a single-sided PCB and allow a design to be drawn/laid out onto the surface of the copper clad board. PCB chemical development tray(s) are provided for the copper etchant, into which the board can be placed for the etching process.

Of the two kits supplied that we investigated, the GT07H contains five single-sided SRBP boards, 200 × 100mm (8 × 4in.), one pen, one bottle of copper etchant and one PCB chemical development tray. The GT08H contains 250 × 150mm (10 × 6in.) single-sided boards, two pens, two bottles of etchant, one etch resist remover, one polishing block, one transfer kit and a complete etchant tray set.

General Comments

Starting with the GT07H – the constructor must ensure the copper surface is thoroughly clean. This can be done by a standard household scourer and a liquid cleaner. Thoroughly clean the copper surface and rinse clean. Cleanliness of the surface can be tested by rinsing the board, then holding it horizontally and observing how any residual water forms into clear droplets on the copper surface.

Shake off all water and allow to dry thoroughly – placing the board into a cardboard box and playing a hairdryer over the surface will aid this process.

The boards are quite large (200 × 100mm) for freehand work and so, if required, can be cut to smaller sizes which will also cut down on waste caused by possible initial design mistakes.

The design, of course, is up to the constructor; it may be a copy of a design from a magazine or text book or from another PCB.

Any freehand design will be improved by first setting out accurately within the space available where everything is to go before committing to using the PCB Pen. Mistakes will only mean starting again and recleaning the board. Use of drawing equipment, such as a rule, set square and/or protractor will help to create a more reasonable looking design.

The Fine PCB Pen will allow quite close track work to be achieved and this is, of course, where drawing equipment is essential.

Once the design has been put down and the ink is dry, the board can be etched.

The Ferric Chloride Etchant is supplied in a bottle with a child resistant cap, so if all the material is not used at once, please ensure the cap is replaced correctly, especially if this work is being carried out at home and young children may be present.

Pour the Ferric Chloride into the tray provided and place the board into the liquid.

Important Safety Warning

Ferric Chloride is corrosive and should be handled with great care. Please use either rubber or plastic gloves when handling this material and try to avoid splashes and spillage. Ferric Chloride will mark more or less permanently and corrode most materials, (especially clothing and upholstery). ALWAYS wear eye protectors when using the liquid. If in any doubt, please ask for and consult the Data Sheet for this material and the Health and Safety Data Information.

Etching

Etching time will depend on the temperature of the Etchant, (approximately 20 to 24°C), the amount of copper to be removed and the age of the etchant (if it has been used before). The etchant can either be used direct from the bottle or for a slower, more controlled etching, diluted with up to 250ml of fresh water.

The PCB Chemical Development Tray should then be gently rocked to allow the etchant to wash over the board, allowing an even etching process to take place. The design of the layout should start to become clear after a few minutes and rubbing a gloved finger over the board will aid visual inspection to ensure a clear design is being created. This will also ensure that the etching process is halted at the correct time and that the process has not gone on too long, whereby undercutting of the copper under the design layout may have begun to take place.

When it is decided that the design is complete, remove the board from the etchant and allow excess etchant to drain off. A good tip here is to wipe the trailing edge with a paper towel and hold it there to catch and stop further drips whilst the board is removed to the sink for thorough rinsing. Rinse the board clean of all Etchant and immediately wipe up any splashes.

Note. In very small quantities, such as in this case, cleaning a PCB into the domestic drainage system will not cause an environmental health problem. However, larger amounts must be disposed off more carefully – please see the end of this article for safe disposal methods.

Etch Resist Removal

The Etch Resist Marker Ink now obscuring the copper track can either be removed by using the Etch Resist Remover (available separately or in the GT08J kit) or again, by gently scouring with a cloth and liquid soap. Rinse and dry thoroughly when cleaning is complete.

The PCB design is now complete and ready for the constructors' next procedures.

GT08J

The GT08J kit, in being the next step up from the GT07H, allows the constructor to design a more professional-looking PCB by the use of two types of Marker Pen, one fine and one medium fine, plus a comprehensive Drafting Transfer kit, which provides for a large array of drafting aids, shapes and symbols.

Preparation

Again, the PCB must be thoroughly clean and in this kit, a Polishing Block has been provided to allow the surface to be cleaned if water washing is not desirable or available. It is advised that for the placing of Etch Resist Drafting Aids, water and liquid soap cleaning of the boards is not recommended, however, if this has been done, then thorough drying of the boards must be carried out before transfers are used.

The Polishing Block will thoroughly clean and degrease across the whole surface, but the board will need to be brushed or gently blown clean of the small debris left behind from the block.

Design

The initial design work will have been carried out on either paper or on a computer before transferring to the board. If possible, the original design may be copied onto either tracing paper or an acetate sheet to act as a guide when placing the transfers and line detail onto the board. (Alternatively, the use of photoresists and your own original film artwork are an excellent step up, but this is another topic for discussion later – watch this space).

Etching

Once the design has been created, then the etching process can proceed and here, because of the larger boards involved, two bottles of Copper Etchant are made available and a full PCB Development Tray pack is provided. In the GT08J kit, you will receive the PCB Development Tray Pack, which includes three trays in different colours (blue, green and white). To help avoid using the same tray for different chemicals, it was decided to colour code the trays.

If graduating from the GT07H kit, where the Green Tray has been used for the Ferric Chloride Etchant, it makes sense to stick with this colour coding, to avoid any possible confusion.

Again, as with the GT07H, care must be taken with etching and the same guidelines for successful etching still apply.

Etch Resist Remover

When the board is rinsed clean and dried, the remaining Etch Resist Marker lines can be removed by the use of the supplied Etch Resist Remover. Removal can be achieved by either putting a little into one of the spare trays (blue or white) and using a cotton bud dipped into the solution and rubbing the bud over the track to remove the ink. Alternatively, shake a little from the bottle on to a cloth or swab and rub the tracks clean.

Further cleaning of the tracks, edge connections or solder pads, can be achieved by use of the Polishing Block.

Disposal of Etchant

The safe removal of the used or, in time, spent Ferric Chloride is most important, both environmentally and for good health and safety practices.

The PCB Development Trays have a pouring spout, which if the Ferric Chloride is to be used again, will allow the material to be carefully poured back into the bottle. (Please use a spare tray to rest the bottle in prior to pouring it back in.)

If, however, it is concluded that the Ferric Chloride is now spent, i.e. etching took a long time or did not occur at all, then safe disposal of this material must be carefully considered. The most obvious method is to flush the spent material down the drain with copious amounts of water. This method is neither environmentally acceptable or safe. A plastic bag or box of earth, sawdust or even Fullers Earth can be used to absorb the waste material prior to its disposal in a landfill site, but again, this is not entirely satisfactory, both environmentally and for personal safety reasons, as the etchant has still not been fully neutralized.

For complete safe disposal, one which is environmentally safe as well as personally safe, we recommend Etchant Neutralizer. A 250ml/210gm bottle is sufficient to safelyneutralize 250ml of Ferric Chloride in the tray where it has been used. Full disposal details, data and Health and Safety are now available – please check with the Maplin Technical Helpline, Tel: (01702) 556001.

Final Comments

As a means of securing a fairly fast and immediate design for PCB work, these two kits give the constructor access to identify the success or otherwise of that design.

As a tool for instruction purposes to clearly show how PCBs can be made for both the student and/or professional, these kits are ideal. They both provide excellent results where experimental or prototype PCBs and/ or where very small quantities are required.

Not withstanding the design limitations of the tracks to be etched, how well the final board turns out will be down to the ability and expertise of the constructor and if instructions are followed from the simple kits, a great deal of satisfaction can be achieved.

STUDENT ETCH KIT

PCB Etch Resist Marker Pen	1	(HX02C)
Ferric Chloride Etching Fluid 250ml	1	(WF10L)
Single-sided SRBP Board 203 x 102mm	5	(HX00A)
Green Etch Tray	1	(CH39N)

The above items are available as a kit, which offers a saving over buying the parts separately.

Order As GT07H (Student Etch Kit)
Price £12.99

ADVANCED ETCH KIT

Dalo Etch Resist Marker Pen	1	(FP40T)
PCB Etch Resist Marker Pen	1	(HX02C)
Transfer Kit	1	(HX44X)
Single-sided SRBP Board 254 x 152mm	5	(WF38R)
Ferric Chloride Etching Fluid 250ml	2	(WF10L)
Etch Resist Remover 100ml	1	(HX03D)
Polishing Block	1	(HX04E)
White Etch Tray	1	(CH38R)
Green Etch Tray	1	(CH39N)
Blue Etch Tray	1	(CH40T)

The above items are available as a kit, which offers a saving over buying the parts separately.

Order As GT08J (Advanced Etch Kit)
Price £44.99

Alloyed Alchemy

A CENTURY OF MAGNETIC MATERIALS

by Greg Grant

A century has passed since the Swiss-French physicist, Charles Guillaume, developed the alloy Invar. This was the beginning of an industry that has changed our world immeasurably, giving us much improved communications, entertainment and, most recently, medical imaging techniques.

Magnets and magnetism literally make much of our world possible, yet few technical subjects have been so much retarded by their history. First studied by Thales of Miletus around 585 B.C., magnetite or lodestone as it was more commonly known, would remain the only magnetic substance until the coming of iron, the first of the ferromagnetic materials. Iron, in its turn, would become the only soft ferromagnetic substance in general use until the latter part of the 19th century, when tungsten steel was produced in Germany.

Another material under investigation at this time was iron powder. Charles Fritts and Oliver Heaviside independently investigated this substance as a basis for low-loss inductor cores. Fritts looked into their possible application in motors and dynamos whilst Heaviside, using cores fashioned from iron filings bound with wax, attempted to improve the performance of telephone coils. This was the beginning of what would later grow into the ferrite and micropowder industry of today.

In 1890, the Scottish engineer, James Ewing, Professor of Applied Mechanics at Cambridge, discovered the phenomenon of Hysteresis, from the Greek word Husterikos, meaning 'coming late', where the magnetic induction of a material lags the changing magnetic field. The curve, long familiar to all electrical, electronic and communications engineers and shown in Figure 1, showed that the phenomenon might be explained by means of the interaction between (permanent) magnets.

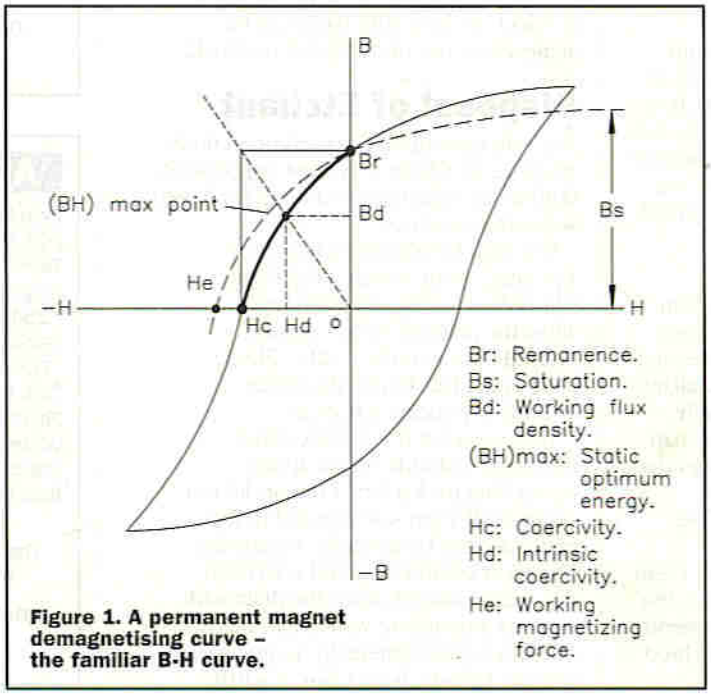


Figure 1. A permanent magnet demagnetising curve – the familiar B-H curve.

Six years later, the Swiss-French physicist, Charles Guillaume, developed the alloy Invar, the result of an exhaustive study of ferronickel alloys. The new material was so named because of the invariability of its dimensions when heated.

Composed of iron, 36% nickel and 0·2% carbon, Invar is frequently used for the bi-metallic strips in thermostats, the metal-to-glass seals in lamps, in the balance springs of watches and in the Housekeeper seals of the few electronic valves still manufactured. Guillaume followed Invar with Elinvar, another name with a purpose, this time to emphasise the new alloy's low coefficient of elasticity. A meld of nickel, chromium and steel, this elastically invariable material is widely used in scientific instruments.

Thanks to Guillaume's pioneering efforts, the past century has seen enormous strides in the development of metallic alloys with extraordinary magnetic properties. As Figure 2 shows, from the turn of the present century onwards, magnetism generally and magnetic materials particularly, have advanced as rapidly as the two main 20th century developments, aircraft and electronics.

As the century opened, Ewing published a paper in which he suggested that all ferromagnetic atoms and molecules could be regarded as tiny basic magnets, able to rotate on their own axes in an applied magnetic field. He also developed a magnetometer for measuring the properties of ferromagnetic metals as well as the Ewing Curve Tracer and the Ewing Permeability Bridge. In the latter, the flux of an iron sample is balanced against that of a standard bar magnet of similar dimensions. The magnetising force of the test bar is varied until it balances that of the known bar, the permeability being estimated from the value of the force.

By 1902, the British metallurgist, Robert Hadfield, the inventor of manganese steel, had noted

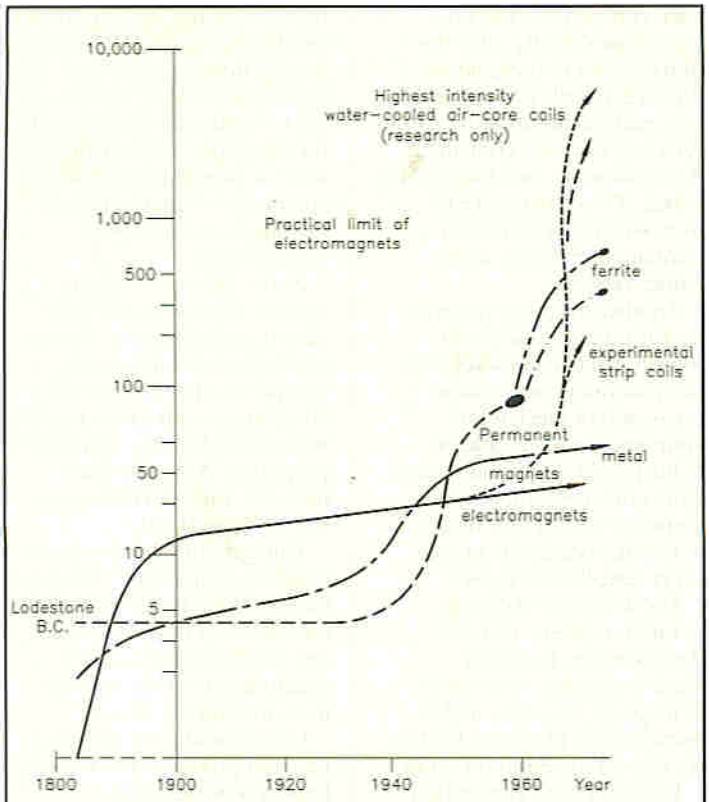


Figure 2. Magnetic material developments in the first sixty years of the present century.

the excellent performance of the silicon steels, which gave a threefold reduction in eddy current and hysteresis losses compared with soft iron sheet. In fact, it was because of such properties that Hadfield, among others, developed these alloys further.

In the following year, the first permanent magnet made without ferromagnetic material appeared, produced by the German chemist and mining engineer, Fritz Heusler. Composed of 10-30% manganese and 9-15% aluminium, the remainder being copper, it was a most effective material.

Later, Heusler replaced the copper with 86% silver to create Silmanal, which, not surprisingly, was expensive. Nevertheless, it was an excellent material, having a far higher coercivity than any other magnet then available. The copper could equally well be replaced by antimony, boron, bismuth or arsenic.

In 1907, magnetic theory took a considerable step forward, with the development of the Domain Theory of ferromagnetism by the French physicist, Pierre Weiss. In it, he explained how metals such as iron form tiny domains of a given polarity and, when these domain poles are aligned, they produce a strong magnetic force.

Nine years later, Permalloy, nickel combined with iron, was discovered at the Bell Laboratories in the United States, and the Japanese physicist, Kotaro Honda, added cobalt to tungsten steel to produce a magnet of considerable strength.

Hearing is Believing

In 1919, the German electronic physicist, Georg Barkhausen, developed a method of actually demonstrating domain movement. He placed a microphone close to a sample of iron undergoing magnetisation.

By slowly and smoothly increasing the magnetising field, Barkhausen found that magnetisation took place in VERY small steps. And you could HEAR those steps, for his microphone fed an amplifier-loudspeaker system which produced a steady series of clicks, the result of the domain nature of the material.

Here, in what came to be known as the Barkhausen Effect, was the first tentative proof that Pierre Weiss had been correct in his analysis of magnetism's nature.

The increasing demand for long distance telephone services had resulted in the discovery that the main factor limiting longer circuits was line capacitance. Telecommunications engineers realised that the problem could be considerably reduced by placing inductors, termed loading coils, at regular intervals along the lines.

The first practical application of the loading coil took place in 1902, when they were inserted in a ten-mile length of telephone cable between New York and Newark, New Jersey. Subsequent trials convincethe American Telephone and Telegraph Company (AT&T) to extend their use, and in 1912, the 235-mile long New York-Washington line was equipped with loading coils.

The British Post Office (BPO) too, were keen on loading coils and in 1915, looped backwards and forwards, the 110-mile circuits on the London-Birmingham cable, producing equivalent lengths of 220, 440, 660 and 880 miles. By the insertion of inductance coils at 2·5 miles spacing, commercial conversation was obtained up to 600 miles.

Loading coils had to meet stringent specifications such as negligible leakage flux to avoid crosstalk, no hysteresis or eddy current losses and have a permeability of between 10 and 100. The early ones were air-cored but it soon became apparent that new materials would be required to meet the increasingly stringent requirements. This led to the development of magnetic powders. Another spur to better electronic materials was the increasing improvements in valve amplifier and filter design at this time.

In 1926, the first commercial Permalloy was produced, containing 21·5% iron and 78·5% nickel. Once again, it was developed at the Bell Telephone Laboratories by a team led by the Swedish-American metallurgist and electrical engineer, Gustav Elmen, who discovered that almost all alloys of iron with cobalt or nickel were strongly ferromagnetic compared to other substances.

The alloys Elmen helped to develop had very high permeabilities in weak fields and were much used in undersea cable loading coils, where the technique was to use permalloy ribbon wound around the core of the cable which neutralised much of the lime's inherent capacitance.

Consequently, signalling speeds rose to around 400 words per minute and for some years thereafter, all submarine cables were of this type of construction. Later, under such tradenames as Mumetal, Superalloy and Permalloy C, this composite was used in Interstage and Pulse transformers. Later still, they would be exploited further in powder form.

Elmen himself devoted the rest of his career to magnetism. He left the Bell Laboratories in 1941 to set up the Magnetism Unit of the Naval Ordnance Laboratory in Washington DC. He remained the Unit's director until a year before his death.

New Materials and Techniques

1930 to 1939 was the decade of major investigation into the magnetic properties of materials generally.

In ferromagnetic substances, which is the name given to the property of greatly increasing the magnetic flux when a magnetising force is applied, the way the atoms bond to form the solid means that the neighbouring atom's dipoles line up in the same direction, as in Figure 3.

This is what characterises the ferromagnetic materials such as nickel, iron and cobalt from the diamagnetic and paramagnetic substances such as mercury and copper, platinum and aluminium.

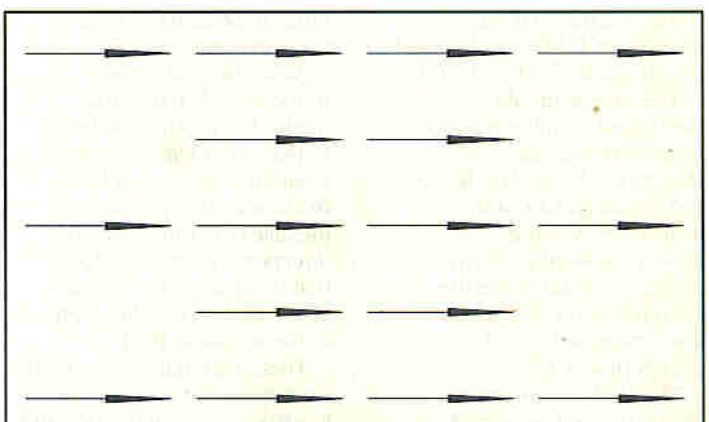


Figure 3. The dipole arrangements in ferromagnetic.

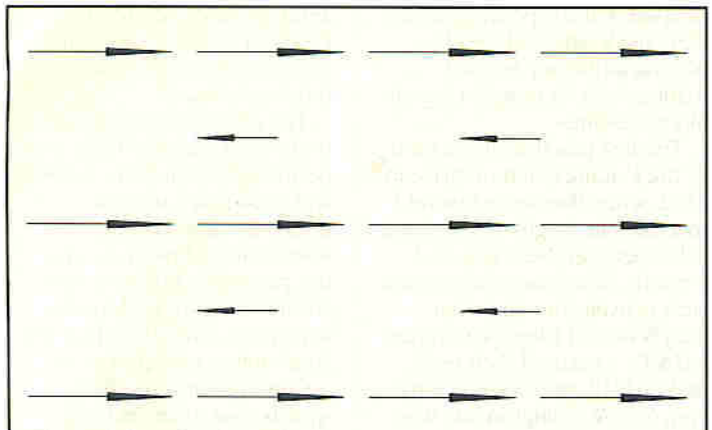


Figure 4. The dipole arrangements in ferrimagnetics.

Ferrimagnetics, or ferrites as they are more commonly known, are different again, as shown in Figure 4. Although arranged in the same manner as antiferromagnetic substances, their dipoles are not the same size and so do not cancel each other out. They are, in short, ceramics, and so their bonds are ionic, resulting from the electric forces of attraction between positive and negative ions.

In 1932, the French physicist, Louis Neel, demonstrated that there was a fourth type of magnetism, which he termed antiferromagnetism.

In such substances, two interlaced atomic lattices have magnetic fields acting in opposite directions, as shown in Figure 5. Five years later, Neel succeeded to the Chair of Physics at the University of Strasbourg, formerly held by Pierre Weiss, where he continued the latter's research into magnetic materials.

One early success of the period was Kato's Oxide, a mixture of iron and cobalt oxides held together by an adhesive, developed by Y. Kato and T. Takei, to produce the first modern ferrite ceramic magnet.

A compound of 50% iron oxide and 50% cobalt iron oxide, the material was sintered at 1,000°C and cooled in a magnetic field from 300°C.

The Americans also developed a similar material some two years later, which they termed Vectolite. It used less cobalt and around 30% iron oxide, which gave a more consistent performance, delivering nearly twice the coercivity level with much lower remanence and energy product.

The British developed a plastic-bonded version of this material, which they termed Caslox.

In 1931, the American physicist, Francis Bitter, developed a technique of covering the surface of a ferromagnetic with a colloidal suspension of magnetic material. The boundaries of the domains were then revealed under the microscope. These Bitter Patterns, as they came to be known, illustrated the boundary of the magnetic domains, the particles gathering there because the magnetic field was at its strongest. The technique was subsequently used in detecting cracks and imperfections in ferromagnetic materials. Here was further proof of Weiss' Domain Theory, demonstrated by what amounted to a refined and sophisticated update of the early iron filings patterns first used by the great Faraday.

Undoubtedly, the development of the 1930s, however, was the Alnico alloys, which brought considerable improvements in permanent magnets.

Developed in the Netherlands, their major constituents were, as their name implies, aluminium, nickel and cobalt in various proportions. To these were added small quantities of one or more of such elements as copper, iron and titanium. In fact, this last group are often referred to by their trade name of Ticonal.

All of these alloys are tremendously hard, their method of production being to place them in a strong magnetic field during heat treatment. This produces a metallic structure which has directional characteristics, that is, a piece of metal will 'align' itself in the direction of the magnetic field.

These materials have a high retentivity, and are used in loudspeakers, magnetrons and other devices requiring strong permanent magnets. Indeed, such components became more cost effective after the introduction of these alloys. Alnico is usually accompanied by a number, for example, Alnico V, a version containing 8% aluminium, 14% nickel, 24% cobalt, 3% copper and 51% iron, which gives stronger permanent magnets than earlier versions.

Another magnetic material produced at this time was Remalloy, a cobalt-nickel-iron-molybdenum combination possessed of mechanical springiness and capable of being produced in thin sheets. Until quite recently, it was common throughout Britain as the diaphragm in virtually every telephone handset.

The 1940s was a decade of rapid magnetic material development. Philips of Eindhoven were very active in magnetic research, and a team of their physicists further developed the Barium ferrites.

In 1946, crystal orientation along a preferred axis was introduced, a technique which virtually trebled the magnetic strength of some alloys. Many present-day magnets are of this type still.

Two years later, Louis Neel continued his investigation into magnetic materials, this time, ferrites, of which magnetite is but one example.

Magnetite has three iron atoms and four oxygen atoms. Neel established that the effects of two of the atoms cancel, leaving the third to produce the magnetic field. He termed such materials perrimagnetic, and since they were electrically non-conducting and so impervious to stray currents, they subsequently became widely used throughout the modern industrial world.

Among their applications are permanent magnet loudspeakers and microphones, as a coating material for magnetic tape, as memory stores in computers and finally, as passive elements in high frequency, low-loss electronic devices. Neel's work led to further developments in micropowder magnets by his team at Grenoble university, in conjunction with the French manufacturing combine, Societé Ugine.

At this time, permanent magnet improvements were almost entirely due to the use of alloys of ever-increasing complexity, there being some 60 different such alloys available with a broad variety of magnetic properties. A decade later, however, this 60 had become 250 or thereabouts.

Throughout the early 1950s, magnetic materials research was largely driven by the demand for television receivers on the one hand and the exacting requirements of the defence industries on the other.

Consequently, the research that had produced the low-loss ferrites was extended, culminating in the discovery of the Ferrimagnetic Garnets in France and the United States in 1956.

By the early 1960s, barium ferrite material was commercially available and by the end of the decade, the Bell Laboratories began to look into the magnetic storage of computer data.

A team led by Andrew Bobeck investigated single-crystal substances whose magnetic domains could be reduced to the size of minute cylinders in the presence of a magnetic field. They could also be readily manipulated by magnetic techniques, and so the presence or absence of a 'bubble' could be used to represent the binary arithmetic that is the staple diet of computers.

The magnetic bubble memory enjoyed considerable success in the computer field for some years until, in the late 1970s, semiconductor memories began

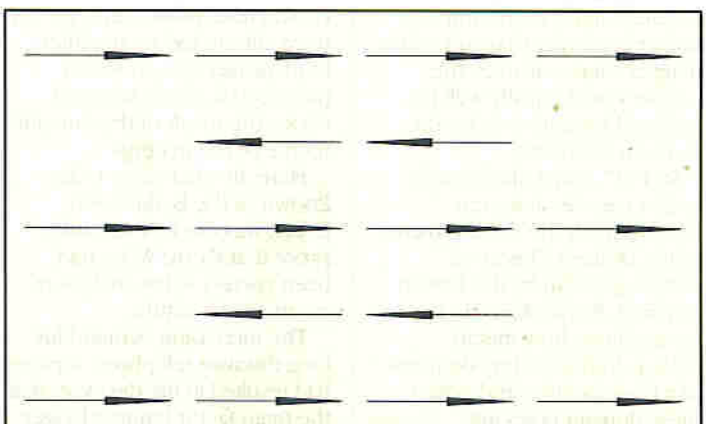


Figure 5. The dipole arrangements in antiferromagnetics.

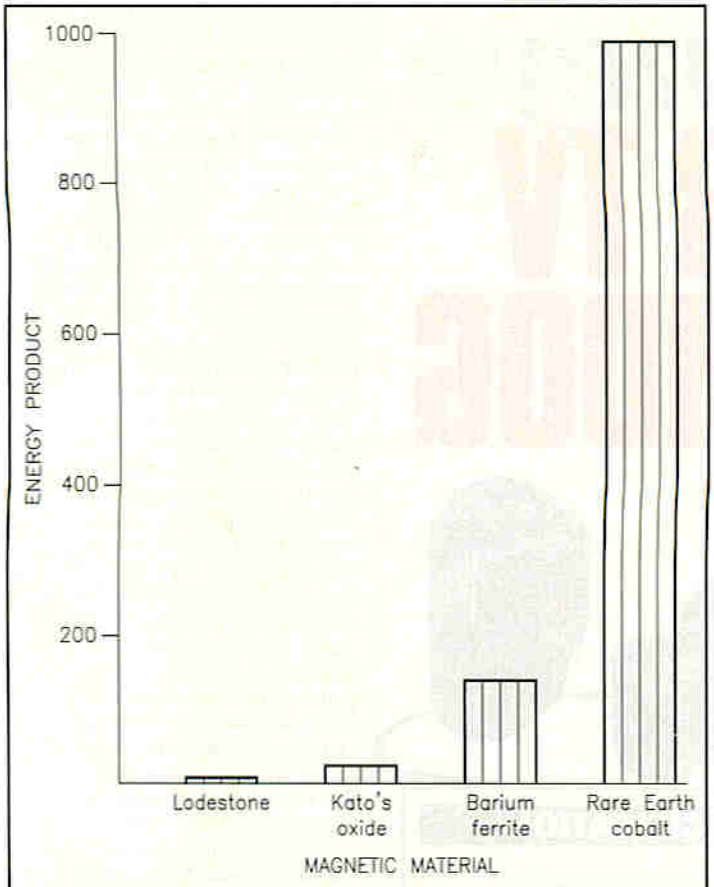


Figure 6. A comparison of Energy Product of some recent magnetic materials against that of the original magnetic material: Lodestone.

to seriously challenge their storage capacity. Today, of course, semiconductor memories have triumphed totally.

It was in the 1970s too, that the rare earth-cobalt magnets appeared, they being a very considerable improvement on almost everything that had gone before.

One way of judging the quality of a magnetic material is to compare its Energy Product against that of the original magnetic substance, Lodestone.

Devices made from Kato's Oxide, for example, gave some four times the energy product of the original base material, whilst the barium ferrites gave seven times the energy product of Kato's Oxide.

The rare earth-cobalt magnets, on the other hand, gave more than seven times the energy product of the barium ferrites or over 200 times the energy product of the original magnetic material!

The Naked Truth

One of the most important recent developments where magnetism is concerned, is Nuclear Magnetic Resonance or NMR, which was brought about by advances in two distinct fields of research, magnetic materials and particle physics.

Superconducting materials were first discovered in 1911, by the Dutch physicist, Kamerlingh Onnes. Having liquified helium, he used it in an experiment with a solid mercury wire and discovered that, at a temperature of 4·2K above absolute zero, the wire's electrical resistance disappeared.

There, broadly, matters rested for some time, since the problem with superconductivity was that it could not be satisfactorily explained theoretically. Moreover, as the few experimenters in this field discovered, stunning laboratory discoveries could not be translated into worthwhile applications in other fields either.

Particle research, on the other hand, had long been considered esoteric, not exactly the sort of field that would bring much benefit to mankind, aside from advancing his knowledge of the structure of matter.

In 1946, however, two physicists, the Swiss Felix Bloch and the American Edward Purcell, changed this perception altogether. Independently, they discovered that chemical substances can absorb some microwave frequencies when they are placed in a powerful, steady and above all, uniform, magnetic field.

Eleven years later, three American physicists, John Bardeen, Leon Cooper and John Schrieffer, put forward what came to be known as the 'BCS' theory to explain the phenomenon of superconductivity. This assumed the existence of coupled electrons, termed Cooper Pairs, which do not undergo scattering through collision with atoms in the conductor.

The way was now open to create magnets composed of superconducting materials, cooled by liquid helium, which could generate the sort of fields Bloch and Purcell had spoken of in their research.

Therefore, if a scanner could be built producing the required field, NMR could become a useful diagnostic tool, as microwaves are much less energetic then X-rays. They are, therefore, excellent at detecting light atoms, which are plentiful in the human body.

Figure 7 illustrates such a scanner. The patient lies within the field generated by the superconducting magnets and the particular point the clinician wishes to study is selected by varying the magnetic field strength in three dimensions, utilising coils above, below and along the axis of the magnet.

The RF, i.e. microwave, field makes the hydrogen atoms spin, which reveals the hydrogen distribution throughout the body, thus displaying different body tissues in a manner less hazardous than X-rays.

Magnetic Resonance Imaging, as the technique is known, will grow apace, not least, because of continually emerging evidence of the damaging nature of X-rays. A recent study in the United States, for example, points to X-rays being the major cause of breast cancer in women up to the mid-1970s, largely because the radiation doses were frequently 50 to 100 times those used presently.

The present century opened with new magnetic materials heralding enormous future developments. Currently, other new materials, the superconductors, are hinting at what the future may bring. The century ahead, therefore, may well prove to be even more magnetic than the present one has been.

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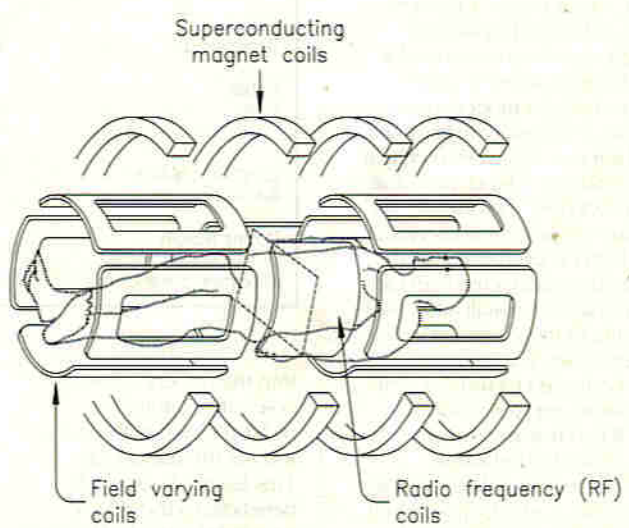


Figure 7. The Nuclear Magnetic Resonance (NMR) scanner, with a patient undergoing a 'scan'.

Domineye
YOUR TV WATCHDOG

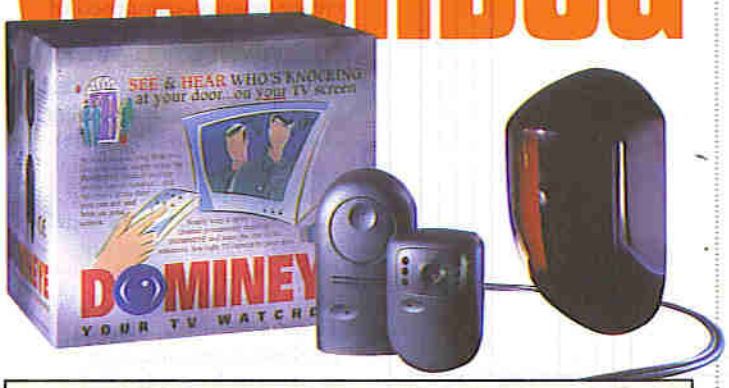
Domestic Closed Circuit Television (or CCTV) is a phrase that is being bandied about more and more. In the last few years, this sector has evolved from expensive industrial applications into affordable systems for the average householder. Increasing concerns about home security, protecting your family, or even protecting your car, for example, has driven this development.

In response to these concerns, Seelex Limited developed a product called Domineye. It is a domestic CCTV system that changes the way people live. Think about how many times you manually change TV channels once you have a remote control. Domineye gives you the same type of instant control when you want to check who is outside your front door. Simply select the Domineye channel on your own TV set and you can see and hear who is at the door. This concept is something that the average homeowner understands immediately. Once they see the Domineye in action, the habit is formed.

Finding the Right Camera – and Supplier for the Job

Much time was spent searching for just the right type of camera. This camera had to fit in with the design concept of offering the best of CCTV for the domestic user, at a reasonable price. Finally, a sub-miniature monochrome CCD video camera was found that was perfect for the job. The camera module, of course, was supplied by **Maplin**, who immediately understood what was required and the importance of quality to the product. The actual camera only occupies 4cm² of the PCB, which means it fits very discreetly into the housing which was designed around it.

The tiny camera is capable of producing a monochrome picture from both normal light and infrared light with excellent resolution and detail, just what we needed for the outside of a house, where infrared is vital at night. In order to enhance the infrared capacity, customers are encouraged to install additional lighting to monitor a driveway, for example. The lens is a universal fixed focus type with automatic aperture control. You'll find that the camera has a wide field of vision (75° horizontal and 60° vertical). Therefore, correctly positioned, it commands a wide view of the area in front of the house, including a car or caravan on the driveway.



TECHNICAL SPECIFICATION

Camera	
Type:	Low light, monochrome camera
F number:	F3·6mm
Image device:	⅓in. (8·47mm) CCD
Lens type:	Electronic shutter 1/60 to 1/10,000
Gamma correction:	0·45 approx.
Video output level:	Composite video 1V Pk-to-Pk
Vertical angle of view:	60Ω
Horizontal angle of view:	75+°
Internal adjustment:	Full 180°
Scanning system:	LIA 512H × 492V CCIR 512H × 582V
Resolution:	Horizontal 400 lines
S/N ratio:	More than 46dB
I.P. rating:	45
Subject illumination:	0·2 lux
IR capacity:	6 built-in infra-red LEDs, allowing camera to see in darkness for a maximum 2m distance.
Working temperature range:	–10°C to 60°C
Dimensions (W × H):	75 × 113mm
Adapter	
TV converter:	RF modulator feeds camera signal to TV receiver by means of an RF input. Wide band RF modulator avoids interference from video, satellite or other TV receivers. Built-in amplifier will feed multiple TV systems. Test pattern generator for easy tuning.
Material:	ABS moulded housing
Dimensions:	80 × 141mm
Cable	
Type:	High quality, low loss cable enables runs in excess of 100m. Single multicore cable fitted with 6 mini-DIN terminations.
Lengths available:	100/50/25/15/10m
Add-ons:	In-line connectors
Power Supply	
Output power:	2W maximum
Maximum current consumption:	150mA @ 12V

The microphone, built into the camera housing, is sensitive enough to pick up sound at the same level as the human ear. This feature is especially beneficial to the elderly who may be hard of hearing. They can amplify the sound just as they would with the volume on their TV set.

Refinement of Domineye's Design

Installation could not be easier, because the package includes everything you need to install it, except an electric drill. The whole kit is neatly packaged and presented in such a way that anyone can pick up the box and immediately understand what it is. In the kit, you have a tinted polycarbonate external dome; a black backplate; a Domineye camera; a TV adapter with fitted mains plug, and a cable package (15m of black multi-core cable terminated with mini-DIN plugs, TV Fly lead, 2 stainless steel security screws, hexagonal wrench, 3 fixing screws and 3 wall plugs).

Simple plug-and-go connectors fit gently into the camera, which then clips onto a backplate. The position of the camera on the backplate allows for adjustment along the horizontal axis. The backplate then screws on to the wall and a unique polycarbonate dome fits neatly over the whole system. The dome makes the unit weatherproof and stops vandals tampering with the camera. In fact, not only does the dome disguise the camera behind what appears to be a bulkhead light, but it can also survive a hefty knock because of the armour plate technology employed. Tamper-proof security screws attach the dome to the back plate.

The six core cable runs through to a modulator, where it plugs into a labelled socket. The modulator in turn plugs into the TV via a fly lead. There is even a pre-fitted plug for the mains on the modulator. To tune in the camera, flick the test button on the modulator to the 'up' position, decide which TV channel the Domineye will occupy, and tune that channel until the test pattern appears (two vertical bars). Then flick the test switch down and Domineye is live.

Applications for Domineye

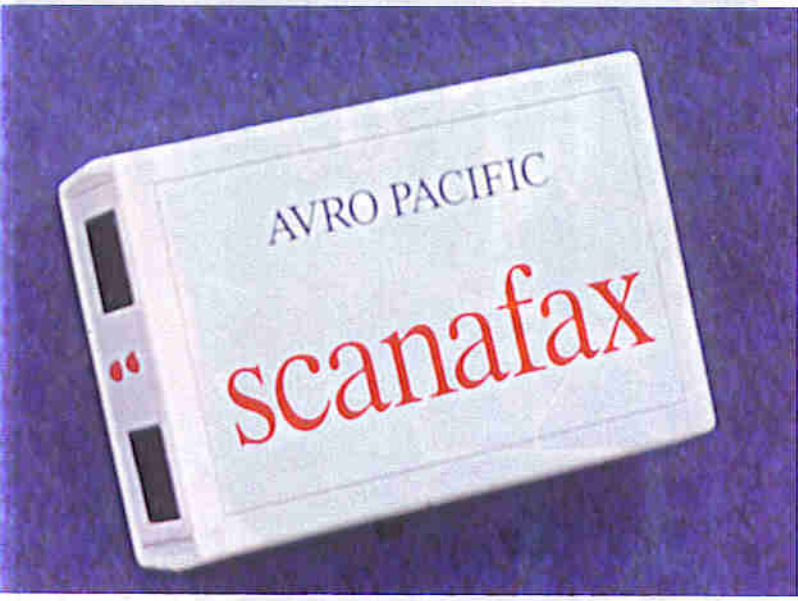
The ease of use, reliability and quality of the product and its unique protective dome (which disguises the camera), means that Domineye has stormed the market. Applications for this simple product range from it being used to watch over a car, to being used by the elderly, families and less able people to check who's at the door. Domineye is even used in hospitals to watch over babies and monitor hallways. It is also installed on some commercial sites, where it monitors back exits from store rooms, for example.

Together, Maplin and Seelex Limited have set the standard for today's domestic CCTV market. The Domineye package has caught the imagination of the trade, who appreciate its completeness and easy installation. It is, moreover, a product whose benefits of safety and security are easily understood by homeowners everywhere. The potential market is huge – anyone with a front door could eventually have a Domineye.

FAX FRIEND

Saves you money by eliminating the need for an expensive second telephone line for your Fax/Internet or Data connection. Simple to install – just plug in to any phone socket. All your extensions, including answering machines & cordless, operate normally and you can switch to your fax from any extension. Fax Friend works with all types of Fax Machines including those with built in telephone switches.

Fax Friend Order As YD61R **£59.99inc.**



SCANAFAX

The Scanafax allows you to use your fax machine as a scanner. Simply plug your fax machine into one socket and computer modem into the other, the unit will simulate a call to your fax modem and allow you to capture the fax as a scan using your standard fax software (not supplied). Ideal for the laptop user who wants to copy price schedules and other important information needed whilst on the move

Scanafax Order As CDO6G **£34.96inc.**

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If you are an international business traveller, the need to communicate effectively is essential. As a laptop computer user you will know the frustration of trying to plug your modem/ PCMCIA card into a foreign telephone socket. BT plugs do not work in Paris, Rome or New York. Avro Pacific can solve your problem with a choice of two economically priced kits. The International Kit connects you to more than 150 countries. The second Eurokit contains six connectors for France, Germany, Holland, Italy, Belgium, and with the UK to USA adapter you can plug into the phone systems of Spain, Ireland, USA, Canada and many other countries.

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Avro Pacific Ltd, Stainton Grange, Stainton, Middlesbrough, TS8 9DF, England

PROJECT

Active TRANSFORMER DI BOX

PROJECT RATING 1

Kit Available
Order as 95139
Price £32.99

Design by Alan Williamson
Text by Alan Williamson and Maurice Hunt

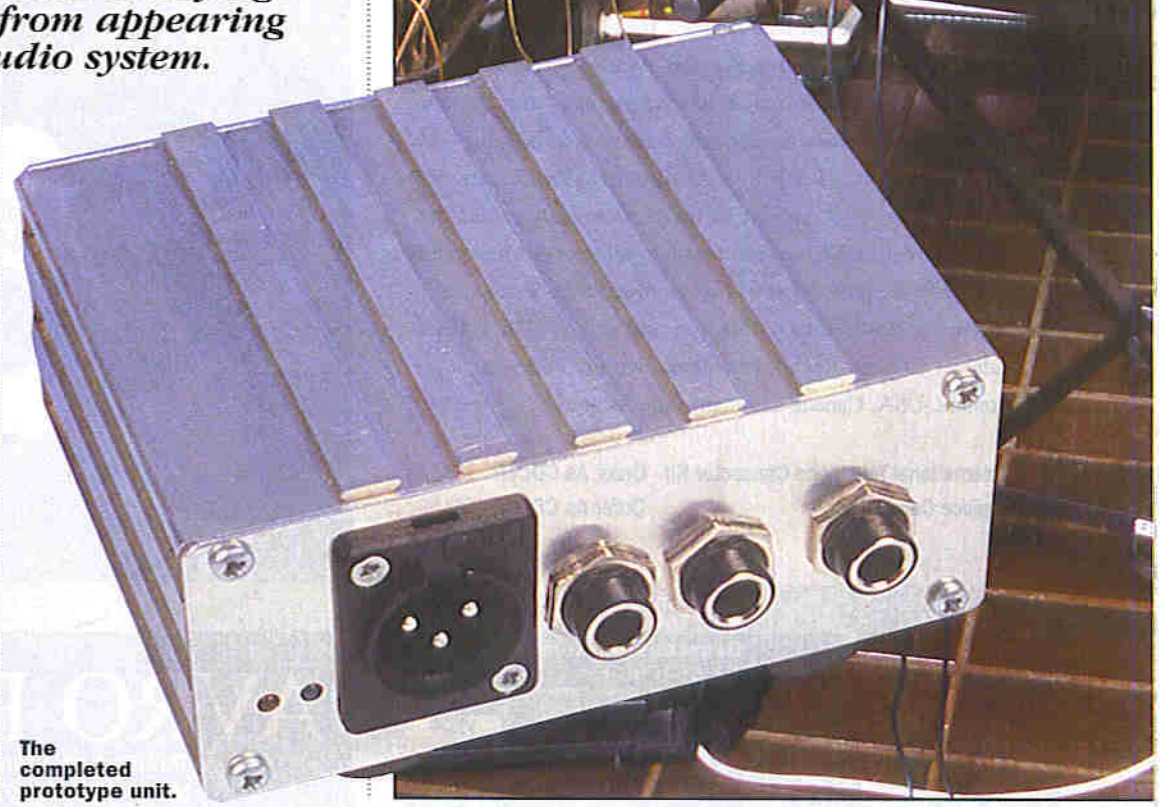
A DI (Direct Injection) Box is a unit used to match the impedances of two items of electronic audio/music equipment, being particularly useful for matching unbalanced line level signals into low (microphone) level balanced inputs on mixing desks or amplifiers. The DI Box can also be used to eradicate annoying earth loop hum from appearing within an audio system.

FEATURES

- Battery or PSU operation
- Low power consumption
- Low battery and power on indicators
- ¼in. jack input and XLR output
- Pre-punched, silk-screen printed panels
- Compact and rugged

APPLICATIONS

- Stage PA and recording
- Gigging bands
- Eliminating earth loop hum



The completed prototype unit.

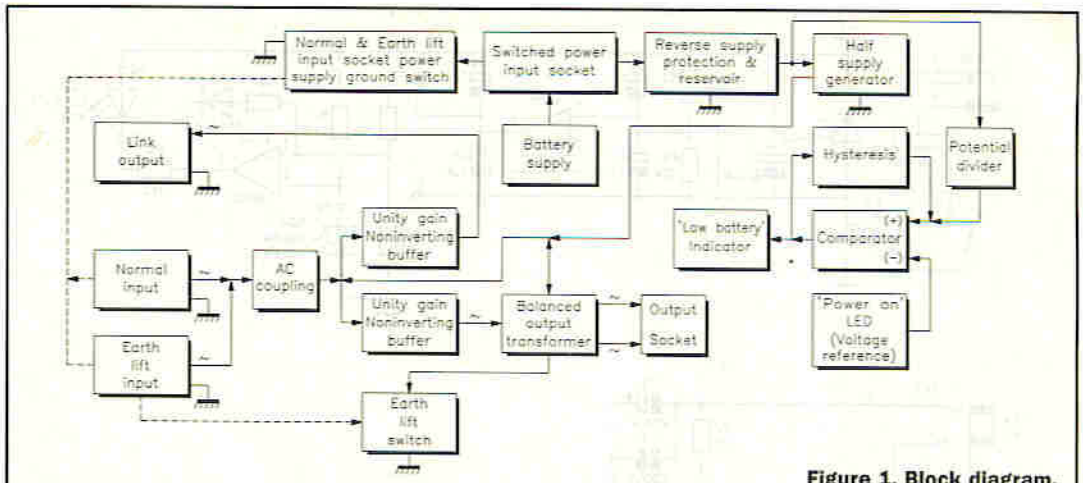


Figure 1. Block diagram.

In most cases, a Passive DI Box (such as the unit featured in Issue 102 of *Electronics*, Order Code 95099/LU23A) can be used effectively, but some items of equipment, for example, Rhodes electric pianos, require an Active version, such as the unit described in this article.

The Active Transformer DI Box is used with items of electronic musical equipment that, due to their high output impedance, are incapable of driving a transformer directly, as would be required when using a Passive DI Box. The circuit design ensures that the transformer is driven properly, while retaining unity overall gain (i.e. no amplification).

Circuit Description

Refer to the block and circuit diagrams, shown in Figures 1 & 2, respectively.

SK1 is the 'Normal' input; SK2 is the 'Earth Lift' input, which is wired in parallel with SK1. Inserting a jack plug into the 'Earth Lift' input socket will break the connection between the transformer secondary centre tap and the circuit ground.

Capacitor C1 AC-couples the signal to the inputs of the non-inverting amplifiers IC1a&b; IC1a is used to drive the transformer and IC1b is used as a 'loop through' buffer, preventing loading of the input signal. The 1MΩ input impedance of the amplifiers is set by R1.

Power for the circuit can be derived from either an external DC supply via SK4 (preferably regulated) or an internal PP3 battery. Inserting a ¼" jack plug into either the 'Normal' or 'Earth Lift' sockets SK1 & SK2 will close the switch contacts (SK1b & SK2b), completing the ground circuit.

Diode D1 is normally reverse-biased across the supply rails, which prevents accidental reverse polarity connections from the external PSU or battery, by clamping the reverse potential to –1V. This is preferable to a series connected diode, where battery voltage is at a premium; maximum use of the battery must be made because they are not cheap, and the circuit cannot afford the 1V loss (with the battery potential of +7V) and maintain maximum input signal headroom at 4V Pk-to-Pk.

Capacitor C4 provides the main supply decoupling and C5 the high-frequency decoupling.

The potential divider resistors R3 & R4 form a half supply reference, symmetrically decoupled by the capacitors C6 & C7. The noise-free reference is then buffered by IC2b, used to generate the low impedance half supply reference, VREF; the output of the op-amp is also symmetrically decoupled by C8 & C9 to improve (current) transient behaviour.

The second half of IC2 (IC2a) is a comparator, used as a low supply voltage detector; the Green LED, LD1, not only serves as a power ON indicator, but also as a voltage reference for the (–) inverting input of the comparator. The (+) non-inverting input of the comparator is connected to the potential divider, formed by R5 & R6; when the supply voltage drops to approximately +7V, the (+) non-inverting input potential will be below the potential at the (–) inverting input. This will switch ON the comparator output, illuminating the Red LED, LD2; this is where R8 & D2 come in to play, which are now effectively in parallel with R6, reducing the potential even further at the (+) non-inverting input of the comparator. The Red LED, LD1, will only extinguish when the supply voltage is raised above (approximately) +7·5V.

PCB Construction

Refer to the PCB legend and track drawing, shown in Figure 3. Construction is fairly straightforward; fit all components to the PCB except the XLR plug, which MUST be fitted to the front panel before being fitting to the PCB.

Begin with the smallest components first, working up in size to the largest; be careful to correctly orientate

SPECIFICATION

Operating voltage:	7-15V DC (9V nominal)
Current consumption:	7·5mA @ 7V 8·5mA @ 9V 12mA @ 15V <25mA maximum (under short circuit/fault conditions)
Input impedance:	500kΩ
Output impedance:	200Ω (Link output) 150Ω (Differential Mic XLR output) 75-0-75Ω (Balanced Mic XLR output)
Gain:	7:1 reduction (–16·9dB) on Balanced Mix XLR output, Unity gain (0dB) Link output
Bandwidth:	Unlimited audio spectrum
PCB dimensions:	80 × 100mm
Boxed unit dimensions (WHD):	109 × 52 × 93mm

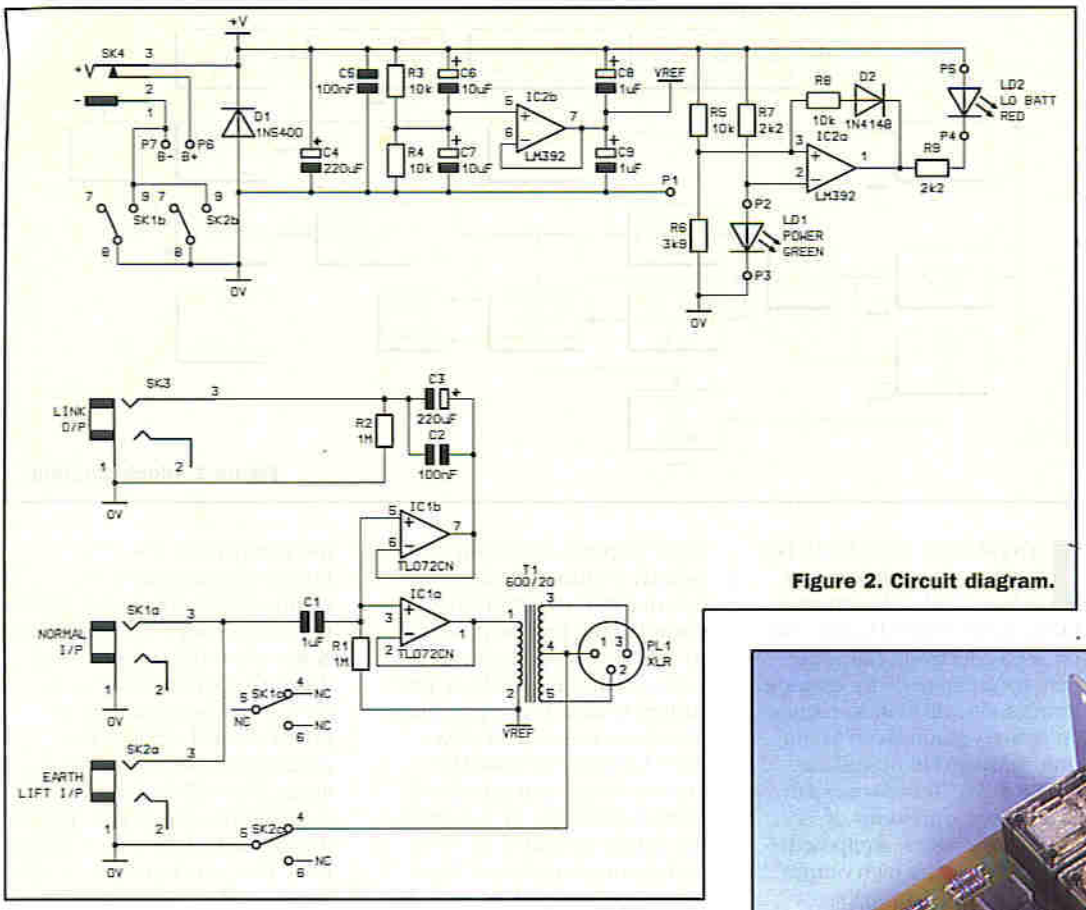


Figure 2. Circuit diagram.

the polarised devices, i.e. electrolytic capacitors, diodes and ICs; the ICs should be inserted into their sockets last of all, ensuring the identification notch/dimple/spot aligns with the holder/PCB legend.

Preform and fit the two LEDs (Green on the innermost and Red on the outermost part of the board) fully into the PCB (note orientation, short lead is cathode/K). The LED lenses should protrude over the edge of the PCB.

Thoroughly check your work for misplaced components, solder whiskers, bridges and dry joints. Finally, clean all the flux off the PCB using a suitable solvent.

Box Construction

Refer to Figure 4, showing the exploded assembly diagram.

Note that the specified casing has pre-punched front and rear panels, requiring no further drilling. Care should be taken during assembly, however, to avoid damaging the silk-screen printed legends on the panels.

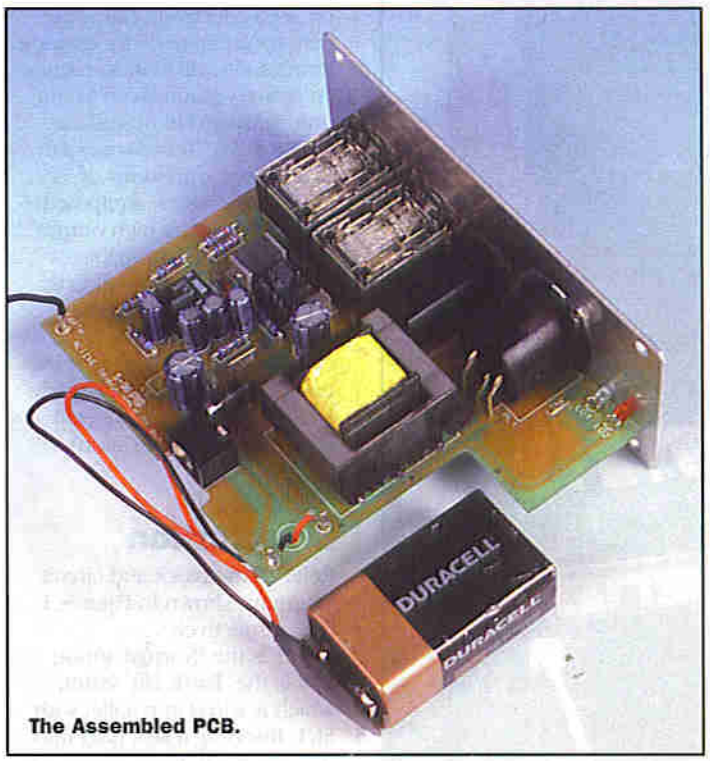
The XLR socket must be fitted to the front panel using the two screws, shakeproof washers and nuts, before soldering the socket to the PCB. Use the nuts supplied with the jack sockets to secure the PCB to the front panel; do not overtighten.

The four small rubber feet supplied should be fitted to each side of the transformer, stuck together in pairs (one above the other), to hold the battery firmly in place, and to prevent the metal case of the battery from coming into contact with the transformer pins.

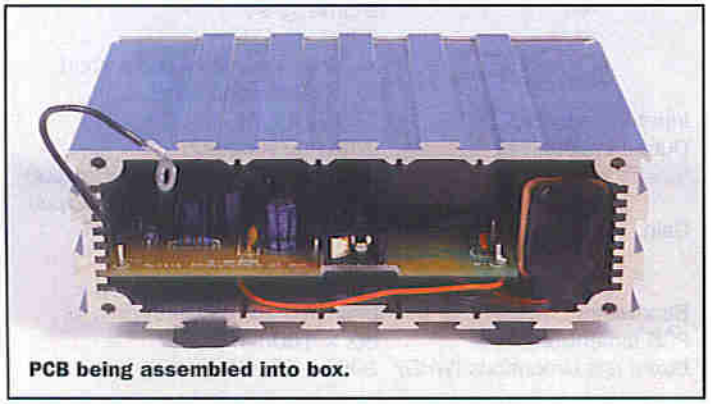
Ensure that the rubber grommet is fitted in the central hole of the rear panel, preventing the power supply plug outer (+V) connection from being shorted out against the casing (0V). Fit two lengths of rubber strip into the outermost grooves in the box base; use a little contact adhesive for permanent fixing. Test the module BEFORE fitting it into the enclosure.

Testing

See Figure 5 for typical application wiring details. The best way to test the unit is to use it! However, if you have a multimeter, a variable power supply, a signal generator and an oscilloscope, it is worthwhile bench testing it to ensure it is fully functional.



The Assembled PCB.



PCB being assembled into box.

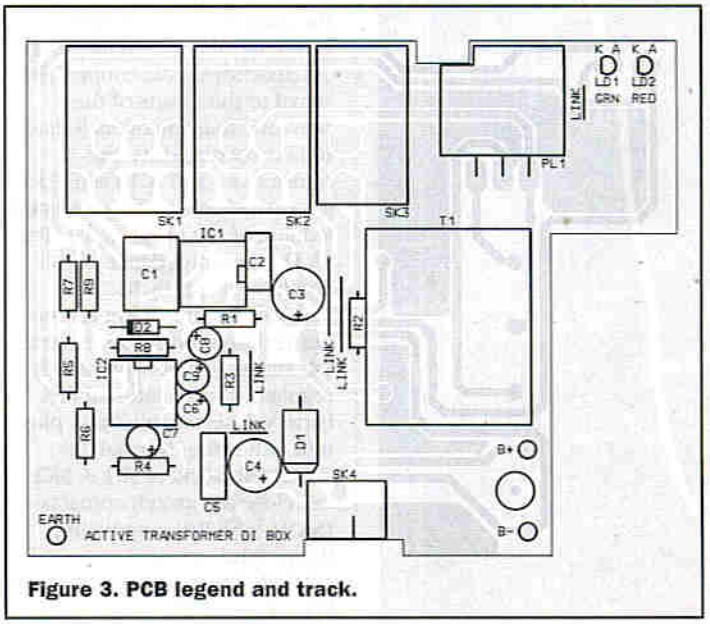


Figure 3. PCB legend and track.

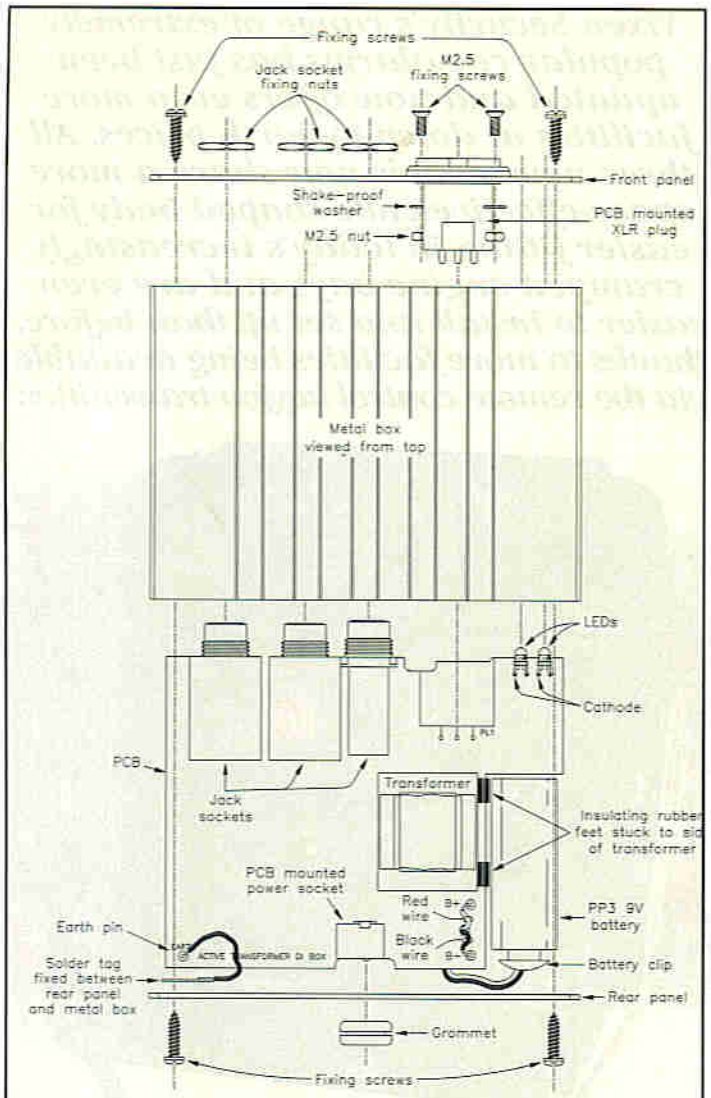


Figure 4. Exploded assembly diagram.

Set the meter to the continuity range and check that there is a connection between circuit ground and pin 1 of the XLR socket.

Set the PSU to +9V and current limit at 0·5A, then connect to the external power socket, SK4 (NOTE, the centre pin of the connector is (–) negative, and that a long reach connector must be used); both LEDs should be extinguished. Insert a jack plug into the 'Normal' input, the Green LED should illuminate; remove the jack plug and re-insert into the 'Earth Lift' input, whereupon the Green LED should again illuminate. Re-check the continuity between circuit ground and pin 1 of the XLR plug (while the jack plug is inserted), no continuity should be found.

Reduce the supply voltage until the red LED illuminates, which should be at approximately +7V. Apply a 4V Pk-to-Pk signal (or if you prefer, a 1·414V rms or +3dBV) to the 'Normal' input; monitor the 'Link' output; the signal should be just on the edge of clipping; also check the transformer in-phase and out-of-phase output signals on pins 2 & 3, respectively, of the XLR plug.

Slowly increase the supply voltage to +9V, and the red LED should extinguish at approximately +7·5V; there should also be a little more signal headroom.

Having completed the tests, install a fresh 9V PP3 battery (optional – preferably alkaline for long life), then fit and secure the module and panels to the enclosure with the screws provided (don't overtighten). Don't forget to fit the earth tag beneath the upper left-hand corner of the rear panel! The Active Balanced Line Transformer has now been fully tested and is ready for use.

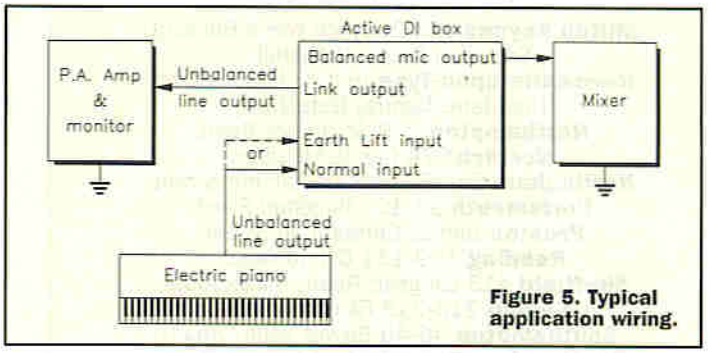


Figure 5. Typical application wiring.

PROJECT PARTS LIST

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

R1,2	1M	2	(M1M)
R3-5,8	10k	4	(M10K)
R6	3k9	1	(M3K9)
R7,9	2k2	2	(M2K2)

CAPACITORS

C1	1µF Polyester Layer	1	(WW53H)
C2	100nF Polyester Layer	1	(WW41U)
C3,4	220µF 16V Radial Electrolytic	2	(AT41U)
C5	100nF 16V Ceramic Disc	1	(YR75S)
C6,7	10µF 63V Radial Electrolytic	2	(AT77J)
C8,9	1µF 63V Radial Electrolytic	2	(AT74R)

SEMICONDUCTORS

D1	1N5400	1	(QL81C)
D2	1N4148	1	(QL80B)
LD1	3mm Low Current (2mA) Green LED	1	(CZ30H)
LD2	3mm Low Current (2mA) Red LED	1	(CZ28F)
IC1	TL072CN	1	(RA68Y)
IC2	LM392N	1	(UH32K)

MISCELLANEOUS

T1	Microphone Transformer 600/20	1	(FD23A)
SK1,2	PCB-mounting ¼in. Stereo Jack Socket with Switch	2	(FJ87U)
SK3	PCB-mounting ¼in. Stereo Jack Socket	1	(CX88V)
SK4	PCB-mounting Power Socket	1	(RK37S)
PL1	Low Cost XLR ACM-PC Socket	1	(KC56L)
	6·4mm Grommet	1	(JX65V)
	8-pin DIL Socket	2	(BL17T)
	PP3 Clip	1	(HF28F)
	Box Type CCN80	1	(YN50E)
	1mm PCB Pin	1 Pkt	(FL24B)
	M3 Solder Tag	1 Pkt	(LR64U)
	M2·5 6mm Countersunk Screw	1 Pkt	(BF39N)
	M2·5 Nut	1 Pkt	(JD62S)
	M2·5 Shakeproof Washer	1 Pkt	(BF45Y)
	Rubber Foot	1m	(XR93B)
	Stick-on Feet Small	1 Pkt	(FE32K)
	7/0·2 Wire 10m Green	1 Pkt	(BL03D)
	PCB	1	(GJ58N)
	Front Panel	1	(KV03D)
	Rear Panel	1	(KV25C)
	Instruction Leaflet	1	(XV98G)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

PP3 Battery	1	(JY49D)
9V Regulator	1	(BZ84F)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding optional) are available as a kit, which offers a saving over buying the parts separately.

Order As 95139 (Active Transformer DI Box) Price £32.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996/97 Maplin Catalogue.

Active Transformer DI Box PCB **Order As 95140 Price £3.99**

Active Transformer DI Box Front Panel **Order As 95141 Price £2.69**

Active Transformer DI Box Rear Panel **Order As 95185 Price £1.99**

Vixen Security's range of extremely popular car alarms has just been updated and now offers even more facilities at down-to-earth prices. All three new models now share a more space-effective cube shaped body for easier fitting in today's increasingly cramped engine bays and are even easier to install and set up than before, thanks to more facilities being available via the remote control keyfob transmitter.

Remote Setup and Adjustment

A choice of 5 different siren sounds and a multi-tone siren can now be selected remotely, using the 2-button keyfob. Sounds can be changed at any time without even touching your car or the alarm. Simply step through the sounds by pressing a button until you hear the one you want, then select it by pushing the other button.

Now also adjustable from the remote keyfob is the alarm's shock sensor which detects your car being physically attacked. The increased ease of adjustment means that the sensitivity of the alarm can be changed whenever required, without having to dive under the bonnet! If the wind suddenly gets up, or you park in a place where there is a high level of vibration, e.g. railway station or airport, you can simply select another of the preset sensitivity levels with a few presses of the keyfob buttons.

When selecting the sensitivity, the alarm emits a sound which changes pitch either up or down corresponding to the sensitivity. There are seven sensitivity settings and an off position which allows you to switch the shock sensor off completely if required.

The Range

As before, the range of alarms starts with a basic, easy-installation model (model 6650), a mid-range model with more built-in features (model 6652), and a top-of-the-range model with battery back-up (model 6645).

Expandability

All three models can be expanded to suit your exact requirements, by adding suitable accessories, like ultrasonic sensors, high sensitivity motion detectors, and central-locking interfaces and motors, etc., from the Vixen range.

V·I·X·E·N CAR ALARMS

Model 6652

Remote Keyfob Operation

Choice of 5 Siren Sounds plus Multi-tone

Remote Shock Sensitivity Setting

Car Locator Facility

Flashing Light Output

LED Status Indicator

A more expandable alarm with additional features like an output for flashing up to 10A of lighting, 2 Pin Switches, for the boot and bonnet, an output which can be used to operate your car's central locking system, an input for add-on accessories like ultrasonic detectors, and a locator facility which helps you to 'find the car in the multi-storey', by sounding and flashing the lights. An LED status Indicator shows whether the alarm is set, or has been set off while you were away, and acts as a powerful deterrent by showing that you car is fitted with an alarm.

Order Code MM36P
Price £59.99

Model 6645

Battery Back-Up

Choice of 5 Siren Sounds plus Multi-tone

Car Locator Facility

Dual Flashing Lights Output

LED Status Indicator

Ignition Disable Facility

Override/Valet Key-Switch

The top-of-the-range alarm with all the features of Model 6652, plus battery back-up which keeps the alarm sounding, even if a thief cuts the wiring or removes the alarm from the car! The dual flashing light outputs allow easy connection to the direction indicators without the need for additional relays, etc. In addition, the alarm incorporates a switch which disables the engine ignition when the alarm is set, and has a key-switch which allows the alarm to be switched off when the car is being serviced or valeted.

Order Code MM37S
Price £69.99

Model 6652
Order as MM36P
£59.99

Vixen Alarm accessories purchased for the old range of alarms are compatible with the new alarms so there's no need to change all your accessories if you want to update your existing alarm.

Compatibility

Backward and forward compatibility has been maintained by continued use of the popular 2-button keyfob transmitter, model 600-2 (CR43W), which is compatible with the 3 old models (630, 632 & 641), the 3 new models, the Remote Receiver Module, and the Fox Wireless Burglar Alarm. All 3 new alarms use the 2-button transmitter which can also be used as a replacement for the single-button transmitter supplied with model 630 (ZF47B).

Model 6650

Remote Keyfob Operation

Choice of 5 Siren Sounds plus Multi-tone

Remote Shock Sensitivity Setting

Easy 2 (or 3) Wire Installation

A low cost alarm that responds to physical shock or vibration, or to the opening of any door, boot or bonnet that operates a courtesy light. An optional third wire allows the connection of add-on detectors like door, boot or bonnet switches, and ultrasonic sensors.

Order Code ME67X
Price £29.99

new from MAPLIN

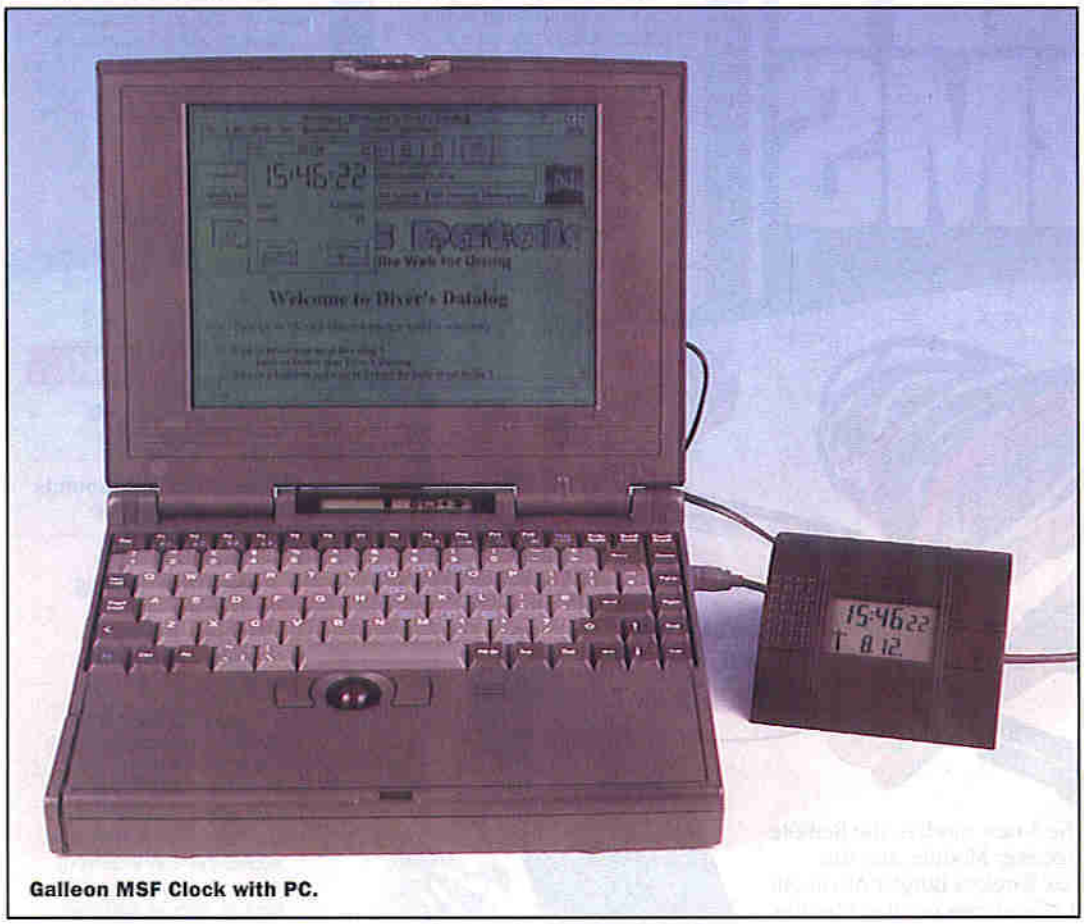
To purchase any of the items featured on this page, telephone Maplin MPS sales on: (01702) 554000, or use the order coupon on page 63. Please check with your local Maplin store if they stock these new items. Export customers call Maplin MPS, Tel: (+44) 1702 554000 or contact your nearest Overseas Maplin Agent.

See the new Maplin MPS Catalogue for full details, or call in at your local Maplin or Mondo store.

Galleon

ATOMIC-REFERENCED CLOCK WITH PC INTERFACE

Annoyed with the inaccurate real-time clock in your PC? Maplin has an inexpensive remedy, which is reviewed by Martin Pipe BSc AMISTC



Galleon MSF Clock with PC.

For some time now, Maplin has been selling clocks that don't use a quartz crystal as a timing reference. Instead of relying on that all-too-common piezo-electric device, these Maplin clocks use a highly accurate caesium atomic reference that is worth several million pounds. You don't have to be a lottery winner to have one, though – this atomic reference is, in fact, maintained by the UK's National Physical Laboratory, and is free to everybody who can receive it over the air.

The atomic reference signal is broadcast – as on/off-keyed digital data modulated on a very low frequency (60kHz) carrier – by the high-powered radio station based at Rugby in the East Midlands. The call-sign of this station is MSF. Since MSF can be received over a range of 1,000 miles, clocks that rely on its tick can be used over a sizeable proportion of the planet. The MSF BCD (binary-coded decimal) serial data stream includes the date/day of the week, time (hours, minutes and seconds), and parity bits (for error-checking).

One of the data bits indicates BST or GMT, and hence, all clocks will adjust themselves at the appropriate times of the year. MSF normally broadcasts 24 hours a day, and 7 days a week, and its accuracy is claimed to be 1 second in a million years. Two types of MSF signal are broadcast – fast data (a quick burst in the first second of every minute) and slow data (the same data, transmitted in the remaining 59 seconds of the minute) – see Issue 88, page 10 of *Electronics* for details.

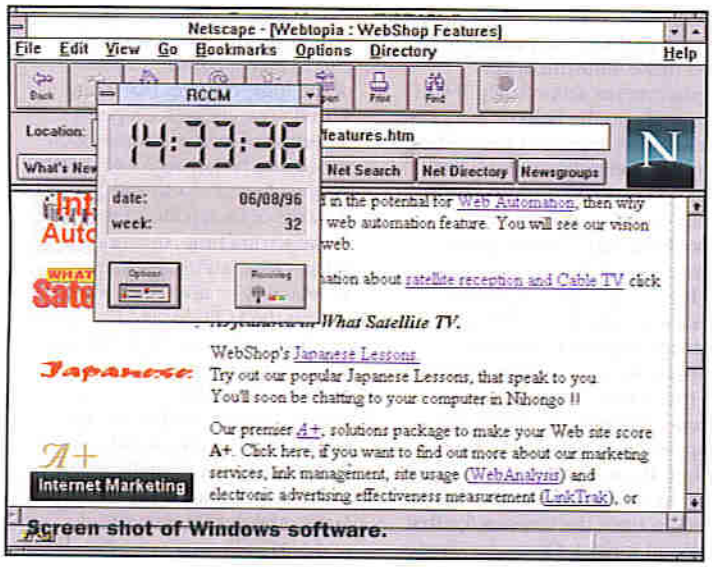
It is not known which is used by Maplin's domestic MSF-referenced clocks, but we would suspect it to be the slow type, which can be processed more easily with inexpensive circuitry.

One of Maplin's most interesting MSF clocks is a pleasantly styled object, known as Galleon, that would look good on any bedside (or office) table, and here, complementary styling goes more than skin deep. While the clock has a very readable display (with switchable backlight) and two alarms, its hidden secret is a serial port. Hook this up to a PC (whether it is at home, or a file server at the office) with the supplied cable, and your computer will always tell you the right time.

PCs feature an internal real-time clock, which is typically used for 'time-stamping' files. If you send faxes, your machine's clock is responsible for telling the recipient when it was sent. If the clock is out, you could run into problems if you needed to prove that the fax was sent by a certain time (share offers, etc.). E-mail is different, in that it is out of your control (and hence, less open to fraudulent use). In this case, your Internet service provider's time server is used to add the time stamp. There are utilities around that will use a time server to reset a PC's real time clock when on-line. Such a utility is, for example, included with the Turnpike Internet access software.

Some such kind of clock resetting provision is, unfortunately, needed in many applications. Unfortunately, the real-time clock is, despite the use of the 32-768kHz crystal reference commonly found in digital watches, not very accurate, and tends to lose or gain time quicker than you would expect. Going into MS-DOS mode and re-entering the date and time manually is possible, but it's a pain in the backside and dependent on you having an accurate clock or watch in the first place. It gets worse, though. If the machine goes into a 'sleep' mode – as many recent 'green' PCs do when they haven't been used for some time – Windows doesn't pick up on the right time, and this is only rectified when the machine is reset.

Such a state of affairs is clearly inadequate for programmers and other professional users, who need to know accurately when files are generated (to keep track of different versions, etc.) or sent to others. A Galleon clock is the easiest and cheapest solution, and can be programmed to update the time every minute if needed. You could use the Internet time server utility, but unless the server uses MSF or a clock of similar accuracy, then it is rather pointless (if, of course, you're on the Internet in the first place!).



Screen shot of Windows software.

The PC's real-time clock is powered by a small Ni-Cd battery, which charges up when the machine is switched on. Over time, however, the battery deteriorates and should the PC not be used – even for short periods – with the battery in this state, then the real-time clock will lose its settings. To replace a battery – which means taking the PC apart completely – is a time-consuming task for which the average dealer is likely to charge between £50 and £100. By using the Galleon clock, though, the correct time will be set whenever the PC is booted up. Both Windows and DOS utilities are provided (the Windows utility has been tested to work with versions 3.1, 3.11 and '95).

Setting the clock couldn't be easier. Insert the two supplied AA batteries and, within three or so minutes, it locks into the radio signal and deduces the correct time. Inserting the batteries was the most awkward task – the batteries spring outwards, making replacement of the cover difficult. You won't have to worry about this too often – a battery life of 2·5 years is claimed, although using the alarm will obviously reduce this. Alkaline batteries are recommended as replacements. An icon at the top-right of the clock display will appear when the battery is nearing the end of its life.

On initial power-up, a little radio mast appears on the bottom left of the display, together with between 1 and 4 dashes that indicate the strength of any 60kHz signal in the vicinity (which could include harmonics and beat frequencies produced by TV timebases, computer clock oscillators, the coil at the end of a graphics tablet's pen and the like). If several minutes have elapsed and nothing has happened, try moving the clock; when the radio mast flashes, the MSF signal has been found. Shortly after this, the time will be displayed.

Regular alarm-clock use is easy. The 24-hour clock display is in two parts. The top section displays hours, minutes and seconds, while the bottom section tells you the month and date. If one of the buttons to the right of the display is pressed, the seconds display indicates the day of the week instead. If you press the large button to the left of the display, you invoke the alarm-setting mode. The Galleon clock has two alarms, and the one required is accessed by the number of key presses.

Alarm time is set by the two keys to the right of the display; the top key increments upwards, while the bottom key increments downwards. A bell symbol on the display informs you that the alarm is primed and ready to go. On the top of the clock is an oversized button which is used to switch off the alarm mode (if in setting mode), or simply silence the alarm when it goes off. The alarm call, incidentally, is loud, piercing and quite difficult to sleep through! Pressing the top button also switches on the backlight – a separate button for this would have been preferred.

The device was used near a PC with its case removed, thus subjecting it to a barrage of computer-generated interference. It still managed to acquire the MSF data after being reset (the batteries removed and replaced), indicating that it can be used with some success in electrically noisy areas. That said, the review location was only 150 miles or so from Rugby. In areas further away from Rugby, or at locations with poor radio reception, we recommend that the clock is kept as far away as possible from devices like display monitors, TV sets and computers. In fact, this policy should really be adopted whatever happens.

On the subject of computers, let's move onto the PC interface. Supplied with the clock is a lead, and a high-density 3·5in. disk that contains the software. The lead has a 4-way modular jack (of the sort commonly found on modems) at one end, which plugs into the clock. At the other end is a 9-way female D-type connector, which plugs into the PC's spare serial port. If the only available serial port on your computer has a 25-way connector, then you'll need an adaptor (order as JM08J, price £5.99).

There are two versions of software on the disk. The first is a resident DOS driver that, after installation, is called up by the start-up files. Installation is made as painless as possible by the use of a 'plain English' installation program that carries out the donkey work for you. The driver, known as PCFD, is then installed onto your hard disk. Depending on the settings chosen during installation, PCFD reads the MSF data from the clock, and updates the PC real-time clock accordingly. Updates can be whenever the machine is turned on, or as frequently as every few seconds.

The Windows software, likely to appeal to the majority of users, is rather more fun. Install the file `a:\win31\setup.exe` and you're greeted with a window, labelled RCCM, that displays a large digital clock with its time derived from the (updated) PC real time clock. Installation allows you to specify whether time, date or both are set, whether updating occurs once (at boot-up) or periodically (with a user-specifiable period), the serial port used (1 to 4), and time-zone correction (for those using the equipment outside the UK).

Once installed, these options can be changed in the RCCM window by clicking on the 'options' button. Clicking on the 'receiving' button, meanwhile, gives you a signal strength display. The hardware/software combination worked first-time with no hassle whatsoever – which is unusual for most computer peripherals, at least if my experience is anything to go by! Galleon was partnered with a 486DX33/8M-byte RAM notebook, running Windows 3.11. This software will also run under Windows 3.1, and has given no trouble to Windows '95 users. If you choose to upgrade to the Windows software from the DOS version, delete all reference to the PCFD driver in the start-up files (and the file/directory itself) – Windows doesn't like it.

Inside the clock, everything is laid out nicely. The double-sided fibreglass PCB holds all the components, except for the ferrite-rod radio aerial, which is mounted towards the back of the case. Extensive use is made of surface mount technology, and the clock's two ICs (a clock chip under the LCD panel, and the MSF receiver IC) are mounted directly onto the board as chips, and covered with blobs of black resin to protect them. A quartz crystal is clearly visible, and this is used as a secondary reference so that the clock will 'free-run' on those occasions when MSF cannot be received, such as during periods of transmitter maintenance or poor reception. On the back of the board are components used in the PC serial interface. A nice point is that the backlight bulbs are standard items, which are easily accessible and thus, easy to replace.

All in all, the Galleon MSF clock is a handy gadget with some very important PC applications. Never again will your PC fail to tell you the right time, unless you live or work in an area that cannot receive the MSF signal! Reinforced concrete buildings in built-up cities could, for example, pose a problem. Galleon also makes a handy alarm clock too, which is compact enough to stow away in travel baggage.

MSF Clock with PC Interface
Order As CH53H
Price £117.44.

TECHNICAL SPECIFICATION

Reference:	MSF radio signal, with crystal backup
Display:	Date, day, alarm, time (24 hour; h:m:s)
Alarm:	2, independent
Time setting:	Automatic
Batteries:	2 × AA (alkaline recommended)
Battery life:	2·5 years
Dimensions (WHD):	111 × 64 × 133mm
Other features:	Automatic BST/GMT conversion RS-232 interface and PC (Windows 3.x/'95, MS-DOS) software for update of system clock Backlight Signal strength meter

Put your finger on the pulse!

FAULTFINDING DIGITAL CIRCUITS

If you have ever designed and built your own digital circuits, you will know that "heart in mouth" feeling when you apply power for the first time and watch to see if the labour of your love works first time. In the authors experience, more often than not, it doesn't!

Circuits driven by microprocessors, microcontrollers or large numbers of linked gates, counters and so on are not at all easy to fault find. When you are dealing with a complex circuit with data and address buses, or many interrelated control and status signals, your trusty multi-meter isn't very helpful. You can (and should!) monitor the current drawn when you first power up, to see if your circuit draws about the expected current, or is about to go into meltdown! The trouble is, if the current drawn looks about right, what do you do next?

Once you have followed the old and invaluable maxim "First, check the power supplies!", you are left with two alternatives, largely governed by your own degree of digital and electronic knowledge. If you don't know much about how these circuits work, you are left with the laborious task of rechecking your layout and soldering looking for a wrong connection, a short or open circuit, or the like.

If you designed the circuit yourself and presumably know exactly how it ticks (or should tick!), or if you have the ability to follow and understand the circuit diagram, breaking down the circuit into its related and interdependent parts, all (sic) you have to do is check which bit doesn't work. Sometimes you can do this with a simple meter, especially if the circuit settles into steady logic states dependent on the last selected step or input. Sometimes an oscilloscope can show the presence or absence of high speed control or access signals, especially if they are repeated regularly.

However, the frustrating thing about fault finding many high speed digital circuits is that digital events lasting only a few microseconds, often in a specific sequence or time relationship, are almost impossible to monitor using common or garden test equipment such as meters and analogue scopes.

Even those of you lucky enough to possess a digital storage scope may find it is not capable of showing you enough about what is happening simultaneously at the various crucial control points in a complicated digital circuit. So what do you do?

You end up playing a guessing game. Just what could be happening? You try to visualise the operation of the circuit, imagine what would result if this or that were happening and make adjustments or replacements accordingly. If you are really on the ball (or just plain lucky!) this approach sometimes hits the nail right on the head, but you may just end up hitting your thumb, particularly if expensive replacement parts prove to have been unnecessary!

It is every digital designers dream to have the ability to actually see exactly what is happening at a number of points in his or her circuit, as well as seeing when those events are happening in relation to each other. If you can see what is (or isn't!) happening, you can start to trace the reasons for that and put it right. Of course, Logic Analysers have been able to do this for years, but have always been frighteningly expensive for all but the biggest company's design labs, with price tags that would look quite at home on a three bedroomed semi!

This has now changed! Black Star, the well known and respected professional test equipment manufacturer, have produced an excellent 32 channel Logic Analyser which allows the capture and display of simultaneous events on up to 32 digital lines, triggered by a choice of two programmable combinations of logic states on those input lines (two 32 bit logical words). Acquisition of data may be single shot, or repetitive to look for a match of logic conditions with pre-stored reference memory. The LCD display allows eight of those channels to be displayed in a scope type timing display, with a number of selectable time resolutions, or will allow display of data in one of sixteen different combinations of HEX, OCTAL or ASCII formats for those looking for specific coded data patterns.

The long and short of all that is that this instrument will allow you to take a digital "snapshot" of the logic changes occurring within your circuit for a period determined by the sample clock, which may be between DC (100Hz for the internal clock) and 33MHz. If a write or latch pulse is happening at the wrong time, or a one shot select pulse isn't happening at all, you will be able to clearly see this on the LCD display. For example, you can check the exact data written to a port, latch or gate and counter combination under chosen trigger conditions, which takes all of the guesswork out of fault finding any digital circuits.

The Black Star model 3332 Logic analyser (Maplin order code DT86T) retails at £498.72 +VAT (£586 inc), which is still a considerable sum of money. However, for anyone regularly involved in the design, building, test or repair of almost any type of 5 Volt logic based circuitry, the time and frustration avoided by being able to observe and analyse the function of a circuit instead of using the "poke and hope" technique will soon make the purchase of this instrument a very worthwhile investment.

It is unfortunately beyond the scope of this feature to detail fully the operating features of this unit, but it does include a serial output for display printouts, as well as providing for a number of optional plug in accessories such as dedicated configuration boards for testing circuits based on selected popular microprocessors and a communications pod designed to simplify monitoring of standard interface ports such as Centronics and RS232. Full details, as always, are in the new 1997 Maplin/MPS catalogue available now from WH Smiths or through Maplin stores and mail order.

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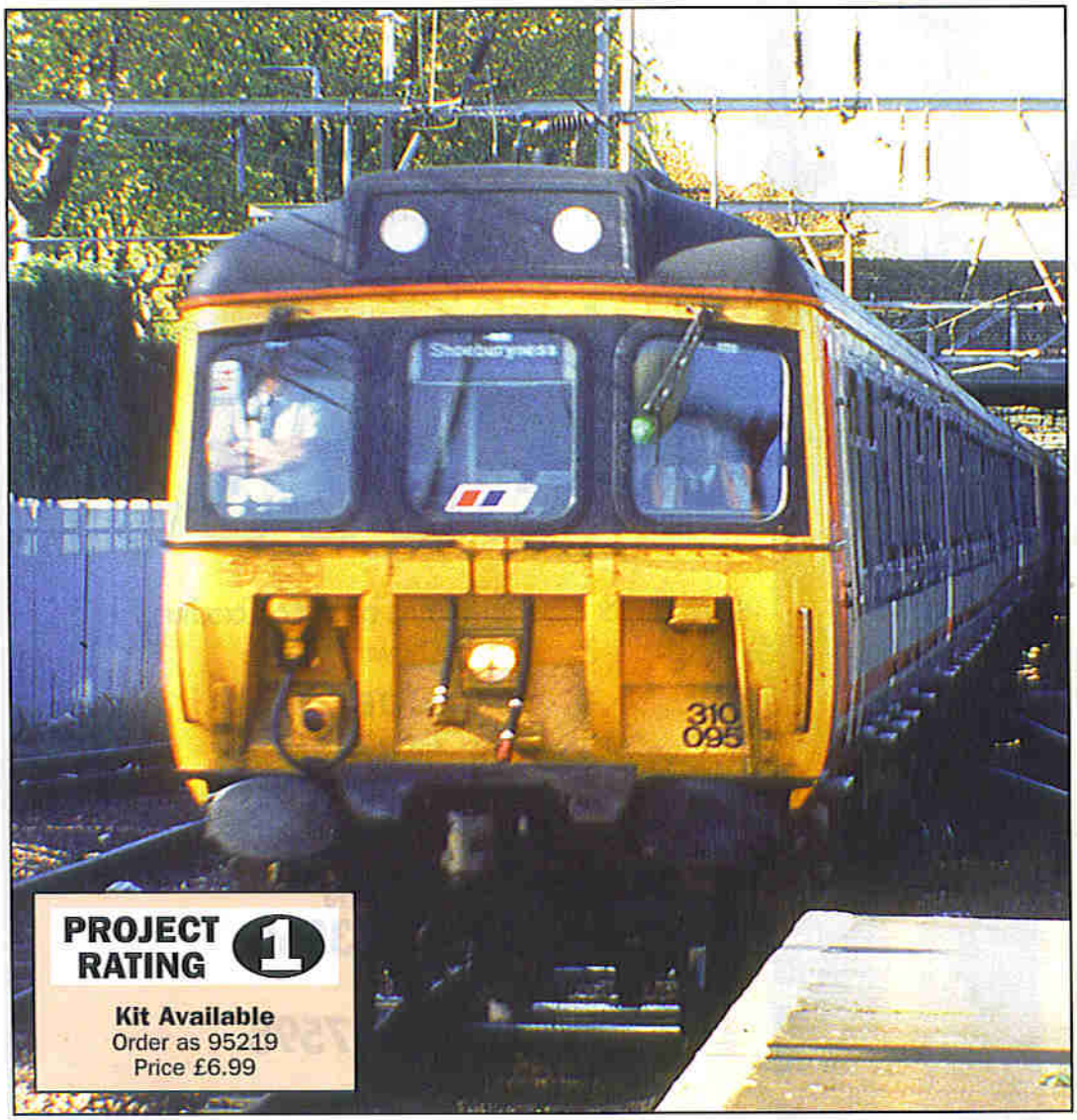
PROJECT

Train Effects GENERATOR

Text by Maurice Hunt

An easy to build and inexpensive, yet highly effective Train Effects Generator Kit, capable of providing four synthesised train sounds – whistle, chuffing, level crossing bell and crossing a bridge. This kit will add the finishing touch to your model train layout for added realism and excitement!



PROJECT RATING 1

Kit Available
Order as 95219
Price £6.99

FEATURES

- Four realistic train sound effects
- Automatic power-down
- Sound effects chip bonded to PCB
- Kit includes hook-up wire and solder

APPLICATIONS

- Model train layouts
- Amateur dramatics productions
- Novelty doorbell
- Toys and games

The Train Effects Generator kit is very simple to construct, and it is also child's play to use – just press the appropriate push switch to activate the required sound effect. There is no need to worry about switching the circuit off after use, since it incorporates an automatic power-down function, and current consumption is low even when activated, giving a long battery life. This makes the project ideal for installation into children's toys and games, providing them with hours of economical entertainment.

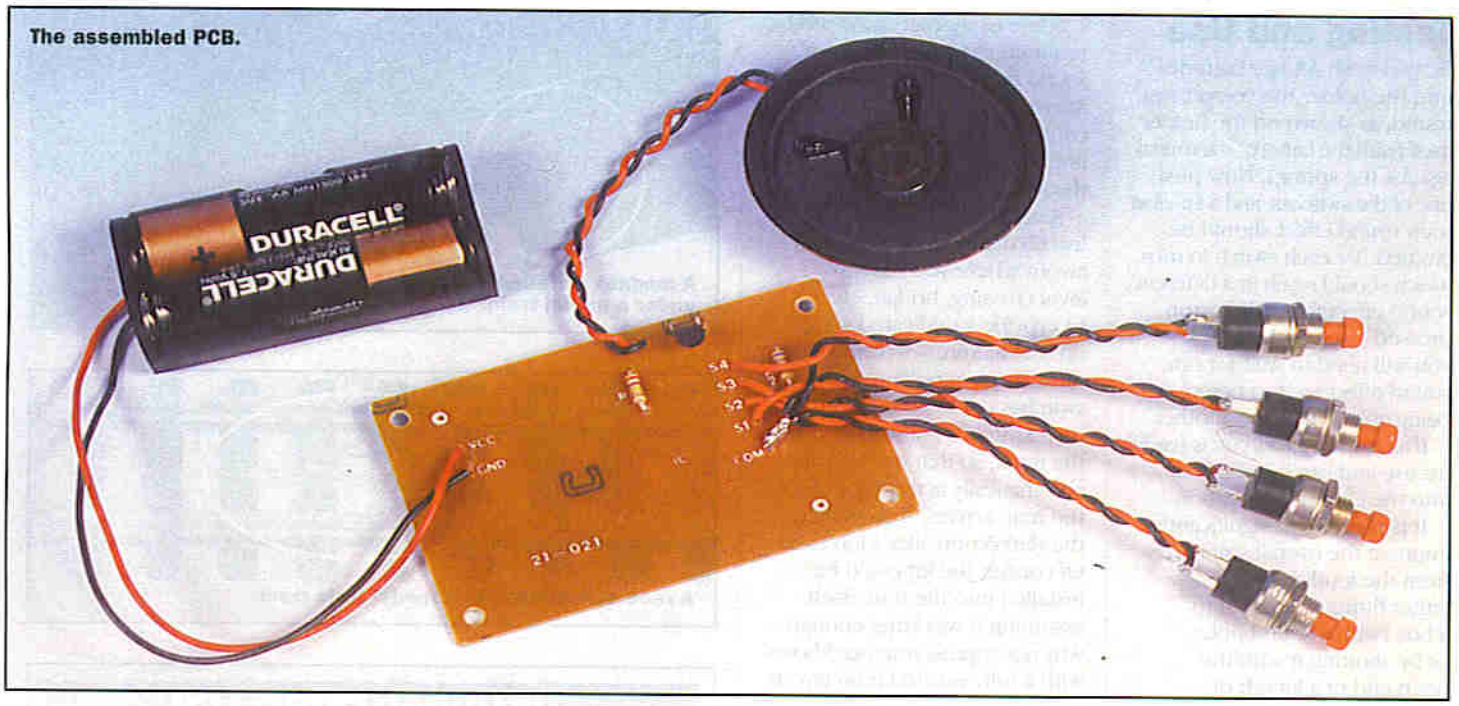
Button	Sound Effect
S1	Whistle
S2	Steam train chuffing
S3	Level crossing bell (American)
S4	Crossing a bridge

Table 1. Sound effects available.

Circuit Description

Refer to Figure 1, showing the circuit diagram of the project. The circuit is based around IC1, a sound effects generator chip, which synthesises the various train sounds. Note that this CMOS chip is supplied pre-bonded directly to the PCB, and is protected by a hard resin coating. Nonetheless, the usual anti-static precautions should be applied when handling the unassembled PCB, to avoid damaging the chip.

IC1's pad designations are shown in Table 2.



The assembled PCB.

The circuit is powered by a 2·2-5V DC power supply, ideally from a pair of AA-size batteries (not supplied), providing 3V DC (a suitable battery holder is provided in the kit).

Push-to-make switches S1-4 are used to activate the four different sounds, and pressing one automatically switches on the unit; if left unused, the circuit will automatically be powered down, hence, no on/off switch is required.

The audio output of IC1 is fed via R2 into the base of npn transistor TR1, which amplifies the signal to drive the loudspeaker, SP.

Board Construction

The only components that need to be fitted to the board are the two resistors R1 & R2, and transistor TR1. The remainder of the off-board parts are connected by means of the hook-up cable supplied.

R1 is the 270kΩ resistor (colour code red, violet, yellow, gold), and R2 the 680Ω (colour code blue, grey, brown, gold). Ensure that TR1 is fitted the correct way round, that is, with its 'EBC'-marked leads in the holes matching those printed on the PCB legend – some manipulation of the transistor leads may be required to achieve this.

Connect the external components – switches S1-4, loudspeaker SP, and battery holder to the appropriate positions on the board, using lengths of the hook-up wire, as required, for the switches and speaker wiring. The bared ends of the hook-up wire should be twisted together and tinned before soldering them to the components/board. Ensure that the battery holder is wired in the correct way, so that the red lead fits in the hole marked 'VCC', and the black lead in the hole marked 'GND'. All the cables can then be twisted together in pairs, for neatness.

Trim excess component leads from the underside of the PCB. Having completed the board assembly, check your work for misplaced components, solder whiskers, bridges and dry joints, then clean excess flux off the board using a suitable solvent.

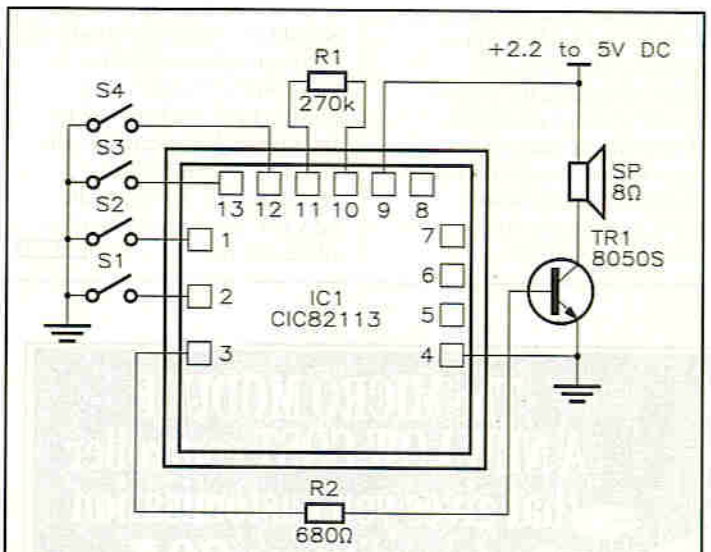
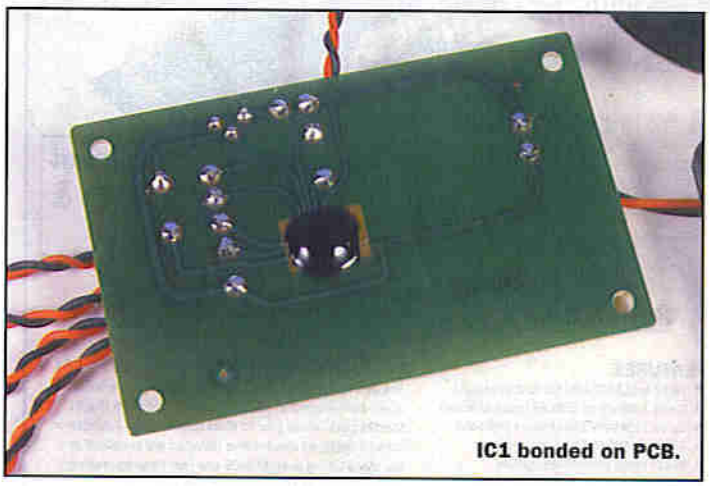


Figure 1. Circuit diagram.

Pad position	Pin	Function
1	TG2	Trigger 2 input pin, active low
2	TG1	Trigger 1 input pin, active low
3	AUD	Audio output
4	VSS	Negative supply, GND
5	END1	Section 1 end pulse output, open drain, active low
6	END2	Section 2 end pulse output, open drain, active low
7	END3	Section 3 end pulse output, open drain, active low
8	TEST	Test pin
9	VDD	Positive supply
10	OSC2	Oscillator output pin
11	OSC1	Oscillator input pin
12	TG4	Trigger 4 input pin, active low
13	TG3	Trigger 3 input pin, active low

Table 2. Pad descriptions of IC1.


IC1 bonded on PCB.

SPECIFICATION

Operating voltage:	2·2-5V DC (3V nominal)
Operating current:	70mA (average)
Standby current:	<1μA
PCB dimensions:	77 × 49mm

Testing and Use

Fit two fresh AA-size batteries into the holder the correct way round, as shown on the holder itself (with the battery '–' terminal against the spring). Now push one of the switches, and a familiar train sound effect should be emitted. Try each switch in turn, which should result in a different sound effect for each button pressed – see Table 1. Note, you will need to wait for one sound effect to stop before being able to activate another.

If all is well, the circuit is ready for use and can be installed into the chosen application.

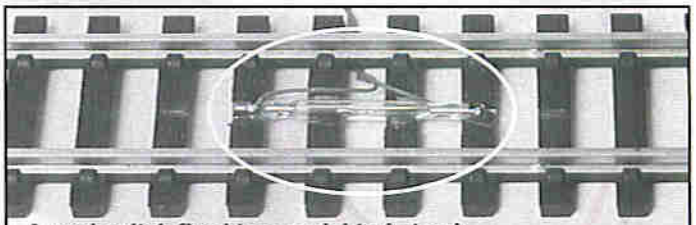
It is possible to significantly improve the overall sound from the loudspeaker, by either fitting it rigidly into a box (with a sound hole), or by abutting it with the open end of a length of tubing of a diameter matching the speaker (e.g. the cardboard tube from a kitchen roll or similar), which has the effect of making the sound louder and more resonant. If your model train layout has a tunnel, the loudspeaker could be installed inside it for an authentic 'train in a tunnel' sound!

Some experimentation will be required to achieve the best sound for the chosen application. Alternatively, a larger loudspeaker could be fitted, of a similar impedance/ power rating to the specified type.

A separate kit could be installed into areas on the layout where you have a level crossing, bridge, etc., to provide a dedicated sound on that feature – worthwhile on large layouts. The push switches could be replaced by reed-switches embedded in the track, so that the sound is automatically activated when the train arrives, thus making the (fat?) controller's job easier. Of course, the kit could be installed into the train itself, assuming it was large enough – why not impress your neighbours with a fully eatured train layout built into the back garden. . . .

Note that the batteries should be replaced periodically, to avoid leakage. Alkaline types will last longer, and tend to be more leak-resistant than normal zinc-carbon cells. Ni-Cad batteries are not really suitable, owing to the very low power consumption of the circuit.

A magnet installed under a model train.



A reed switch fixed to a model train track.

OPTIONAL PARTS LIST

AA Battery – Pack of Four	1 Pkt	(EM15R)
Duracell AA	2	(JY48C)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The project items (excluding optional) are available in a kit form only.

Order As 95219 (Train Sounds Kit) Price £6.99

NEW BOOKS

30 Simple IC Terminal Block Projects

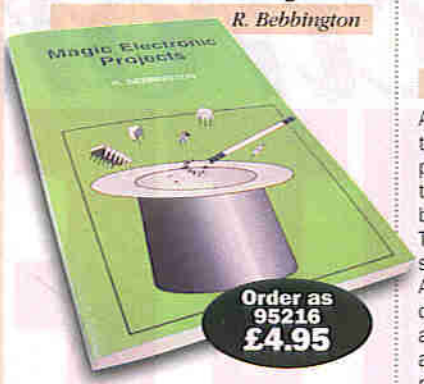
R. Bebbington

Constructors in electronics, particularly youngsters and beginners, may think that the step from discrete components to integrated circuits is a 'bridge to far'. Here are 30 easy-to-build IC projects that will prove otherwise! Continuing the minimal soldering, screwdriver technique of *45 Simple Electronic Terminal Block Projects*, this IC version forms a natural sequel. The book also provides safe and simple integrated circuit solutions for games, security, communications, music and other projects.
1996. 128 pages. Illustrated.

All of the books featured on this page are available by Maplin MPS Mail Order. Credit Card Hotline on (01702) 554000. All orders for Maplin MPS account holding customers and other orders over £30.00 inc. VAT will be despatched free of all handling carriage charges. Orders less than £30.00 will warrant a small order charge of £2.95 inc. VAT. Export customers see current edition of the Maplin MPS catalogue for details of carriage.

Magic Electronic Projects

R. Bebbington



The top hat and magic wand are familiar trademarks of the magician, but throw in a few electronic components and you have the ingredients for a 'magician extraordinaire'. This book offers some simple circuits that will add an electronic flavour to some of the basic tricks up the performer's sleeve as well as adding a few more. Most of the circuits are easy to construct and introduce the reader to series and parallel circuits; sensors, such as reed switches and light-dependent resistors; LEDs; multivibrator and Hartley oscillators; monostables, bistables and schmitt triggers; NAND-gates and decade counters. All the circuits are ideal for beginners in electronics and/or magic, and as a very practical approach has been adopted by the author, they may also be suitable for schools electronics courses.
1993. 84 pages. Illustrated.

Test Gear and Measurements

Danny Stewart

This book is a clear introduction to test gear in the field of electronics. As well as being a first class guide to test gear and its use, the book includes much practical information and reference material for the more experienced electronics enthusiast or student. Based on a collection of feature articles originally published in *Electronics*, this book is sure to be of great value. Details are included of all the common (and not-so-common) items of test gear, alongside information regarding its use in various measurement situations.
1996. 166 pages. Illustrated.

The Novice Radio Amateurs Examination Handbook

I. Poole

Amateur radio has long captivated the interests of may thousands of people. To help more people into the hobby, a novice license has been introduced into the UK. This book covers the basic syllabus for the Novice Radio Amateurs Examination, and is designed to supplement the associated course. It also provides a basic introduction into amateur radio and the technology behind it for anyone wanting to learn more. Topics included in the book cover basic electronics, radio receivers, transmitters, operating practices and much more.
1996. 144 pages. Illustrated.

The Internet and World Wide Web Explained

J. Shelly

Whenever the media get hold of something new, they make a meal of it, hyping it up out of all recognition. This book explains what the information superhighway really is and how it relates to the Internet and the World Wide Web. However, whether we wish to find out information or to 'converse' with others on the Internet who share our particular interest, we come face to face with Internet jargon, which is explained in plain simple English. This book will help you understand and more importantly, give you the knowledge and expertise to use the Internet.
1996. 144 pages. Illustrated.

Electronic FILTER CIRCUITS PART 2

by Ray Marston

Ray Marston takes an in-depth look at modern electronic filter circuits in this 3-part series.

Resonant L-C Filters

L-C filters are used primarily, but not exclusively, in high-frequency applications. Like C-R types, they can easily be designed to give low-pass, high-pass, band-pass, or 'notch' filtering action, but have the great advantage of offering at least 12dB per octave of roll-off, compared to the 6dB/octave of C-R types.

The two most important types of L-C filter, from which all others are ultimately derived, are the series and the parallel resonant types. Figure 1(a) shows the actual circuit of a series resonant filter, and Figure 1(b) shows its simplified equivalent circuit; 'R' represents the resistance of the coil. The circuit's basic action is such that the reactance of C decreases, and that of L increases, with increases in frequency, and vice-versa, and the circuit's input impedance is equal to the difference between these two reactances, plus R. Thus, if at some particular frequency, C and L have reactances of 10kΩ and 1kΩ respectively, the circuit's input impedance (ignoring R) will be 9kΩ at that frequency, and so on.

The really important thing about all this is that at some particular frequency, f_c, the reactances of C and L will inevitably be equal, and the circuit's input impedance will then equal R, as shown in Figure 2(a). Suppose this occurs when the reactances of C and L are each 1kΩ, and that R equals 10Ω. In this case, the input impedance falls to 10Ω, and the entire signal voltage is generated across R. R's signal currents, however, flow via C and L, which each have a reactance 100 times greater than R;

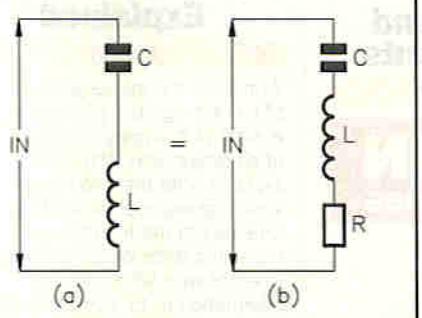


Figure 1. Actual (a) and simplified equivalent (b) circuit of L-C series resonant filter.

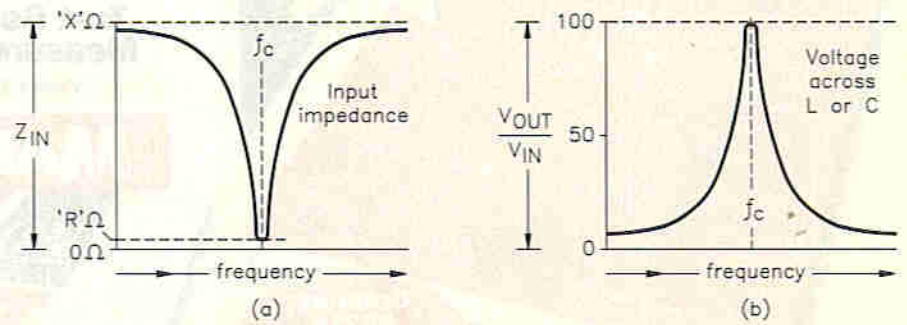


Figure 2. Graphs showing how (a) the input impedance and (b) the L or C signal voltage of the series resonant filter varies with frequency.

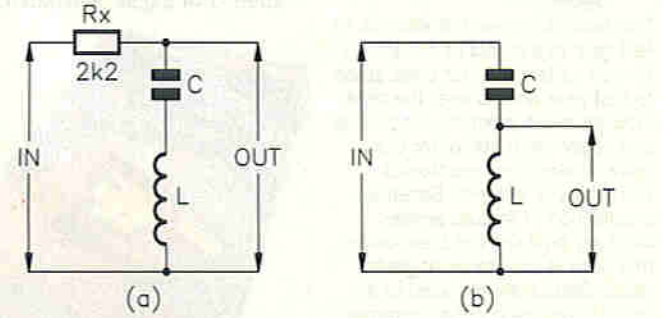


Figure 3. Ways of using a series resonant filter as (a) a notch rejector and (b) a notch acceptor.

$$f_c = \frac{1}{2\pi\sqrt{LC}} \qquad Zo = \sqrt{\frac{L}{C}}$$

$$L = \frac{Zo}{2\pi f_c} \qquad C = \frac{1}{2\pi f_c Zo}$$

$$Q = \frac{XL}{R} = \frac{Zo}{R}$$

Figure 4. Basic design formulae for all the L-C filters shown in this article.

consequently, the signal voltage generated across C and across L is 100 times greater than the actual input signal voltage, as shown in Figure 2(b); this voltage magnification is known as the circuit's 'Q'. Note that the L and C voltages are in antiphase, and the voltage generated across the series L-C combination is thus zero. The f_c impedance of L (or C) is known as the circuit's 'characteristic impedance, Z_o', and equals $\sqrt{(L/C)}$.

Figure 3 shows two basic ways of using a series resonant L-C filter. In (a), the 2k2Ω resistor (Rx) and the filter act together as a frequency-selective attenuator that gives very high attenuation at fC, and low attenuation at all other frequencies, i.e., the circuit acts as a notch rejector. In (b), the input signal is applied directly to the filter, and the output is taken from across L; this circuit thus acts as a notch acceptor that gives high gain at f_c and low gain at all other frequencies.

Figure 4 lists the major formulae that apply to the Figure 1 series resonant circuit, and also to all other types of L-C filter described in this article.

Figures 5(a) and 5(b) show the actual and equivalent circuits of a parallel resonant filter; 'R' represents the coil's resistance. This circuit's basic action is such that C's reactance decreases and L's increases with increases in frequency, and vice-versa; each of these components draws a signal current proportional to its reactance, but the two currents are in antiphase, so the total signal current is equal to the difference between the L and C currents. At f_c, the L and C reactance are equal, and the total signal current falls to near-zero; the filter thus acts as a near-infinite impedance under this condition. In reality, the presence of 'R' modifies the action slightly, and reduces the f_c impedance, Z_c, to Z_o^2/R. Thus, if Z_o equals 1kΩ and R equals 10Ω, the actual Z_c value is 100kΩ. Figure 5(c) shows how the input impedance varies with frequency. All of the formulae of Figure 4 apply to the parallel resonant filter.

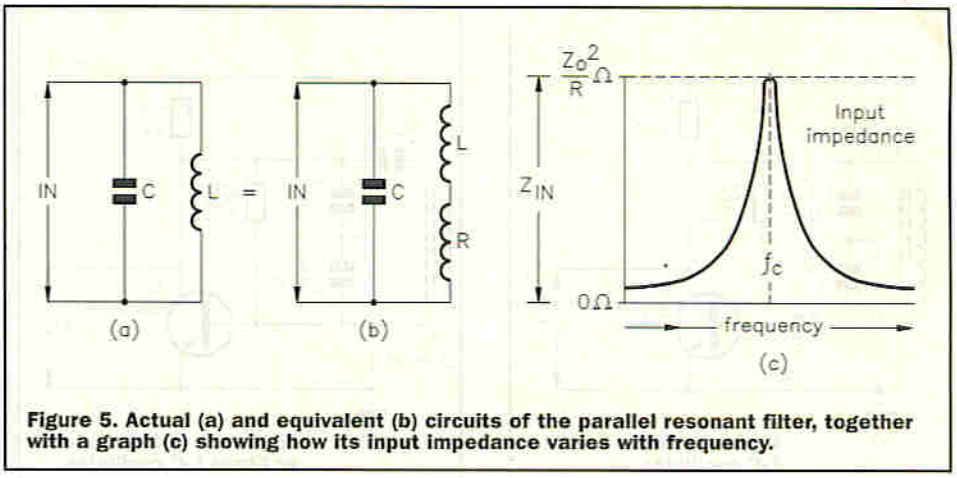


Figure 5. Actual (a) and equivalent (b) circuits of the parallel resonant filter, together with a graph (c) showing how its input impedance varies with frequency.

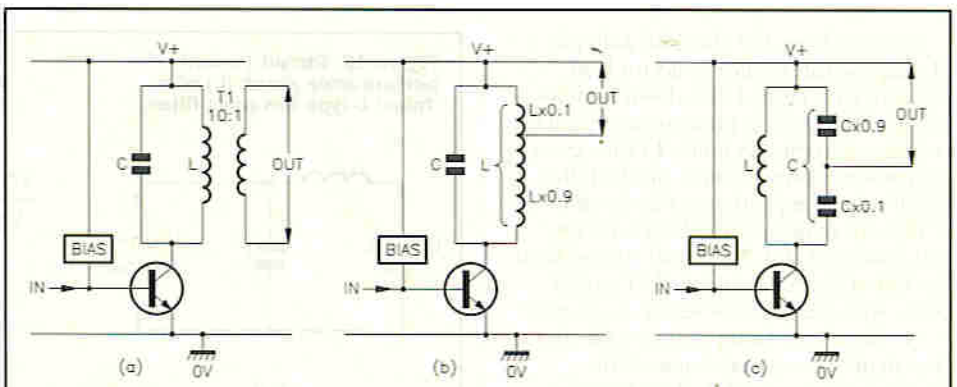


Figure 6. L-C tuned amplifiers with low-impedance outputs using (a) transformer coupling, (b) auto-transformer coupling, and (c) capacitive-divider coupling.

Output Coupling

The two most popular applications of the parallel resonant or 'tuned' filter are in narrow frequency band amplifiers and L-C oscillators. In the former case, the filter usually acts as the collector load of a common emitter amplifier, etc., as shown in basic form in Figure 6, so that the circuit gives high gain at the resonant frequency and low gain at all others. An obvious problem here is that of gaining access to the circuit's output signals without loading the tuned circuit and thus lowering its effective Q. There are three alternative solutions to this problem, and they are all shown in the diagram.

One way to gain successful output coupling is to use the primary winding of an RF transformer as the filter's 'L' component, and to take the output from the transformer's secondary, as shown in Figure 6(a). This system has the advantage of giving a fully floating output. If the transformer has a 10:1 turns ratio, the output signal will have an attenuation factor, 'a', of 10. Alternatively, the coil itself can be provided with a tapping point, as shown in Figure 6(b), to give an output by autotransformer action, or the tuning capacitor can be made of two series-connected components, as shown in Figure 6(c), to give an output across the larger of the pair by capacitive divider action. Note in these diagrams, that each circuit has arbitrarily been given an 'a' value of 10. Each of these circuits gives an output impedance of Z_c/a^2. Thus, if Z_c equals 100kΩ and 'a' equals 10, Zout equals 1kΩ.

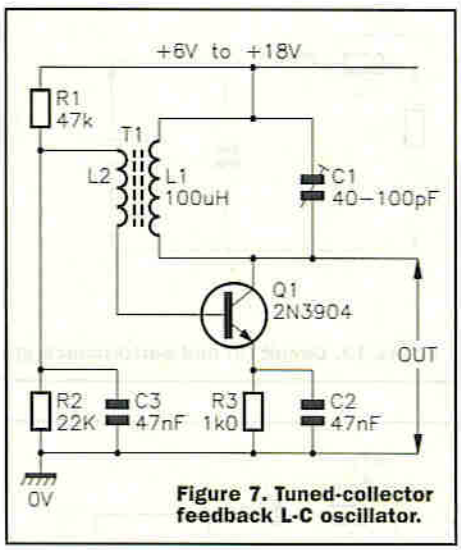


Figure 7. Tuned-collector feedback L-C oscillator.

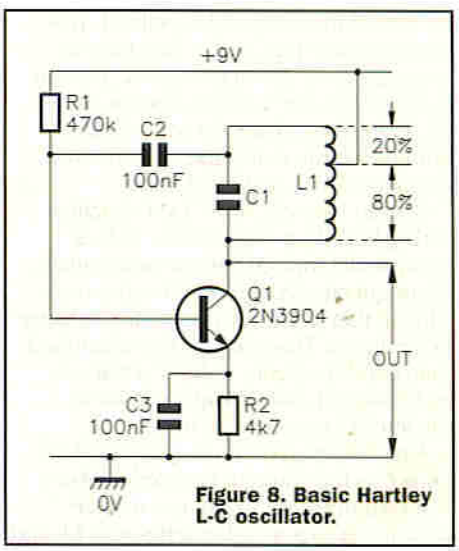


Figure 8. Basic Hartley L-C oscillator.

L-C Oscillators

There are many different ways of using a parallel resonant filter as the tuning element in an L-C transistor oscillator – Figures 7 to 11 show a few of them. The simplest of all L-C oscillators is the tuned-collector feedback type, shown in Figure 7. Here, Q1 is wired as a common emitter amplifier, L1 & C1 form the tuned collector filter, and collector-to-base feedback is provided via L2, a small winding inductively coupled to L1 and which thus provides a transformer action. By selecting the phase of this feedback signal, the circuit can be made to give zero loop phase shift at the tuned frequency so that, if the loop gain (determined by T1's turns ratio) is greater than unity, the circuit oscillates. With the component values shown the oscillation frequency is variable from 1 to 2MHz via C1.

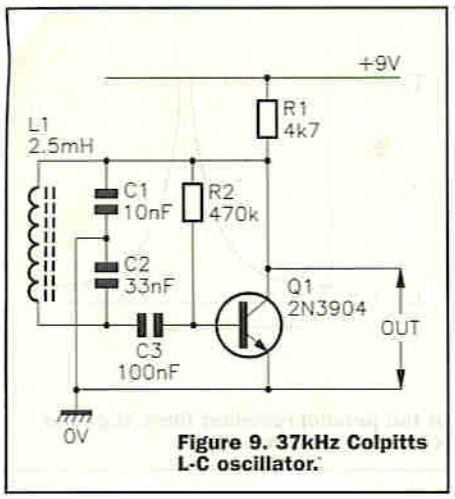


Figure 9. 37kHz Colpitts L-C oscillator.

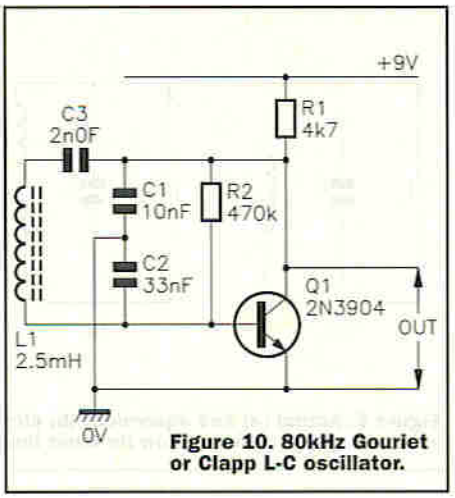


Figure 10. 80kHz Gouriet or Clapp L-C oscillator.

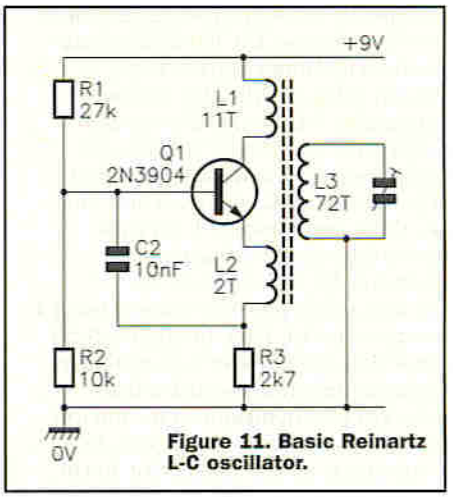


Figure 11. Basic Reinartz L-C oscillator.

Figure 8 shows the circuit of a simple Hartley oscillator. Here, collector load inductor L1 is tapped 20% down from its top, and the circuit's positive supply rail is connected to this tap point; L1 thus gives an auto-transformer action, in which the signal voltage appearing at the top of L1 is 180° out of phase with that on its low (Q1 collector) end. The signal voltage from the top of the coil (which is 180° out of phase with the collector signal) is coupled to Q1 base via isolating capacitor C2, and the circuit thus oscillates at a centre frequency determined by the L-C values.

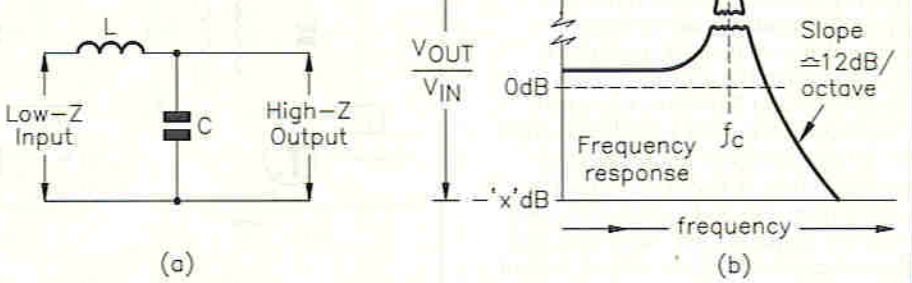
Note from the above description, that oscillator action depends on a 'common signal' tapping point being made into the tuned circuit, so that a phase-splitting autotransformer action is obtained. This tapping point does not, in fact, have to be made in the actual tuning coil, but can be made into the tuning capacitor, as in the Colpitts oscillator, shown in Figure 9. With the component values shown, this circuit oscillates at about 37kHz.

Note in Figure 9, that C1 is in parallel with Q1's output capacitance, and C2 is in parallel with Q1's input capacitance. Consequently, changes in Q1 capacitance (due to thermal shifts, etc.) cause a change in frequency. This effect can be minimised (and good frequency stability obtained) by making C1 and C2 large, relative to the internal capacitances of Q1.

A modification of the Colpitts oscillator, known as the Clapp or Gouriet oscillator, is shown in Figure 10. Here, a further capacitor (C3) is wired in series with L1, and has a value that is small relative to C1 and C2. Consequently, the circuit's resonant frequency is determined mainly by the values of L1 and C3, and is almost independent of variations in transistor capacitances. This circuit thus gives excellent frequency stability. With the component values shown, it oscillates at about 80kHz.

Finally, Figure 11 shows the basic circuit of a so-called Reinartz oscillator. Here, the tuning coil has three inductively coupled windings. Positive feedback is obtained by coupling the collector and emitter signals of the transistor via windings L1 & L2. Both of these inductors are coupled to L3, and the circuit oscillates at a frequency determined by L3 & C1. The diagram shows typical coil-turns ratios for a circuit designed to oscillate at a few hundred kHz.

Figure 12. Circuit (a) and performance graph (b) of a 'false' L-type low-pass filter.



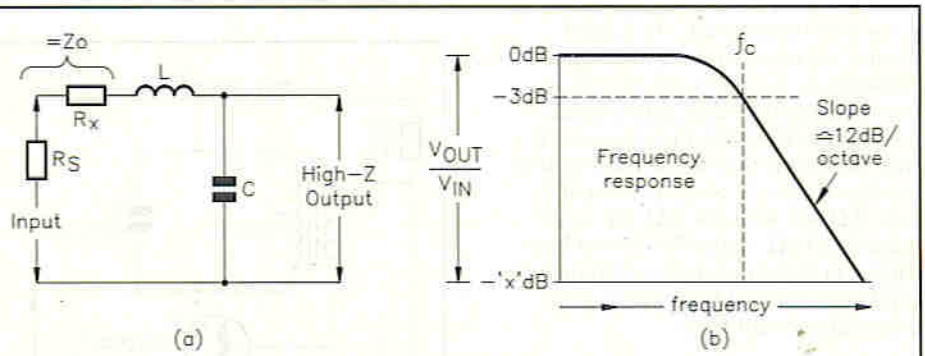


Figure 13. Circuit (a) and performance graph (b) of a genuine L-type low-pass filter.

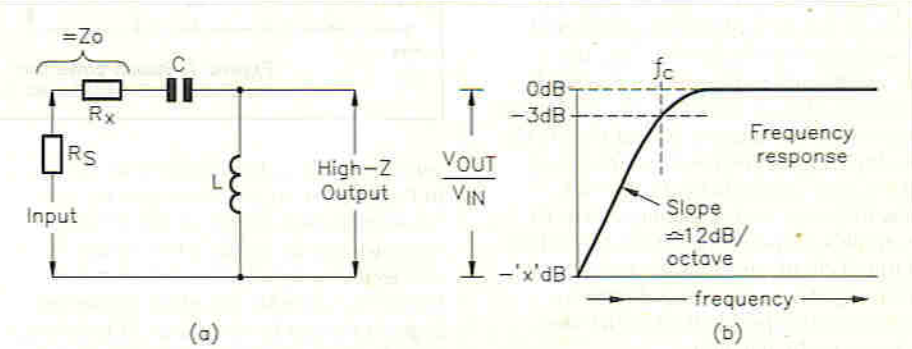


Figure 14. Circuit (a) and performance graph (b) of an L-type high-pass filter.

Low-pass and High-pass L-C Filters

Figure 12(a) shows the basic circuit of a 'false' L-type low-pass filter. L and C act together as a frequency-dependent attenuator. At low frequencies, the reactance of L is low and that of C is high, so the circuit gives negligible attenuation, and at high frequencies, the reactance of L is high and that of C is low, so the circuit gives high attenuation. The circuit thus acts as a low-pass filter. I have called it a 'false' filter because the circuit will only work

correctly if it is driven from a source impedance equal to Z_o, but there is no indication of this fact in the diagram. The circuit is actually a series resonant filter (like Figure 1), with its output taken from across C. If the circuit is driven from a low-impedance source, the output will consequently produce a huge signal peak at f_c, as shown in Figure 12(b). The magnitude of this peak is proportional to the circuit's Q value.

Figure 13(a) shows how the above circuit can be modified to act as a genuine L-type low-pass filter, by wiring Rx in series with the circuit's input, so that the sum of Rx and Rs (the input signal's source impedance) and R (the resistance of L) equals the circuit's characteristic impedance, Z_o. The addition of this resistance reduces the circuit's Q to precisely unity, and the low-pass filter consequently generates the clean output shape shown in Figure 13(b).

Figure 14 shows how the above principle can be used to make a good L-type high-pass filter; the output is simply taken from across inductor L, rather than from C. Note in both these circuits, that resistor Rx can be reduced to zero if the filter's Z_o value is designed to match Rs, as shown in the design formulae of Figure 4. Also note that the outputs of these filters, like those of the series and parallel resonant types, must feed into high-impedance loads only.

The most widely used types of low-pass and high-pass filters are balanced, matched impedance types that are designed to be driven from, and have their outputs loaded by, a specific impedance value. Such filters can readily be cascaded, to give very high levels of signal rejection. Amongst the most popular of these filters are the T-section and π-section low-pass types shown in Figure 15, and the T-section and π-section high-pass types shown in Figure 16. Note that all of these types give an output roll-off of about 12db/octave (= 40dB/decade), and must have their outputs correctly loaded by a matching filter section or terminating load. Their design formulae is given in Figure 4.

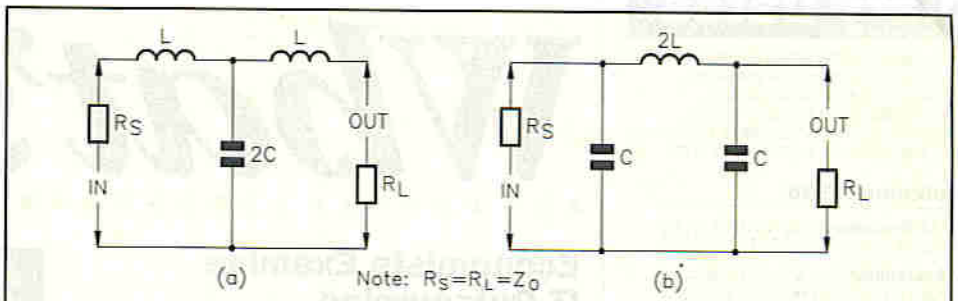


Figure 15. (a) T-section and (b) π-section low-pass filters (see Figure 4 for design formulae).

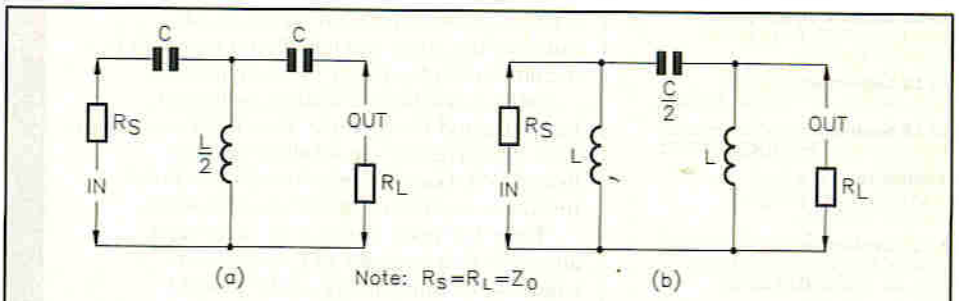


Figure 16. (a) T-section and (b) π-section high-pass filters (see Figure 4 for design formulae).

Finally, to complete this look at L-C filters, Figure 17 shows a useful 'test gear' application of T-section low-pass filters, as AC power line filters that will stop line-borne interference from reaching the test gear, or test gear generated hash from reaching the AC power line. The circuit is useful up to about 25MHz.

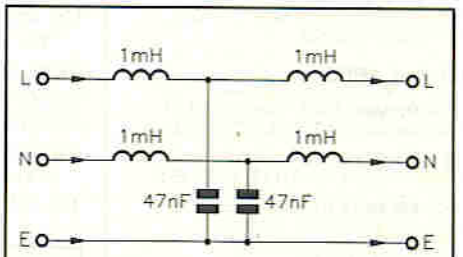


Figure 17. T-section mains (AC power line) input filter rejects line-borne interference up to about 25MHz.

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.

September 1996

8 to 11 September. Presentation Technology, Earls Court, London. Tel: (0171) 370 8229.

12 September. City & Guilds Radio Amateur's Course at Highbury College, Portsmouth. Tel: (01705) 383131.

12 to 15 September. Hi-Fi Show, Ramada Hotel, London. Tel: (0181) 686 2599.

17 to 19 September. Computing in Manufacturing, NEC, Birmingham. Tel: (01932) 564455.

18 to 19 September. EMC UK, Olympia, London. Tel: (01981) 590481.

18 to 19 September. Instrumentation Exhibition, Aberdeen. Tel: (01822) 614671.

21 September. Radio Rally, Scottish Convention, Glasgow. Tel: (01707) 659015.

25 to 26 September. Digital Signalling Processing, Sheraton Skyline Hotel, London. Tel: (0181) 614 8042.

25 to 27 September. Object Technology Conference & Exhibition, QEII Conference Centre, London. Tel: (01306) 631331.

25 to 29 September. LIVE – Consumer Electronics Show, Earls Court, London. Tel: (0181) 742 2828.

October 1996

4 to 6 October. RSGB International HF Convention, Windsor. Tel: (01707) 659015.

5 to 6 October. Model Railway Exhibition, NEC, Birmingham. Tel: (0121) 558 8851.

7 October to 16 December. Science Museum Superhighway UK Tour, Kelvingrove Museum, Glasgow. Tel: (0171) 938 8192.

8 to 10 October. Voice Europe, Olympia, London. Tel: (01244) 378888.

18 to 19 October. Leicester Amateur Radio Show, Leicester. Tel: (01707) 659015.

18 to 27 October. PC Home Show, NEC, Birmingham. Tel: (0181) 849 6200.

28 to 30 October. International Conference on Sizewell B – The First Cycle, IEE, London. Tel: (0171) 344 8432.

29 to 31 October. Electronics Commerce, Barbican Exhibition Centre, London. Tel: (0181) 332 0044.

30 October. Networld Interopt – Computer Networking & Interoperability, Earls Court, London. Tel: (0181) 849 6200.

November 1996

1 to 3 November. Acorn World Computer Show, Olympia, London. Tel: (01295) 788386.

6 to 9 November. Apple Expo, Olympia, London. Tel: (0171) 388 2430.

9 to 10 November. Radio Rally, Llandudno, North Wales. Tel: (01707) 659015.

11 November. System Approach to Manufacturing, IEE, Savoy Place, London. Tel: (0171) 344 5427.

26 November. Manufacture – Save Time, Save Money, IEE, Savoy Place, London. Tel: (0171) 344 5427.

December 1996

3 to 4 December. DSP UK – Digital Signal Processing Exhibition, Ramada Hotel, London. Tel: (0181) 547 3947.

3 to 5 December. International Online Information Exhibition, Ramada Hotel, London. Tel: (01865) 730275.

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

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 3, Rayleigh, Essex SS6 8LR or e-mail to swaddington@cix.compulink.co.uk.

What's On?

Economists Examine IT Outsourcing

The Computer Security Research Centre at the London School of Economics (LSE) is to host a conference on the future of outsourcing, under the title 'Better Out than In – the limits of outsourcing' on November 11.

Speakers will include leading politicians, Ian Taylor and Doug Hoyle, as well as Guy Griffiths from British Aerospace, Godfrey Thomas from SEMA, Gary Richards from Royal Global Insurance and Diana Billingham of Hoskyns.

"There has been a great deal of concern among both academics and practitioners over how far outsourcing can be pushed, and in particular, how far a company's essential functions can be entrusted to a third party", says Peter Sommer, a Visiting Fellow at the LSE and one of the organisers.

"We are providing a one-day event at which these matters can be thoroughly aired and we are pleased with the readiness with which industry leaders accepted our invitation to participate", added Sommer.

Contact: London School of Economics, Tel: (0171) 955 6153.

Light Work at Science Museum

The incandescent lamp was developed in around 1880 in the UK and the USA, and within a few years, several firms were manufacturing lamps and lighting systems. They soon began advertising. This Summer's IEE Archives Department exhibition, held at the Science Museum, explores the advertising of electric light.

Manufacturers picked up on themes that had been used successfully for other products. Glamorous women have been used throughout the history of advertising to sell almost anything – electric lamps were no exception.

Another popular theme was the Empire, appealing to the patriotism of the consumer. With the completion of the National Grid in the 1930s and developments in lamp technology, manufacturers emphasised the savings to be made with their brand, or they insisted that no smart modern home was complete without their lamps. With the recent development of energy-saving and long-life lamps, these themes have been employed yet again.

The exhibition draws on advertising leaflets dating back to 1883, and includes a remarkable series of adverts from the magazine *The Electrical Age*. Modern packaging brings the story right up to date, and the illustrations are supported by lamps and packaging from The Science Museum's vast collections.

The exhibition is located in the Update Area of the Science Museum Lighting Gallery, and will run until January 1997. Contact: IEE, Tel: (0171) 344 5427.

Manufacturing Update From IEE

The IEE is organising a seminar on developments in manufacturing, ranging from prototyping to full scale production. Entitled 'Manufacture – Save Time, Save Money', it will be held at the IEE, Savoy Place, London on November 26.

It is essential that both designers and manufacturing engineers are aware of new developments in production techniques.

The designer must be aware of how products are shaped and formed – both for the rapid translation of idea to the prototype stage, and for cost-effective full-scale production. The manufacturing engineer must give guidance on the range of techniques available and their relative cost, accuracy and repeatability.

Stero-lithography is primarily intended for prototype manufacture, whereas the latest development in wire EDM are for both prototype and small volume production.

Laser forming is often thought of as suitable for prototypes and small volumes, but it is gaining ground as a production toll, especially for usual shapes or difficult materials.

Electroforming is normally used for volume production and has an outstanding variety of applications.

Contact: IEE, Tel: (0171) 344 5427.

Children and the Internet

NCH Action For Children is publishing an easy to understand parent's guide to the Internet at the country's leading consumer electronics show, Live '96 at the end of September.

The guide will include topics such as safeguards which parents can take to protect their children from pornography on the Internet and advice for parents on how to help children access the enormous range of educational material available in a safe way. Other dangers, such as how to shield children from paedophiles masquerading as friends on bulletin boards and Cyber chat channels will also be examined.

The guide has been prompted by the publicity surrounding the dangers to children using the Internet, and issue that has led to numerous prosecutions in the US. Whilst experts debate whether or not the Internet should be exempt from a country's laws on printing obscene material, children are accessing unsuitable publications with very little effort.

Anybody wishing to obtain a copy of the NCH Action For Children Parents' Guide to the Internet should write to the Information Department, NCH Action For Children, 85 Highbury Park, London N5 1UD.

Live '96 runs from 25 to 29 September at Earls Court, London. Tickets are now on sale, priced £9 for adults and £5 for children, from (0171) 396 4545.

Boxing Clever

THE EVOLUTION OF THE SET-TOP BOX

Photo 1. Robin Saxby, CEO of Advanced RISC Machines.

Outside Microsoft, the IT industry is pinning its future on the network computer and set-top box. But while 150 million PCs will be sold globally this year, set-top boxes are still on trial, and we'll have to wait until November to see the first network computer from Oracle. Here, Stephen Waddington talks to Robin Saxby, CEO of Advanced RISC Machines (ARM), and asks how real is the vision of the set-top box, and how will manufacturers produce products that are within the price range of the consumer.

The set-top box is one of the key components of the much-hyped information superhighway, but no one is sure what facilities customers will want or for that matter, are prepared to pay. A variety of roles have already been slated for it: the set-top box will serve as a gateway to subscription and pay-per-view services delivered by satellite, cable or terrestrial links; it will marshal video-on-demand and other interactive services such as home shopping; it could provide a low cost entrée to the Internet, turning 'net surfing into a family past-time. It could also serve as a games console for advanced 3D video games.

Just how these options will be packaged is an issue for the entrepreneur or the marketing professionals. Whatever they decide, the technical challenge facing the systems developer is formidable.

Robin Saxby, CEO, Advanced RISC Machines, reckons that a fully featured set-top box providing interactive multi-media services such as Video on Demand (VOD) is about twice the complexity of a PC. "But it will have to sell for one third of the price, or around £330, reducing to that magic price point of the video recorder of £130 to £150, if it is to win widespread acceptance", adds Saxby.

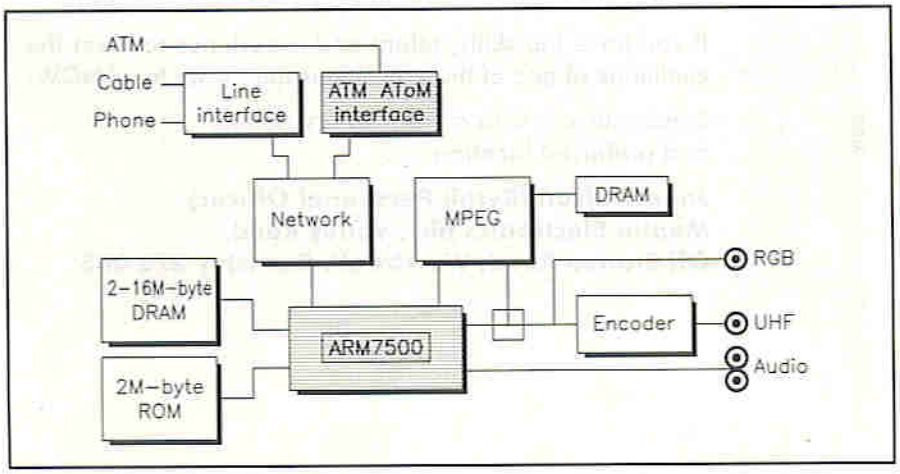


Figure 1. A generic set-top box.

Network Computers

Undeterred by the problems, consumer electronics, telecommunications and computer manufacturers are scrambling to develop a market-winning set-top box. Innovative ideas continue to appear. Recently, Teknema, based in Menlo Park, California, has demonstrated a prototype £330 network computer for use as an ARM-powered Internet browser, called Easy Rider. At Comdex Europe, Viewcall Europe demonstrated a set-top box, Webster, specifically designed for TV sets to access the Internet's World-wide Web sites.

According to Saxby, "The development of a set-top box at a price target of £330 ultimately depends on the semiconductor industry's ability to continue a pace of integration that, over the last decade, has seen circuit complexities double every 18 months to two years. Personally, I am confident that this law, first coined by Intel's Gordon Moore, still applies and can deliver the goods".

However, it means that, to make a set-top box at an acceptable price, the system electronics will need to be shrunk to one or, at most, two very large scale integrated (VLSI) chips. Getting the right silicon strategy will be crucial. The designer's primary objective must be to minimise chip area and hence, overall system cost. The chosen design methodology should also be capable of delivering first time right silicon, thus cutting time to market. And since the system developer may need to support several different set-top applications, the system architecture must also be flexible.

Since implementation of application software comes free, the resulting system will almost certainly be based on an embedded microprocessor architecture; one that is capable of performing a multiplicity of signal processing and control functions in real time, with a large part of the work done in software rather than hardware.

Components

What will such a system look like? First, let's examine the systems functions that are performed by the interactive set-top box and then the electronic functions that will be needed to provide this capability.

Whether services are delivered by satellite, terrestrial transmitters or cable, the set-top box will incorporate a common set of functions, as shown in Figure 1. These include the network interface; decompression of the digitised and compressed video and audio transmission; demodulation of incoming data; modulation of outgoing transmissions; error correction; sophisticated graphics acceleration and up to 4M-byte of main memory.

"The semiconductor industry consultancy, Dataquest, recently estimated that the component cost alone of an interactive set-top box, using present-day technology, would amount to between £270 and £400. But the marketing people say that the target price of fully engineered set-top boxes in the shops should start at the £330 mark. So, the industry still has a long way to go. Although network computers (cut-down set-top boxes) easily reach the £330 selling price using ARM7500", says Saxby.

To achieve these goals, systems designs will need to migrate to higher density IC processes. Today, ASIC processes with 0·8μm line widths are in widespread use, while 0·35μm design rules are now coming on stream for high-volume leading-edge products like the Pentium Pro. The shrink in circuit dimensions by moving from 0·8 to 0·35μm line widths will reduce the system chip count for a set-top box from four to a single chip, while the relative cost of the silicon would be cut by a factor of five, as shown in Table 1.

Process Geometry (μm)	0·8	0·6	0·5	0·35
Number of Chips	4	2	2	1
Chip Size (mm²)	70	79	57	54
Relative Solution Cost	1	0·56	0·41	0·19

Table 1. Semiconductor technology provides one solution to driving cost down.

Speed Benefits

The move to smaller circuit dimensions brings other benefits. The physics of semiconductor devices is such that clock speeds (and hence, processor throughput) increase rapidly as circuit geometry shrinks, as shown in Table 2. For example, a microprocessor that runs at 33MHz when implemented in a 0·8μm, can be clocked at over 100MHz when designed in a 0·18μm process. This increased clock speed translates into greater microprocessor throughput, and this in turn means that many more functions can be executed in software. The net result is to the chip size and overall component cost.

Process Geometry (μm)	0·6	0·5	0·35	0·25	0·18
Maximum Clock Speed (MHz)	40	50	66	80	100

Table 2. Clock speed and data throughput improves dramatically with diminishing process geometry.

Choice of Embedded Processor

Since cost is a key factor in the design of a set-top box, the choice of embedded processors will be guided by the smallest die size compatible with the required system performance. This handicaps Complex Instruction Set (CISC) processors such as the Intel x86 family and favours one or other of the RISC-based processors.

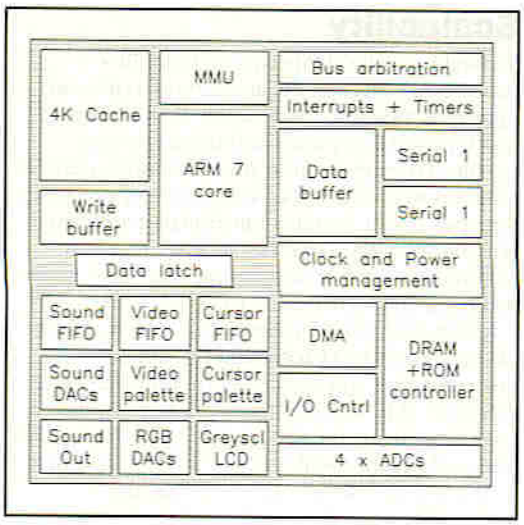
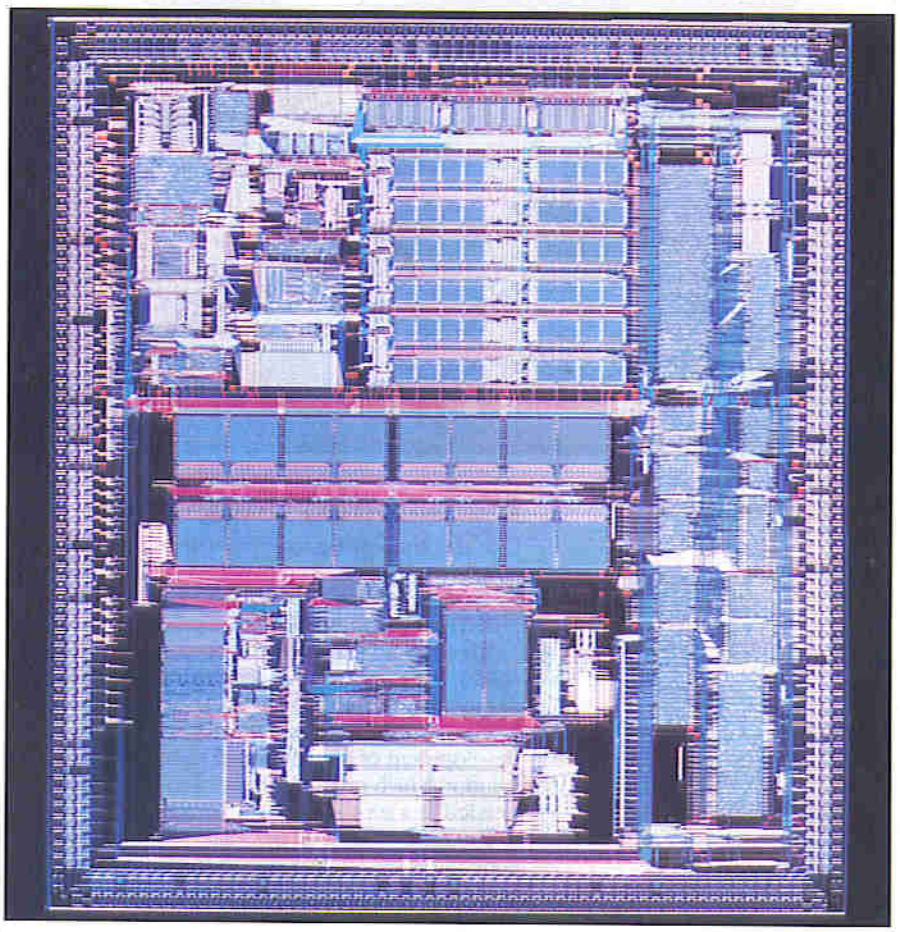


Figure 2. Block diagram of the ARM7500.

System cost is also heavily affected by memory costs. The solution with the most efficient use of memory will be the cheapest. The ARM7500 uses unified memory for both main memory and video memory, giving cheapest memory solution, but with innovative hardware to maintain high performance. A block diagram of the ARM7500 is shown in Figure 2, while a chip plot is shown in Photo 2.

According to Saxby, "A 32-bit processor is mandatory for this application, but the die size of a 32-bit embedded RISC microprocessor can vary by an order of magnitude from one RISC processor to another. The smallest, by a big margin, is the ARM7. When implemented in 0·60μm line widths, it takes up just 3·88mm². But despite its small die size, the ARM7 is directly comparable with other processors in terms of raw MIPS performance and MIPS/Watt, an important factor in controlling chip dissipation".

Photo 2. ARM7500 die shot.



Scalability

Scalability, or the ability to match the RISC processing power to the application, is also an important design consideration. Provide too much processing power and there is a cost penalty. Provide too little, and the system may not function to specification. The choice of processor depends on the systems functionality, and could range from a basic Internet browser to a fully featured set-top box supporting video-on-demand and other interactive services.

Ideally, systems designers would like a choice of core processors each using the same instruction set and capable of running the same software. The ARM RISC family now comprises 3 core processors, the ARM7, ARM8 and StrongARM. The performance scales from 0 to over 200MIPS.

The most powerful of these cores, the StrongARM, is a joint development between ARM and Digital Equipment. It combines ARM's low-power architecture with Digital's high-performance processor design expertise and CMOS processor leadership to produce an embedded chip core with supercomputer-class performance.

Putting numbers on these claims, the SA-110, running at 100MHz and operating at 1·65V, delivers 115Dhrystone 2.1MIPS while dissipating less than 300mW of power. The 200MHz part operates at 2·0V and performs 230 Dhrystone 2.1MIPS while still running on under a watt of power.

Figure 3. Second level integration.

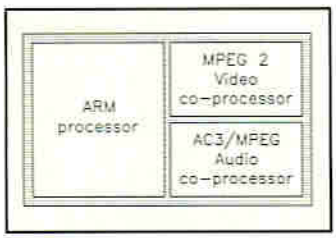


Photo 3. Online Media set-top box.

Incremental Integration

One day, the set-top function will be provided by a standard off-the-shelf chip, but its development will be an evolutionary process as more functions are pulled onto the embedded microprocessor core chip.

A collaborative project between Acorn Online Media, the Cambridge-based set-top box designer/manufacturer, and ARM, provides a good example. The two companies have collaborated in the development of an embedded microprocessor solution which provides many of the core functions needed in a set-top box.

The ARM7500 is used by Online Media in its second generation set-top box shown in Photo 3, but is also available as an industry standard product for use by other manufacturers. It comprises the core 32-bit RISC processor with a user I/O, graphics/text processor, sound DACs, serial I/O, DRAM/ROM controller and some basic glue logic.

The ARM7500 incorporates the functionality of three previous chips – CPU, graphics controller and input/output memory controller – to achieve a saving of approximately £40 on the Dataquest cost model.

ARM 7500 uses unified memory for both the video buffer and main programme use, to reduce memory costs. Performance is maintained by using DMA and other hardware to transfer the video, cursor or mouse, and sound data.

It is implemented in a 0·6μm process, comprises 550,000 transistors and fits on a die size of 70mm^2. When clocked at 33MHz, the chip dissipates between 0·5 and 1W, and delivers 30MIPS of processor performance. It is designed for use with MPEG 1 or MPEG 2 decoders. The ARM7500 dissipates typically 688mV normal operation on an SVGA monitor.

The next stage of integration will see the ARM processor combined on-chip with both an MPEG 2 video co-processor and an AC3/MPEG audio co-processor, as shown in Figure 3. This will eliminate the need for separate MPEG/CP memories and deliver a further £60 cost saving on the Dataquest cost model. Together with the integration already described, the component cost for a set-top implementation will be reduced to between £170 and £200.

The Network Interface

One of the most important design choices is the network interface function. This is an area of great design diversity – in terms of bandwidth requirements, communications protocol and type of physical connection.

Several approaches are being taken to delivering high bandwidth services over the local loop and into the home. Online Media has opted for Asynchronous Transfer Mode (ATM) to pipe services into the home. Another approach is to use a combination of traditional coaxial and digital Integrated Services Digital Network (ISDN) telephone lines. The asymmetrical digital subscriber lines (ADSL) – an upgrade of the traditional telephone line – is also being considered as a set-top box interconnection.

In the United Kingdom, user trials of Video on Demand (VOD) and other interactive services such as home shopping, are being carried out in Cambridge by a consortium of companies including Online Media. The aim is to assess both the technology and the services (see panel). The trial system uses ATM.

In the Cambridge set-up, broadband services are delivered to the home via kerbside ATM switching modules, each serving a cluster of houses. Multi-channel services are delivered over fibre-optic links running at 155M-bps to the kerbside unit, then distributed to individual houses at rates of up to 2M-bps over coaxial cable and twisted pair.

The kerbside switch uses Asynchronous Transfer Mode switching technology developed by Advanced Telecommunications Modules, Cambridge. This is built around an embedded ARM processor as shown in Figure 4, to perform a high-speed cell-switching function.

Modular Design

Other network issues to be decided include the choice of modulation/demodulation and error-correction schemes used. Within the telephone industry, the favoured approach is quadrature phase-shift keying (QPSK); within the cable industry, quadrature amplitude modulation (QAM) is favoured. DAVIC, the Digital Audio-Visual Council, which is currently defining interface standards for end-to-end interactive systems, favours a 256 QAM standard.

With such a wide variety of design variants, modulation and demodulation schemes, network-interfaces and so on to choose from, it's not surprising that many set-top manufacturers have adopted a modular design approach. Modularity provides a way to keep our system-implementation costs as low as possible without losing the ability to serve as wide a vendor base as possible. In these first generation systems, a processor board is teamed with a variety of daughter boards, each catering for different options.

However, within five years, they should be thinking in terms of implementing their modular design schemes in silicon, or they will be left behind.

The AMBA Silicon Bus

The idea of rapidly designing embedded processor systems to a specific application and delivering first-time-right design solutions is the driving force behind the Advanced Microcontroller Bus Architecture (AMBA). This was developed with the support of the European Union Open Microprocessor Initiative (OMI) project, and is being promoted as an open standard.

The basic idea is that design time and development cost can be cut by re-using proven macrocells that conform to a common bus standard. It is based on a standard on-chip 32-bit system bus specification, to which different microprocessor cores, memory I/O and peripheral cells can be added.

AMBA represents a complete design methodology, embracing both hardware and software. It comprises a fully defined 32-bit silicon bus, together with a library of macrocells. All aspects of the silicon and software macrocell design are specified. The design methodology extends from an initial HDL circuit description to final test vectors. It includes an HDL behavioural model for each macrocell, as well as on-chip test methodology. This consistency of approach ensures that all macro cells can be integrated in a unified design.

According to Saxby, "AMBA allows the chip architect to quickly partition his chip for high performance, low power, and for production test access with minimal silicon overhead".

AMBA's open bus architecture provides a mechanism for ARM and its partners – companies such as GEC Plessey, VLSI Technology, Texas Instruments, Digital Equipment Corporation, Samsung, Sharp, Cirrus Logic – to pool development resources and speed the development of a comprehensive macrocell library. As this approach gains momentum, the mother-daughter board approach to system building will be superseded by the rapid prototyping of embedded silicon processors.

ARM engineers are already using the technology in-house. The recently announced ARM7100, shown in Photo 4, is a reference embedded design for PDA applications, designed around the AMBA bus and – significantly – delivered first-time-right silicon. Indeed, these first silicon samples are now being evaluated by customers.

Multiple Suppliers

ARM offers multiple silicon sources. The company licenses its technology to 15 semiconductor partner companies, who focus on manufacturing, applications, sales and marketing.

ARM is the volume RISC standard. The ARM community includes world-leading silicon manufacturers including Alcatel Mietec, Asahi Kasei Microsystems, Atmel/ES2, Cirrus Logic, Digital Semiconductor, GEC Plessey Semiconductors, LG Semicon, NEC, Oki, Samsung, Sharp, Symbios Logic, Texas Instruments, VLSI Technology and Yamaha.

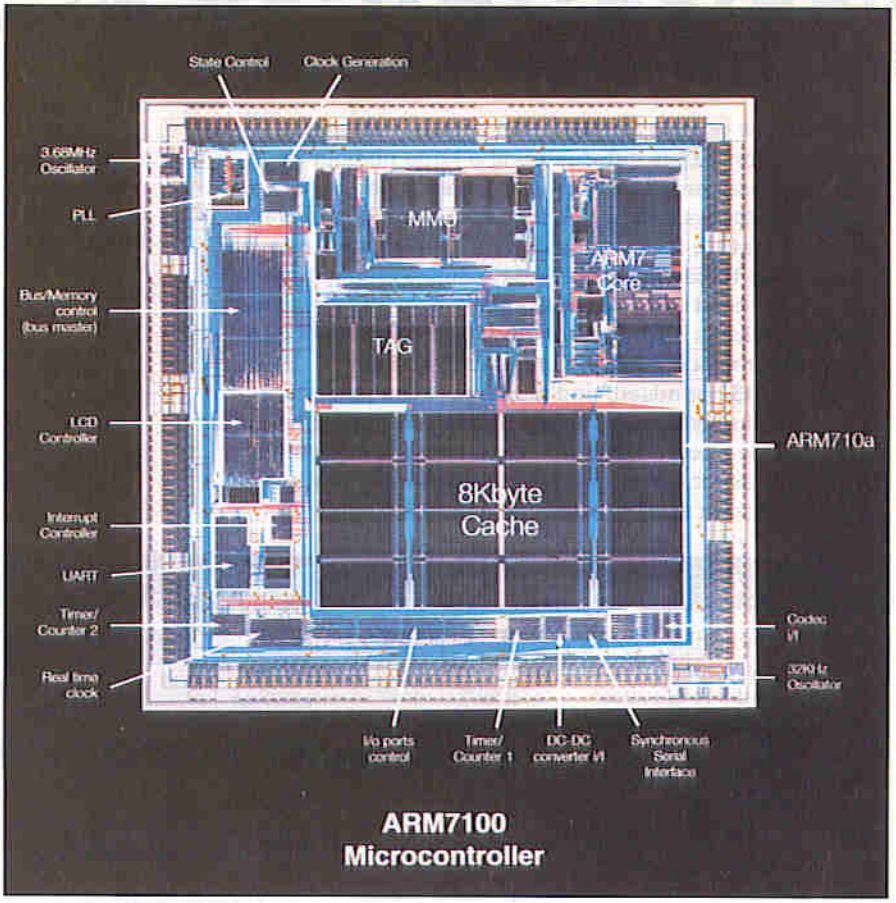


Photo 4. ARM7100 PDA reference microcontroller.

Conclusion

What then, are the requirements for success in the set-top market? According to Saxby, "First, equipment manufacturers that achieve the highest levels of integration will be ahead of their competitors in the price/performance game".

"Second, manufacturers will need to be responsive to global standards that are now emerging. The Digital Audio-Visual Council (DAVIC) has now begun this process, by defining different classes of interactive service. This will encourage the emergence of standard chips for the set-top function and leverage chip costs. Long term, we can look to the emergence of the single-chip set-top ASIC", said Saxby.

Before then, however, systems developers will move through several generations of embedded microprocessor designs. The winners in this game will be those with a well thought-out silicon strategy, embracing the choice of processor and the software support tools available for it.

Finally, manufacturers must understand the market and provide appealing services. In the end, marketing pull rather than technology push, will decide the place of the set-top box – and who the winners and losers will be.

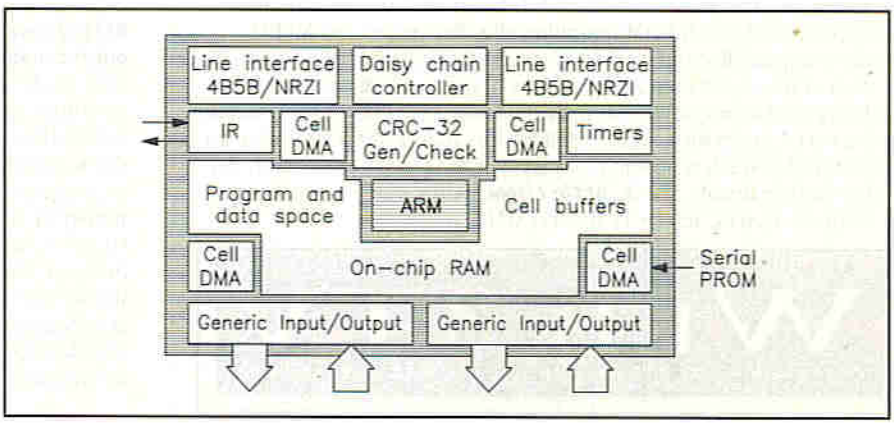


Figure 4. Kerbside ATM switch from Advanced Telecommunications Modules.

@Internet

The new version of PIPEX Dial access software (version 3.0) is out, featuring a large number of improvements over previous incarnations. Now, up to five mailboxes can be accessed from the one account, an ideal feature for families or small businesses, or even if you need to have separate home and work mailboxes. Also, a licensed suite of applications including Netscape Navigator 2.0 is included. Together with 1M-byte of Web server disk space, the program is now fully Windows '95 optimised, and modems in the points of presence throughout the PIPEX Dial network have been upgraded to allow 33,600bps connections if customers' modems have the necessary ability, making a pretty decent Internet service provision all round.

UK Companies Welcome the Internet

Eight out of ten UK companies see the development of the Internet as a business opportunity and only 1% feel it to be a threat, according to a survey commissioned by Barclays of the top 1,000 companies. Barclays now plans to develop services for business customers to help make the Internet even more of a commercial reality.

Commenting on the survey, Roger Alexander, managing director, Barclays Emerging Markets Unit said, "There is no evidence from our survey that British businesses are being left behind on the hard shoulder of the Information Superhighway. I am heartened to hear that so many are already on the Internet and that their appreciation as to how it might help them do business in the future is so high".

The survey did indicate companies accept that Internet usage is set to grow and become more popular. More than 22% believe that over half of their customers will be using the Internet by the year 2000.

Barclays has published a guide for businesses outlining the opportunities for using the Internet as a business tool, available from Barclay.

Contact: Barclays, Tel: (0800) 400170.

Maplin on World Wide Web

Maplin are now dipping their toes into the vaste pool of the internet. A variety of pages (not graphic intensive) are now on site. These pages include company news, a variety of technical pages including FAQs, manufacturers links and more. The technical site is under continuous construction and any requests for additional subject areas on the site should be directed to **webmaster@maplin.co.uk**

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

Contact: Technical Enquiries, Tel: (01702) 556001.

E-mail Virus Scare Quashed

US academics say that fears of e-mail borne viruses appear to be overblown, and are urging network users to stop their misguided efforts to warn others of the non-existent threat. Panic over unfounded rumours causes another very real problem – floods of e-mail warnings that can slow Internet traffic to a crawl. Security specialists say that plain e-mail cannot carry a virus, and that users can best protect themselves by not opening attachments unless they have a good idea of what's inside.

Sony and Philips give Boost to WebTV

US start-up WebTV Networks working on low-cost devices for connecting television sets to the Web, has signed up two powerful partners: Sony and Philips. The endorsement by Philips and Sony transforms WebTV Networks into a front-runner in the race to give consumers a way onto the information highway, other than with $2,000 personal computer systems.

The WebTV box incorporates a 112MHz CPU, a 33·6k-bps, call-waiting compatible modem, CD-quality sound, and studio-quality video – an important consideration when moving PC-based images to lower-resolution television sets. In fact, WebTV executives promise viewers won't see the flicker common on PC monitors on their TV screens.

A 'smart card' slot accommodates Visa and MasterCard credit cards, as well as ATM/debit cards for online transactions. A cordless keyboard is optional, but most online navigation can be done with the remote, which also works with an on-screen software-based keyboard.

WebTV works with a proprietary HTML 3.0-compatible browser, Netscape Navigator 3.0, and Microsoft Internet Explorer 3.0; other features include flash-ROM upgradeability, RealAudio and MPEG audio compatibility and foreign-language font capabilities.

Almost the entire computer industry and the consumer electronics industry are looking at ways to make Internet-access devices that would hook up to a television set and sell for less than $500. The leader, so far, is Oracle, which is pushing a concept called the network computer.

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

Contact: WebTV, Tel: (+1) 408 451 0712.

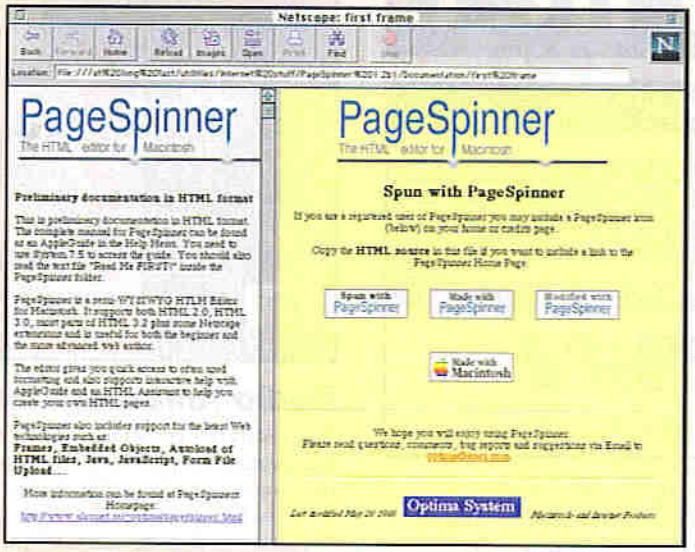
Stone Circles

Coinciding with summer solstice, Intel, English Heritage, and Superscape have unveiled a 3D virtual Stonehenge at **http://www.intel.com/techone/stonehen/index.htm**. The model addresses the mysteries of Stonehenge, the beliefs that may have inspired the monument, and the techniques used to shape, transport, and erect the huge stones. Using a Java enabled browser, it's possible to watch the sun set over stonehenge at different times of the year and decide for yourself why Stoneage man errected this huge monument. If you're planning an actual trip to the site, the Stonehenge Association at **http://www.stonehenge-association.co.uk:80/stonehenge** offers its members information on Stonehenge and the surrounding area, and arrangements for a special pass to go inside the circles. Meanwhile, Save Stonehenge at **http://www.britac3.britac.ac.uk:80/cba/cba/stone1.html**, run by the Council for British Archaeology, offers information on preservation efforts.

Roll Your Own

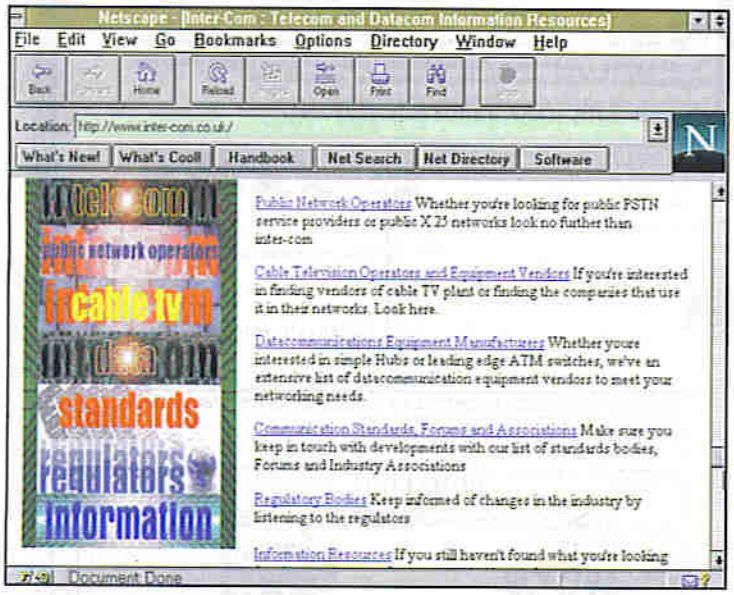
Over the last few months, we've had the honour of looking at various methods of creating home pages. We've seen how commercial products can be used to filter documents created in desktop publishing packages like PageMaker and QuarkXPress or word processors like Word and WordPerfect, creating files which can be used directly as World Wide Web pages. We've also seen complete applications which let you create Web pages from scratch, inputting text and placing graphics before creating HTML files. Users of Internet service providers like PIPEX Dial, Demon, AOL and the like can then upload these HTML files, however, they are created, to the Internet service providers' Web servers, ready for anyone else with Internet access to see.

While it's great to see such a range of products on the market to create HTML documents, it's even better to see some which don't belong to the big boys. There are a few shareware applications around which are so good that they need to be seen to be believed. One we look at now is PageSpinner, an HTML editor which features almost-WYSIWYG (what you see is what you get) features to allow creation of HTML under a very nice environment. With only a smattering of knowledge of HTML and all its nasty little tags, PageSpinner – for a price considerably cheaper than any of the commercial products out there – will do the business very nicely, thank you. It's even nicer to know that PageSpinner is a Macintosh-only product, featuring the same sort of power and performance as the likes of HoTMetaL Pro, SoftQuad's HTML editing program, at a fifth of the price and with an infinitely better and more intuitive (read Mac-like) interface.



The latest version of PageSpinner (1.2 beta 1) has just been released and is available for download on-line (details in Site Survey), and is well worth the 1M-byte of download time you'll spend. It features up to HTML 3.2 standard support, as well as Netscape extensions such as frames, embedded objects, and Java. For a rough idea of how fast it is to get to grips with, the Web page shown was created in less than 10 minutes from scratch, with no prior knowledge of the program's use. The PageSpinner document beside the Web page shows how frames are built up within PageSpinner as framesets.

Central to PageSpinner is its HTML Assistant palette, which allows simple and controlled creation of document parts, together with extensive use of a very detailed and useful PageSpinner Guide (accessed through the Mac's Apple Guide system). For a shareware product, PageSpinner is very thorough, very stable and reliable, and what's more, very good.



Telecom Web Directory

If you are searching for details of a telecom or internetworking supply, check out WebShop's Inter-Com Web directory. The directory, at **http://www.inter-com.co.uk**, provides a comprehensive database of telecom and datacom equipment vendors. Inter-Com also lists many network operators and standards organisations in the data, voice and cable sectors. Search facilities enable companies to be quickly located without the need for guesswork. It is then possible to go directly to the Web sites of the companies found.

Search Engine Market to Expand

Forrester Research says that Internet search engine suppliers such as Yahoo and AltaVista will move into the database and database warehouse markets by 1997, providing competition for traditional database systems that, in contrast to such newer search engines, cannot locate information in unstructured documents.

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

Web-based Automatic Upgrades

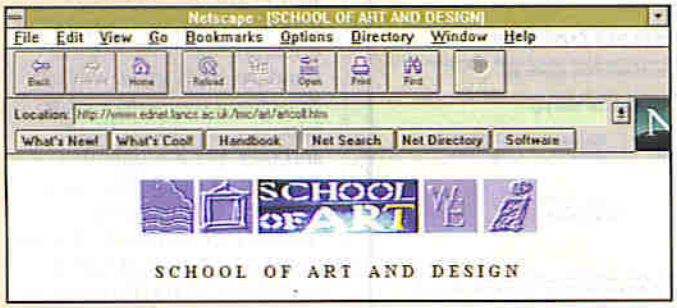
A new subscription service from Cybermedia automatically checks the Web sites of all the software manufacturers represented on your hard drive to see if there are any upgrades available, and then can automatically install whatever's available.

Oil Change dials into Cybermedia's Web server and compares the list of updates with what's on the customer's machine. It displays the list of those not yet installed on the user's PC and then the user can choose whether or not to accept the upgrade.

For a beta version of Cybermedia, check: **http://www.cybermedia.com**.

@Internet

Painting by Web Page



The School of Art and Design at Lancaster and Morecambe College, Lancaster, has launched a Web site at **http://www.ednet.lancs.ac.uk/lmc/art/artcoll.htm**, showcasing student artwork from its end-of-year exhibition. Highlights include photography by Sarah Ridding, digital imaging by Peter Smyth, 3D design by Ellen Plunket, and sculpture by Reda Kennedy.

Radio Amateurs Go Online

The RSGB has launched a Web site at **http://www.rsgb.org.uk**. Following an experimental presence on the Web using volunteer resources, the official RSGB Headquarters site has been developed to allow fast and easy access to news and information.

Visitors to the site can find out about amateur radio and discover the benefits of RSGB membership. The site currently contains the latest GB2RS News Bulettin Script, information about what is in the current issue of RadCom, the RSGB magazine, and an online book catalogue.

Contact: RSGB, Tel: (01707) 659015.

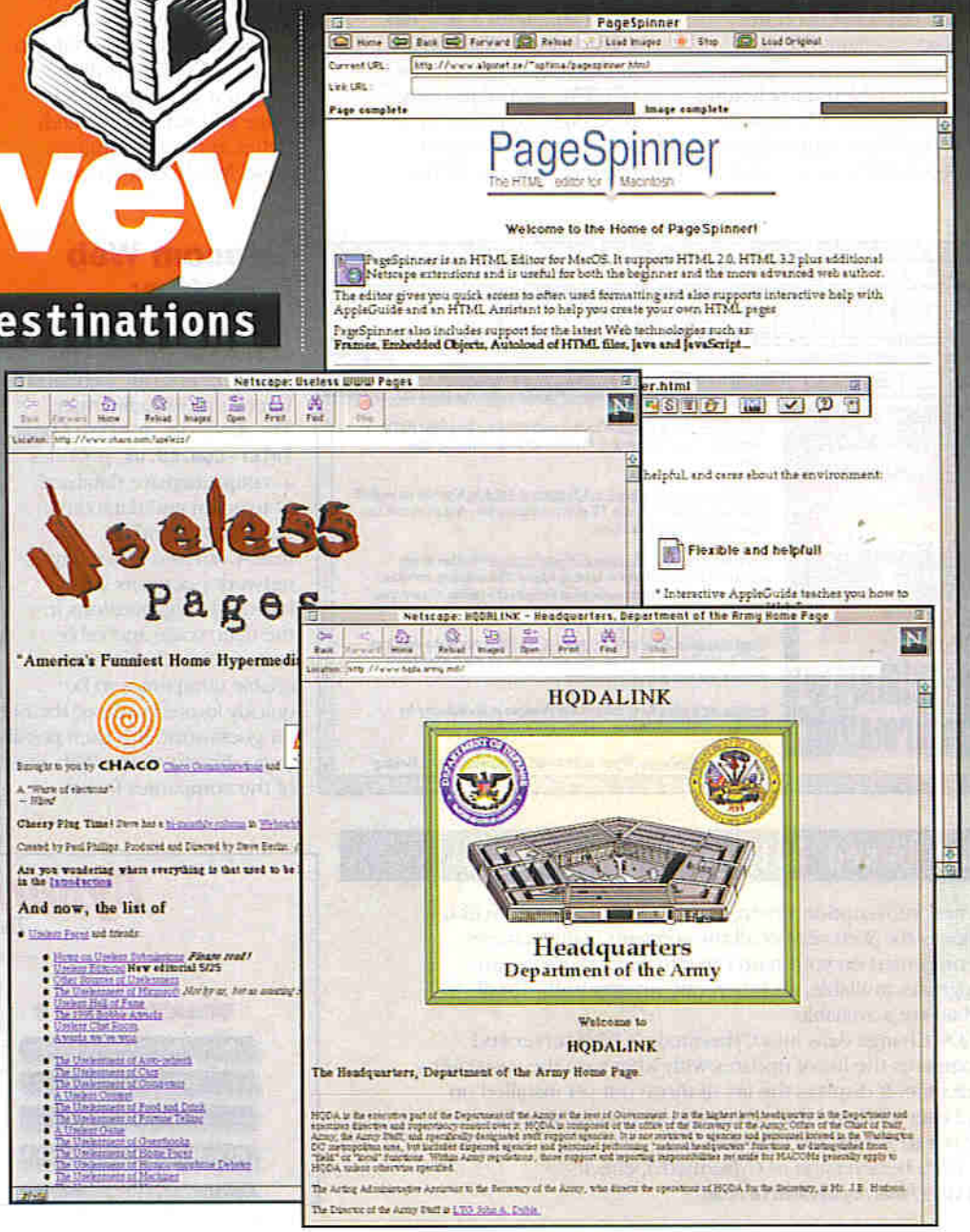
Site Survey

The month's destinations

You'll find the latest update of PageSpinner at: **http://www.algonet.se/~optima/pagespinner.html**, available for free download. After 30 days use, if you like it and want to keep it, you're asked to pay the shareware fee to register your copy.

Hup, two, three, four, get on over to the Pentagon by entering the Department of the US Army headquarter's home page URL, **http://www.hqda.army.mil/**, where you'll find a fascinating series of hotlinks to walk you right around the American military.

Finally, for a really useless look at the Internet, take a useless browse at the useless pages at **http://www.chaco.com/useless/**, where you'll find the most useless load of useless links ever to hit the useless Internet.



Top right: PageSpinner (Version 1.2 beta 1).

Above Right: Useless pages of the Internet.

Right: Department of the US Army headquarter's home page.

ELECTRONICS and Beyond next issue

150W Power Amplifier MkII

An improved, easier to build and updated version of the popular and powerful 150V Power Amplifier kit.

Remote Lighting Controller

The system is designed to allow up to four separate channels of mains lighting to be either dimmed or switched by remote consists of four different circuit boards. The first is the IR remote control handset, which is housed is a proprietary handheld case (with molded-in battery compartment and buttons).

One-to-Two Scart Splitter

A compact and useful unit that enables the SCART signal from a TV, VCR, satellite or other source to be split into two paths with no signal degradation.

Infrared Car Alarm

A sophisticated microprocessor-controlled remote-control car alarm that 'listens' to a wide variety of sensors, with sensor diagnosis facility and outputs for central locking, pager, and hazard lights.

Projects galore plus lots, lots more!

NEAL POTTER ASSOCIATES

Earth Galleries

View with Alan Simpson the exciting world of the former Geological Museum, now part of the Natural History Museum, with its hefty dose of high technology, the newly created Earth Galleries is claimed to be the finest earth science complex anywhere in the world.

PLUS Read Douglas Clarkson's informative article on *The Ring of Dazzling Light: The Daresbury Synchrotron*. The Syncrotron Radiation Source (SRS) at Daresbury Laboratory near Warrington is part of the Council for the Central Laboratory of the Research Council and is a twin with the Rutherford Appleton Laboratory. The SRS at Daresbury is the world's first dedicated source of high energy syncrotron radiation. The concluding part of Ray Marston's series on Electronic Filter Circuits covers active R-C filters and their applications. PIC Programming is a new series from Stephen Waddington, showing you how to go about programming the popular range of PIC microcontrollers.

Issue 107 on sale Friday 4th October

ELECTRONICS and Beyond

BRITAIN'S BEST MAGAZINE FOR ELECTRONICS

Project Ratings

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

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.demon.co.uk` or visit the Maplin web site at `http://www.maplin.co.uk`.

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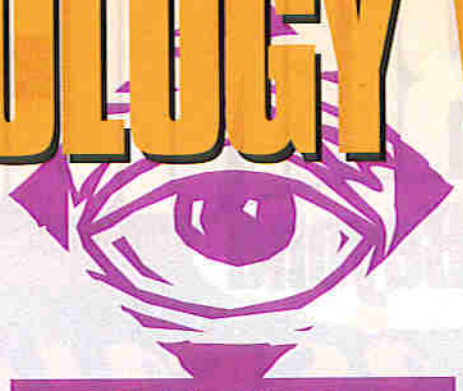
TECHNOLOGY WATCH



with Martin Pipe

It's not just the layout of *Electronics* that's changed! The Technology Watch mantle has been passed along to me. I am devoting the rest of this column this month to recent developments by computer giant IBM which, if it is to be believed, could mean that computers are endowed with a sense of smell. Computers already have video and audio input capabilities, although the computer normally just processes, stores and outputs the information – in very few instances can it process it intelligently.

That said, simple but accurate voice dictation systems (one of which, VoiceType, is available from IBM) are available for office and home use. University and corporate researchers, meanwhile, continue to refine computer-based visual recognition. These systems, which use neural network processors and a video camera for an eye, will discriminate between object shapes, sizes and positions. An obvious use is a sensory input for robotic applications.

Until now, computers have been denied the sense of smell. Scientists at IBM's Research Laboratory in Zurich, Switzerland are working on technologies that could rectify this shortcoming. If successfully adopted, it looks like computers will be empowered with the ability to do even more of the jobs that were previously restricted to boring old humans!

At Zurich, IBM has expended much effort on micromechanics; in this case, tiny mechanical structures fabricated from silicon. To give you some idea of the scale, over 50 such devices could be laid side-by-side in a human hair's width. The first fruit of the Zurich research is a device that its inventors call an atomic force microscope. It is currently being used to test the smoothness of IBM's silicon wafers and hard disk surfaces.

So how does it work? At the end of a long silicon cantilever (a pivot that forms the basis of all of IBM's micromachines so far) is a sharp point that skims surfaces rather like the stylus on an old-fashioned record player. The forces involved are so low that damage is negligible. Any roughness in the surface causes the cantilever to wobble up and down, and these movements can be transferred to a strain gauge, which is also fabricated on the silicon chip. Its output signal is processed using low-noise analogue electronics, an ADC, and, following that, a computer.

So how can this structure be used to give computers the sense of smell? By making possible the accurate analysis of chemical composition! IBM have developed a molecular-level heat-measuring device (calorimeter), in which the tiny cantilever is coated with aluminium. When the two materials are subjected to heat, they expand at different rates and the strip bends, rather like the bimetallic strips found in central-heating thermostats and the like.

At the cantilever's tip is a material that promotes reaction of the chemicals to be investigated. The cantilever will bend with the minuscule amount of thermal energy released through such a reaction, and the strain gauge will quantify the degree of bending. IBM claims that the device is thousands of times' more accurate than conventional calorimeters.

A significant quantity of these detectors, each sensitised to a different chemical, could be packed into a tiny space. Each cantilever has, at its tip, a different material that behaves uniquely in the presence of a specific chemical. The collection of strain-gauge output voltages contain the unique signature' of the chemical – and hence its smell (which is, after all, seldom anything other than minute quantities of airborne chemicals). After they have all been digitised, the amplified outputs from the strain gauges are fed into a neural network, which (after training) will be able to identify accurately the smell.

An electronic nose has enormous potential. Drugs detection, smoke alarms, perfume counterfeiting, air quality measurement, drink production and even the film industry could all benefit. A release film print carrying an extra optical track with the chemical signature recorded at the original movie shoot, or post-production could be used to operate smell boxes dotted around the auditorium.

Each box would release the correct mixture of smell-producing chemicals, as and when they are needed. Since IC-style fabrication processes will be used, electronic noses could be cheaply mass-produced, and end up in consumer applications by the next millennium. The Internet could be poised for yet another revolution – or gimmick, depending on your viewpoint.

You could transmit, via e-mail, smell-related attachments (such as rose scent for a distant loved one), that could be decoded by the recipient's computer – if it has been interfaced to a domestic smell-box. Better than stuffy old emotions, eh? It would also be possible to set up olfactory equivalents of the Internet cameras that are proving popular at the moment.

It's not just smells, though. These micromachines could be employed in hard disk drives. If the point is replaced by a nanomagnet', you have a high-resolution disk head that could be used as the basis for a multi-terabyte hard disk.

During a read cycle, the nanomagnet is repelled from or attracted to the disk surface by the tiny magnetic field produced by each bit. The resulting movement is transmitted, via the cantilever, to the strain gauge. A tiny silicon-fabricated actuator attached to the cantilever would bring the nanomagnet into momentary contact with the disk at appropriate times, and thus write data to it.

I encourage feedback, and so if you feel strongly about something (be it the words that you read here, or technology issues generally) then write to the usual address, or e-mail me as `whatnet@cix.compulink.co.uk`.

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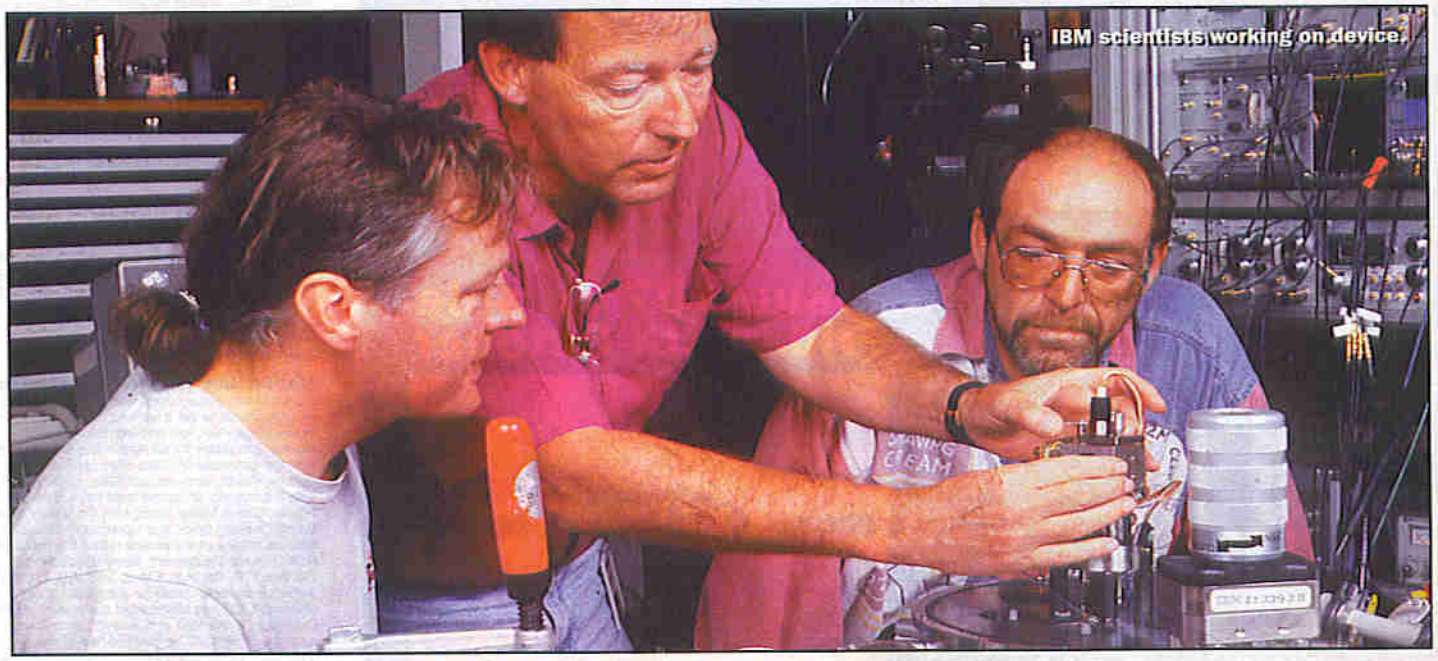

IBM scientists working on device.

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