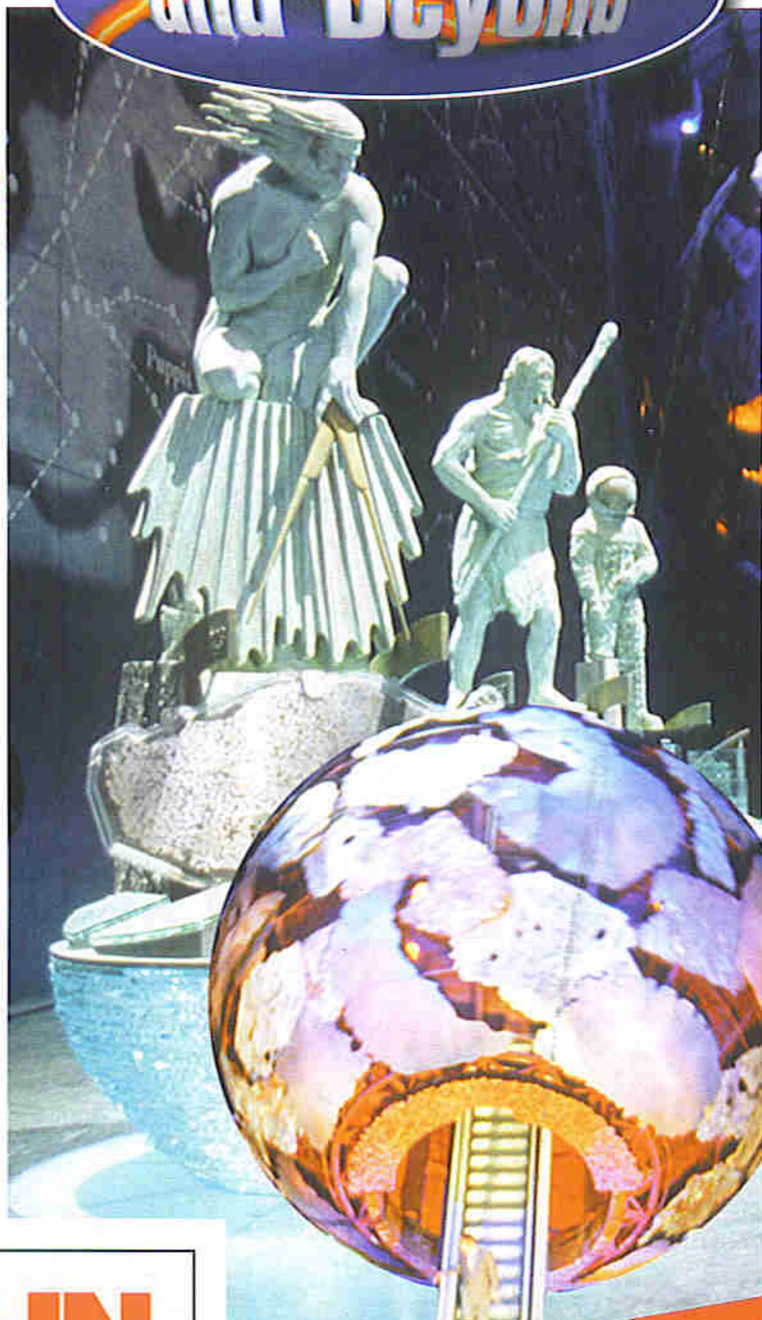
THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

November 1996 No. 107 £2.25

Hi-Tech at the Natural History Museum



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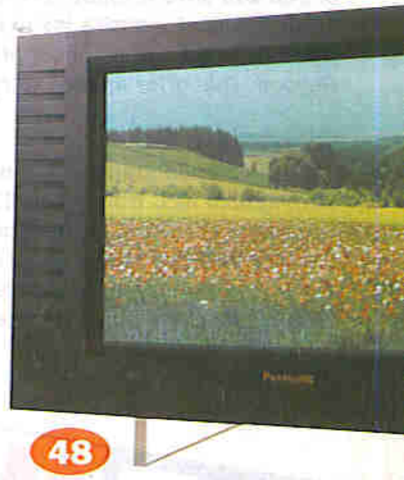
THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

November 1996 Vol. 15 No. 107

Projects

Features



Regulars

Cover pictures:

Editorial
Editor Robin Hall FBIS, G4DVJ
Technical Author Maurice Hunt BSc (Hons)
Editorial Assistant Lynda Hardy
News Editor Stephen Waddington BEng (Hons)
Drawing Office Ross Nisbet
Technical Illustrators Paul Evans, Kevin Kirwan Dip.Comp.
Project Development Chris Barlow, Alan Williamson

Production
Production Controller Jason Hyatt
Design Layout Artist David Holt
Photography Co-ordinator Peter Blackmore
Photography Librarian Tracy Swann
Published by Maplin Electronics plc., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Tel: (01702) 554155. Fax: (01702) 554001.
Lithographic Reproduction by Planagraphic Studios, 18 Sirdar Road, Brook Road Ind. Estate, Rayleigh, Essex SS6 7UY.
Printed by St Ives (Andover) Ltd., West Portway, Andover SP10 3SF.

Management
Manager Paul Freeman-Sear BSc (Hons)
Marketing Services Manager Steve Drake
Product Manager Tony Bricknell.

Subscriptions
Maureen Harvey
Tel: (01702) 554155 Ext. 311.

Advertising
Advertising Manager Paul Freeman-Sear
Tel: (01702) 554155 Ext. 288.

UK Newstrade Distribution
Seymour, Windsor House, 1270 London Road, Norbury, London SW16 4DH.
Tel: +44 (0)181 679 1899.
Fax: +44 (0)181 679 8907.

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Inside

Free pull-out Electrolube Wall Chart

Your guide to all the products in the Electrolube range

See centre pages

ELECTRONICS and Beyond

Hello and Welcome to this month's issue of *Electronics and Beyond*! As usual we have a fine collection of projects and features for you read and build.

We have this month, an exclusive Electrolube pull-out wall chart. This will be extremely useful in looking up the right product from the full Electrolube range.

This issue also includes a £5 money off voucher to save on purchases of £50 or over from Maplin Stores or on orders from the 1996/97 Maplin MPS Catalogue, or you can save it together with the £2 voucher to be printed in next month's issue and receive a free gift when you take out a subscription to *Electronics and Beyond*. This offer applies to readers in the UK only.

CONNECT '96

Visit the Maplin stand at Connect '96 at the Birmingham NEC from 18 to 27 October. Connect '96, The Home PC Show, Autumn Ideal Home Show and the International Motor Show are all taking place at the NEC simultaneously, offering an unbeatable day out. The advance ticket hotline is 0121 767 4114.

Robin Hall, Editor

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Hi-tech Bar Code Replacement

Micron Technology has developed a radio identification chip likely to replace the traditional product bar code for such uses as remote tracking of shipping containers. With support from the Federal Aviation Agency, the company plans to develop an airline luggage security system that would use the new chips to track every package on an aeroplane, identify its owner, and call attention to possible bombs in packages not properly identified.

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

Contact: Micron Technology, Tel: (+1) 208 368 4000.

Specialist CD ROM for Antennas Users

Shareware publishers, PDSL (Public Domain and Shareware Library), has pulled together over 2,000 antenna related files on a single CD ROM. Intended for telecommunications, radar and broadcast engineers as well as radio amateurs, the CD ROM carries modelling applications for 50 different types of antenna.

Reference design and application data on a wide range of subjects is provided, including: masts, towers, elements, wire and anchor antennas.

The CD ROM is available by mail order or phone from PDSL, priced £24.

Contact: PDSL, Tel: (01892) 663298.

Seagate Adopts TI DSP Core for Disk Controllers

A customisable digital signal processor (DSP) core from Texas Instruments will serve as the sole processing element in a new product offering from one of the world's largest hard disk drive manufacturers, Seagate. The 2·5G-byte ST52520A drive, aimed squarely at high-volume, graphics-oriented Windows application markets, is the first mainstream 3·5in. disk drive to adopt a uniprocessor DSP design, integrating logic, flash memory, and a DSP core into a single unit.

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

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

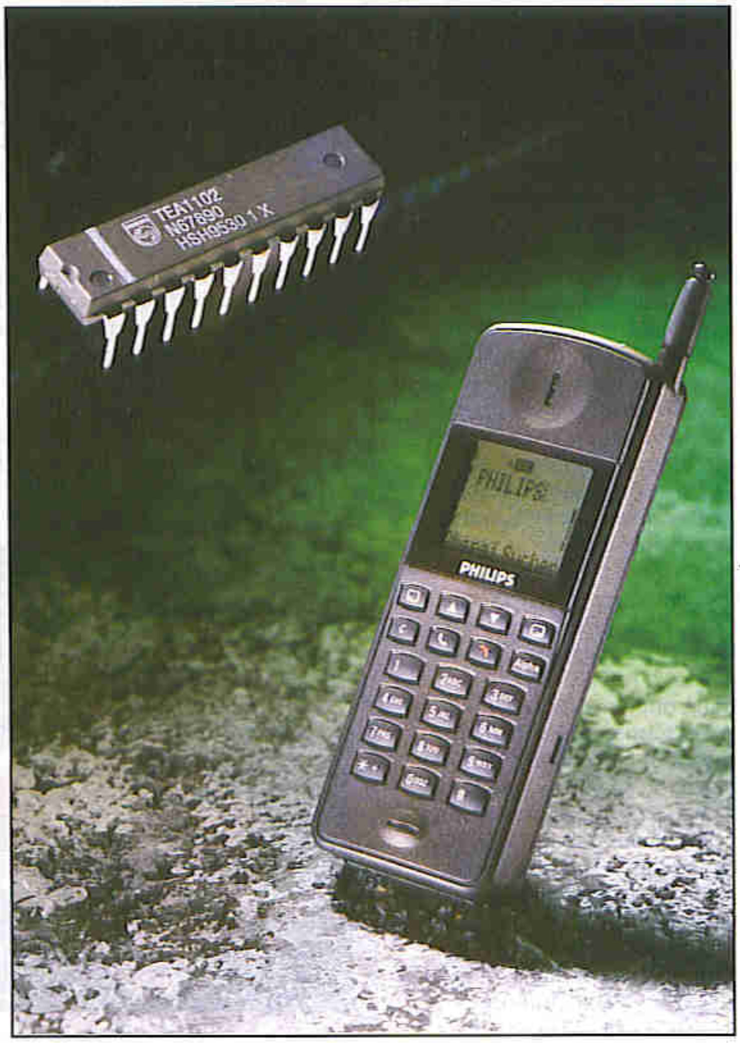
On Course for Engineering Success

A unique guide to science and engineering initiatives aimed specifically at girls and women has been published by the Engineering Council. 'Awards, Courses and Visits 1996', published as part of the Council's Women Into Science (WISE) Campaign, lists a full range of academic courses and other schemes designed to attract more young women into science and engineering careers.

Copies of the booklet are available free from the Engineering Council at 10 Maltravers Street, London WC2R 3ER. Please send an A5 stamped addressed envelope for 29p.

Contact: Engineering Council, Tel: (0171) 240 7891.

Single-chip Fast-charge Controller



The increasing number of battery technologies being used in equipment such as mobile phones, camcorders, laptop computers and other portable appliances, mean it is becoming increasingly difficult to design a universal fast-charge circuit that will cope with all battery types.

Philips Semiconductors has overcome this problem by introducing the TEA1102 – the world's first single-chip fast-charge controller for nickel cadmium (NiCd), nickel metal hydride (NiMH), lithium ion (LiIon) and sealed lead-acid (SLA) batteries.

"The TEA1102 is the first single-chip fast-charge controller to handle all common battery types, enabling designers with little specialist knowledge to build sophisticated charging circuits into their equipment", Bas Fransen, Product Marketing Manager told Electronics.

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

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

BT and Apple Join Forces to Aide Ambulance Crews

TraumaLink, a new system from BT and Apple, which transmits high quality pictures over the Cellnet digital telephone network from the scene of an accident to a hospital in a matter of minutes, is undergoing its first-ever field trials. The pictures give the hospital's Accident and Emergency department vital early warnings of the circumstances of the incident, and the casualties' injuries.

The TraumaLink prototype is being evaluated by the East Anglia Ambulance Service and Norwich Hospital. It combines the latest digital imaging and GSM digital cellular network technologies to establish a visual link between paramedics and the Accident and Emergency department.

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

Contact: BT, Tel: (01473) 647448.

Fabrication Breakthrough

Bell Labs researchers have come up with a way to use electron beams to imprint integrated circuits, inscribing four times more features onto a chip than today's standards. The electron beam machine, dubbed Scalpel, will enable the chip industry to continue the success that it's had over the past decades of reducing the size of the chip every couple of years.

"It looked like with conventional optical lithography techniques would run out of gas sometime around the end of the century", a spokesperson from Bell Lab's told *Electronics*. "Electron beams have been around for a long time. But in terms of writing chips on wafers, they were slow so nobody used them commercially. What we've done with Scalpel is figure out a way to make an electron beam printing technique that is not slow and will have the ability to imprint smaller and smaller features".

Bell Labs is the research and development arm of Lucent Technologies, formerly the systems and technology division of AT&T.

For further details, check: **http://www.bell-labs.com**.

Contact: Bell Labs, Tel: (+908) 582 6994.

NEWS BYTES

Apple Boost from Microsoft

In an effort to boost Apple's appeal, rival Microsoft is setting up a separate unit that will focus on assisting small software companies to develop Internet applications for the Apple Operation System.

The unusual move is motivated, in part, by Microsoft's concern that it would face serious antitrust problems if Apple were to go out of business. The new strategy leaves software writers free to create applications purely for the Mac community, a reversal of Microsoft's previous policy that required independent developers to write software for Windows as well as Mac systems.

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

Contact: Apple, Tel: (0181) 569 1199; Microsoft, Tel: (01734) 710021.

Windows NT Requires Pentium

US trade publication, *Byte Magazine*, reports that Microsoft's latest Windows NT version suffers a slowdown when run on computers equipped with a Cyrix 6x86 microprocessor running at 150MHz rather than a comparable Intel Pentium chip. The Windows NT 4.0 operating system ran 16% slower than a previous release of NT on a Cyrix chip, and 24% slower than Windows '95. Cyrix says the problem is a hardware malfunction, and is offering customers a free software patch.

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

Contact: Cyrix, Tel: (01793) 417777.

PC Market Up 16·5%

The global PC market increased 16·5% to 15·9 million machines in the second quarter compared with the 1995 period, according to Dataquest. This figure is significantly below the 18·4% gain in the first quarter. But the company is standing by its prediction of 19% growth for the year, indicating that the second half will see strong performance.

Analysts have said falling prices, spurred by a glut of components, and next month's release of a new version of Microsoft's Windows NT operating system are expected to generate more corporate demand.

Dataquest estimates showed Compaq continued to be the market leader with 9·7% of the worldwide PC market with 1·55 million machines, down from 10·4% for the second quarter last year, while IBM followed with 8·8% at 1·41 million, up from 7·7%.

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

Contact: Dataquest, Tel: (01752) 814600.

NEWS BYTES

Analysts Doubt Gates Milestone

Microsoft chairman, Bill Gates, said the installed base of the software giant's Windows '95 operating system will surpass 40 million units in August, a year after the product's launch. Meanwhile, market analyst Dataquest this month forecast that Microsoft would ship 45·7 million licences for Windows '95 by the end of 1996.

Windows '95 is not gaining adherents as fast as previously predicted due to the continued success of older versions of the Windows 3.1 system, the market researcher said.

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

Contact: Microsoft, Tel: (01734) 710021; Dataquest, Tel: (01752) 814600.

Talisman Bears Fruit

The rumour doing the rounds of Silicon Valley this month is that Microsoft's two-year microchip research project is bearing fruit, in the form of Talisman – a chip that delivers fast, realistic graphics using a $300 PC circuit board. The new chip will be marketed as a way of enabling PC owners to produce graphics similar in quality to those produced by $50,000 Silicon Graphics workstations, resulting in a proliferation of animated, online, storefront and other applications.

For further details, contact: **http://www.microsoft.com.**

Contact: Microsoft, Tel: (01734) 710021.

Mercedes and IBM Develop Architecture for Auto Electronics

The story goes that while talking business at the Olympic Games, Helmut Werner, chairman of the board of Mercedes-Benz and Louis Gerstner, the top man at IBM, agreed to team up to develop the next generation of automotive electronics.

Today's cars have many automation components, but very little integration or communication capabilities between them. Initially, IBM and Mercedes will develop a new architecture, based on network computing, that will monitor and control many systems such as lights, the engine and climate control. The architecture will be developed with the participation of automotive suppliers, creating standards similar to those in other industries.

For further details, check: http://www.mercedes.com or http://www.ibm.com.

Contact: IBM, Tel: (0171) 202 3744.

RA Revises DAB Rules

Following the level of interest in the Radio Authority licensed Digital Audio Broadcast (DAB) restricted service licence (RSL) experiments in London and Birmingham, and reflecting provisions of the new Broadcasting Act 1996, the Authority has decided to revise its rules on the eligibility of programme providers.

Currently, only the Authority's licensees can offer a programme service on a digital multiplex. The Authority is now willing to consider programme services that are not existing national or local licensees for inclusion on the multiplex in order to broaden the range of programme experimentation. At present, there is one experimental DAB RSL in effect. Programme providers vary each month. National Transcommunications Limited (NTL) is operating a multiplex in London until Spring 1997, on which the following commercial stations are currently transmitting a programme service: Kiss 100 FM, Melody FM, Sunrise Radio, Virgin Radio London and Talk Radio. There are plans for other experimental DAB RSLs during the second half of 1997.

Contact: Radio Authority, Tel: (0171) 430 2724.

Freight Industry Blackbox Recorder

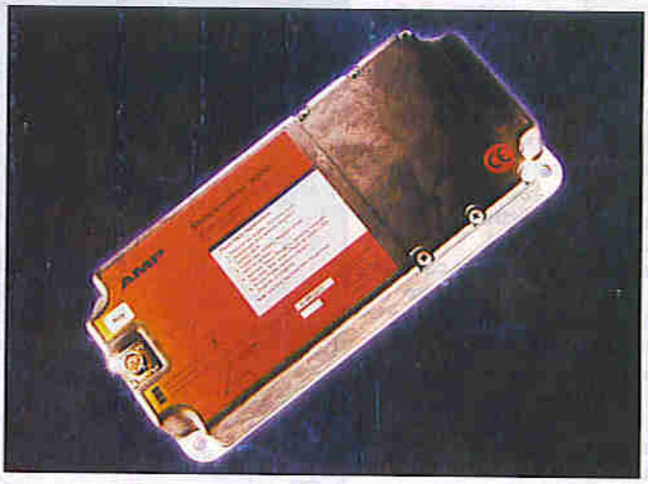
AMP has applied the concept of the black box flight recorder to the freight industry, in a bid to cut the cost of hidden damage to freight in transit.

The Shockwriter 3000 data recorder is a palmtop-sized unit which is fixed to a crate prior to shipment. Once armed, the unit will continuously monitor and record the amplitude if shocks and jolts exceed a user defined threshold. All events are time and date stamped.

Once the cargo has completed its journey, the Shockwriter can be removed and the contents of its memory downloaded to a PC. By analysing the output data, the user can determine if hidden damage has occurred, and if so, at what point during its journey.

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

Contact: AMP, Tel: (0181) 420 8044.



200MHz Flagship PC

Carrera has launched a range of PCs based on the latest Intel processor, the 200MHz Pentium. The system, based on a SuperMicro motherboard, also features the Intel 430HX PCI chipset with 512K-byte of pipeline burst-mode cache for enhanced performance. Features such as hard drives, monitors, sound and video cards, CD-ROM drives and software can all be tailored to individual requirements. Prices range from £1,700 to £8,000.

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

Contact: Carrera, Tel: (0171) 830 0586.

Trouble Shooter Toolbox for Windows '95

Quarterdeck has launched a troubleshooter toolbox for Windows '95. WINProbe '95 focuses on solving Windows '95 problems and boosting overall PC performance.

An all-in-one toolbox, WINProbe's features include Registry Guru which safely optimises and edits the Registry, increasing overall performance and decreasing Windows start-up time; an application control panel, eliminating performance bottlenecks by allowing the user to manage the priority of important jobs; and CrashShield, a background protection tool which automatically saves important work from fatal errors, and Windows crash recovery tools for simple recovery of a damaged system.

WINProbe '95 is to run alongside WINProbe4 which offers Quarterdeck's existing users support for Windows 3.1, and will be available in Quarterdeck's extensive retail channel in September. The average street price is expected to be around £50.

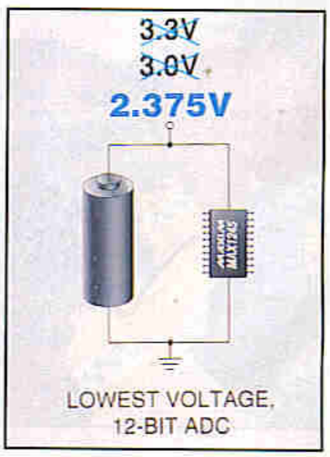
For further details, contact: **http://www.quarterdeck.com.**

Contact: Quarterdeck, Tel: (01245) 496699.

First 12-bit ADC to Operate At 2·375V

Chipmaker Maxim has introduced the MAX1245, a 2·375V, low-power 12-bit monolithic data-acquisition system. As the lowest-voltage 12-bit ADC available, it guarantees performance specifications from 3·3V down to 2·375V. Combining an 8-channel multiplexer and high-bandwidth track/hold with a serial interface, it offers high conversion speed up to 100k-bps and ultra-low power consumption. Supply current is less than 1mA and the device powers down to 1μA.

Contact: Maxim, Tel: (01734) 303338.



RECRUITMENT ADVERTS

MONDO
MAPLIN SUPERSTORE

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

TEAM LEADERS
Technical

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

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

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

TEAM LEADER
Store Support

Applicants should be able to demonstrate an understanding of operating systems, gained within a retail environment, and be able to manage and administer staff training and deployment issues. Crucial to the success of this role is your ability to interpret customer needs in relation to company systems and to accept challenges in a responsible and innovative manner. Previous supervisory/health and safety experience would be an advantage.

SALES ASSISTANTS
Technical/General

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

Applications from experienced non-technical retailers are also welcome.

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

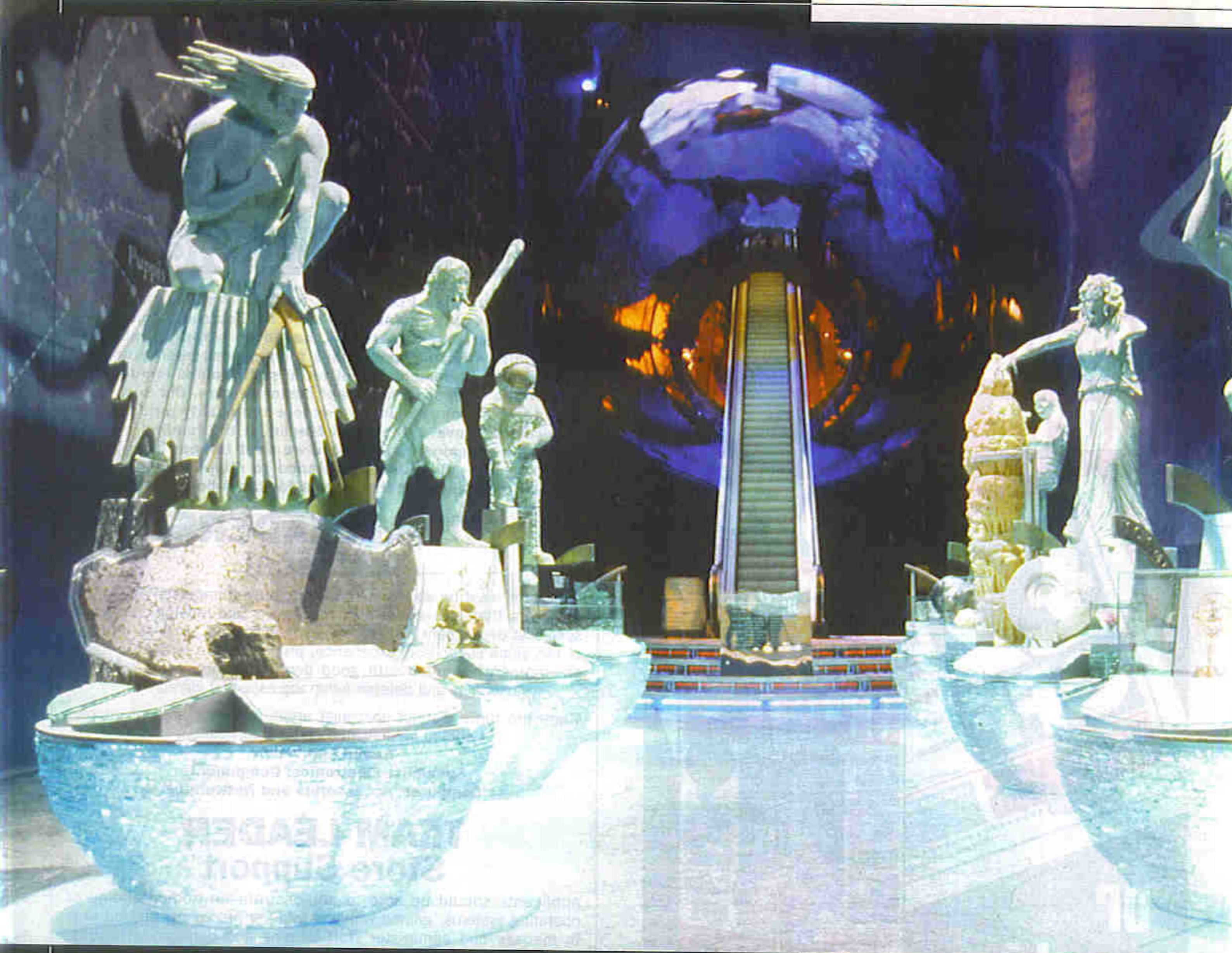
Interested applicants should write to:

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

Please specify the post you are applying for.

Applications should contain sufficient information about qualifications, experience, personal qualities, etc. to enable us to short list candidates for interview.

Maplin Electronics PLC is an equal opportunities employer.



Natural History Museum

JOURNEY TO THE CENTRE OF THE EARTH

by Alan Simpson

Few would argue that the old Geological Museum in Kensington, London was the one to avoid. Rocks and fossils lost out compared to such centres of excellence as The Science Museum and the Museum of Moving Image. But stand-by to be amazed. The former Geological Museum, now part of The Natural History Museum, has taken a hefty dose of high technology and emerged a winner. The newly created Earth Galleries dramatises the importance of earth science, creating what is claimed to be the finest earth science complex anywhere in the world.

For centuries thousands of people around the world have struggled to survive the devastating impact of earthquakes and volcanic eruptions. These terrifying natural events are caused by titanic forces within the Earth, driven by inner heat that has powered change for 4,600 million years. This history of the evolving world has been contained in two notable exhibition galleries, The Power Within and Restless Surface. In both cases, visitors can feel, hear, see, find out, explore, discover, recreate, and experiment the structure and making of the world we live in.

We are talking seriously here of volcanoes, earthquakes and glaciers with realistic demonstrations sited on three floors of the Earth Galleries, designed says the Natural History Museum to excite and inspire visitors of all ages. The theme may well be 'step into the past' but for many visitors, it could be a step in the high tech future. Rather like a visit to the Epcot or Disney centres in the USA.

The Wonders of the World

Dr Bob Bloomfield, head of exhibition research and design at the museum says his role was to reveal in an highly innovative way, just how people cope with their everyday lives in adversity. To achieve his aim, the 1930's building had to be completely gutted, rewired, replumbed with air and heating controls implemented. Twisted pair cabling now circles the exhibition area with 155M-byte of ATM cable delivering AV services up to Super Janet standards. This will also enable the galleries to incorporate Internet services as and when required.

A central control centre has been constructed behind the scenes on the third floor which houses laser disk players which drive the overall event. The centre also drives the security systems for visitors, contents and the building. Meanwhile in-house power supplies connect to various circuits, giving a mixture of 24 hours operational life or a more restricted supply where appropriate. A key element has been to conserve energy at all stages. The gallery, says Bob is future proof having been designed with many layers of high-technology providing a flexible environment.

Way In: Way Out

An imposing new entrance created in the central space of the building welcomes visitors to the new galleries. Dominating the space is a massive revolving globe sculpture of beaten copper, iron and zinc, measuring 11m in diameter and suspended around a giant escalator. This carries visitors on a 'journey through the centre of the Earth', with pulsating sound and light effects as they ascend through the globe and into the exhibitions. Vast 15m high sheets of slate etched with dramatic visions of the heavens and the solar system clad the walls of The RTZ Atrium.

Dominating the atrium floor are six anthropomorphic sculptures each standing some three metres high. Standing on glass, theatrically lit from beneath, each life-size icon represents a basic concept about our Earth which is explored in the further exhibitions. For those of a classical mind the sculptures embrace: Atlas struggling to balance the world on his shoulders; Cyclops, visions of Earth's past; Medusa, visions of Earth's processes; Scientist, visions of Earth's future; Astronaut, visions of Earth's order; and God, visions of Earth's beginnings – stories of the origin of the world and people, in both folklore and theology.

The vast space also contains some 44 portholes through which the curious can peer at a range of geological material. But for most, ascending via the escalator and accompanying Hendrix rock themes and lighting to the centre of the Earth will be highlight number one. Highlight number two will be the volcanic experience in The Power Within exhibition. This area deals with the power and scale of the processes at work inside the Earth. It includes volcanoes and earthquakes as well as the dynamic structure of the Earth. The exhibition shows how the Earth's internal processes create mountain ridges, rift valleys, and ocean trenches. More detailed sections and specimens from the collections give background evidence for these phenomena.

In the Volcano Experience, visitors can see film footage of the devastating affects of the volcanic activity of Mount Pinatubo in the Philippines in 1991, as 'live' news reporters tell the story of the eruption through TV monitors. For centuries thousands of people around the world have struggled to survive the devastating impact of earthquakes and volcanic eruptions. These terrifying natural events are caused by titanic forces within the Earth, driven by inner heat that has powered change for 4,600 million years. But it is not exactly comforting to know that despite state of the art technology, vulcanologists still cannot accurately predict when volcanoes will erupt.

An Earth Shattering Experience

Highlight number three also probably scores as the star attraction. A dramatic room sized recreation of the Kobe, Japan earthquake which struck in 1995 and killed 6,300 people. The action takes place in a damaged supermarket with a floor that shakes, rattles and rolls. Apart from the floor shuddering, food and drinks are spilt and masonry crashes. Real-life video footage is displayed on TV screens.

Although why the authorities choose not to feature the quake which struck Los Angles a couple of years back is a puzzle. This caused not only a heavy loss of life and injury, it also put many freeways out of service as well as closing LA airport. Also all but the most urgent local telephone calls were blocked and communications lost. Overall damage estimated at over £6 billion was caused. As a direct result, many companies in LA got the safety-first message and moved their sensitive operations together with personnel, to less vulnerable areas well away from the well-charted earthquake fault lines.

For those of nervous disposition, checking-out the Earth monitoring station might be rewarding. Here a live earthquake monitor displays current geological activity, fortunately at the time of the *Electronics* visit, current earthquakes and eruptions were taking place at locations somewhat distant from Exhibition Road, South Kensington.

Restless Surface

Moving along, the Restless Surface exhibition explains how external forces have shaped the landscape over millions of years. These forces include the action of wind, rain, pounding waves and scouring ice, as well as the deposition of minerals, plants and animals. It explores how the surface of our planet has been blasted, battered, frozen and sculpted beyond all recognition since it was formed some four billion years ago. Mind bending notions of deep geological time, and the processes of change are the focus of the exhibition.

It is here that you can discover how the Colorado River has been carving out the Grand Canyon for over 20 million years; see how glaciers have scoured the land; how avalanches occur under the sea, and how high mountain peaks have eroded away as restless winds and waters have reshaped their surfaces. Nature's secrets – the powerful agents of change: air, heat, wind, ice, gravity, plants and animals – are unlocked as you trail through the exhibits. Great if you are hooked on pyroclastic physics but still fascinating if you are not. Worth lining-up to operate is the suitcase sized wave-machine and to note the patterns and script projected on to the walls.

Certainly the world is a mysterious place. For the record, the highest point on land is 8848m; the greatest ocean depth a remarkable 10,924m; while gigantic heat power exists at the centre of the Earth, some 6,400km beneath our feet. Perhaps more down to earth are the displays of a lava-covered car, and a graphic display of the hotel that fell into the sea. Still with the spectacular, is the display of sand that turned into glass many thousands of years ago, and a stunning lightning display of a storm tempest. Highlights here include the Mount Vesuvius eruption in AD79. Fortunately for the organisers, there remain some eyewitness accounts of how thousands of people who were engulfed by hot blasts of volcanic dust and gas in the nearby Italian city of Pompeii. From high technology Earth-moving plates to primitive sundials, nothing is overlooked.

Schools Out

Local and not so local schools are doubtless already planning curriculum visits. As Roy Hawkey, head of education reports, the aim of The Earth Galleries is to stimulate interest and widen perceived horizons. The obligatory set of educational activity sheets has been produced which help present earth science as being a dynamic and evolving subject relevant to all our lives. However, on hand is an actor whose role is to entertain the younger visitors looking for a respite perhaps from riding the quakes.

Apart from the new Earth Galleries, the Natural History Museum has much to interest children – of all ages. Not-to-be-missed is the ultimate dinosaur exhibition. Recent scientific research is used to illustrate the lifestyle of these impressive creatures. The Museum also has a highly impressive collection of creepy-crawlies – a celebration of the ubiquitous arthropod as the brochure puts it. Plus much on human biology, ecology; and a inspiring display of lesser beaked eagles from South Western France.

Almost obligatory in today's museums and galleries there is a sizeable gift shop. Here for £1.25 you can take away agate and amethyst slices, or for an upmarket £1,950 an amethyst geode hacked from an ancient lava beds formed some 200 to 250 million years ago in Brazil plus a wide range of cards and posters. There is also a cafe where you can reflect on the 5,400 square metres of the Earth Galleries, and the 416 specimens selected from the Museum's nine million fossils, over half a million rocks and minerals and 3,200 meteorites.

Total funding for the Earth Galleries development is £12.116 million with the National Lottery through the Heritage Lottery Fund providing half of the amount

Into the Future

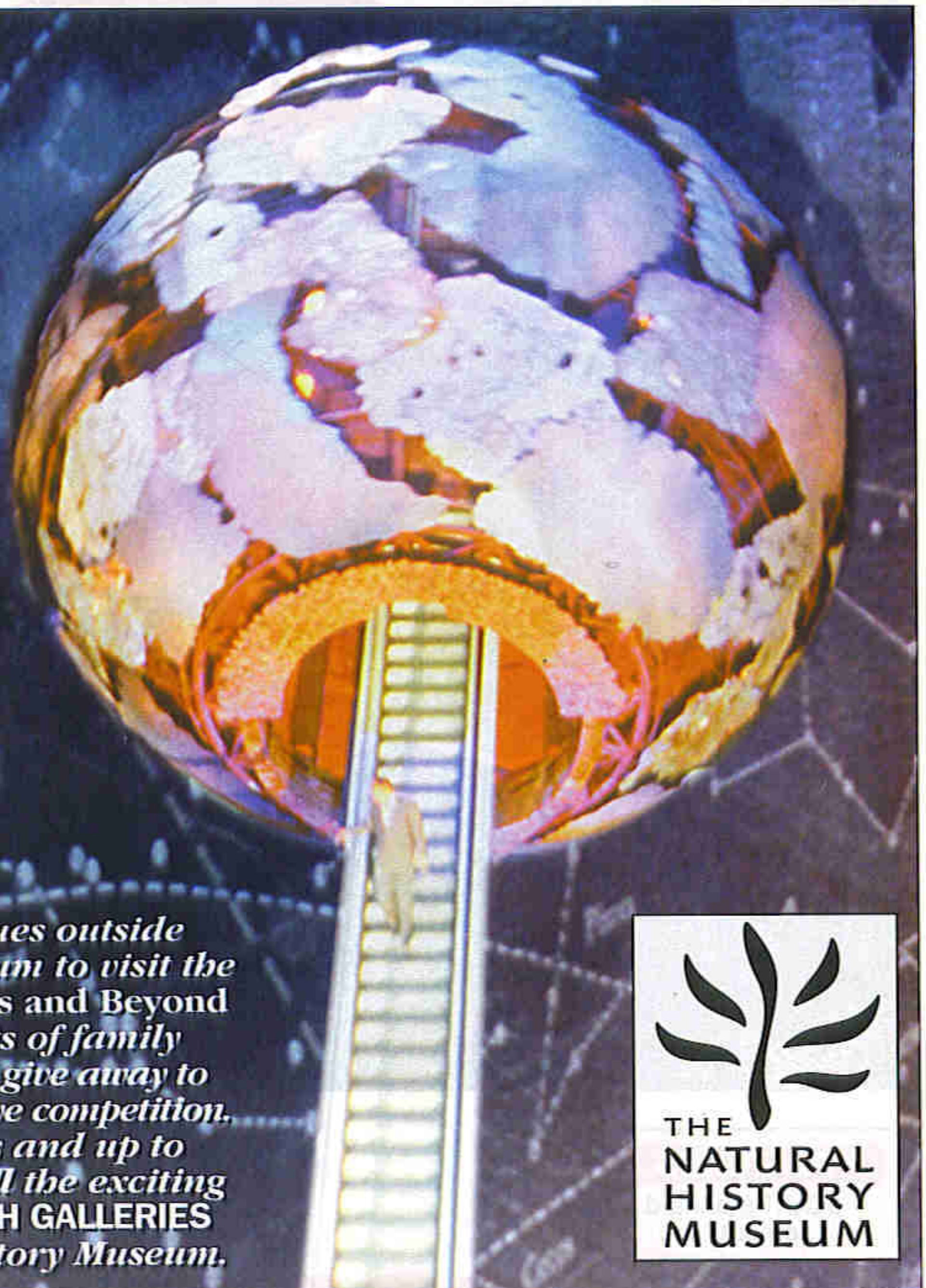
Within the next 18 months, two further major exhibitions will be opened. From the beginning and The Earth's treasury will be followed a year later by The Earth for today and tomorrow and The Earth lab. However, the organisers will be hard put to create such a stunning display of high technology already in place. Not surprisingly, the organisers are expecting the number of visitors to increase 2 million a year. But don't worry about queuing. We have ten sets of family tickets to award the first all correct answers drawn from our exclusive competition. See opposite for details of how to enter and you might be seeing the Earth Galleries for yourself. ELECTRONICS

The Natural History Museum

The Natural History Museum is open Monday to Saturday from 10.00am to 5.50pm and on Sunday from 11.00am to 5.50pm. (Closed over Christmas). Admission is £5.50 for Adults, £2.80 for Children (5 to 17 years), £3.00 concessions, and £15.00 family ticket (2 Adults and up to four children). Children under 5 years admitted free. Admission includes entry to all other galleries and exhibitions at The Natural History Museum. Tel: 0171 938 9123.

EARTH MOVING

Exclusive Competition



THE NATURAL HISTORY MUSEUM

No need to join the queues outside The Natural History Museum to visit the Earth Galleries.* Electronics and Beyond *have no less than 10 sets of family tickets (worth £15 a set) to give away to lucky winners of our exclusive competition. Each set allows 2 adults and up to 4 children full access to all the exciting delights of* THE NEW EARTH GALLERIES *including The Natural History Museum.

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 28th October 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.

EARTH GALLERIES COMPETITION

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

1. Are the Earth Galleries part of:

- ☐ Battersea Embankment.
- ☐ The Greenwich Millennium site.
- ☐ The Natural History Museum.

2. What would you expect to find in The Earth Galleries?

- ☐ A collection of rocks, gems and minerals.
- ☐ A replica of Kew Gardens.
- ☐ A museum of parks and open spaces.

3. What is the Lepidodendron?

- ☐ A type of organ played at your local cinema.
- ☐ Part of a fossilized tree.
- ☐ An Irish jig.

4. What is a seismologist?

- ☐ Someone who studies earthquakes.
- ☐ A salesperson at Marks and Spencers clothes department.
- ☐ A person who studies the sizes of buildings.

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

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Earth Galleries Competition,
The Editor, *Electronics and Beyond*,
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PROJECT RATING 2

Kit Available
Order as LU21X
Price £39.99

FEATURES

- SCART standard compatible
- Composite and S-Video compatible
- Phono stereo audio outputs
- Units can be 'daisy chained' for multiple outputs
- Low power consumption
- Easy to build and use
- Compact

APPLICATIONS

- Video recording
- Relaying of a single TV, VCR or cable/satellite unit's signals to two other units
- Buffering of composite or S-Video and audio signals

Active SCART SPLITTER

Design by Alan Williamson
Text by Alan Williamson and Maurice Hunt

The Active SCART Splitter is a video and audio signal buffer that enables the SCART signal from a TV, VCR, satellite/cable unit to be split into two paths with virtually no signal degradation. The unit could be used, for example, to allow two VCRs to record the output from a TV, or the output of a VCR to drive two TVs/monitors. Several units could be interconnected in 'tree' formation to increase the number of output paths in multiples – 2, 4, 8, etc., with minimal degradation of the audio and video signals.

The Active SCART Splitter, in addition to its pair of SCART (Peritel) output sockets, also features twin phono output sockets to allow connection to a Hi-Fi for stereo sound – an easy way to dramatically improve your enjoyment of films, music television and the like. This low power, compact unit is designed to be left permanently connected to the mains supply and is simplicity itself to use – no critical controls or complicated setting-up are needed.

Circuit Description

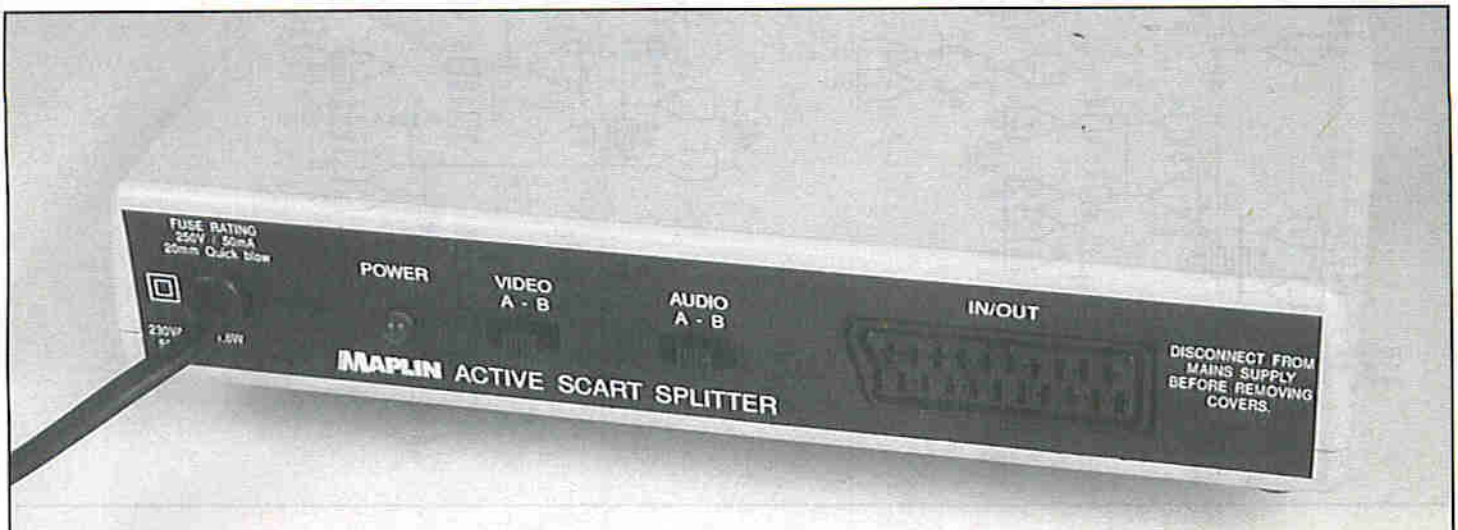
The block and circuit diagrams of the Active SCART Splitter are shown in Figures 1 and 2. The basic operation of the circuit is to split the single-channel SCART input source into two output channels, A and B, these being available at two SCART (Peritel) sockets. In between are video and audio buffer stages to avoid degradation of the signals that would otherwise occur as a result of splitting them into two paths – as is the case with simple passive SCART splitters, the use of which often results in grainy/grey picture quality. A selectable signal return path is provided, since some SCART systems require a return signal while others operate fine without it; slide switches S1 and S2 are used to select video and audio signal returns (respectively) from either channel A or B. Thus, an audio and/or video signal return (or neither) can be obtained from either channel.

The circuit design is such that the video and audio signal paths are kept separate to avoid crosstalk distortion. To this end, there are two buffer amplifier integrated circuits; IC1, a EL2245CN wideband (100MHz) op-amp, handles the video signals, while IC2, a TLO72 (3MHz bandwidth) op-amp, is employed for the audio section. Both devices are dual amplifiers, in 8-pin DIL packages.

The EL2245CN is a fairly 'exotic' breed of op-amp, being a low-power, wideband, gain-of-2 stable monolithic op-amp, built using a high-speed complementary bipolar process. It uses a classical voltage-feedback topology, which allows it to be used in a

SPECIFICATION

Operating voltage:	230V AC 50Hz mains
Current consumption:	8mA
Power consumption:	1·84W
Video bandwidth:	DC-100MHz (–3dB)
Audio bandwidth:	DC-3MHz (–3dB)
Video input impedance:	75Ω
Audio input impedance:	10kΩ
Video output load:	75Ω
Audio output load:	1kΩ
Audio input:	10V Pk-to-Pk (maximum)
Video input:	3V Pk-to-Pk (maximum)
Overall audio/video gain:	0dB
Audio/video S/N ratio:	80dB
PCB dimensions:	178 × 100mm
Box dimensions:	205 × 108 × 38mm



The completed unit.

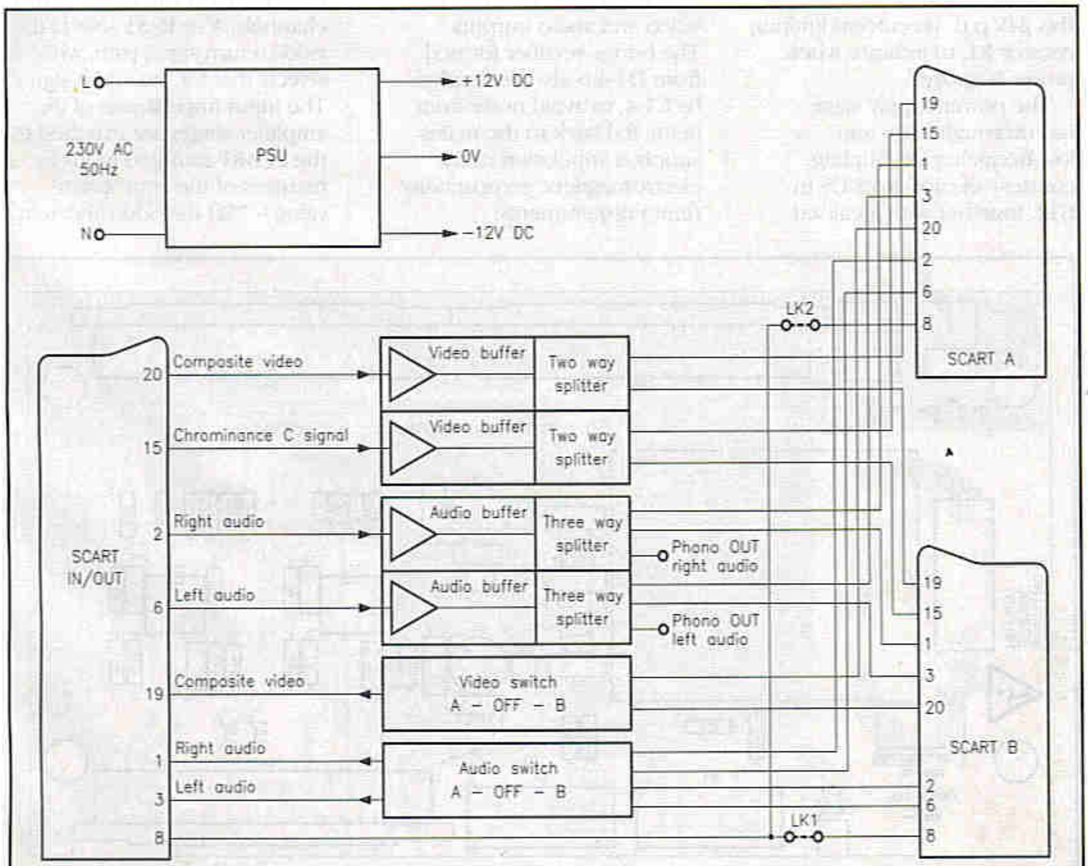


Figure 1. Block diagram.

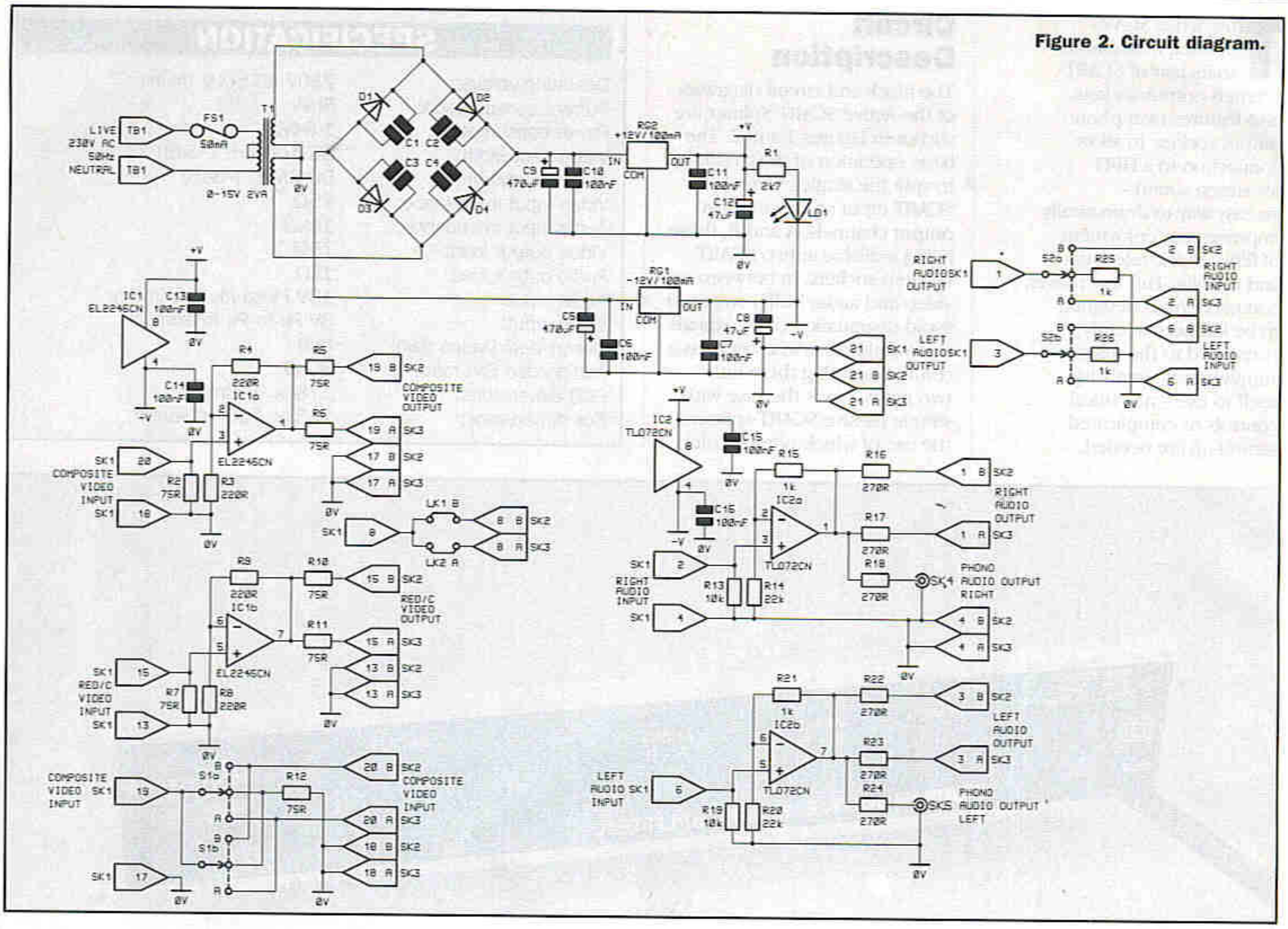


Figure 2. Circuit diagram.

variety of applications where current-feedback amplifiers are inappropriate because of restrictions placed upon the feedback element used with the amplifier. It is also ideal for this circuit, due to its ability to handle the video bandwidth requirement of domestic TV composite video signals – up to a maximum of around 6MHz.

The TLO72 is a more common-or-garden device, chosen for its low noise and low harmonic distortion, making it ideal for buffering the audio signals in the left- and right-hand (stereo) channels. The audio outputs are available from both the SCART sockets SK2 & SK3, and the phono sockets SK4 and SK5. (The phono sockets allow stereo audio connections to be readily made to most Hi-Fi systems.)

Power for the circuit is derived from the mains AC supply, which is fed via fuse FS1 (for protection of the mains lead against short circuits) into a PCB-mounted step-down transformer, T1. The AC voltage from the secondary windings is fed into the bridge rectifier formed by diodes D1-4, and thence into the DC voltage regulators, RG1 and RG2, to produce a regulated ±12V DC to supply the remainder of the circuit. LD1 is wired across this 24V p.d. via current limiting resistor R1, to indicate when power is applied.

The power supply stage has thorough high- and low-frequency decoupling, courtesy of capacitors C5 to C12, together with localised decoupling of the ICs by C13-16, to prevent modulation distortion from reaching the video and audio outputs. The bridge rectifier formed from D1-4 is also decoupled by C1-4, to avoid noise from being fed back to the mains supply, a stipulation of the electromagnetic compatibility (emc) requirements.

S1a & S1b, and S2a & S2b, are centre-off DPDT slide switches used to select the signal return channels, A or B; S1 selects the video return signal path, while S2 selects that for the audio signal. The input impedances of the amplifier stages are matched to the SCART standard levels by resistors of the appropriate value – 75Ω for video and 10kΩ

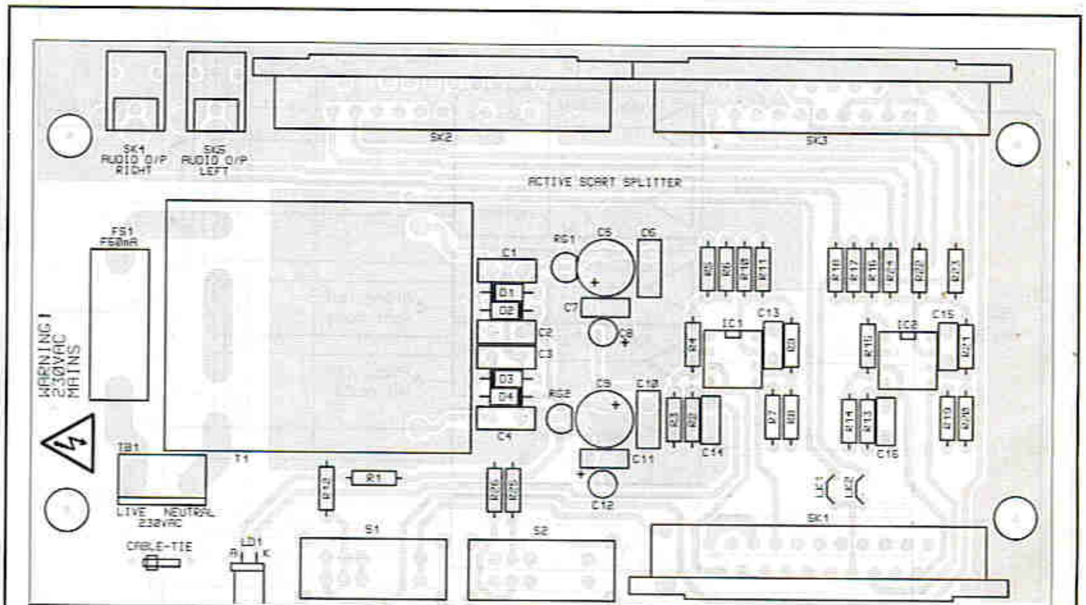


Figure 3. PCB legend and track.

for audio, and the outputs are configured to drive standard SCART loads.

The video and audio signal amplitudes are normally at around the 1V Pk-to-Pk level, and since the circuit can handle up to 3V Pk-to-Pk video and 10V Pk-to-Pk audio, it should not be possible to overload the unit with the SCART signals obtained from TV and video equipment.

PCB Assembly

The project features a double-sided PCB design, whereupon all the components are mounted directly onto the board to minimise the wiring and simplify construction; in fact, only two wires are required, these being the live and neutral mains lead connections. The PCB legend and track are shown in Figure 3.

Commence the board construction by installing the resistors and capacitors, followed by the other parts, in order of ascending component size. Take care to ensure the correct polarity of the polarised devices – semiconductors and electrolytic capacitors. Using component lead offcuts, fit the two wire links LK1 & LK2. Use DIL holders in the IC1 & IC2 positions, but do not fit the ICs into them yet. Refer to Figure 4, showing how to fit the mains cable, LED and fuseholder. Fit the specified fuse into the holder.

Once the board assembly is completed, carefully check and double-check your work for mistakes, solder whiskers, bridges and dry joints. Remember, this is a mains-powered project, so there is no room for errors! Finally, clean excess flux off the board using a suitable solvent.

Final Assembly, Testing and Use

Having satisfied yourself that the PCB construction has been completed correctly, fit the board into the base of the (pre-drilled) plastic box, with the ICs left out of their sockets at this stage – see Figure 5, showing the exploded assembly diagram. Fit the strain relief grommet into its hole in the front panel and pass the mains lead through it. Strip an appropriate length of the insulation from the free ends of the mains cable, twist the bared strands together and affix a 3-pin plug fitted with the correct (2A) fuse to the mains cable.

DO NOT attempt to test the unit out of the box base, as areas of the PCB underside are at mains potential. Please read the mains safety warning printed in this article prior to commencing testing of the unit.

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 engineer.

First, using a multimeter, measure the resistance between the live and neutral pins on the mains plug – the reading should be around 2·3kΩ. Next, measure the resistance of the power supply pins (4 and 8) of ICs 1 & 2 to ground (0V), to check for short circuiting of the regulators (the reading should be not less than 4kΩ).

Remove fuse FS1, and with the multimeter set on a suitably high AC current range (e.g. 200mA), connect its test leads across the fuseholder contacts (preferably using insulated crocodile clips). Switch on the unit. LD1 should light to confirm that power is being applied, and a current reading of around 6mA AC should be obtained. Power down the unit and replace the fuse.

Apply mains power to the unit again. Using a multimeter with its '–' lead connected to a 0V point on the board (e.g. SK1, SK2 or SK3 pins 4, 13, 17, 18 or 21, or the metal body of switches S1 or S2), use the other test probe to check the voltage reading at the IC sockets' +V and –V terminals, i.e. pins 8 and 4, which should be at +12V and –12V, respectively. Do not touch any exposed metal parts with your hands when doing this! If the correct voltage readings are obtained, disconnect the mains supply, and plug the ICs into their respective sockets, taking care not to mix them up (they are both 8-pin DIL packages).

Again, remove fuse FS1 and test the AC current by reapplying the mains supply to the unit – a current reading of approximately 8mA should be obtained. Ensure that the ICs do not get warm, which would indicate a mistake in either the board assembly or, rather less likely, a component fault. Take great care not to touch any of the live parts on the board during the testing process.

Disconnect the mains supply, replace fuse FS1 and fit the lid onto the box with the screws supplied.

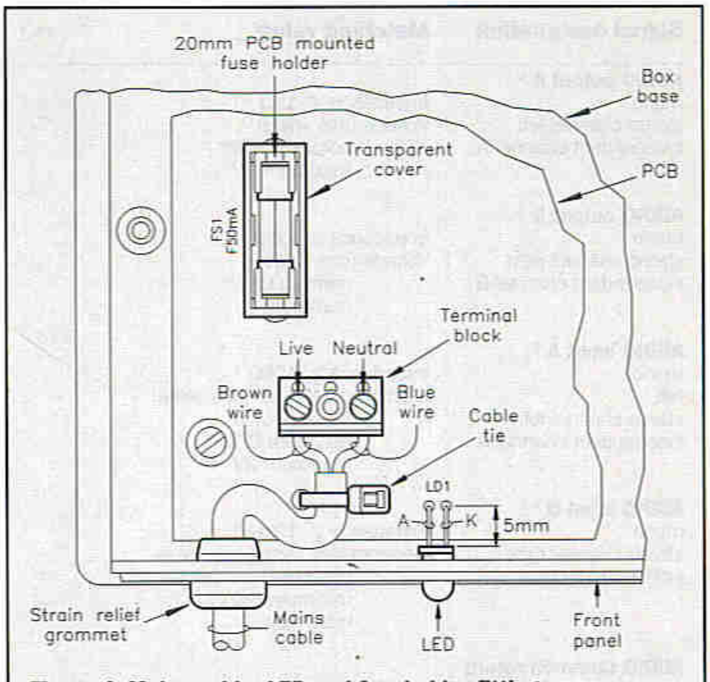
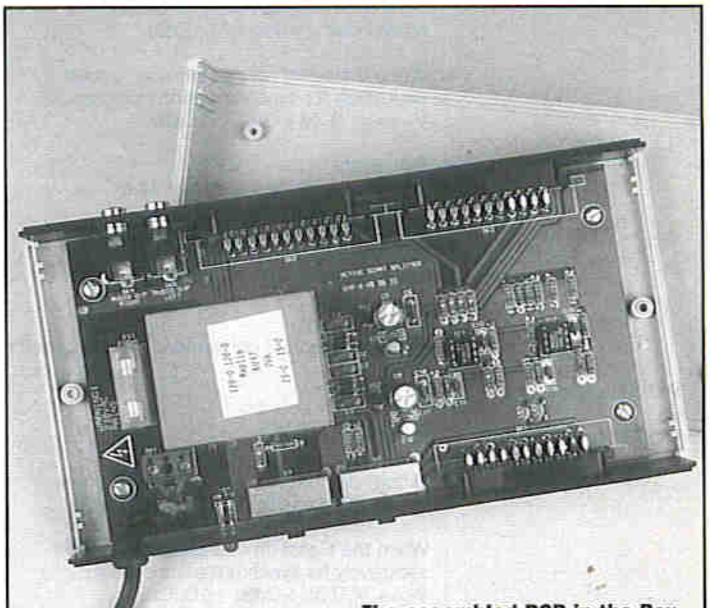


Figure 4. Mains cable, LED and fuseholder fitting.



The assembled PCB in the Box.

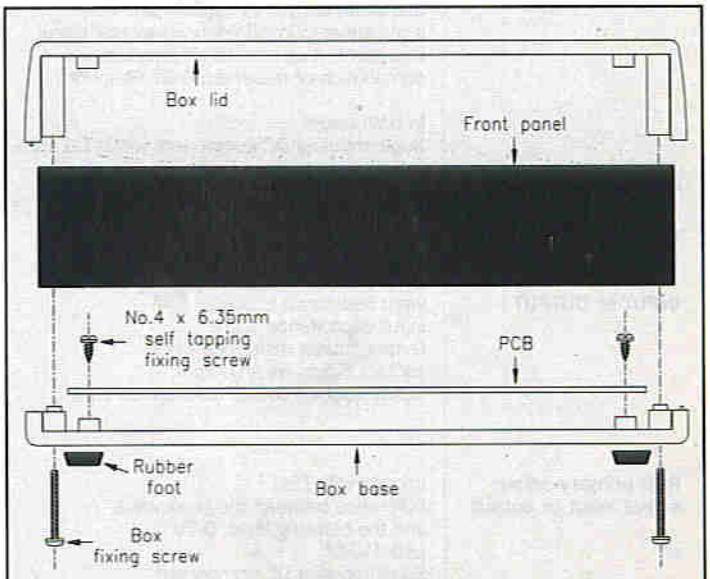


Figure 5. Exploded assembly diagram.

Signal designation	Matching value	Contact number	Test conditions and comments
AUDIO output A [1] mono stereo channel left independent channel A	Impedance ≤ 1kΩ [2] Voltage (rms value) nominal 0·5V* maximum 2V	3	Load impedance for compliance testing: 10kΩ * for a modulation factor at the transmitter of 54%. If a MAC coded signal is present at pin 19, the connected equipment should shall ignore the signal at this contact.
AUDIO output B [1] mono stereo channel right independent channel B	Impedance ≤ 1kΩ [2] Voltage (rms value) nominal 0·5V* maximum 2V	1	Load impedance for compliance testing: 10kΩ * for a modulation factor at the transmitter of 54%. If a MAC coded signal is present at pin 19, the connected equipment should shall ignore the signal at this contact.
AUDIO input A [1] mono left stereo channel left independent channel A	Impedance ≥ 10kΩ [2] Electromotive force (rms value) nominal 0·5V minimum 0·2V* maximum 2V	6	Source impedance for compliance testing:1kΩ * for a nominal output value according to the equipment specifications
AUDIO input B [1] mono stereo channel right independent channel B	Impedance ≥ 10kΩ [2] Electromotive force (rms value) nominal 0·5V minimum 0·2V* maximum 2V	2	Source impedance for compliance testing:1kΩ * for a nominal output value according to the equipment specifications
AUDIO Common return		4	
VIDEO output	Impedance: 75Ω [4] Composite video signal or Y'' [10] Difference between white level and synchronising level: 1V (±3dB) [3]		Positive-going video
	When the signal on this terminal is used exclusively for synchronisation purposes, V_{SYN} = 0·3V (–3dB, +10dB)		Negative-going signal
	MAC Signal The amplitude between black level and white level is 1V (±3dB) and if the superimposed energy dispersal signal is present, it can cause an amplitude contribution of maximum 0·3V Pk-to-Pk	19	If the equipment is designed to deliver a MAC coded signal, at this contact, the MAC coded signal shall be free of linear pre-emphasis in case of satellite reception, but it may or may not contain the energy dispersal signal
	In both cases; Superimposed DC component within 0 and 2V		
VIDEO output return		17	
VIDEO input	Impedance: 75Ω [4] Composite video signal or Y'' [10] Difference between white level and synchronising level: 1V (±3dB, +10dB)		Positive-going Video
	When the signal on this terminal is used exclusively for synchronisation purposes, V_{SYN} = 0·3V (–3dB, +10dB)		Negative-going signal
	MAC signal The amplitude between black level and white level is 1V (±3dB) and if if the superimposed energy dispersal signal is present, it can cause an amplitude contribution of maximum 0·3V Pk-to-Pk	20	If the equipment is designed to receive a MAC coded signal, at this contact, the MAC coded signal shall be free of linear pre-emphasis in case of satellite reception, but it may or may not contain the energy dispersal signal
	In both cases; Superimposed DC component within 0V and +2V		
VIDEO input return		18	
FUNCTION switching [6] **(slow switching)** **INPUT or OUTPUT**	Level 0: 0 to 2V Level 1A: +4·5 to +7V Level 1B: +9·5 to 12V input resistance ≥ 10kΩ input capacitance ≤ 2nF Output source resistance when contact 8 acts as an output: 300Ω ≤output source resistance≤ 1kΩ	8	Load resistance for compliance testing: 10k≥ Ω For a television receiver, the control voltage is an input signal delivered by the peripheral equipment. Level 0: television broadcast reproduction Level 1B: peritelevision reproduction * Level 1A: reproduction of an external source with aspect ratio of 16:9, if the equipment is designed to display in this aspect ratio
RED primary colour signal input or output or **C signal** [9]	Impedance: 75Ω [4] Difference between the peak value and the blanking level: 0·7V (±0·1V) [5 8] Superimposed DC component within 0V to +2V	15	Positive-going signal C'' consists of the colour subcarrier, modulated with two chrominance signals and the reference burst signal.

Signal designation	Matching value	Contact number	Test conditions and comments
input or output	Standard chrominance level ±3dB (see CCIR Report 624-3)		The complementary application of C signal on pin 15 can use the same contact as RED, with appropriate switching.
RED return		13	
GREEN primary colour signal input or output	Impedance: 75Ω [4] Difference between the peak value and blanking level: 0·7V (±0·1V) [5 8] Superimposed DC component within 0 and +2V	11	Positive-going signal
GREEN return		9	
BLUE primary colour signal Input or output	Impedance: 75Ω [4] Difference between the peak value and blanking level: 0·7V (±0·1V) [5 8] Superimposed DC component within 0V and +2V	7	Positive-going signal
or C" signal Input or output	Standard chrominance level ±3dB at $1V_{p-p}$ of Y" input signal		
BLUE return		5	
BLANKING [7] (Rapid switching) Input or output	0V to 0·4V logical '0' +1V to +3V logical '1' Impedance: 75Ω [4]	16	Bandwidth and time delay shall be matched to those of the RGB primary colour signals
BLANKING return		14	
Intercommunication data line No.1	No connection permitted (future use under consideration)	12	
Control signal line bidirectional	All measurements are with a power supply of +5V, unless otherwise stated. The control signal is a pulse shaped burst with a burst time of maximum 500ms. The time between the first falling edge and the next within the PSB is maximum 10ms. The time gap between two PSBs is minimum 15ms 1. Maximum voltage slew rate measured with external circuit both open circuit and also with external test circuit connected to contact 10 consisting of a 3·9kΩ±5% resistor connected to +5V power supply: Maximum slope dv/dt=0·2V/µs 2. Voltage of the control signal with the device in logical '0' state and external test circuit connected to contact 10 consisting of a resistor of worst case value 27kΩ–5% connected to +5·5V power supply: Maximum voltage = 600mV 3. Voltage of the control signal with the device in logical '1' state and external test circuit connected to contact 10 consisting of a resistor of worst case value 27kΩ+5% connected to +4·5V power supply: Minimum voltage = 3·7V 4. Input threshold shall be such that a reading of the control signal line should give a logical '0' level with the voltage set to: 800mV 5. Input threshold shall be such that a reading of the control signal line should give a logical '1' level with the voltage set to: 2·7V 6. Maximum capacitance load of a device (excluding external cable): 100pF 7. Maximum rise time from 10-90% of pulse amplitude: 500µs 8. Maximum fall time from 90-10% of pulse amplitude: 100µs 9. Maximum leakage current with equipment in 'standby' mode, or 'power off' switched by a front mounted power switch or when the mains is removed: Maximum current ±1·8µA 10. Maximum polling interval time equals: 0·5ms	10 10	* Optional means: if the signal is not in accordance with the listed values, the pin 10 shall not be connected. PSB = Pulse-Shaped Burst
Common return		21	Connected to reference potential and plug shield

Notes

1) The existence of various modes of operation in audio circuit (mono, stereo, independent channels) requires suitable switching in the originating equipment.

2) For frequencies from 20Hz up to 20kHz.

3) For television systems using positive video modulation, the tolerance may be enlarged to -3dB, +6dB.

4) The specified signal voltages shall be measured under matched conditions.

5) For monochromatic signals, the difference between any two primary colour signals shall not exceed 0·5dB. The peak values of primary colour signals are those that give rise to a peak white luminance signal.

6) A low data rate communication between pieces of equipment can be implemented via contact 8, it is permitted to superimpose this AC signalling information on the DC function switching line, provided that the peak-to-peak value remains within the voltage limits defining logical '0' and logical '1' that are specified in the standard.

7) Logic '1' corresponds to blanking active: the external RGB primary colour signals are then displayed.

8) If the video signals represent text or synthetic, rather than natural, pictures (for example, teletext or video graphics), the tolerances are ±3dB.

9) In the case of PAL: The C signal shall be time coincident with the Y signal within 100ms. This shall be measured at the output of the source equipment, using a standard colour bar signal, and measuring at the green-magenta transition, where the C signal makes a zero crossing. The amplitudes of the green and magenta chroma signals shall be equal within 10% for this measurement.

10) Y" comprises the luminance and synchronisation signals.

Note that no on/off switch has been provided, because this low power unit has been designed to be left on continuously (as with VCRs) and mounted in a discrete position, perhaps behind the television or VCR unit(s). However, you may wish to ensure that the front panel 'power on' LED remains visible to confirm that the unit is in operation.

Table 1. SCART pinout designation.

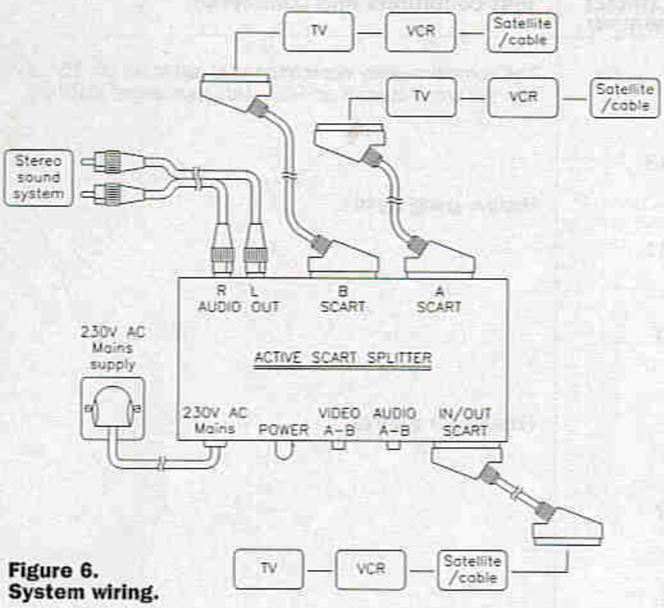


Figure 6. System wiring.

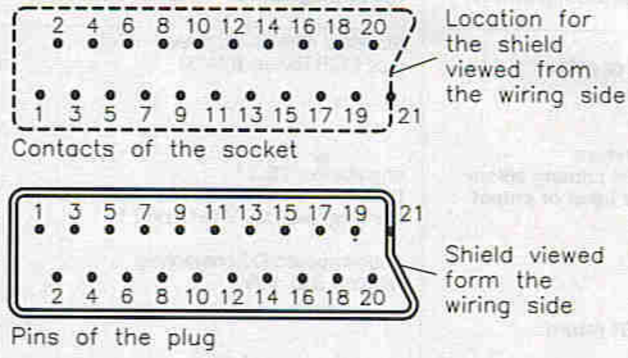


Figure 7. SCART socket pinout.

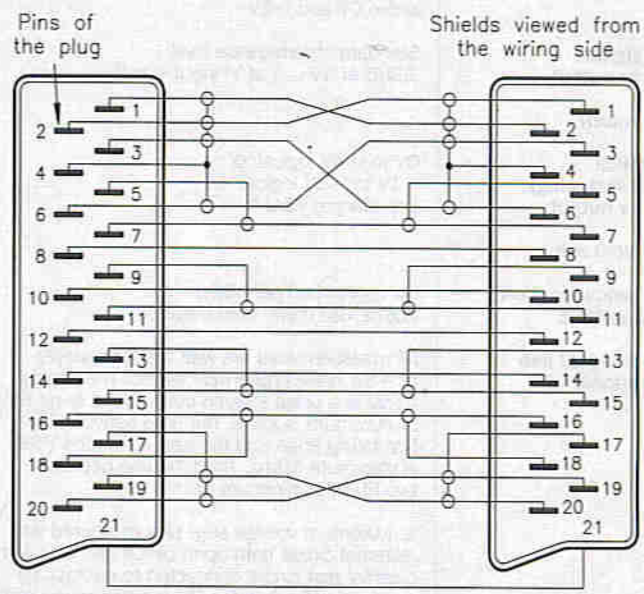


Figure 8. SCART-SCART lead interconnections.

The next test is to connect a SCART signal source (e.g. from a VCR, etc.) into the input socket, and to ensure that a satisfactory signal is obtainable from the two output sockets – see the system wiring diagram, Figure 6. A pair of SCART-compatible monitors connected to the outputs would be the best way to check that there is no discernable degradation of either the audio or video signal from the input source.

Depending on the type of SCART equipment you are using, you may need to alter the function switching path on pin 8 of the SCART socket, which is achieved by cutting either or both of the onboard links, LK1 & LK2 – disconnect the mains supply beforehand. If in doubt as to how to make up suitable connection leads for your SCART equipment, refer to the SCART socket pinout and lead interconnection diagrams/ descriptions, shown in Figures 7 and 8 and also Table 1. Also see the optional parts list for details of ready-made SCART leads and accessories.

PROJECT PARTS LIST

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

R1	2k7	1	(M2K7)
R2,5-7, 10-12	75Ω	7	(M75R)
R3,4,8,9	220Ω	4	(M220R)
R13,19	10k	2	(M10K)
R14,20	22k	2	(M22K)
R15,21, 25,26	1k	4	(M1K)
R16-18, 22-24	270Ω	6	(M270R)

CAPACITORS

C1-4,6,10	100nF 50V	6	(BX03D)
C5,9	470µF 35V	2	(AT62S)
C7,11,13-16	100nF 16V	6	(YR75S)
C8,12	47µF 16V	2	(AT39N)

SEMICONDUCTORS

D1-4	1N4002	4	(QL74R)
LD1	Red LED	1	(WL27E)
RG1	LM79L12ACZ	1	(WQ86T)
RG2	LM78L12ACZ	1	(WQ77J)
IC1	EL2245CN	1	(AJ58N)
IC2	TL072CN	1	(RA68Y)

MISCELLANEOUS

TB1	2-way 10mm PCB-mounting Terminal Block Type 300	1	(JY93B)
SK1-3	Right-Angled PCB-mounting Lugless SCART Socket	3	(BP65V)
SK4,5	PCB-mounting Phono Socket	2	(HF99H)
S1,2	DT3T Right-angled PCB-mounting Slide Switch	2	(FV02C)
T1	0-15V 2VA PCB-mounting Transformer	1	(KU97F)
FS1	50mA 20mm Quickblow Fuse	1	(WR93R)
	20mm Fuse Block	1	(DA61R)
	8-pin DIL Socket	2	(BL17T)
	No.4 × ¼in. Self-tapping Screw	1 Pkt	(FE68Y)
	Twin-core Black Mains Cable	2m	(XR47B)
	100mm Tie-wrap	1	(BF91Y)
	13A Nylon Mains Plug	1	(RW67X)
	2A Plug Fuse	1	(HQ31J)
	PCB	1	(GJ77J)
	Box	1	(JS82D)
	Instruction Leaflet	1	(XZ36P)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

SCART Plug-to-plug Connecting Cable	As Req.	(JW36P)
SCART Universal Connecting Cable	As Req.	(JW37S)
SCART Plug to Phono Plugs Cable	As Req.	(JW38R)
SCART Plug to Phono & BNC Plugs Cable	As Req.	(CC04E)
SCART Universal Connection Kit	As Req.	(JW35Q)
Twin Phono Plug to Phono Plug	1	(RW50E)

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 LU21X (Active SCART Splitter) Price £39.99

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 SCART Splitter PCB **Order As GJ77J Price £12.99**
Active SCART Spliter Box **Order As JS82D Price £14.99**

An interview with SIR CLIVE SINCLAIR

by Paul Freeman-Sear

PFS: Were you actively encouraged to be inventive at school?

SCS: I went to a great many schools, about thirteen, in fact; my parents circumstances changed, so it varied a lot. One school I was at had a lot of equipment, a machine shop and so on, but that was fairly unusual, certainly at that school, I did a lot more at making things than at other schools. I was always interested in inventing things, particularly mechanical calculating machines and in radio and electronics which was radio to me in those days.

PFS: Do you have any brothers and sisters who are also creative and inventive?

SCS: My brother is an industrial designer and also designs end products and my sister is a psychotherapist.

PFS: Did your parents actively encourage you to go out into the workshop and build new inventions?

SCS: That's not what I did. In fact, I was more interested in the more theoretical side, but anything I wanted to do I certainly had encouragement in.

PFS: What is your company name and how does it differ from the past?

SCS: My company is called Sinclair Research, as it has been for many years, but we work in a very different way now from the way that I worked in the past because I don't want to get bogged down in the management aspect. So what I'm hoping to do in the future is to try and form alliances with companies that will come up with the idea and invent the product say and they take it on. I don't employ a lot of people – I leave that to others. I've got lots of colleagues who I can call upon to form teams for various projects.

PFS: What are your current developments?

SCS: We sell at the moment the Zeta (Zero Emission Transport Accessory), which converts the bicycle to electric power and that is our only product at the moment. We have developed, to the prototype stage at the moment, a unit for wheelchairs because we have a lot of people asking for that. It converts a conventional NHS type chair to electric power to help people push it and it can completely propel the wheelchair.

PFS: What type of battery does it use?

SCS: I'm sorry, it's a new product and I can't tell you. On that particular product, it's not been decided because the prototype uses a sealed lead acid battery but it's possible that we might use Nickel Cadmium, although it hasn't actually been decided.

PFS: And what about the motor, is it conventional?

SCS: I'm sorry, I can't say. All I can say is that it is a highly unconventional solution to the problem and I'm very pleased with it. Other people have tried to solve that problem and come up with some very cumbersome heavy units and this is very neat and light. It is a very nice solution to the problem.

PFS: The Zero Emission Transport Accessory (Zeta) which is sold through the Maplin catalogue (Order code DZ90X – Ed.) **is an aid to cyclists to help them transport themselves around. What type of battery does it use?**

SCS: A lead-acid battery

PFS: What is the range of Zeta, the transport accessory?

SCS: A journey of about 10 miles.

PFS: And it's a suitable aid to cyclists to help them go uphill?

SCS: That's right. It's when you come to a hill or encounter a headwind where it might normally require excessive effort to ride the bicycle and you just push the button and it's an easy ride, as it would normally be on the flat. So it takes the effort out of it.

PFS: How long ago was Zeta developed?

SCS: About three years ago.

PFS: Where is it being sold, other than in the Maplin catalogue?

SCS: Almost all the sales are by mail order. We take advertisements in the newspapers.

PFS: Is it selling well at the moment?

SCS: Yes it is, it's very popular and we've done a survey of the customers that have bought it and there's a very high degree of satisfaction. People use it in the way we've expected and hoped and we are very pleased with it.

PFS: You've been very keen on developing electric vehicles in the past, would you say that you are an environmentalist?

SCS: That's not how I would describe myself, I am an inventor, but as an inventor is concerned with problems and one of the problems is pollution, so I am concerned about pollution. It is an environmental concern that led me to this interest in transport and I do believe that electric transport is the sensible answer to cities – it's just rather a long time coming.

PFS: You're famous for electronic products in the past but have you invented any non-electric or mechanics-only products?

SCS: No, we have not marketed anything non-electric, but I spent several years developing a lightweight bicycle called the X bike. I didn't bring that to market because it didn't get far enough. Again, it's this interest in the pollution problem with the appeal that if anyone could have a bicycle that is as easy to carry as an umbrella say, then you would use it very much more frequently, particularly as it couldn't get stolen because it would be with you all the time. You could take it on the train and it would make a big difference to the degree and ease at which you could use a bicycle – something I would relish having myself. The reason that this is a difficult problem is that bicycles haven't got lighter for a hundred years. The reason being that most of the weight of the bicycle is not in the frames but in the cranks, chain and heavy metal bits. Remarkably, these are standardised throughout the world, and everybody uses the same bits fundamentally, so the bicycles are not any lighter. The lightest bike you can buy is about 20lbs. So in order to change that, you've got to be very radical and you've got to redesign all the parts of the bicycle – a hell of a big job, which we did with the X bike, and we got the weight down to about 8lbs. But I decided it didn't go far enough, and I have been working on it myself on paper with a second generation which would be very much lighter still.

PFS: 8lbs is remarkably light for a bike!

SCS: Yes, but it's still not light enough, an 8lb umbrella would not sell very well! It one of those things where its a dramatic change, but not a sufficient one. People who like folding bikes would say great, that's a marvellous folding bike because its so light, but they are already using folding bikes so that's not a new market. In order to create a really new market, we have got to change a lot more and that's what I'm working on. That bicycle will be very much more radical even than the X bike when it has a new drive, and so on.

PFS: So have you moved away from using any metal in the next generation bicycle?

SCS: That's an interesting question. Not necessarily, the frame might well be metal on the first one. I would like to use carbon fibre, because that's the obvious material choice. It's not only expensive but it's quite difficult to use in some respects. The weight reduction is achieved to some degree by new materials, but it's fundamental redesign so it can be made in metal and still be light. It's complete rethinking of the whole thing from scratch – every single part and aspect, the drive, the wheels and steering system.

PFS: What sort of time to market is on this very radical change in bicycle technology?

SCS: A few years away yet

PFS: So do you see lots of people say in the city walking around with a portable mobile source under their arm in the future?

SCS: I don't how many there will be, but there will be enough to make a difference. It's not the solution, it's part of a solution – it's one of the elements. The other thing we need is local electric town cars, very different from the ones that are being designed at the moment. I think the trouble is, the ones that are being designed at the moment are really just petrol cars with the engine taken out and electrics put in,and that's a very bad mistake.

PFS: But some are hybrids – diesel with electric drive for about town use.

SCS: A hybrid is quite a good approach I think, and there you would end up with the same sort of body as an existing car. What is really needed, in my opinion, is a car for town use dedicated to local use with around 30 mile range. In which case, it needs to be very lightweight, then it will not need to use batteries and it won't need to be expensive. Then people will use it because it will be cheaper to use than an ordinary car we won't have twist their arms to use it they will be dying to use it. Trying to make pure electric cars that have a long range is a mistake because they will not replace the ordinary car – they will not do the same job, because of the charging problem. The thing is not to do that. We need to go down two routes, one is to make local cars which are for just 30 mile range, and a lead acid battery will do for this. The other extreme, if you want a car that is electric in the town but also has a long range, is the hybrid. Alternatively, you want the car with a fuel cell, which will no doubt be used in the next century. So there is very definitely a slot for a new concept of car to us that is an ultra-light one just for local use, and a lead acid battery will meet that need. Of course, if you can use Nickel Cadmium batteries, you will save some weight but the weight for a 30 mile range is not too bad either way.

"... the Spectrun used compu

PFS: No radical change to electric motor design then?

SCS: The electric motor is an extremely good device and does the job well. There are lots of different sorts of electric motor. Recently, there have been a lot of interesting developments. There are some highly efficient ones now, switch reluctance motors, for example, are a very exciting new development.

PFS: Have you any new developments in producing a good, cheap, powerful computer in the future?

SCS: I have got some ideas but again, it is not possible to talk about them.

PFS: What about the silicon wafer technology you were working on a while ago that could reduce the rejection rate at manufacture?

SCS: We put it into production but it was in the recession and the market didn't turn out right, and at the moment, it's on the back burner.

Back to the Future

PFS: In the past, on a television programme, you were quoted as saying that unemployment in the UK would rise dramatically in the long term and most consumer products would be made in third world countries.

SCS: That programme was a long time ago in the early eighties. I said then that there would be a very large rise in unemployment, but that we would get through it and it would decline again. A lot of people would be put out of jobs because of the computer revolution and that is exactly what has happened.

When I gave that talk, 21% of the workforce were employed in manufacturing and I said that would come down to 8-10%, which indeed, it is getting close to now.

We can only afford to pay the high salaries in this country from the manufacturing point of view if we are making things with a very high level of intellectual property involved with the product.

n ... it's the biggest-selling ter in Russia today."

PFS: But doesn't making goods in the emerging countries lead to higher pollution and wasted energy if they are not made locally?

SCS: No, on the contrary. It's more efficient to transport the finished goods than the raw materials to make them. Mostly, we would have to import the raw materials, which would be bulkier than the finished goods. Manufacturing is performed where it's cost effective, so long as China has very much lower pay rate than us, then it will be cost effective to make products there, assuming the cost of transport is not too high than to make them here.

PFS: What is your current interest in satellite TV technology?

SCS: None, we had a company that we sold to SCI that made satellite receivers, but we are not involved in that at the moment.

PFS: How do you see the future of television developing?

SCS: That's very interesting. There's talk of very large numbers of channels – hundreds, in fact. It would be very interesting to see it happen, although I'm not certain that it's very good economics – but who knows? It's very interesting that despite all the satellite channels there are now, the ground base stations BBC and ITV still completely dominate and have an overwhelming chunk of the time; Sky TV has not managed to capture a very large percentage of the viewing hours.

PFS: What is your opinion of the Information superhighway and the Internet?

SCS: As it stands at the moment, rather like CB radio, it is a tremendous hobby for a lot of people – an exciting one. There's a small group of people, professionals, to whom it's a very useful tool, there's a very much larger number of people to whom it's a 'toy' and a very good toy. And I don't disparage that, but it is a toy, nonetheless. It's up against this awful problem of bandwidth isn't it, and I don't know how it's going to be overcome – we really do need the higher bandwidth into our homes. Clearly, that's technically possible at the moment with optical links, but there doesn't seem to be the political will at the moment for it to happen. Without that, the Internet can't really be what we would like it to be, but I think it is an exciting and dramatic development. It's one of things that at 20 years of age, I wouldn't have dreamed of – or didn't dream of!

PFS: But also, Sir Clive, a lot of electronics enthusiasts have turned to computer interests, something which you perhaps started the revolution in cheap home computers with your ZX80 and ZX81.

SCS: Yes, that's right, and that became a big hobby and sucked people away. There was a generation of people that would have dabbled in electronics and then dabbled in computers and now, of course, the Internet is the latest one.

I think integrated circuits have changed things as well, because in the days before integrated circuits, you'd make up a circuit and understand what was happening but if you are just connecting some ICs together, you don't know fundamentally what's happening, so it's taken the fun out of it.

PFS: Would you say that you have made your greatest discovery yet, or is it still to come?

SCS: Oh, it has still to come.

PFS: So, you think you might be even more popular in times to come than with the Sinclair Spectrum computer.

SCS: To design anything that has sold in larger numbers than the Spectrum would be quite a trick. Who knows? I had a letter from Russia the other day, and a chap there thanked me for coming up with the Spectrum, because it's the biggest-selling used computer in Russia today. There are lots of companies in Russia that make Spectrums illegally – not under licence.

PFS: One thing I remember on the Spectrum was the soft rubber keys. What was the original thinking behind using soft rubber?

SCS: Cost and reliability. We had to make the keyboard ourselves – we couldn't go and buy one off the shelves. That was a very cost effective solution. They were a bit wobbly, weren't they? We then tooled up at tremendous expense with the QL and we did a spectrum with hard keys later on.

PFS: Why do you think it is so difficult to get financial backers for innovative ideas in Britain?

SCS: It is certainly much harder than it is in the United States, though it is probably easier than in Europe and is becoming easier, but it is taking a long time for the city to gear itself up to backing high tech. It's a question of change – when I first knew Cambridge, there was virtually no industry at all, now there are hundreds of high tech companies there. As these succeed and people see them succeed, the urge to invest in high tech companies will grow because people will see that there is a quick buck to be made out of investing in the right company. That's what has happened in the States, and I think that's what is happening here now we have a lot of high tech companies starting and flourishing.

PFS: Finally Sir Clive, are you ready to retire yet?

SCS: No, no I don't plan to retire at all.

PFS: Thank you.

Sine of the Times: THE EARLY OSCILLOSCOPES

by Greg Grant

In 1897, Karl Ferdinand Braun developed the Oscilloscope and, for the first time, electrical and radio engineers could see what was happening in an electrical circuit.

For the next forty years, however, the new invention would be regarded as little more than an exotic tool with very limited applications.

The oscilloscope was a child born of scepticism. The German physicist, Karl Ferdinand Braun, had considerable reservations concerning two, late nineteenth century discoveries. To begin with, there was Heinrich Hertz's revelation that electromagnetic waves existed, the mathematical base for this phenomenon having been established as early as 1865 by James Clerk Maxwell. Secondly – and to Braun, more disturbingly, – there was Wilhelm Roentgen's discovery of X-rays, a revelation that appeared to set physics off in an entirely new direction.

It was as a result of these doubts that Braun decided to begin his own investigation into this burgeoning field of radiation. However, he chose to look into neither X-rays nor electromagnetic radiation but Cathode Rays, which had an even longer, equally mystifying history.

The Nature of Cathode Rays

This aspect of physics began in 1855 when the German inventor, Heinrich Geissler, developed the Mercury Air pump. With it, he produced tubes that enclosed what was, for those days, a good vacuum. These tubes, some of which are shown in Photo 1, illustrated the colourful effects one could create by discharging electricity through rarefied gases.

In 1858, the German physicist-mathematician, Julius Plucker, forced an electric current through a Geissler Tube. This produced a beam which, Plucker discovered, could be bent when a magnetic field was located close to the tube. Therefore, whatever was happening within the vacuum, there was no doubt that an electric charge was involved.

Eleven years later, Plucker's former student, Johann Hittorf, took another look at this phenomenon. Having made his own version of Geissler's Tube, he established that the glow came from the negative pole, or cathode, and moved in a straight line towards the positive pole, or anode. He established this because an object placed in the way of the rays cast a shadow.

In 1876, another German researcher, the physicist Eugen Goldstein, repeated Hittorf's experiment and drew the same conclusions, naming the phenomenon Cathode Rays. By the end of that decade, the British electrical engineer, C. F. Varley, demonstrated that cathode rays could equally well be deflected by an electrostatic field.

In 1880, the British physicist and scientific editor, William Crookes, demonstrated that cathode rays travelled in straight lines and, as well as casting a shadow, could also drive a small wheel, provided they struck the wheel on its edge! Crookes, like Hittorf, made his own, improved version of Geissler's origination, the Crookes Tube and, from his investigations with it, concluded that cathode rays were a stream of electrically charged particles.

A decade later, the Irish physicist, George Stoney, put forward the idea that electricity, like matter, existed as fundamental particles. Furthermore, he thought that such particles carried the same electrical charge and suggested they be called Electrons.

Four years later, the French physicist, Jean-Baptiste Perrin, demonstrated that when cathode rays struck a cylinder, it slowly gained a large negative potential. This was the deciding factor: cathode rays were a stream of negative particles. It was at this juncture that Braun entered the picture.

The Braun Tube

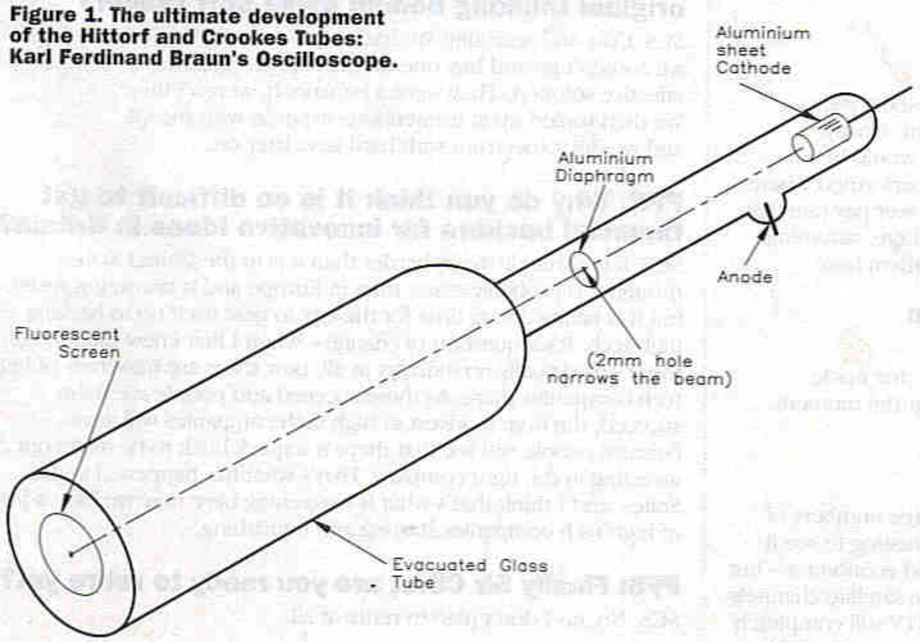
The earliest cathode ray tube, made by Braun at the University of Strasbourg, is shown in Figure 1.

Measuring 45 × 8cm, it consisted of an aluminium cathode, a diaphragm of the same material with a 2mm hole at its centre and finally, a mica screen coated with a phosphorescent colour.

The Braun Tube had been a gradual development, its creator modifying it so that the spot formed by the particle stream shifted in accordance with the electromagnetic field set up by the varying mains current applied to the field coil. In fact, the spot formed a wobbly vertical line.

When Braun placed a rotating mirror in front of the screen, a horizontal movement was added, and the mains current sine wave could be clearly seen. It was for this reason that the Braun Tube came to be called an Oscilloscope, because its electron beam could follow, and therefore display, current and voltage oscillations.

Figure 1. The ultimate development of the Hittorf and Crookes Tubes: Karl Ferdinand Braun's Oscilloscope.



Braun had created his tube principally for experimental purposes, and from observing the mains current variations of the local power station, he took to investigating the alternating current of the Strasbourg telephone exchange (50 complete vibrations per second), the curve produced by a tuning fork and the phenomenon of Lissajous Figures.

In 1899, Braun's assistant, Jonathan Zenneck, developed horizontal deflection, making the rotating mirror unnecessary. The basic oscilloscope was now in place. Yet, as late as 1911, there was not a single beam-deflection device on the market. Why?

Further Developments

It is difficult for many people, brought up in a world overloaded with communicative equipment, to realise that such devices are a quite recent development. At this time, amplifiers and oscillators did not exist and so there was no demand to produce the oscilloscope commercially. Nevertheless, a number of researchers world-wide continued to develop them further.

In 1902, Cornell University's Harris J. Ryan manufactured a 13cm diameter tube, but experienced problems with high voltage leakage. Three years later, the Austrian physicist, Artur Wehnelt, suggested that Braun's cold cathode cylinder be replaced by a lime-coated platinum filament.

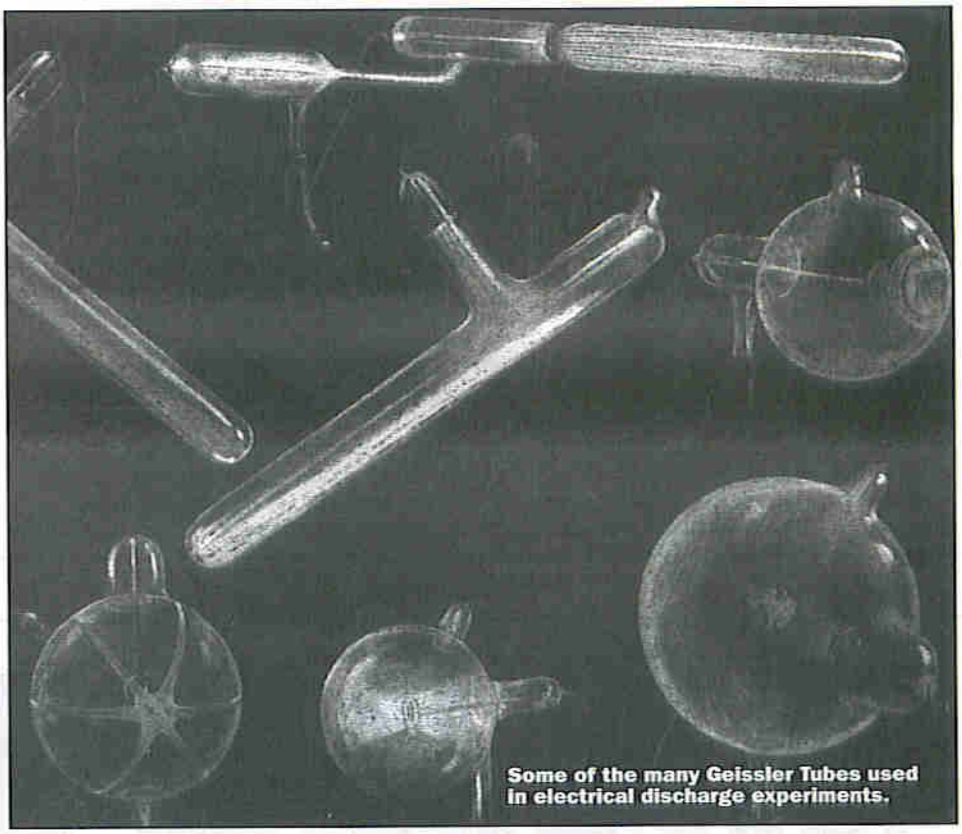
Wehnelt had carried out fundamental research into thermionic emission from platinum wires coated with a variety of oxides such as calcium, barium and strontium and discovered that, in a vacuum, such wires emitted more electrons per square centimetre than platinum alone. His work considerably improved vacuum valve efficiency and he later developed the Wehnelt Cylinder, which enabled oscilloscope beam current to be controlled, thus giving sharp-point focusing. This was the first of a number of small, yet very significant, developments in thermionic tube technology.

The watershed year in electronic developments, however, was 1912, when Lee de Forest, H. B. van Etten and Charles V. Logwood of the Federal Telegraph Company began working on amplifier design, centred on de Forest's triode valve. Before the year was out, the United States (US) government's Bureau of Standards tested the team's three-valve amplifier and found that it had a gain of 120! Here was another indicator of the way things were moving, in that the amplifier was designed by a team. True, lone inventors and originators would still come forward with stunning ideas and designs but, increasingly, they would become an endangered species.

In September 1912, Edwin H. Armstrong developed the first oscillatory circuit, his Regenerative design, which had considerable, near-immediate, success.

It was followed shortly afterwards by similar circuits, designed by such greats of the profession as Germany's Meissner, Britain's Round and Canada's Fessenden.

In 1915, the General Electric Company's Irving Langmuir applied for a patent for what he termed a 'Getter', for producing a high vacuum in cathode ray tubes and



Some of the many Geissler Tubes used in electrical discharge experiments.

Courtesy: The Ann Ronan Picture Library.

valves. He also discovered the Space Charge around a valve's cathode which, in turn, led to his developing thoriated tungsten as a valve heater, thus further improving electron emission. Shortly, thoriated tungsten became the standard heater material of the vacuum tube industry.

Four years later, William G. Housekeeper patented the Housekeeper Seal, a method of sealing metals through glass. He did this by tapering a piece of copper strip to a feather edge and then sealing the glass to the edge of the taper. Since the expansion of copper is 165×10^{-7}m/°C compared to glass's 52×10^{-7}m/°C, this technique equalised the contraction/expansion difference between the two substances. The electrical industry could now manufacture large diameter seals using such materials as high purity copper.

1923, however, saw one of the greatest developments where the oscilloscope was concerned: the Tipless Tube. In this version of Braun's creation, evacuation was done from the base, the tip being protected by the base itself. A magnesium getter was also incorporated, to absorb any residual air still lingering after evacuation.

The Early Oscilloscopes

By the mid-1920s, the oscilloscope was becoming more widely known and used more frequently, certainly among scientists. Professor Harold Nordinger of Sweden's Uppsala University first used an oscillograph to investigate lightning strikes on power lines at this time. Britain's National Physical Laboratory also used oscillographs, in the study of waveforms and Lissajous figures, among other things.

By 1931, the American General Radio Company had developed the first oscillograph for general use. A three-piece device, its power supply, sweep circuitry and cathode ray tube were contained in separate enclosures. The first Spectrum Analyser appeared at this time too, developed by the Panoramic Radio Corporation's Marcell Wallace. It was, essentially, a scanning receiver with an upper frequency limit of 35MHz.

In the following year, the German physicist, M. von Ardenne, produced an oscilloscope using a hot cathode and gas filling, for beam focusing. Although this model showed some of the advantages to be got from a high vacuum, it suffered from large spot size, instability and poor modulation.

In America, meanwhile, the Du Mont Laboratories – founded by Dr. Allen B. Du Mont, who developed the 'Magic Eye' tuning indicator in 1931 – began to manufacture oscilloscopes. In 1933, they introduced their Model 130 Oscilloscope with a 13 cm screen, 5kHz sweep and a bandwidth extending from 20Hz to 10kHz. Two years later, the Radio Corporation of America (RCA) produced the first oscilloscope, aimed primarily at the Service Engineer.

Perhaps the most unusual feature of these early oscilloscopes was gas focusing, where argon or helium gas was introduced into the tube at pressures of around 1×10^{-3}mmHg for argon and some 20×10^{-3}mmHg for helium. As the electron beam moved up the neck of the tube, it collided with the gas molecules, ionising them. Since the ions were heavy and slow-moving compared to the beam electrons, they tended to remain in the beam path, forming a positive core to it. When the quantity of positive ions produced equalled the number of electrons in any given area, the mutual repulsive force was neutralised and an increase in the number of ions meant an attractive force on the electrons, bringing them in towards the axis.

The result was spot diameters of between 0·2 and 0·5mm, the focusing being determined by the gas's 'Ionisation Probability,' a function of gas pressure and beam current.

At this time, many engineers in Britain and the U.S. were beginning to see television as a perfectly viable medium, provided a suitable receiving device could be found. The cathode ray tube of the day, however, was not the most satisfactory device for this role!

To begin with, the gas focusing could not be maintained over the range of beam current required to create a picture. Secondly, far better screen phosphors were needed, ones that would produce high efficiency white light. Finally, to achieve a bright trace over several hundred lines, a far more intense beam was required, yet one that would remain sharply focused. This last, of course, required an increase in the tube's final voltage.

All of the above were of great concern in Britain, where Electrical and Musical Industries (EMI), were close to producing the world's first television broadcasting service. Yet, they were by no means in favour of the cathode ray tube. One of the engineers involved, L. F. Broadway, remarked at the time that "we believed the CRT as a display device was only an interim measure. We didn't really believe that this huge vacuum envelope, a cumbersome sort of thing, would last."

That the 'cumbersome thing' not only lasted but went on to inspire development of both the Electron Microscope and the Visual Display Unit (VDU) says much, not only for the engineers involved but above all, for Karl Ferdinand Braun. His generosity in refusing to patent his discovery became, as he intended, a great benefit to science and an even greater one to the world at large.

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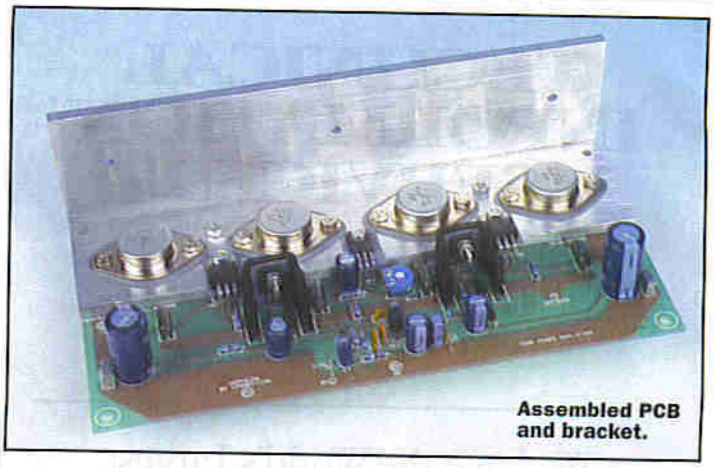
PROJECT

150W POWER AMPLIFIER

Design by RCA,
Revised by Alan Williamson
Text by Alan Williamson and Maurice Hunt

The original 150W Power Amplifier kit (LW32K) is (electrically) perfectly adequate for its intended purpose of high(ish) power sound reinforcement in PA and disco equipment – it is undoubtedly a popular kit, as borne out by the sales history; however, it was felt that, mechanically, its design left something to be desired, since there was a lot of 'spaghetti' between the PCB and output devices, and the heatsink was something of a nightmare to drill accurately, which was also inadequate for full power reproduction into 4Ω. Basically, the kit was in need of revamping.



Assembled PCB and bracket.

PROJECT RATING 2
Kit Available
Order as LP33L Price £34.99

This updated MkII version (LP33L) is much easier to construct, since all components are mounted on a single PCB with minimal wiring – restricted to PSU (+/0V/–), signal input and speaker output. The heatsink bracket is pre-drilled to accept the power transistors, and greaseless insulators replace the Mica + thermal paste types (always a messy job).

Other alterations to the amplifier include adding some extra capacitors, C3 decoupling ZD1, C10 stabilising the bias voltage across TR4 and adding C13 & C14 for local decoupling of the supply. Some of the semiconductors have also changed; TR1 & TR2 have been upgraded to low noise types (2SA1085E), TR3 has changed to BD140 and TR4 & TR5 to BD139.

This amplifier is a bipolar transistor-based design, with a complementary push-pull (Class B) output stage. The advantage of a Class B type over a Class A equivalent is the much lower quiescent current drawn (around 100 times less in this instance). Class A amplifiers are the preferred choice for Hi-Fi applications, due to the lack of crossover distortion, but the Class B type is ideal for PA systems, requiring high output power and where ultimate sound quality is not such an important criterion.

Circuit Description

Refer to the Block diagram (Figure 1) and the Circuit diagram (Figure 2); the capacitors C1 & C2 and resistors R1 & R2 form a band pass filter – setting the bandwidth of the amplifier. C1 limits the low frequency and C2 the high (under no circumstances increase the bandwidth of the amplifier, if you do, it will be at your peril). R1 & R2 also set the input impedance.

TR1 & TR2 form a long-tail pair (also known as a differential amplifier), the gain is set at 26dB (×20). TR3, D2 & D3 and R12 form a constant current source feeding the chain of TR4 & TR5.

TR4 combined with R10, R11 & RV1 form an amplified diode, the resulting constant voltage between the collector and emitter of TR4 sets the bias of the output stage (via the emitter follower drivers, TR6 & TR7).

TR5 is the Voltage Amplifying Stage which is controlled by the overall feedback loop. R13 provides a small amount of series feedback to TR5, C8 also provides feedback to TR5 and forms the dominant pole (the limiting factor in the amplifier).

TR6 & TR7, as previously mentioned, are emitter followers, providing plenty of drive current to the output emitter follower stage. R17 to R20 help to even up any gain differences the output devices.

FEATURES

- Powerful bipolar design
- Easy to build

APPLICATIONS

- PA systems
- Disco Equipment

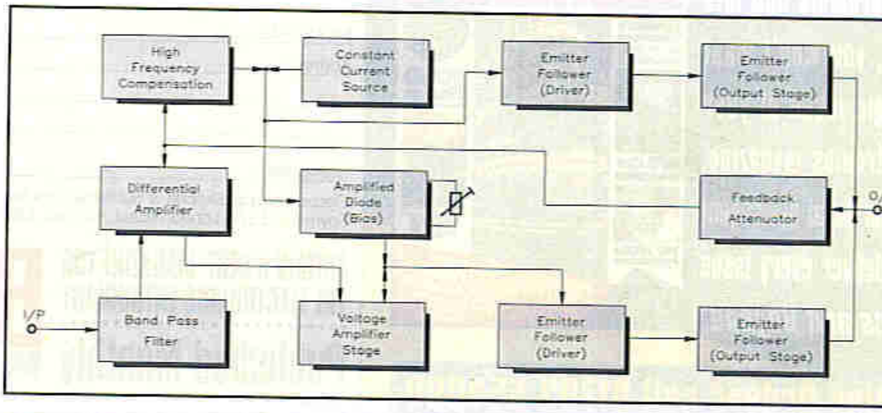


Figure 1. Block diagram.

R7 & R9 attenuate the output signal to the speaker and apply it as global feedback to TR2; R7 & R9 also set the overall gain of the amplifier and also the input sensitivity for full output. At first glance, it would appear that TR1 is not within the feedback loop, but it is indirectly. TR1 & TR2 can be viewed as a 'seesaw', with the emitters as the pivot point. Applying a signal to the base of TR2 will cause it to conduct more or less current (depending upon the polarity), this in turn will affect the 'tail' current (emitter connection) and therefore, TR1 alters its conduction (in the opposite direction) to maintain 'balance' at the 'tail', ergo TR1 is affected by the global feedback.

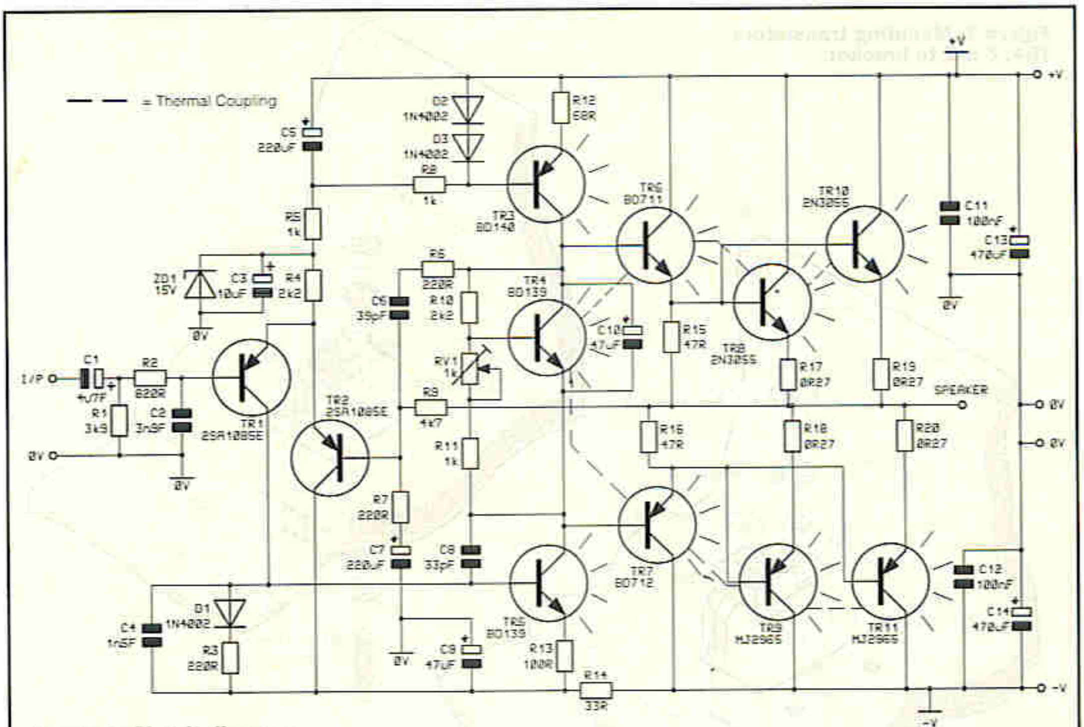
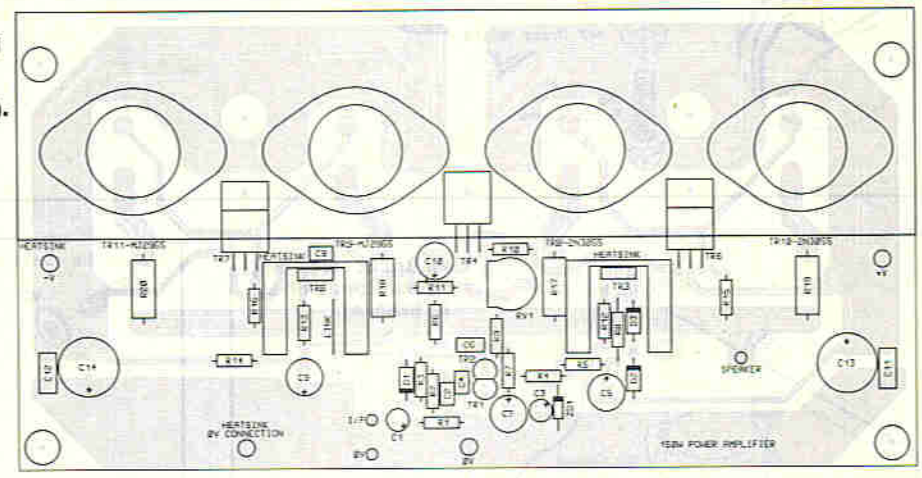


Figure 2. Circuit diagram.

Figure 3. PCB legend and track. (60% of actual size).



Construction

Refer to Figure 3, showing the PCB legend and track. Construction is fairly straightforward, but a few tips may be helpful.

Begin with the smallest components first, working up in size to the largest; be careful to correctly orientate the polarised devices, i.e. electrolytic capacitors & diodes. Use the component lead off-cuts for the link.

Use a drop of cyanoacrylate adhesive (super glue) to bond TR1 & TR2 together face to face, or alternatively, use a piece of heatshrink sleeving; this is to achieve thermal matching of these components.

Bolt the heatsink bracket to the PCB using the supplied M3 hardware; refer to Figure 4, showing the exploded assembly of TR4, TR6 & TR7. NOTE, use the M2·5 hardware for the TO126 device (TR4). Fit the other TO126 package transistors (TR3 & 5) to the separate vaned heatsinks as shown in Figure 5, again, using M2·5 hardware – not forgetting the insulators. Assemble the TO3/TO5 power transistors (TR8-11) onto the bracket as shown in Figure 6; once firmly bolted in place (within reason; overtightening will snap the brass bolts – used for superior electrical conductivity over stronger steel bolts – and could cause other component damage), the transistor leads and the heads of the screws can be soldered to the PCB. Using a multimeter set on the highest resistance range, check the continuity between the heatsink bracket and the collectors of TR8 to TR11; an 'out of range' reading should be obtained (i.e. open circuit).

Fit the heatsinks to TR3 & TR5 using the M2·5 hardware, then fit the assemblies to the PCB.

Should you wish to connect the heatsink bracket to 0V (which is normally at earth potential), refer to Figure 7; others may wish not to do so, as hum from earth loops can arise when a stereo configuration with a single power supply is built into a metal case. The problem can be negated by using an EIC bridge (Earth Isolation Circuit) – see the (optional) power supply circuit, shown in Figure 8.

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.

Before attempting to power up the module for testing, double check EVERYTHING!

Testing and Use

First of all, an adequately sized heatsink (or heatsinks) and a suitable power supply are required.

In order to keep the amplifier as reliable as possible while delivering continuous full power into a load, a large heatsink is required to limit the temperature rise to an acceptable level of say, +55°C above the ambient room temperature of +25°C, giving a total heatsink temperature of +80°C.

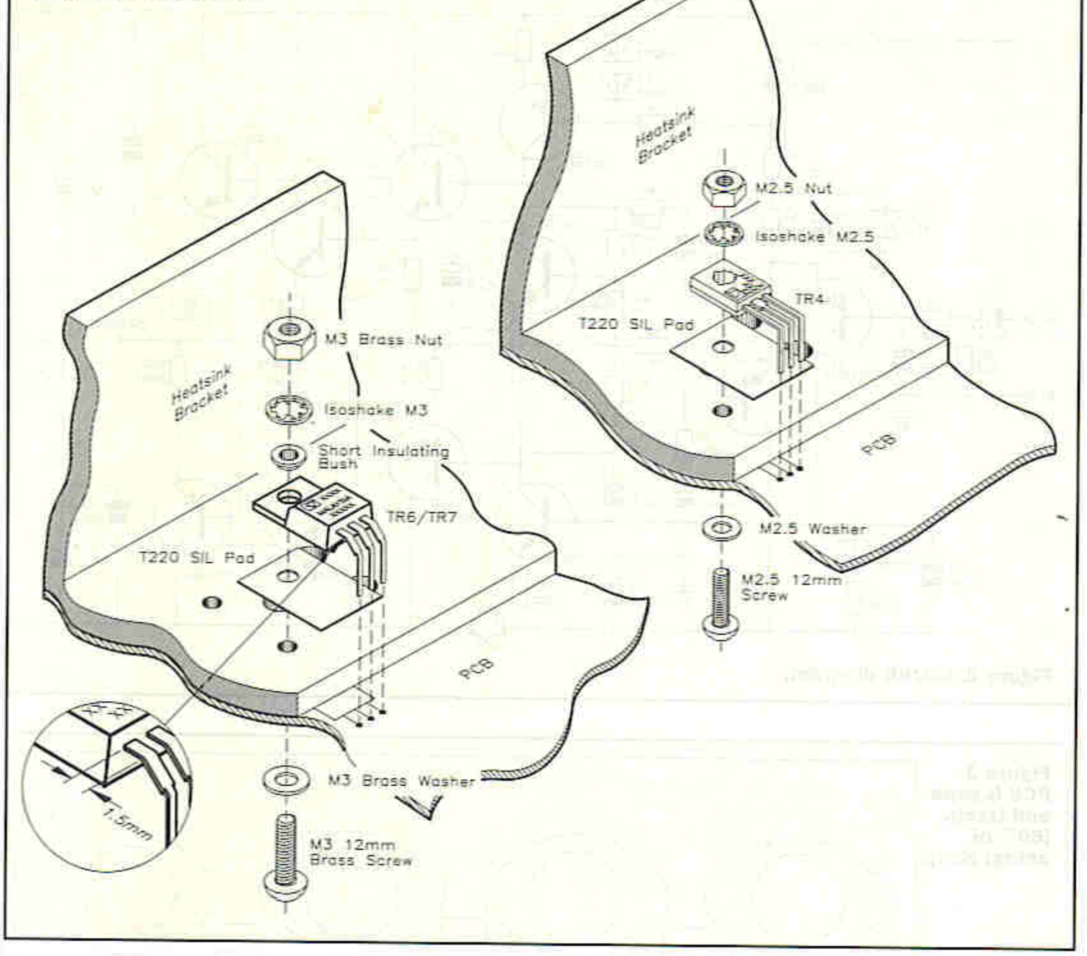
For continuous full power into 8Ω, a pair of 2E-type (2·4°C/W) heatsinks (HQ70M) are recommended; and for 4Ω use, a minimum of three 2E-type heatsinks are recommended. Note that the supplied aluminium heatsink bracket must be drilled to accept the heatsink(s) of your choice. It is important to remember to apply a small amount of thermal conducting paste (not supplied) to the heatsink and bracket for a reliable thermal

SPECIFICATION

Operating voltage:	±50V DC maximum
Operating current (quiescent):	70mA
Amplifier classification:	Bipolar push-pull (Class B) output stage
Maximum signal amplitude:	28·5V (rms) into 8Ω* 26·5V (rms) into 4Ω*
Maximum continuous output power:	100W (rms) into 8Ω* 175W (rms) into 4Ω*
Frequency response:	30Hz to 20kHz (–1dB) 15Hz to 37kHz (–3dB)
Total harmonic distortion:	<0·1% at 1kHz
Damping factor:	80
Sensitivity for full output:	1V rms
PCB dimensions:	196 × 101mm

* Above measurements taken with amplifier powered by the specified PSU, producing ±44V DC.

Figure 4. Mounting transistors TR4, 6 & 7 to bracket.



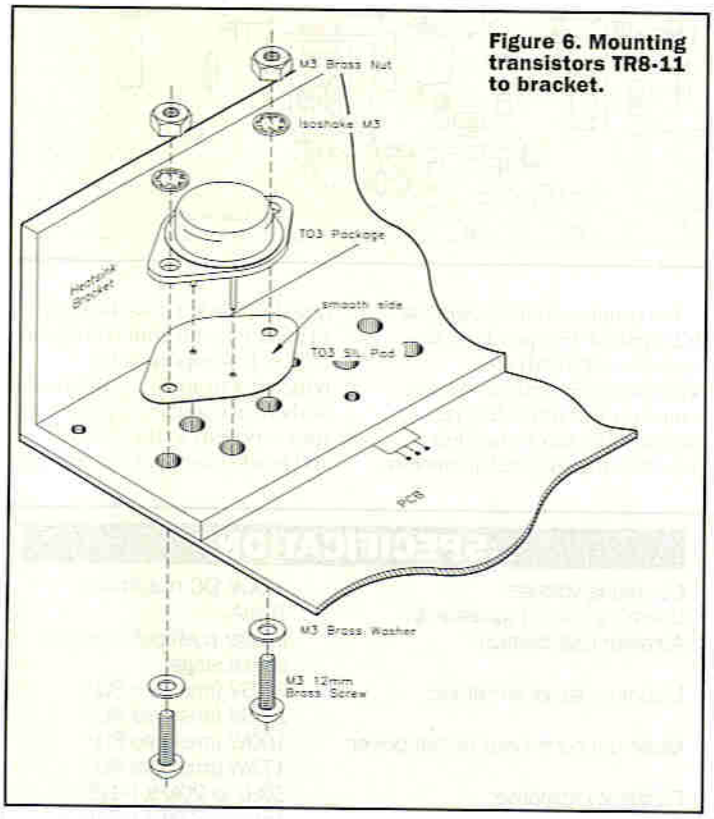
The budget choice would be BR1, 2× 10,000μF and a 300VA transformer for stereo 8Ω use or mono 4Ω (500VA for stereo 4Ω).

And for those with deeper pockets, who are trying to get the most from the amplifier, the choice would be a mono construction, with a 500VA transformer, D1-4 and 2× (or 4× if you can afford it!) 22,000μF audio grade capacitors.

The four capacitors across the bridge rectifier (BR1) are included for EMC reasons (strictly speaking, they are not necessary for D1-4, as they are 'fast [but soft] recovery types'); in fact, they ruin the performance of the bridge rectifier by slowing down the forward conduction and reverse bias recovery time, and increase reverse leakage current. However, by slowing down the recovery action of the diodes, the PN junction is less likely to radiate an EM pulse (a bit like clapping your hands together slowly).

On completing the power supply, make absolutely certain that the large electrolytic capacitors are connected with the correct polarity; you wouldn't want these to explode on switch-on, and we don't want pieces of customer scattered everywhere!

Figure 6. Mounting transistors TR8-11 to bracket.



bond. When mounting the amplifier into a box, ensure that the track side of the board is elevated at a height of at least 10mm from the box base – use insulated spacers (e.g. FS36P-40T) at each corner of the PCB.

Figure 8 shows a suitable power supply circuit; however, the choice of components is determined by configuration (mono or stereo) load impedance (8Ω or 4Ω) and how deep your pockets are!

Figure 5. Mounting transistors TR3 & 5 to bracket.

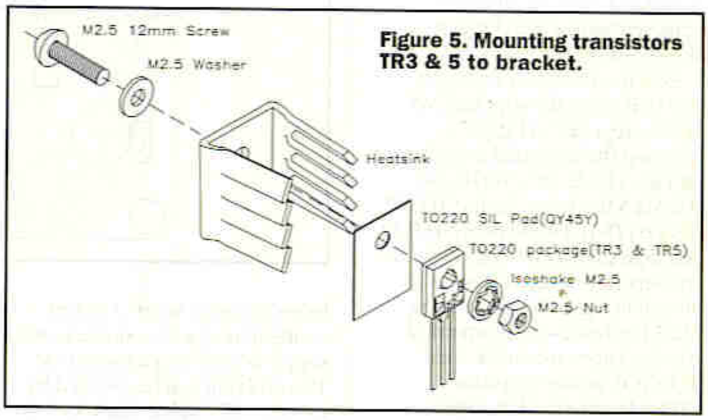
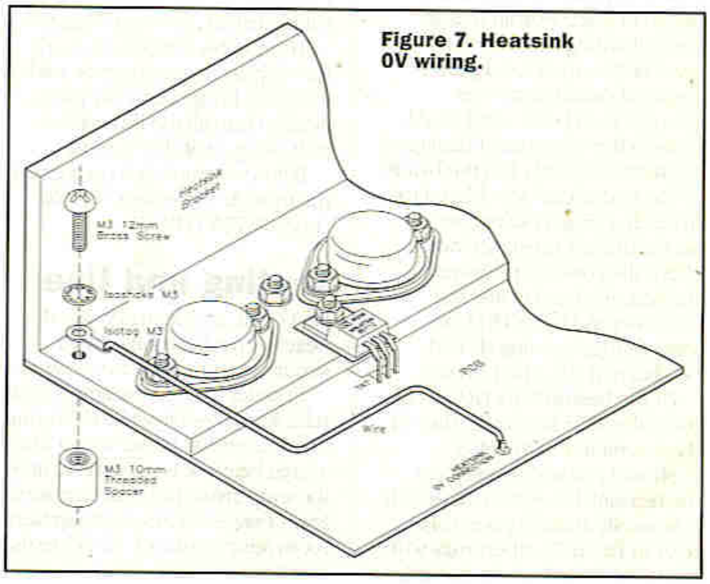
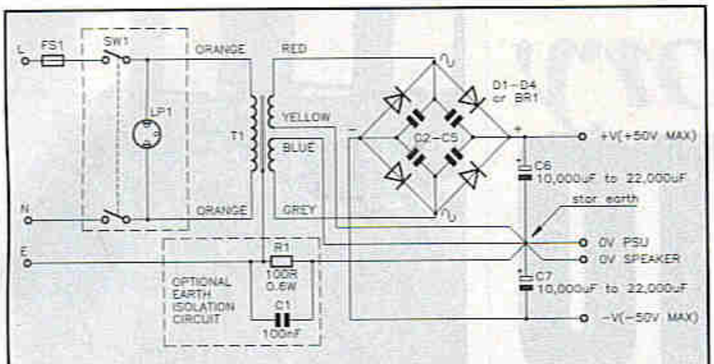


Figure 7. Heatsink 0V wiring.





PARTS LIST		
REF	DESCRIPTION	STOCK CODE
R1	Min Res 100R 0.6W	M100R
C1	HV Cap 100nF	FA21X
C2,3,4,5	Polyester 100nF	BX76H
C6,7	10,000uF to 22,000uF Can	LE04E or FA18U or FA20W
D1,2,3,4	P600D or BYW80–150	UK60Q or UK63T
BR1	K04	BH48C
T1	300VA or 500VA 35VAC	YK22Y or YK23A
FS1	Fuse 20mm T2.5A or T6.3A	DA00A or DA02C

NOTES:–

T1 IS 300VA FOR MONO–8 OHM OR 500VA FOR MONO–4 OHM OR STEREO–8 OHM

C6 & C7 IS 10,000uF FOR MONO–8 OHM OR 22,000uF MONO–4 OHM OR STEREO–8 OHM

FS1 IS A T2.5A FOR 300VA OR T6.3A FOR 500VA TRANSFORMER

Figure 8. PSU circuit diagram.

Once the heatsinks have been added to the amplifier and a power supply constructed and tested (keep the transformer, rectifier and capacitors close to each other to reduce the wiring length; make the 0V connection between the two electrolytics the 'star earth' point), testing of the amplifier can begin. Figure 9 shows the general interconnection of the amplifier to the ancillary items.

Connect the power supply to the amplifier using THICK cable (2·25mm domestic ring mains cable is ideal), and keep the wiring lengths as short as possible. Fitting fuses in the supply lines is NOT recommended (it's amazing how much distortion a fuse can add); a correctly chosen transformer primary fuse will blow just as quickly as one in the DC supply line. Similarly, fuses fitted at the speaker output are not recommended; if you are worried about protecting your speakers from a DC offset caused by a faulty amplifier or PSU, use the 'Amplifier Monitor' kit (LP32K).

Thick cable should be used for the speaker output and return to the 'star earth', and a low capacitance screened cable should be used for the signal input.

Power up the amplifier without a load connected, watch out for things getting hot, and should something begin to smoke, switch off immediately and check your wiring. Also look for short circuits; re-check the insulators of the transistors mounted on the heatsink bracket.

Should everything be OK up to this point, switch off the power and connect a multimeter (set to read 50V DC minimum) between the speaker output and 0V; switch the power back on and note the meter reading; 0V should be observed. Re-select the meter to range to 2V DC minimum, a reading of no greater than ±0·2V should be observed. Switch off the power and disconnect the meter.

There are two possible methods of setting the bias; the first is to connect an ammeter in series with the +V supply line, adjust RV1 (anticlockwise to increase) for a reading of 70mA, wait 15 minutes for thermal equilibrium to be achieved, then re-adjust for a reading of 75mA.

The second method is to measure the voltage across the output transistor emitter resistors (R17-20); sum the four voltages together then divide by four for an average reading of 3·7mV. Wait 15 minutes, then re-adjust RV1 for an average reading of 4mV across each of the resistors; NOTE, the transistors are not matched and therefore, a variation of up to 1·5mV may be experienced between devices.

Connect an 8Ω 200W load to the amplifier and apply a music signal (via an attenuator set to minimum) to the input of the amplifier; slowly turn up the volume and listen for any peculiar distortions.

Further power/distortion/bandwidth testing can be carried out if you own the appropriate equipment, i.e. signal generator, oscilloscope, distortion meter and a dummy load of adequate power rating (to save your ears from the assault).

Happy listening.

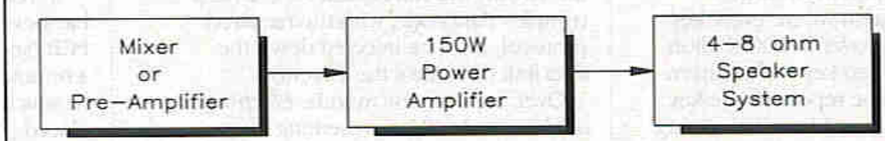


Figure 9. System wiring.

PROJECT PARTS LIST

RESISTORS (All 0·6W 1% Metal Film, Unless Stated)			
R1	3k9	1	(M3K9)
R2	820Ω	1	(M820R)
R3,6,7	220Ω	3	(M220R)
R4,10	2k2	2	(M2K2)
R5,8,11	1k	3	(M1K)
R9	4k7	1	(M4K7)
R12	68Ω	1	(M68R)
R13	100Ω	1	(M100R)
R14	33Ω	1	(M33R)
R15,16	47Ω	2	(M47R)
R17-20	0Ω27 2·5W	4	(S0R27)
RV1	1k Horizontal Preset Potentiometer	1	(UH00A)
CAPACITORS			
C1	4μ7F 63V Radial Electrolytic	1	(AT76H)
C2	3n9F Ceramic	1	(WX75S)
C3	10μF 63V Radial Electrolytic	1	(AT77J)
C4	1n5F Ceramic	1	(WX70M)
C5,7	220μF 16V Radial Electrolytic	2	(AT41U)
C6	39pF Ceramic	1	(WX51F)
C8	33pF Ceramic	1	(WX50E)
C9,10	47μF 63V Radial Electrolytic	2	(AT80B)
C11,12	100nF Polyester Layer	2	(WW41U)
C13,14	470μF 63V Radial Electrolytic	2	(AT84F)
SEMICONDUCTORS			
D1-3	1N4002	3	(QL74R)
ZD1	15V 1·3W Zener	1	(QF57M)
TR1,2	2SA1085E	2	(QY12N)
TR3	BD140	1	(QF08J)
TR4,5	BD139	2	(QF07H)
TR6	BD711	1	(WH15R)
TR7	BD712	1	(WH16S)
TR8,10	2N3055	2	(YH98G)
TR9,11	MJ2955	2	(BL38R)
	TO3 SIL Pad	4	(QY44X)
	TO220 SIL Pad	5	(QY45Y)
	Short Insulating Bush	1 Pkt	(JR78K)
	M3 12mm Brass Screw	2 Pkt	(BF52G)
	M3 Brass Nut	2 Pkt	(BF58N)
	M3 Shakeproof Washer	2 Pkt	(BF44X)
	M3 Brass Washer	2 Pkt	(BF62S)
	M3 Solder Tag	1 Pkt	(LR64U)
	M2·5 12mm Screw	1 Pkt	(JY31J)
	M2·5 Nut	1 Pkt	(JD62S)
	M2·5 Washer	1 Pkt	(JD77J)
	M2·5 Shakeproof Washer	1 Pkt	(BF45Y)
	TO126 Heatsink	2	(JX21X)
	1mm Single-ended PCB Pin	1 Pkt	(FL24B)
	Green/Yellow Wire	1m	(XR38R)
	PCB	1	(GJ73Q)
	Bracket	1	(BL97F)
	Instruction Leaflet	1	(XZ37S)
	Constructors' Guide	1	(XH79L)

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

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

Order As LP33L (150W Power Amplifier) Price £34.99

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.

150W Power Amplifier PCB **Order As GJ73Q Price £5.99**

150W Power Amplifier Bracket **Order As BL97F Price £8.49**

Touch Memory

THE KEY TO THE FUTURE

PART 1

by Tony Ellis

Imagine a World where you only had one key (the universal key), which would de-immobilise your car, other family members' vehicles also, open your garage door, unlock your front door, disarm your home security system and other household items – the possibilities are endless.

Stretch your mind even further! Imagine a system where every key is unique with over 200,000 billion differs. The laser etched key code pattern guaranteed never to be repeated, the key being virtually indestructible and requiring no power source, and where the legitimate user can 'lock-out' a lost or stolen key without specialist personnel or equipment, also likewise enable a new key to operate on the system.

Science fiction? – No, this technology is here today. ERD (UK) Ltd. have developed the required decoder technology in the form of a small hybrid circuit which to the end user acts as a single component. This device gives high security, together with ease of use, in short flexibility at a surprisingly low cost. There are also many other advantages in utilising this form of locking/unlocking, enabling/disabling system. For instance, touch technology uses a serial data link, the touch receptacle can be remote from the alarm/control system and if the receptacle or its wiring is tampered with, the system will still remain secure (as a complex data code, with the required protocol, must be injected down the data link to control the system).

Over the next few months *Electronics and Beyond* will be presenting a series of constructional projects, that will utilise this exciting technology in everyday type products. This will mean that our magazine's constructors will be among the first in the world, to have access and to actually use this universal key technology in actual working projects. There can be no doubt that in the next century, such universal, high security and flexible locking/control systems will be the norm.

Each Touch Memory Key (hereafter TMK) has its own unique 64-bit word laser etched into its ROM during manufacture. Compared with the relatively low number of combinations (or 'differs' as they are known in the security industry) available with conventional keys, the Touch Memory allows for over 200,000 billion different codes.

To read the key's serial number, ERD has developed the Touch Hybrid – a small PCB (see Figure 1) which is connected to a remote receptacle (reader device) on to which the TMK must be momentarily placed. This connects it with a 5V supply thereby stimulating the ROM and allowing the 64-bit data word to be transmitted serially into the Touch Hybrid.

The Touch Hybrid is based around a custom micro, the TDA.1. For even greater security, when accessing the code, the TDA.1 adds in an additional 8-bit control word as part of the command signal. The Touch Hybrid functionality block diagram is shown in Figure 2. Once the code sequence has been recognised by the TDA.1, the user can decide what action should then be taken. For example the TDA.1 could be programmed to activate a solenoid on a door lock, send an inhibit signal to a vehicle engine management system or simply inhibit a personal computer of video recorder.

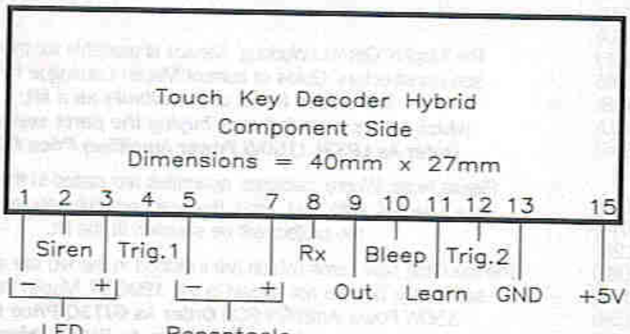
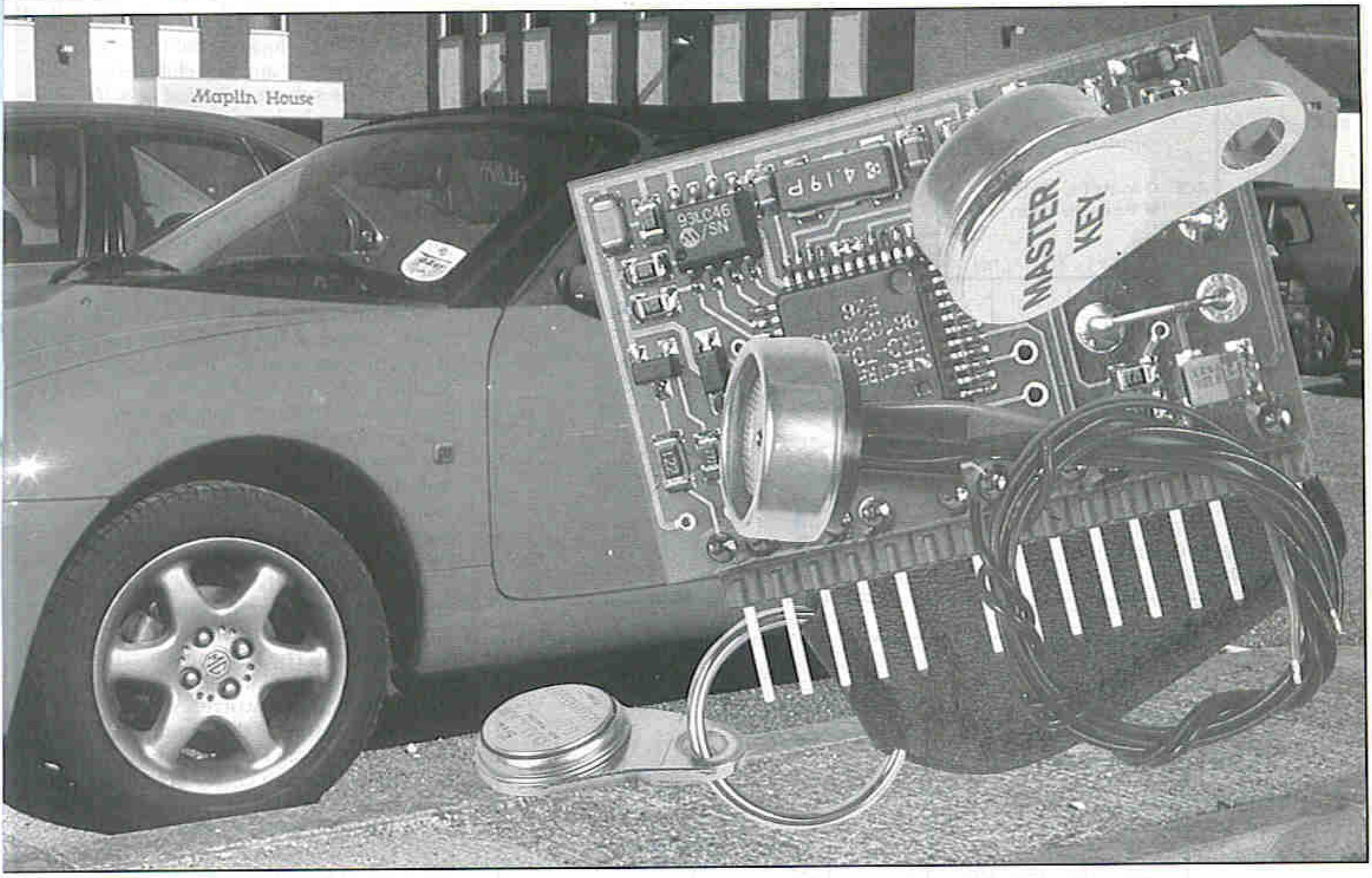


Figure 1. Touch Key Hybrid.

Touch Hybrid Features

- Ultra high security (over 200,000 billion key 'differs')
- Codes laser etched (no code numbers ever repeated, so there will never be two keys the same
- Keys are passive (i.e. no battery required)
- Keys are virtually indestructible
- System can learn up to eight keys at any one time
- Lost keys can be 'locked out' by authorised personnel without any specialised equipment



- Replacement keys can be taught by authorised personnel without specialised equipment
- As Touch Keys are a contact device (i.e. not radio), they are not 'grabbable'
- Hybrid gives low cost entry route for OEM's to utilise Touch Memory technology
- System remembers and returns to last state when power is disconnected/reconnected
- Hybrid has full spec. alarm system incorporated, with selectable passive arming mode
- System can 'slave arm', i.e. the hybrid follows a master's system arm command and provides an alternative method of disarm

Characteristics		Min	Typ	Max	Unit
Vdd	Supply Voltage	4	5	5·5	VDC
Is	Supply Current				
	Armed*	1·1	1·2	1·4	mA
	Disarmed	0·9	1	1·2	mA
Vo	Output Voltage	-0·3	To Vdd	+0·3	V
Ioi	Low-Level Output Current		15		mA
Ioh	High-Level Output Current		-10		mA
Top	Operating Temperature Range		-25	+80	°C
Tstg	Storage Temperature Range		-30	+85	°C

Ta = 25°C unless otherwise specified
* Excludes LED Current NOTE: The Touch Key Hybrids have provision to accept an EMI filter, if it is required.

Table 1. Electrical Characteristics.

At installation a 'Master Touch Key' is used to facilitate the programming of each lock. In this case the Master, which in practice is simply another key in a slightly larger can, is placed on the receptacle followed by the key to be programmed. In this way, the micro controller recognises the master code and authorises that key's code to be programmed into its memory. The delight of the ERD system is that it can be easily re-programmed for a different TMK should the original be lost or stolen.

Because the Touch Memory devices are passive, it has been possible to reduce the electrical interface between the Touch Memory and the hybrid to a minimum, one data line plus ground. This leaves plenty of I/O on the micro controller to provide other system features. As electrical contact with the receptor is required, there is no scope for 'grabbing' the code, as in some radio

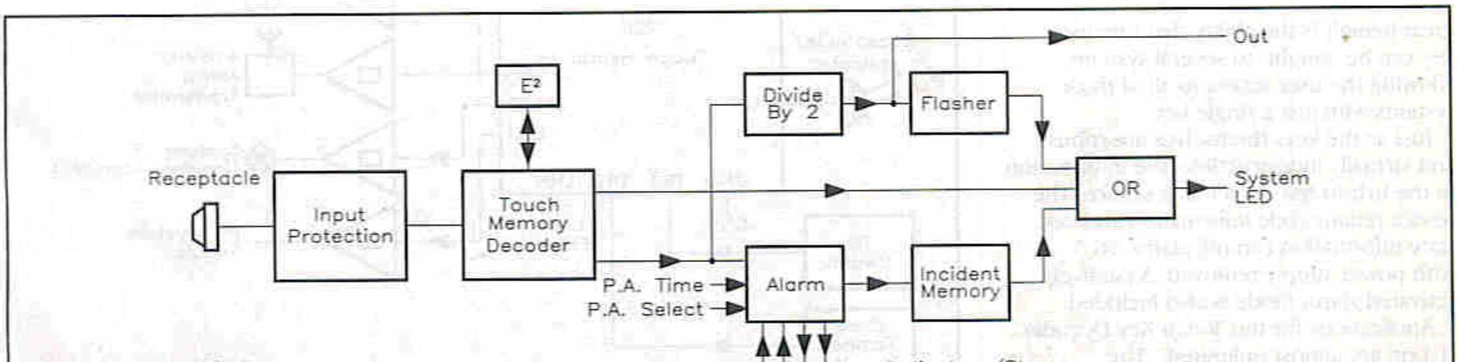


Figure 2. Touch Hybrid Functionality Block Diagram.

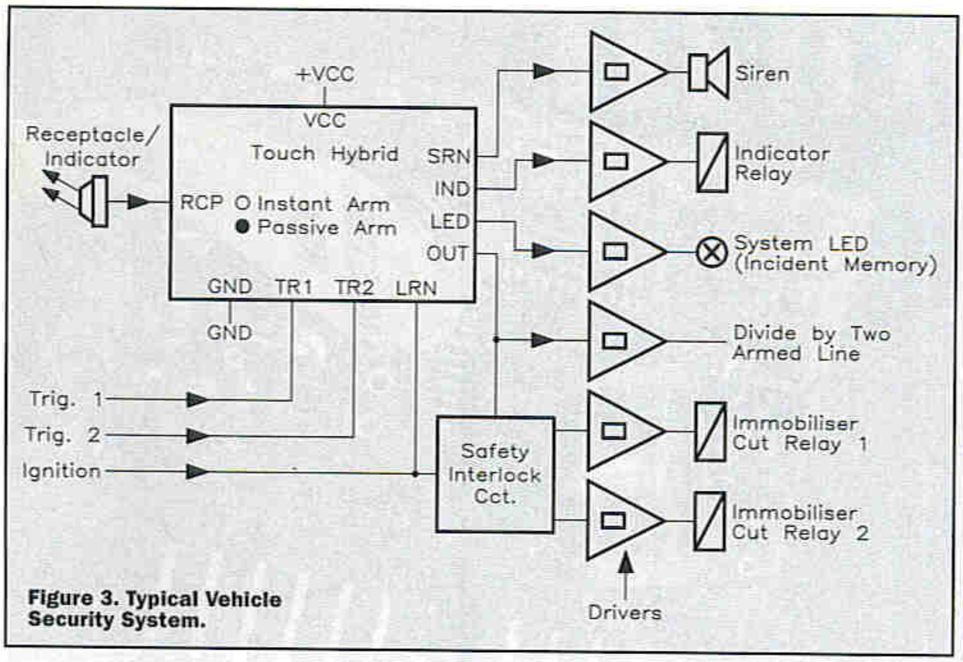


Figure 3. Typical Vehicle Security System.

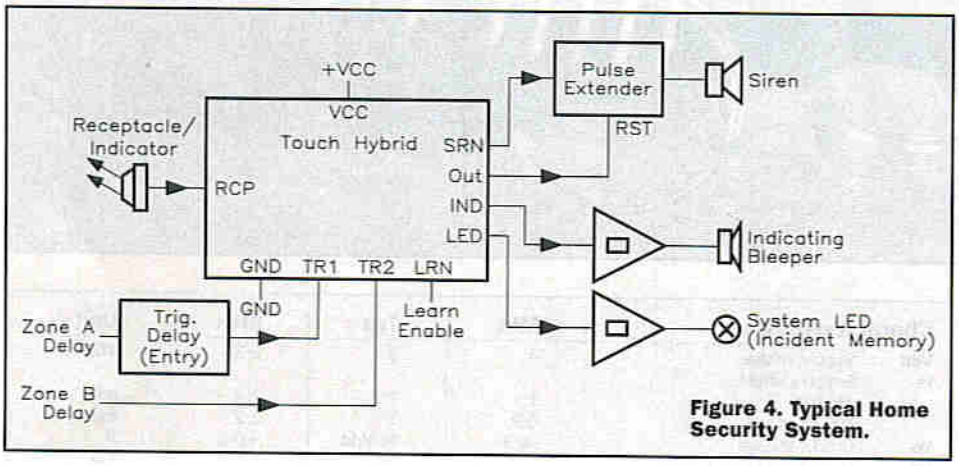


Figure 4. Typical Home Security System.

based systems. Further, as mentioned previously, touch technology uses a serial data link, the touch receptacle can be remote from the alarm/control system and if the receptacle or its wiring is tampered with, the system will still remain secure as a complex data code with the required protocol must be injected down the data link to control the system.

In operation, the hybrid can be trained to recognise up to four or eight valid keys. As mentioned above, only the Master Key gives access to reprogramming the device for other key variants. Because every key is unique, lost keys present no problem – once the system is programmed to accept a new key, the old one is automatically locked out. At the same time another great benefit is the ability that one user key can be 'taught' to several systems, allowing the user access to all of those systems with just a single key.

Just as the keys themselves are robust and virtually indestructible, the information in the hybrid has been made secure. The device retains code information and last state information (on/off, alarm, etc.) with power supply removed. A passively activated alarm mode is also included.

Applications for the Touch Key Decoder Hybrid are almost unlimited. The availability of this module allows OEMs and system developers to use this technology without getting involved in the programming of the decoder device itself.

Touch Key Decoder technology is already being used in commercial vehicle alarms (Figure 3), motorcycle immobilisers and PC locking systems, and has further applications in home security systems (Figure 4); PC locking/protection systems (Figure 5); electronic door locks (Figure 6); cash register access (Figure 7); telephone access; gaming machines; fire/security/heat and vent control panels and many others (Figure 8).

Another application being evaluated is TMK accessed lockers, the type used in leisure centres and golf clubs, etc. In some cases the mechanical keys that operate these lockers have few 'differs' and a stolen key can access a number of lockers in the building. This coupled with the need to call out a specialist locksmith to replace the required locks (which is usually an expensive exercise), makes TMK a valid technology to look at for this application.

With the TMK system, every TMK is totally unique, it can only access the locker that is programmed for. If lost, then the leisure centre manager can lock out the lost key and replace it with the new, with no specialist equipment other than the system's Master Key. Also, the virtually indestructible nature of the MicroCan make it ideal for this form of 'wristband' type key (the MicroCan being attached directly to the wristband).

There are many benefits of the system, apart from the inherent high security and the pleasure of having one key for everything. The keys are low cost, virtually indestructible and have no internal batteries to worry about.

Another feature of the system is that Touch Hybrids can be programmed to read up to eight different codes and configured to operate in parallel with a different action being implemented for each. For example, a process control system could be programmed for different keys with differing levels of authority attached to each. One further application currently being investigated is a programmable vehicle engine management system. In this case, father and mother would have access to the full performance of the car with their respective TMK's, whilst the teenage son or daughter with different keys would have to suffer a somewhat de-tuned version! (See Figure 9). This application has been made possible, through a new 'front end' device developed by ERD called 'Touch Key Multiplexing'. With this, more than one control function can be controlled via one receptacle, e.g. with one receptacle mounted on a control panel, a manager with a valid TMK, could control the operation of an air conditioning system, while a subordinate could only control lower functions like switching local fans off etc. with their TMK.

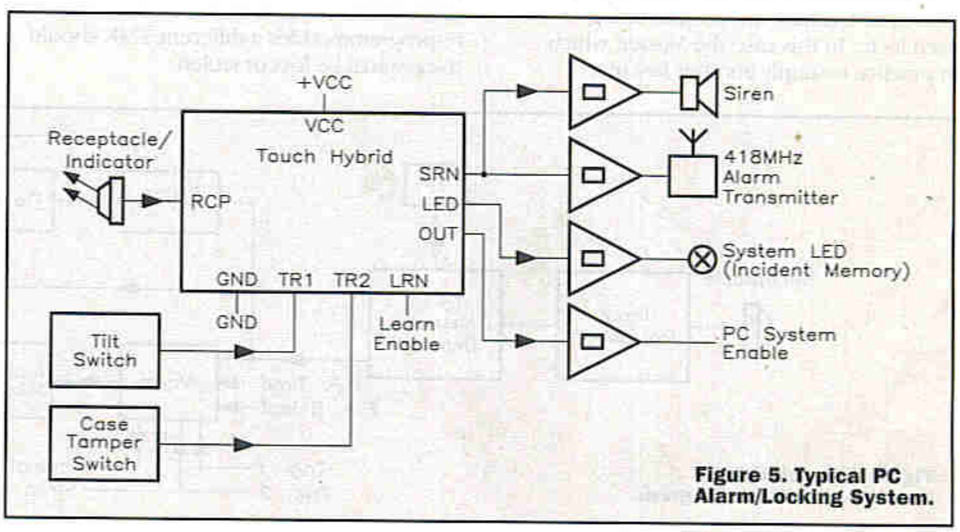


Figure 5. Typical PC Alarm/Locking System.

Touch Memory – How It Works

The secret to the operation of this technology, is the information used to validate access. This is a tamperproof serial number laser-etched on to silicon, which is in turn packaged in a stainless steel MicroCan. This is a miniature, low cost coin shaped data carrier that can be read by a micro if it is given momentary contact. The conductive surfaces of the MicroCan are signal and ground, which form a conduit for data transfer to the outside World. This form of communication is often referred to as a 'one-wire protocol' and is similar in operation to conventional morse-code.

After the TMK is stimulated by the hybrid, via the receptacle (sourcing the 5V needed for operation) it responds by pulling the signal line down, with an impedance that changes from between 500kΩ and 50Ω. This fourth order magnitude impedance shift permits sensing of the digital signal to take place. The length of time for which the signal is pulled down represents the logic level, (i.e. 1 or 0). Since the data is stored in laser-cut polysilicon links (and not as charges on gates or as flip flop states), the TMK needs no energy to retain data.

Furthermore, almost no energy is required for its operation, as the TMK uses the voltage of the signal line and stores a minimum of charge internally to maintain operation during the 'presence pulse' and the low time of any time slot during a read operation, this is known as 'parasite powered'.

After a 'presence pulse' is detected, data transfer starts between the TMK and the hybrid, 64 bits are sent from the Touch Key and this forms the basis of its unique serial number. The serial transfer is done half-duplex, (i.e. either transmit or receive) within discretely defined time slots. In every case the micro controller (TDA.1) initiates the transfer by sending a command to the TMK.

The hybrid also has a complete alarm system on chip (this has been specifically configured to automobile systems) but many of the functions can be utilised in any alarm application. The system has many diverse features such as trigger input signal conditioning, (i.e. a trigger must be valid for >500ms before accepted) incident memory, power up return to last status. The system also has a siren, armed line, and indicators/bleeper outputs. With these features it is a simple matter to construct alarm systems with few support components.

Pre-Taught Touch Hybrid with Master Touch Key
Order As CK41U Price £29.99

User Touch Key
Order As CK42V Price £6.99

Touch Key Receptacle
Order As CK43W Price £9.99

Touch Key Receptacle/LED
Order As CK44X Price £9.99

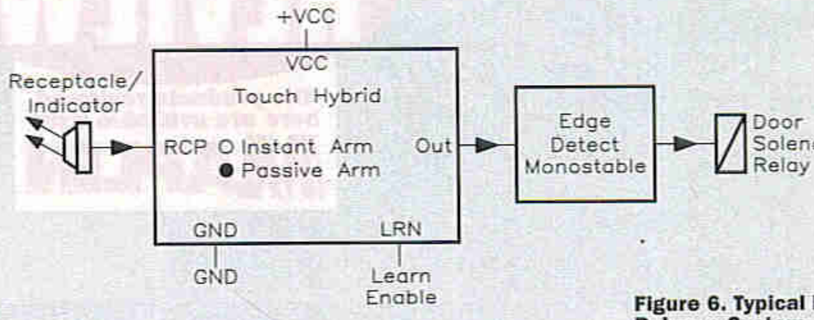


Figure 6. Typical Door Release System.

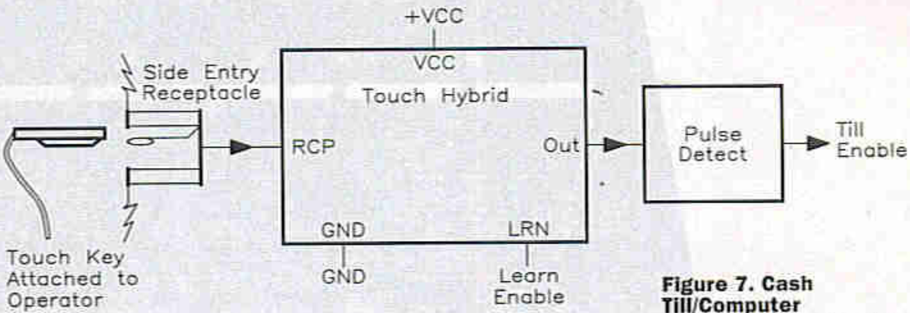


Figure 7. Cash Till/Computer Supervisory Alarm Unit.

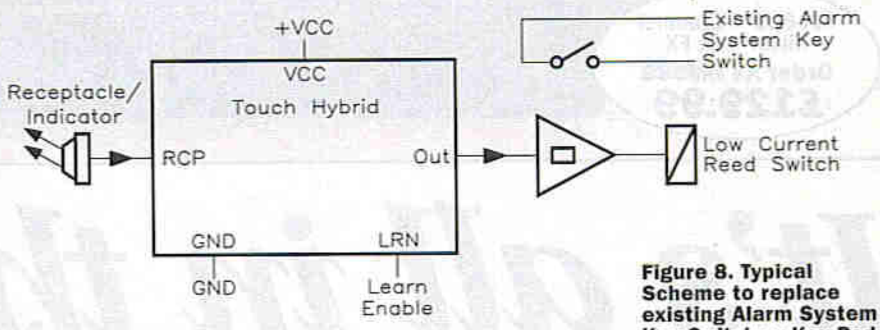


Figure 8. Typical Scheme to replace existing Alarm System Key Switch or Key Pad.

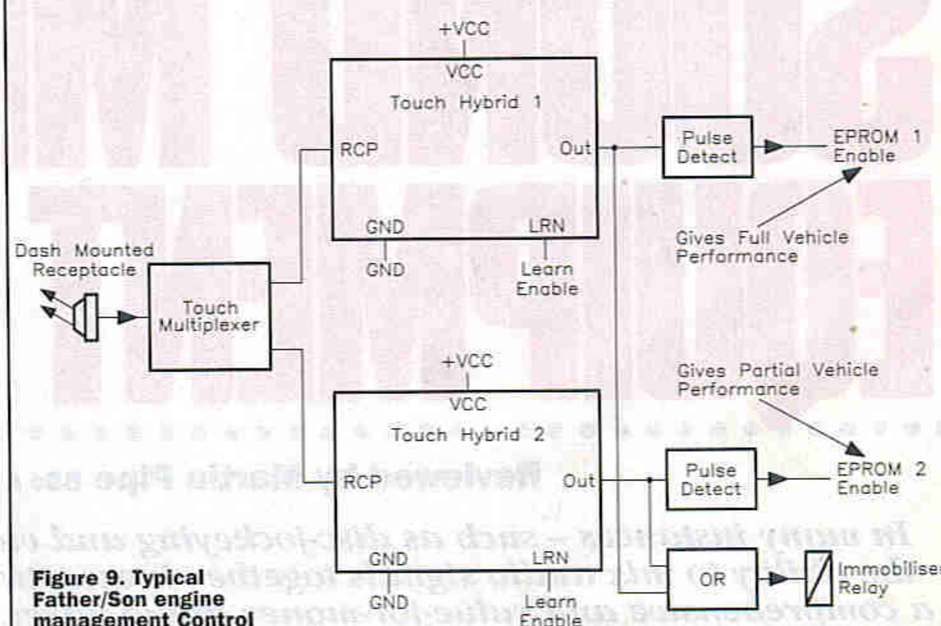


Figure 9. Typical Father/Son engine management Control with additional engine immobilisation.

It's all in the mix!

SOUND MIXING EQUIPMENT GUIDE

Reviewed by Martin Pipe BSc AMISTC

In many instances – such as disc-jockeying and video soundtrack editing – the ability to mix audio signals together is essential. This review focuses on a comprehensive and value-for-money audio mixer, the MX-602, from Maplin. We also tell you about the other equipment you need – and the value-for-money DIY approaches you can take.

The World of the DJ

Mixing dance records together is now an accepted art form. Simultaneously combining three or more audio sources – including samplers, turntables and CD players – with accurately synchronised beat and melody patterns is not uncommon, and the best DJs frequently use their extensive imaginations to give familiar records a completely different feel, something known as remixing. Some of the top DJs move onto careers as record producers, or form pop groups.

Mix DJs even have their own organisation – the Disco Mix Club – which issues the best recordings of its members, and hosts an annual competition sponsored by Technics, manufacturers of the legendary SL1200 turntable, the DJ's vinyl workhorse since the early '80s. For a great introduction to mixing, check out dance music station Kiss FM on 100MHz (if you're near London), or tune into the Radio One's Essential Mix, which is broadcast extremely early on a Sunday morning. Essential Mixes have included artists of the calibre of Underworld, Norman Cook, Erick Morillo, The Future Sound of London, LTJ Bukem and Sasha.

If you know the records such DJs play, you can often make out the techniques they use to combine them. Mix DJing is, as with learning to play a musical instrument, one of those areas where practice makes all the difference. It is, however, an art available to anybody with a basic sense of rhythm and melody. If all you want to do is to make sequenced tapes for the car, pretend to be a radio disc-jockey, set up a college radio studio or mobile disco, there's no need to learn mix DJing – unless you want to. All you need to do is to start one record as the other finishes, possibly with a jingle or microphone-derived announcement in between.

Although the equipment the professional DJs use is expensive, you can guarantee that they started out with budget turntables and mixers – particularly the high proportion who started in London pirate radio stations which weren't going to risk the loss (and eventual destruction) of expensive Technics turntables every time their studios were raided by the authorities! The loss of the DJ's records was, in itself, bad enough.

We'll discuss the source equipment in a minute. But let's start with the mixer, the device which is at the heart of any DJ's set-up. In the past, mixers had to be built by those who used them. It was then uncommon to find units that provided all of the features needed by mix DJs. Then came inexpensive mixers like the legendary Phonic MRT60 which offered a decent range of features and a good sound quality. Thanks to the rise of DJ culture, many mixers are now available. These range from stripped-down models that have two turntable inputs only, to full-blown units with in-built samplers, graphic equalisers, echo chambers and other gadgets. In the latest edition of its catalogue, Maplin itself offers a range of eight (count 'em) mixers with DJ appeal.

Maplin's MX-602

A good general-purpose mixer from the Maplin range is the mains-powered MX-602, which has been designed to mount into a console with a pair of turntables (it is, however, a self-contained unit). All of the inputs needed by the aspiring DJ are present. There are two mono microphone inputs, two turntable inputs (RIAA-equalised, and high-gain, for low-output magnetic cartridges), four line-level inputs (such as jingle machines or CD players) and two outputs (one fixed, for tape decks, and one variable). A pair of VU meters allow the programme level to be monitored, and a sound effects generator has also been incorporated. An earthing lug has been provided for the turntables.

The MX-602 can mix four different sources simultaneously, each channel having its own level slider control. Channels 1 and 2 can be fed from either a stereo turntable, or a mono microphone. Switches above the faders determine which of the sources are selected. Channels 3 and 4 can be fed from the four line level (e.g., CD, camcorder audio, tape) sources, and again, switches are used to select the desired source.

The advantage of this approach is that you don't have to worry about plugging and unplugging cables. Being forced to choose between turntable and mike isn't much of a problem. Mix DJs don't tend to use mikes while putting together their epic productions, and hence, the Channel 1 and 2 source switches will remain in their phono positions. General mobile and radio DJs are more likely to use CDs, and will either combine these with vinyl records (notably old classic singles) or other CDs. Hence, either (or both) of the channels will be available for the microphone.

Another advantage of the switchable-source approach is of interest primarily to the mix DJ. Switching from a live source to an unconnected pair of input sockets obviously results in silence. Do this in time to the beat of one of the other records playing, and you have an effect that's commonly referred to as 'transformer scratching'. It was once popular among hip-hop DJs and, subtly used, can still sound good.

DJs will also appreciate the cross-fader, which can be used to control the relative levels of two sources and hence fade one record into another. The MX-602's cross-fader can be switched to operate between Channels 1 and 3, or Channels 2 and 4. It's thus possible to cross-fade between turntables or line-level sources. In normal DJ use, the cross-fader is one of the most used controls – and hence, will wear out before the others (the fader controls are normally used to match the input levels of each channel to a desired common point – recording levels of CDs and records tend to vary, after all).

The MX-602 cross-fader can be replaced. A couple of screws will release the control, which is connected to the rest of the mixer using a Minicon plug that unclips. Replacing the fader only takes about a minute.

If the source level is unevenly balanced (e.g., a badly recorded tape or jingle), you can apply the left channel to one of the Channel 3 left inputs, and the right channel to one of Channel 4's right inputs. The two sliders can then be adjusted to match the level. If the cross-fader is switched to operate across Channels 3 and 4, it can be used as a balance control.

The headphones socket can be used to monitor the final output, or any of the four sources before they are faded in. The latter feature, known professionally as pre-fade listen (PFL), allows DJs to cue their records and/or get them into synchronism before they are brought into the mix. Under each of the channel level controls – and the master output level slider – is a locking cue button that adds the source to the PFL bus for monitoring. The headphone level, like the master output level, can be varied via a slider control.

Finally, we have a sound effects generator. Up to six different effects – snare, bomb, video gun (whatever that is), laser, phone and UFO – can be added to the mix. The sounds are rather like those produced by the novelty units popular among drivers and CB enthusiasts a few years ago. Speed and level can be adjusted, and it's possible to create new sounds by pressing down one button while jabbing the others. Overall, it's a bit of a gimmick and most DJs (even dub DJs, who often use sound effects) will tire of them after about 10 minutes or so.

In all, then, the MX-602 is an easy to use mixer that combines all of the inputs that are likely to be needed by the beginner DJ. It offers a good sound quality, with no noticeable noise or distortion. The controls are good in their action with no crackling evident during the fade, and the control panel is well laid-out. The MX-602 is also more than adequate for the camcorder user who wants to add commentary, music or sound effects to his footage during the editing stage (one of the line-level inputs is, funnily enough, labelled 'camcorder audio').

Now we've discussed the mixer, let's talk about what you can use with it. . . .

Turntables

At the top end of the market, things are rather expensive. SL1200 turntables sell for around £400 each, and the Stanton 500 cartridges favoured by DJs sell for around £30. For those only familiar with CDs, it's worth saying what a cartridge actually is. It's the device, sitting at the end of the rod-like tonearm, that actually plays the record, converting the wobble of the record's groove (picked up by the stylus) into electrical signals that can be handled by the mixer.

Vinyl records are preferred by DJs, since they can be manipulated far more easily, leading to effects like cutting and scratching. DJ turntables must offer a vari-speed (pitch) facility if beat-mixing (the most common variant, in which the beats of two tracks are synchronised for seamless transition between them) is to be achieved. The Technics was the first turntable to have a DJ-friendly slide control for varying speed (over a decent 8% range). Needless to say, speed drift should be negligible – at least over the course of six or seven minutes – the length of the average dance record (turntables often have in-built stroboscopes so that speed drift can be monitored).

DJ turntables must also have a high-torque motor, to cope with the friction of a record that is held stationary on a slip-mat just before it is needed in the mix. If the motor doesn't have sufficient torque, the speed of the record will be wrong at the point where the record is released, something that can throw the mix out of kilter. The speed of most turntable motors is regulated by a servo, and in some cases, you would actually hear the servo hunting over a fraction of a second while it finds the right speed.

Although the SL1200 is a direct drive deck, it is capable of supplying decent levels of torque and is aided by a reasonably heavy platter for attaining angular momentum. Start time is claimed as 1 second at 45rpm, and even less for 33rpm. Cheaper direct drive decks can't provide this torque, and have lighter (i.e. cheaper) platters. At the cheaper end of the market, belt drive decks are the preferred choice.

Obviously, DJ turntables must be built to last (particularly for mobile use) and have a solidly made tonearm with a removable headshell (the mounting plate upon which the cartridge sits) for speedy interchangeability. Vibration insensitivity is also a highly important issue. Dance music genres such as jungle place much emphasis on bass, and feedback would result if the turntable wasn't isolated in some way from its environment. Such feedback is produced by the speaker vibrations being transmitted back into the system via the stylus. Not only that, but an accidental rap to the chassis by the DJ would be picked up as a loud thump, possibly blowing speakers in a sound system. The Technics SL1200's isolation is achieved admirably (but simply) via an aluminium die-cast chassis and a heavy rubber base.

There are cheaper alternatives to the SL1200, though, which are worth considering if you are starting out, or you don't intend to get into mix DJing. Maplin themselves sell a trio of vari-speed turntables from Soundlab, ranging from a good basic belt drive model (£99.99, order as BE57M) to a Technics-style quartz-locked direct-drive type (£209.99, BE59P). Ariston's Pro 1200, available from Richer Sounds stores around the country, sells for around £160 and is revered as a decent budget mixing turntable.

You don't even have to spend that much. Belt-drive decks with vari-speed – the cast-offs from rack systems (together with millions of perfectly-listenable vinyl records) when their owners decide to go CD – are seen at boot fairs around the country. Team them up with a slip-mat and a decent cartridge, and you've got an ideal beginner's turntable. A Pioneer deck was recently picked up for £2 – a new belt, a change of cartridge, a slip-mat, and it's now ready for action.

If not, there's an even cheaper alternative. Before rack systems, came music centres – ungainly objects that contained turntable, cassette deck, tuner and amplifier. Some of the top-end music centres produced by companies like Hitachi and Panasonic towards the end of the 1970s accommodated decent belt-drive decks – which weren't integral to the casing. They offered vari-speed, a decent die-cast platter with strobe, a removable headshell and a sound that wasn't bad at all.

Even better news is that they seldom attract any interest at boot fairs because they do look so old-fashioned (despite the fact that the better examples produce a far superior sound to many of today's MIDI systems) and don't have a CD player. At the end of the boot fair, you could pick one up for £5 (try your local tip as well, by the way). Buy two, remove the turntables and build them into home-made chipboard plinths. A 500mA 12V DC power supply should be sufficient to power the motors of both. Nothing has to be wasted, though: the rest of the music centre could be turned into a 'casseiver' (close off the hole where the turntable was, with wood, to provide a platform for a CD player, which can be fed to the unit's aux input). Motors are about the only thing to go wrong, and tend to be a standard manufacturers' replacement item.

Another DJ-friendly deck, by the way, is the simple Goldring GL75. A heavy synchronous-motor powered relic from the early 1970s, its saving grace is an oversized platter that weighs several kilograms, ironing out speed irregularities and the effects of a slip mat. The Swiss-made GL75 also has vari-speed – a lever varies speed from under 16rpm to over 78rpm. Even now, it seems a truly incredible piece of heavy engineering – which is more than can be said for its tonearm, which is useless for DJ use. The arm can be removed, and replaced with something a bit more substantial. GL75s are still seen from time to time at markets and boot fairs, selling for low prices, and were built into music centres by manufacturers like Dynatron.

Slip-mats and Cartridges

Slip-mats are inexpensive but essential DJ items. Maplin sells Sound-Lab anti-static slip-mats for £4.99 (order as DW34M). A cheaper alternative is to make your own from thin felt material, obtained from a clothing fabric store or similar supplier. I find it helpful to add a small tab that can be gripped by the fingers (use several layers of Sellotape or similar material).

A robust cartridge is also important. Magnetic cartridges are the best choice, since they offer the best compromise between sound quality (ceramic cartridges – found on cheaper disco units – sound awful, while audiophile-type moving coil cartridges are too flimsy and expensive for disco use). The American Stanton 500AL, purpose-designed for disco use and available from disco retailers, is perhaps the best choice. Any good cartridge with a robust shank (the thin aluminium rod with the stylus at its end) and a spherical stylus tip can, however, be used. In disco use, the tracking weight is often set high (2 to 3 grams) to keep the stylus in the groove during record manipulation. Two cartridges in the Maplin range worth considering include the Sonotone V100 (£13.99, HR17T) and the Shure ME70B (£19.99, FV16S).

CD Players

Much to the disgust of the mix DJ, new-release vinyl records are becoming harder to obtain, and when they are available, they tend to be expensive or issued as free promos to a restricted few (most DJs would appreciate the inexpensive record-cutting services of the 1960s and 1970s). For the non-mix DJ, though, CDs have many advantages. They are smaller, lighter and several orders of magnitude more robust than vinyl records. What's more, they start instantaneously (no waiting for the platter to build up speed). Some DJs use domestic CD players, but these are simply not designed for the rigours of (semi) professional use and mechanisms (notably the loading tray) frequently give up the ghost all too soon.

Thankfully, DJ CD players are becoming available. Such units provide features like rock-steady pitch control and the accurate determination of cue points. DJ CD players also provide other features that you can't get with turntables, such as looping – the continuous repeating of an accurately determined phrase (a sort of limited sampling). The first DJ CD player, the Pioneer CDJ-500, was launched over two years ago to an initially suspicious, but gradually impressed, DJ fraternity. CDs are now becoming more mainstream. Maplin recently introduced a double CD transport designed specifically for DJ use. The Soundlab CDJ2600 (order as 51252, £499.99) is a professional unit that offers all of the features needed by DJs, including accurate CD manipulation and 8% pitch control.

Headphones and Microphones

Since you may be wearing them for hours at a time, the headphones that you use to cue up records and monitor the final output level must be comfortable to wear and listen to. Ones that enclose the ear are preferred, since you are not distracted by external noises. This is particularly true if you're DJing at a party, and the output from the mixer is being fed to a powerful amplifier and speakers. Maplin's robust BZ58N (£6.99) are a good cheap choice, while the dearer BZ25C (£16.99) is capable of better sound quality.

For making announcements (and for certain types of music, like hip-hop and jungle, rapping), a microphone is essential. Rugged build quality is important, as is a unidirectional response – you don't want to pick up extraneous noise. Manufacturers like Shure are renowned for high quality mikes, and the company's rugged 515SD (around £50) is popular for disco use. Maplin's BD98G (£47.99) can also be operated in an unbalanced mode, which makes it ideal for partnering with disco mixers that don't tend to include professional-type balanced inputs.

Jingle Machines

If you would like to add jingles – short stabs of music, often-repeated announcements or jokes, these could be provided by a cassette deck. I have found the old-fashioned top-loading decks (available for next to nothing at boot fairs) with mechanical pause button ideal for this task. It is advisable to add, with a microphone, a countdown to the jingle, to aid cueing. A PC with soundcard could be used to source jingles that you have previously captured to hard disk – however, taking a computer around with you is hardly practical for mobile DJs (unless the machine is also used for MIDI music, impressive lightshow control or, in the case of the Turtle Beach Tahiti sound card, sampling).

In the old days, disco equipment suppliers would sell jingle machines that were modified stereo 8 track cartridge players (usually the compact BSR models). 8-track was an endless-loop tape cartridge system, originally developed for in-flight stereo music playback by the Lear Jet Corporation, and which, during the 1970s, was popular with Ford Cortina-owning sales executives around the country. The 8-track name derived from the way in which the tape was recorded; there were four stereo channels arranged as staggered track pairs, and a piece of metal foil was used to change tracks (the position of the head) after one complete circulation of the tape loop. 8-track has, of course, since been eclipsed by the cassette (and latterly, the CD) for general domestic use.

In the jingle machine variant, one stereo channel was used for the mono jingle, while the other was used for a cue tone. When the playback button on the machine was pressed, the jingle would play. The tape would continue running after the jingle had finished, until the cue tone – arranged at the start of the next jingle – told the machine to stop running (a light would tell the DJ that the next jingle was cued up). Only one of the four track pairs were used in most of these jingle machines, which is probably just as well, because 8-track nearly always suffered from cross-talk between the track pairs.

Very short cartridges were used (2 minutes, rather than 20 minutes, per track – enough for four or so jingles, with spacing). The jingles recorded on the loop of tape are played in rotation – if you want the jingle that has just been played, you have to work your way through the rest of them – hence the low number of jingles per cartridge. The system was simple but effective, and not unlike the way in which radio stations used to insert jingles and adverts into their programmes (these days, it's all done with computers and direct-to-disk recording).

8-track cartridge players (especially the in-car types) and tapes can be found second-hand dirt-cheap (I've also seen the jingle machine variants up for grabs). Modifying the players into cartridge players would be relatively straightforward – the output from one of the preamplifiers would be rectified, and fed into a transistor switch that activates the stop solenoid or controls the motor supply.

Recording the jingles is more of a problem – 8-track cartridges were intended to be a playback medium, and the recorders that became available never sold in huge numbers. You could butcher an old cassette deck and use its electronics to feed the 8-track's record/playback head – adjustments to the bias current would be required, however, and possible corrections for differing head impedances).

Since there is no erase head in the playback-only machines, you would have to bulk-erase the tape before you could (re)use it. If you take this approach, our advice is to record the jingles and cue tones onto a cassette first, and then dub them across to the cartridge. Remember that if you make a mistake, you'll have to bulk-erase the tape and start again. We recommend that you shorten the length of the cartridge to remove tape, or record the same batch of jingles again and again (this is preferable, since tape wear will be less).

Conclusion

With a bit of ingenuity and technical know-how, it's possible to build up a studio for very little outlay. Student and special-event radio stations, with hard-pressed funds, know how important this is. The same is true of the aspiring DJ who wants to try mixing records without enduring the cost of professional-level equipment. It's worth remembering, though, that the mixer is at the heart of any such system.

MX-602 SPECIFICATION

Input Sensitivity/Impedance:	
Mic 1,2:	1mV/1kΩ
Mag. Phono:	3mV/50kΩ
Line inputs:	150mV/100kΩ
Output:	
Master (Normal):	1_5V (0dB)
Master (Max.):	8V
Record (Normal):	0·775V
Record (Max.):	5V
Headphones:	150mV/8Ω
Frequency Response:	
Line-Level/Mic:	20Hz to 20kHz 0·5dB
Mag. Phono:	RIAA (2dB)
Signal-to-Noise Ratio:	
Mic 1,2:	60dB
Line-Level:	75dB
Mag. Phono:	75dB
Effects:	
Snare, bomb, video gun, laser, phone, UFO (with speed and level control).	
Dimensions (WHD):	343 × 71 × 270mm
Weight:	2·7kg

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.

October 1996

1 October. Discussion Meeting on Corporate Culture, Savoy Place, London. Tel: (0171) 344 5427.

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.

8 to 10 October. Euro-EMC, Sandown Exhibition Centre, Esher, Surrey. Tel: (0181) 910 7983.

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

18 to 27 October. The Home PC Show, Autumn Ideal Home Show, International Motor Show and Connect '96, Birmingham NEC. Tel: 0121 767 4114.

20 October. Memorabilia '96. Europes largest collectors for pop, film, SF culture, TV and comic collectables. Tel: (01462) 683965.

26 October. Computer Show. Concentrating on the 2X Spectrum and SAM Coupé. Quedgeby Village Hall, (outskirts of Gloucester on the B4008 Bristol Road, just off Junction 12 on the M5). Doors open to the public at 10.30am and close at 4.30pm. Tel: (01452) 412572.

28 October. Latest Kits and Demonstrations, Stratford-upon-Avon & District Radio Society, Tiddington, Stratford-upon-Avon. Tel: (01789) 773286.

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.

11 November. Sounds of Yesteryear, Stratford-upon-Avon & District Radio Society, Tiddington, Stratford-upon-Avon. Tel: (01789) 773286.

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

25 November. Night on Air. Stratford-upon-Avon & District Radio Society, Tiddington, Stratford-upon-Avon. Tel: (01789) 773286.

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

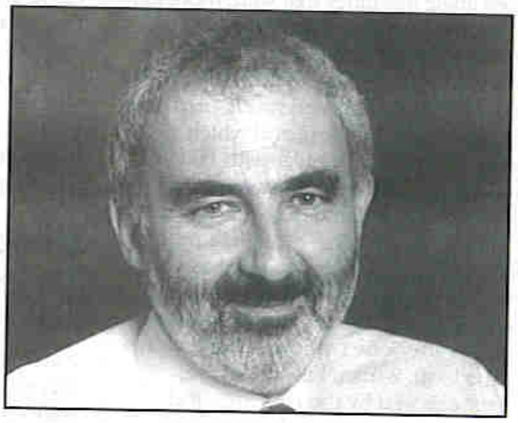
December 1996

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

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 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.

What's On?



Tony Stoller Speaks to the Radio Festival

The Radio Festival took place in Birmingham on 16th July. Tony Stoller, Chief Executive of the Radio Authority, used his key note speech to address the issues of Digital Audio Broadcast (DAB), and the merger of broadcast mediums.

In a speech entitled 'Brave New World', Tony Stoller said, "The millennium has come early for radio. We stand, at the moment, precisely balanced on the fulcrum of change. The Broadcasting Bill will produce not only new patterns of ownership in commercial radio, but has let slip the dogs of DAB into an increasingly digital world. The BBC has joined the fashion for convergence by bringing together radio and television in a way which is bound to change the senior medium profoundly".

The new Broadcasting Act will liberalise the ownership rules for radio. However, recognising the importance of promises of performance, Government has introduced safeguards to protect the nature of radio services which are the subject of take-overs by allowing the Authority to tighten up promises of performance.

The Authority's Chief Executive continued, "I can certainly say that we regard the 'promises of performance' as a key lever in carrying through our responsibilities under the 1990 Act. The Authority's programming staff will continue to welcome informal contacts and discussions with programmers about how they can meet what we recognise are the changing needs of audiences without breaching statutory rules. Nevertheless, the Authority will regard the 'promise of performance' as the key document and will expect it to be treated as such by our licensees".

"With this in mind, we have already taken steps to give more public access to these documents. They are, after all, a summary of the successful applications which have already been made available for public view".

"I should add that the Authority is clear that except in the circumstances provided for in Section 106 of the 1990 Act, we are not empowered to agree to fundamental changes in 'promises of performance'. Should a format prove so unsuccessful that it cannot be sustained through the licence period, the Authority would normally expect the licence to be returned to us for re-advertisement rather than to agree to any fundamental change which would get away from the original spirit of the application on which the licence was granted", concluded Stoller.

Contact: Radio Authority. Tel: (0171) 430 2724.

Apple Expo '96

The Electronic Imaging Centre, a showcase for the latest developments in electronic imaging, is a first for Apple Expo. The inclusion of this area demonstrates the growing importance for electronic imaging and the interest it continuously generates.

The Electronic Imaging Centre will be one of the high lights of Apple Expo '96, Europe's leading independent Mac Industry exhibition.

Amongst other exhibitors launching products, Polaroid will unveil their Sprintscan 35 Plus at the show. This is their high-end product in the Sprintscan 35 Plus range, and is capable of delivering detailed images from positive or negative films.

Hitachi will be demonstrating their range of imaging applications together with their range of colour and monochrome network laser printers featuring magicolor CX 100 dpi colour laser and the QMS 2425.

Another leader in this field is Linotype-Hell who will be exhibiting two of its industry-acclaimed desktop flatbed CCD scanners, Saphir (A4) and Opal (A3).

Other show highlights include the Internet Arena, will offer the choice of two hands-on seminars, and The Multimedia Arena which will provide an insight into how your business can benefit from the latest developments in multimedia technology.

The Free Conference and Seminar programme, sponsored by MacWorld magazine for the first time, in association with Apple Computer (UK) Ltd., proves highly successful every year.

This year the Newton Business Solutions Village showcases the innovative range of PDA's developed by Apple and demonstrates their wide range of practical applications.

Apple Expo '96 runs from 6 to 9 November at the Grand Hall, Olympia London Contact: Tel: (0171) 388 2430 or Fax: (0171) 388 2620.

Corporate Culture – Panacea or Poison

An IEE meeting on 1st October will discuss the issue of corporate culture. The debate will explore both the benefits and the inevitable downside of the implementations plagued by a history of industrial unrest and active non-participation of the workforce.

On the other hand, complaints to the industrial tribunals have increased dramatically in the last ten years, and many people are citing heavy-handed management as a reason for leaving employment.

Whilst many benefit from the environment and structure of a strong culture, others find themselves constrained and productivity reduced. And is it not these internal entrepreneurs that will be needed most in the agile manufacturing arena and the next generation of manufacturing?

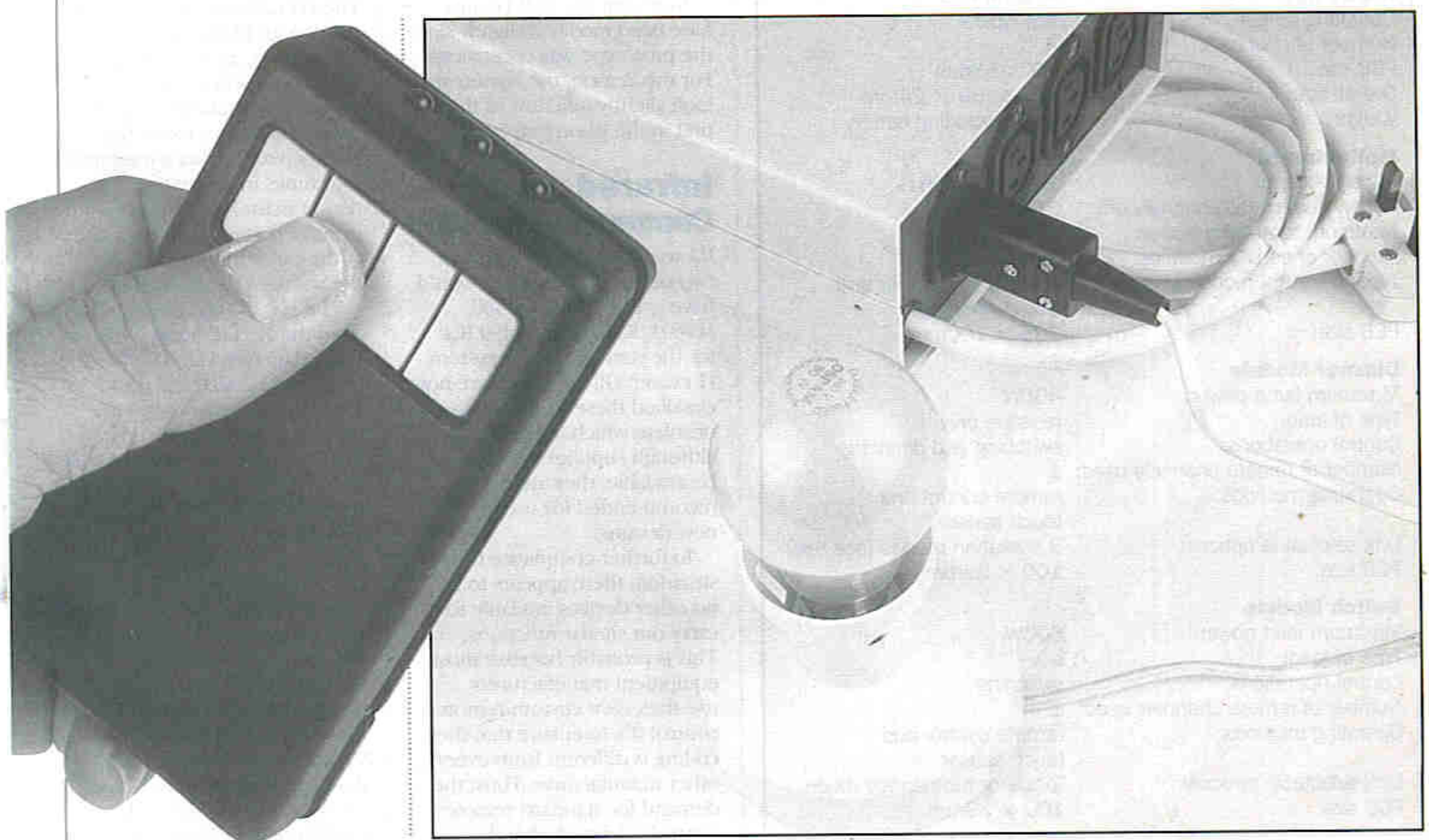
So, does the implementation of corporate culture lead to increased profitability and cohesion? Or does it contribute to the alienation of skilled staff and massive waste of precious resources? This discussion meeting will attempt to answer these questions and many more.

For further details, check: **http://www.iee.org.uk**
Contact: IEE, Tel: (0171) 344 5427.

Four Channel REMOTE CONTROL LIGHTING SYSTEM

Design by Paul Stenning
Text by Paul Stenning

Many household items are now supplied with remote control handsets – all designed to encourage laziness! However, to adjust the room lighting, it is usually still necessary to get up and do it manually. This is probably because the lighting was specified by the house builder, and most householders are understandably reluctant to alter it. Some single-channel remote control dimmers are becoming available, but they are still rather expensive.



The system described here allows up to four channels of lighting to be remotely controlled. It has been designed to be relatively inexpensive, without compromising safety and reliability.

Such a system could be helpful for persons who cannot move as easily as they would like, such as the elderly or disabled. If necessary in individual cases, the remote handset may be housed in a larger box with suitable push buttons.

The prototype was used as a stand-alone system, connected to table lamps and a desk fan. Ambitious constructors could consider incorporating the unit into the household wiring, if they are satisfied that the installation will comply with the relevant wiring regulations.

System Overview

The receiver consists of a motherboard, onto which are mounted separate control modules for each channel. Two different types of control module are available. The first, and probably more popular type, is the dimmer module. This allows up to 400W of lighting to be switched or dimmed from a single button on the remote handset. This module can only be used with resistive loads such as normal incandescent light bulbs. It cannot be used with inductive loads such as fluorescent lights, low voltage transformer powered lighting, etc.

For inductive loads the switch module may be used. This allows switching only, and can be used with any type of load up to 600W. As well as lighting (including fluorescent and transformer powered), it could also be used to control other loads such as fans, low power heaters and video game consoles.

This module can be configured to either of two modes of operation by means of a single link. Probably the most useful is Toggle, whereby the load is switched alternately on and off each time the remote button is operated.

In Momentary mode, the load is only driven while the button is pressed. This may be useful for operating outdoor security lights, or for activating a bell or sounder to call for assistance.

SPECIFICATION

Transmitter	
Supply voltage:	9V
Standby current:	<2μA
Operating current:	50mA typical
Battery type:	Alkaline PP3
Operating range:	5m typical
Number of channels:	4
PCB size:	66 × 53mm
Overall size:	108 × 59 × 24mm
Weight:	100g including battery
Motherboard	
Supply voltage:	230V AC, 50Hz
Supply current (all channels off):	35mA typical
Maximum total lamp power:	1,500W
Number of control modules:	up to 4
Type of control modules:	Any mix of Dimmer and Switch modules
PCB size:	135 × 100mm
Dimmer Module	
Maximum lamp power:	400W
Type of load:	resistive only
Control operations:	switching and dimming
Number of remote channels used:	1
Operating methods:	remote control and touch sensor
Link selectable options:	3 operation modes (see text)
PCB size:	100 × 25mm
Switch Module	
Maximum load power:	600W
Type of load:	any
Control operations:	switching
Number of remote channels used:	1
Operating methods:	remote control and touch sensor
Link selectable options:	Toggle or Momentary mode
PCB size:	100 × 33mm

Photo 1. Inside the remote control transmitter handset.

Each of the four channels may also be operated by touch sensors on the receiver box – very useful if the handset gets lost or the battery is flat! The remote control handset is built into a proprietary case with built-in buttons and battery compartment.

The author does not have the facilities to carry out official EMI emission and susceptibility tests to comply with the relevant EEC directive for CE marking. However, the unit has been designed with adequate suppression and screening to minimise these problems. The prototype has been tested in close proximity to various pieces of sensitive and electrically noisy equipment, and no problems have been experienced.

Note that the PCB layouts have been modified slightly since the prototype was constructed. For this reason, the layouts may look slightly different to the unit in the photographs.

Infrared Communication Link

If I was designing this system two or three years ago, I would have specified the MV500, MV601, SL486 and SL490 ICs for the remote control system. However, GEC-Plessey have now classified these useful devices as obsolete which means that, although supplies may still be available, they are not recommended for use in new designs.

To further complicate the situation, there appears to be no other devices available to carry out similar functions. This is probably because most equipment manufacturers use their own custom remote control ICs to ensure that their coding is different from every other manufacturer. Thus, the demand for standard remote control ICs has declined.

In this design, I am using the HT12E and HT12D devices from Holtek. These result in a design that is more complicated and gives slightly reduced range compared to that obtained with the GEC-Plessey devices. However, I have very little choice – the Holtek devices are about the best of a fairly poor range of available ICs.

This should not be taken as a criticism of the devices themselves, since they are intended for security coding systems (such as car alarms and cordless telephones) rather than infra-red remote controls.

Holtek HT12E and HT12D

The HT12E encodes the 12-bit data on its 12 data input lines (A0 to A11), and then serially transmits it when the transmit enable pin is taken low. The data output appears on the D-OUT pin. The data is transmitted four times in succession. The data consists of differing length positive going pulses for 1 and 0, the pulse for 0 being twice the width of the pulse for 1.

The HT12D receives the data from the HT12E on its D-IN pin. If the data received matches the levels on the A0 to A7 pins four times in succession, the valid transmission (VT) pin is taken high. The data on pins A8 to A11 of the HT12E appears on pins D0 to D3 of the HT12D. Thus, the device acts a receiver of 4-bit data (16 possible codes) with 8-bit addressing (256 possible channels).

The third device in this family (not used in this design) is the HT12F. This is similar to the HT12D, except that the levels on all 12 data pins must match those on the HT12E for the VT line to be taken high. This device acts as a single channel receiver with a 12-bit address (4,096 possible channels).

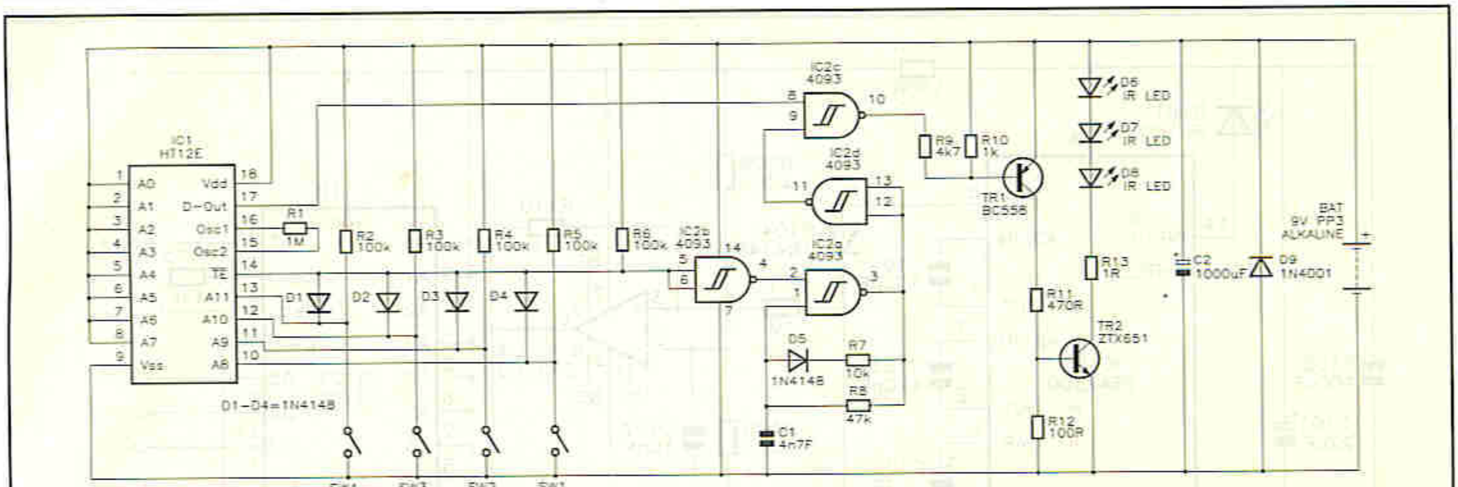


Figure 1. Circuit diagram of remote handset.

The devices contain an internal clock, the frequency of which is set by a single external resistor connected between the OSC1 and OSC2 pins. The frequency of the receiver (HT12D/HT12F) clock should be approximately 50 times the transmitter (HT12E) clock. The relationship of frequency to resistance is not linear, and also depends upon the supply voltage. The clock resistor values used in this design were obtained with reference to the graphs in the device data sheets.

The devices operate over a supply voltage range of 2·4V to 12V, with a typical standby current of 0·1μA at 5V and 1μA at 10V. The operating current is under 1mA.

Transmission Problems

The Infra-red transmission medium works best with very short pulses, and is ideally suited to coding systems that rely on the presence or relative timing of pulses. This is the type of coding used in most commercial pieces of equipment, as well as by the obsolete GEC-Plessey devices mentioned earlier.

Infra-red does not lend itself so well to pulse width based systems such as the Holtek devices used in this design. This is partly because the transmitting LEDs must be operated at currents of around 1·5A to give a reasonable range, and this sort of current can only be sustained for very brief periods to avoid damaging the LEDs and to keep the average current consumption to a reasonable figure. Also, the receiving photodiode and amplifier IC are designed for very short pulses, to prevent interference from lower frequency light variations such as mains fluorescent lighting at 50Hz.

In this design, the variable width pulses from the HT12E are used to control a higher frequency pulsing circuit which in turn drives the LEDs. At the receiving end, the groups of pulses are recombined to give the variable width pulses required by the HT12D.

This system works fairly well in practice although, as mentioned earlier, the range may not be as great as some commercially made remote control systems. The prototype operates reliably at distances of up to about 5m (16ft.), which should be ample for an average sized room.

Remote Control Handset Circuit Operation

The handset circuit diagram is shown in Figure 1. The HT12E data lines A0 to A7 are taken high. This is because the IC outputs shorter pulses for a logic 1 than for a logic 0. Thus, the output LEDs are lit for less time, giving a reduction in current consumption from the battery.

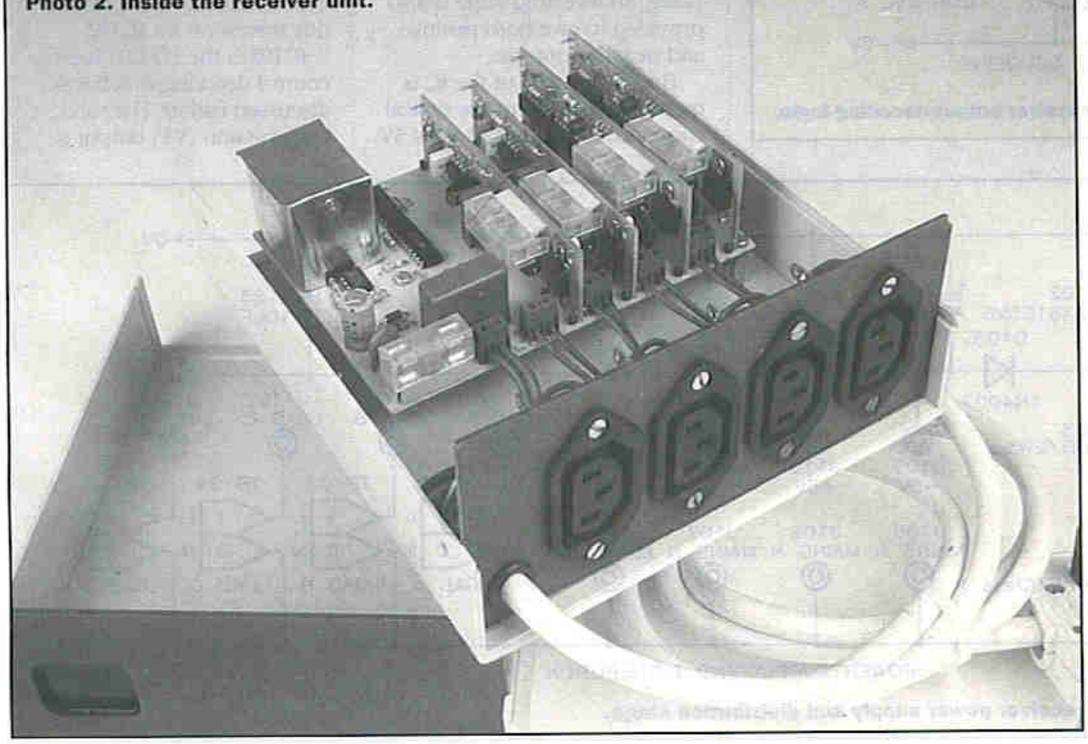
If this coding causes problems with other pieces of equipment, some of the lines may be taken low by cutting the appropriate PCB track and linking pins 8 and 9 of the IC. Obviously, the tracking on the motherboard must be modified in a similar manner. The PCB tracking of both boards have been designed to make this modification easy.

The remaining four data lines are connected to the four channel push buttons, so that one line goes low when the appropriate button is pressed. The four push buttons are also gated to the active low transmit enable (TE) line via diodes D1 to D4 and R6.

IC2a (4093), and surrounding components form an oscillator running at about 30kHz. This oscillator only operates while one of the push buttons is held, due to IC2b. D5 and R7 modify the mark-space ratio such that the output on pin 3 is low for about 20% of the time. This is inverted by IC2d and then gated with the data output (D-OUT) from IC1 by IC2c.

The output LEDs (D6, D7 and D8) are driven by TR2, which is in turn driven by TR1. R13 limits the LED current to about 1·5A, although the value could be reduced at the expense of battery life if extra range is needed. C2 provides the power for these brief high current pulses, while D9 protects the circuit if the battery is connected incorrectly.

Photo 2. Inside the receiver unit.



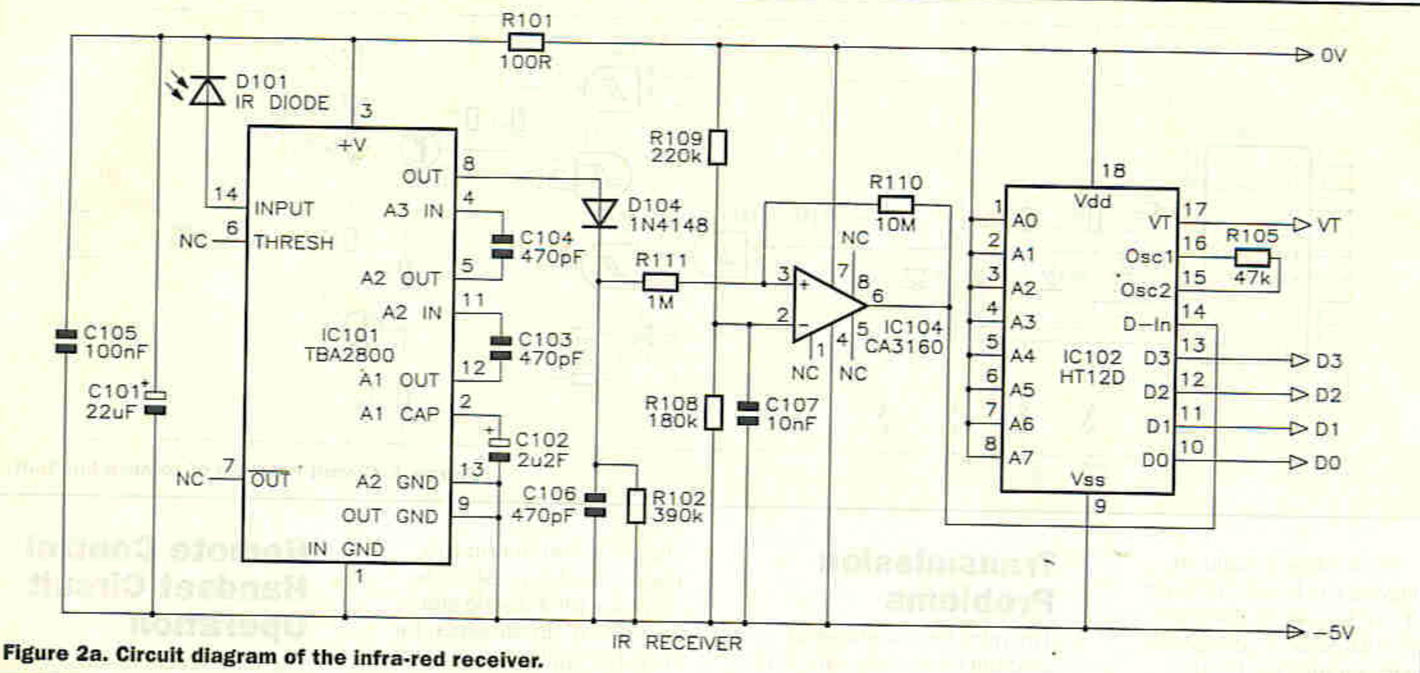


Figure 2a. Circuit diagram of the infra-red receiver.

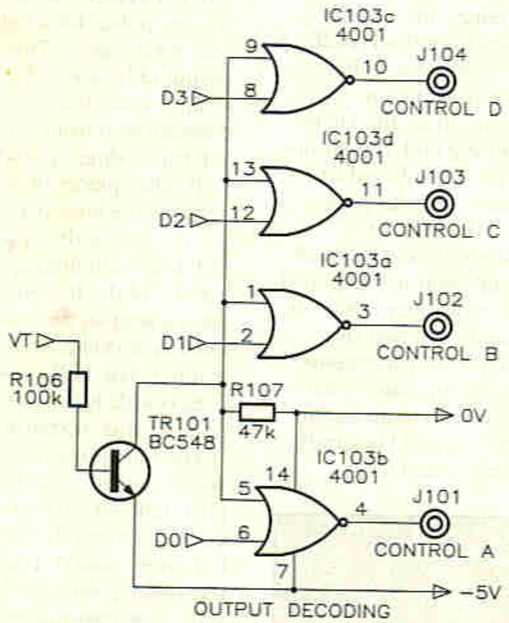


Figure 2b. Circuit diagram of the receiver output decoding logic.

Motherboard Circuit Description

The motherboard contains the IR receiver and decoder, together with the power supply. The circuit is shown in Figures 2a to 2c.

D101 is the IR photo-diode and IC101 (TBA2800) is the infra-red amplifier. This IC contains three stages of amplification, the first of which has an automatic gain adjustment system to cope with varying signal and ambient light levels. The second amplifying stage simply provides further amplification, and the third separates the wanted signal from the general background noise. An inverting stage is also provided to give both positive and negative outputs.

The overall gain of the IC is quoted as 70dB, and the typical current consumption is 1mA at 5V.

C103 and C104 are the coupling components between the amplifying stages. The values of these have been chosen to give good coupling at the IR transmission frequency, while rejecting lower frequency noise and interference. C102 is the filter component for the automatic gain control of the first amplifier in IC101. The power supply to IC101 is decoupled by R101, C101 and C105.

The output of IC101 will be groups of pulses, similar to those transmitted by the handset. D104, C106 and R102 recombine these, but the rising and falling edges of the resulting waveform are rather imprecise. IC104 is configured as a comparator with hysteresis to produce a tidy waveform for IC102.

IC102 is the HT12D remote control decoder, which was discussed earlier. The valid transmission (VT) output is

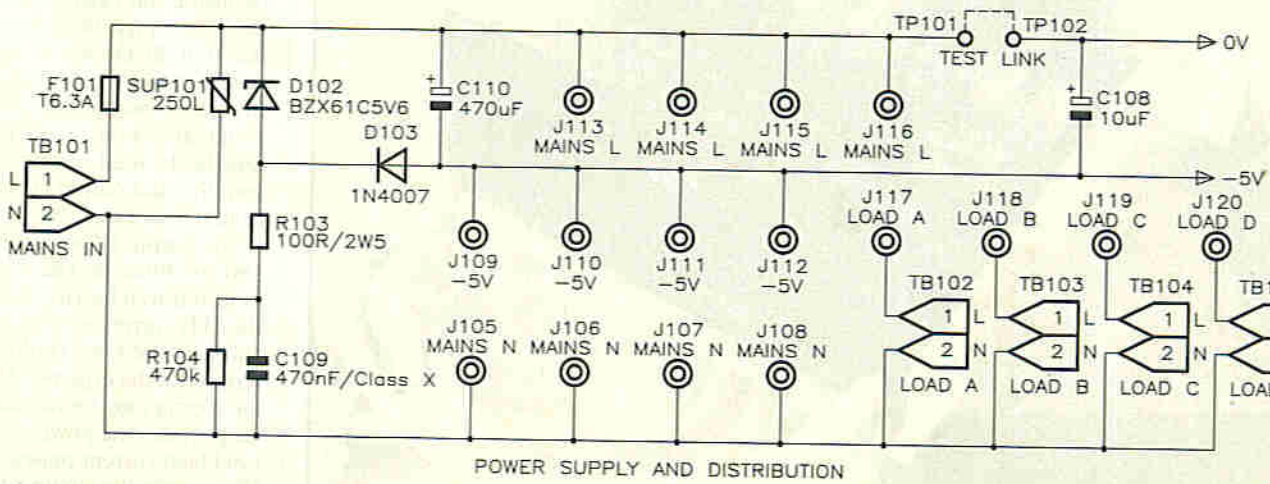


Figure 2c. Circuit diagram of the receiver power supply and distribution stage.

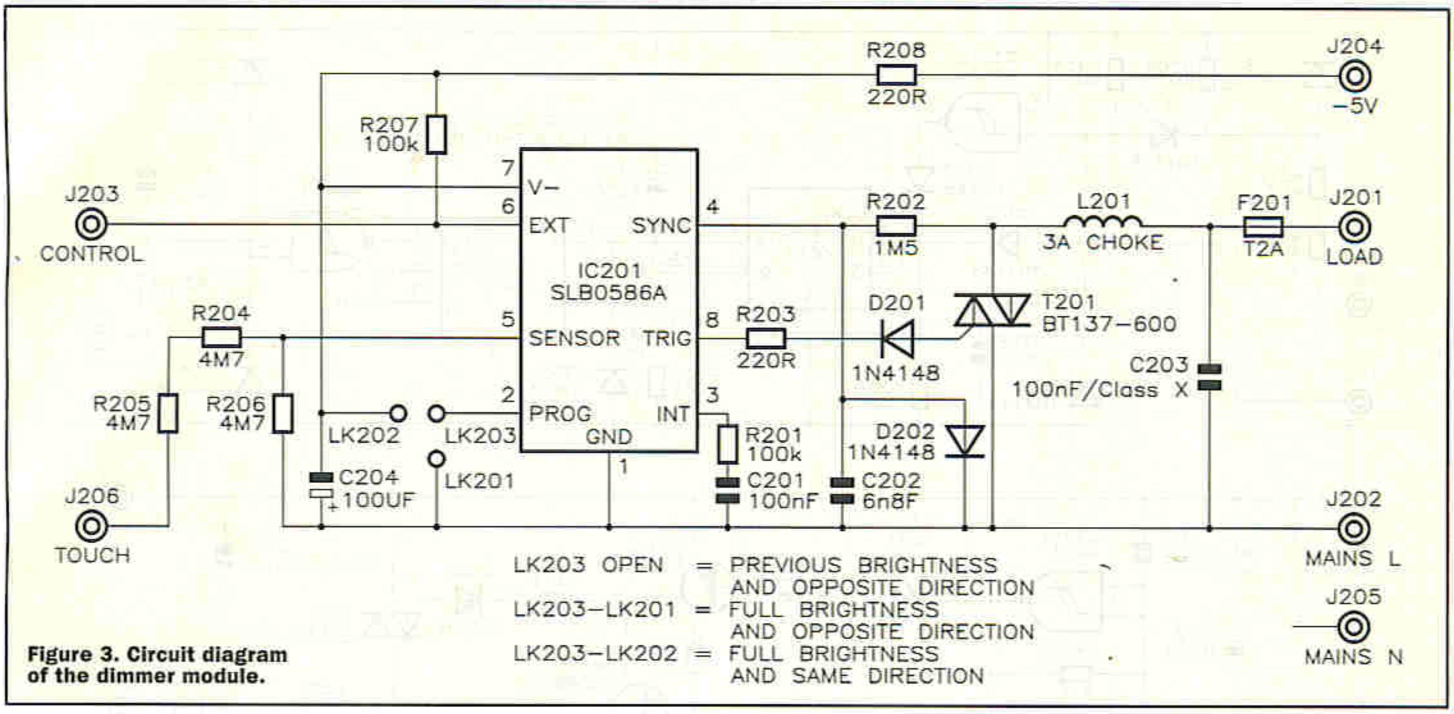


Figure 3. Circuit diagram of the dimmer module.

inverted by TR101, and gated with the data outputs (D0 to D3) by IC103. This gating is necessary because the data outputs of IC102 remain when the transmission finishes. The appropriate output of IC103 goes high when a button is pressed on the remote control handset, and the signal passes to the appropriate lamp control module.

As the total power consumption of the control circuitry including four modules is only about 10mA at 5V, a basic mains-derived power supply arrangement is adequate. The control circuits are connected directly to mains live on the lamp control modules in any event, so there would be no advantage in using an isolated supply from a mains transformer. The mains input is connected to TB101.

In circuits such as this, a capacitor (C109) is used to drop the excess voltage as, unlike a resistor, it does not dissipate any power due to the 90° phase shift. R103 limits the surge current at switch-on, and R104 discharges C109 when the unit is disconnected from the mains. The +0·6V/–5·6V pulses on D102 are rectified by D103 and smoothed by C110 to give a stable 5V supply, at up to about 15mA. SUP101 is a surge suppressing component.

The test link allows the power supply to be tested (before the control modules are fitted) without being connected to the remaining circuitry. J101 to J120 are the connections to the control module boards, and TB102 to TB105 are the connection points for the lamps being controlled.

Dimmer Module Circuit Description

The circuit, shown in Figure 3, is based around the Siemens SLB0586A touch dimmer IC. This IC permits the design of fully electronic dimmers for resistive load incandescent lamps, operated by a single touch sensor or remote control channel. The lamp brightness is set by phase control. The IC contains a phase-locked loop which is synchronised to the mains frequency.

A digitally determined period of approximately 50ms ensures a high degree of immunity to interference in the control inputs, while allowing almost instantaneous operation. The device can distinguish between turning on/off and dimming by the duration of the control input signal period. A brief pulse (50 to 400ms) will switch the light on or off.

If the input is operated for a longer period, the lamp brightness will be varied up and down for as long as the input is operated. The complete cycle takes 7·6 seconds (e.g. bright-dim-bright) and stops at the chosen brightness when the input is removed. The lamp brightness is varied in a physiological-linear manner to enable easier setting at lower brightness levels.

There are three modes of operation, which are link selectable. In modes A and C, the lamp always comes on at full brightness, over a 380ms soft-start period. In mode B, the lamp comes on at the same brightness as when it was turned off. In mode A, a dimming operation will start in the same direction as the previous dimming operation, while in modes B and C, the dimming will start in the opposite direction. For mode A, join LK203 to LK202 on the PCB. For mode C, join LK203 to LK201, and for mode B, leave LK203 unconnected.

The SLB0586A IC was discussed in greater detail in the Pattress Mounting Dimmer Switch project, in issue 103 of *Electronics*.

The supply to IC201 is decoupled by R208 and C204. R201 and C201 are the integration components for the internal phase locked loop. L201 and C203 are EMI suppression components. J206 is the signal from the remote control decoder circuit on the motherboard and J203 is the connection point for an optional local touch sensor. R204 and R205 limit the touch sensor current to about 25μA, which is so low that it cannot be felt. **For safety, the two separate resistors must not be replaced by a single component.** Mains Neutral is not required by this module, but the terminal (J205) is provided for compatibility with the Switch module.

The recommended triac is a BT137-600 or a T410-600. The author does not recommend the use of the C206, C216 or C226 range of devices as he has found these to be unreliable in several different applications.

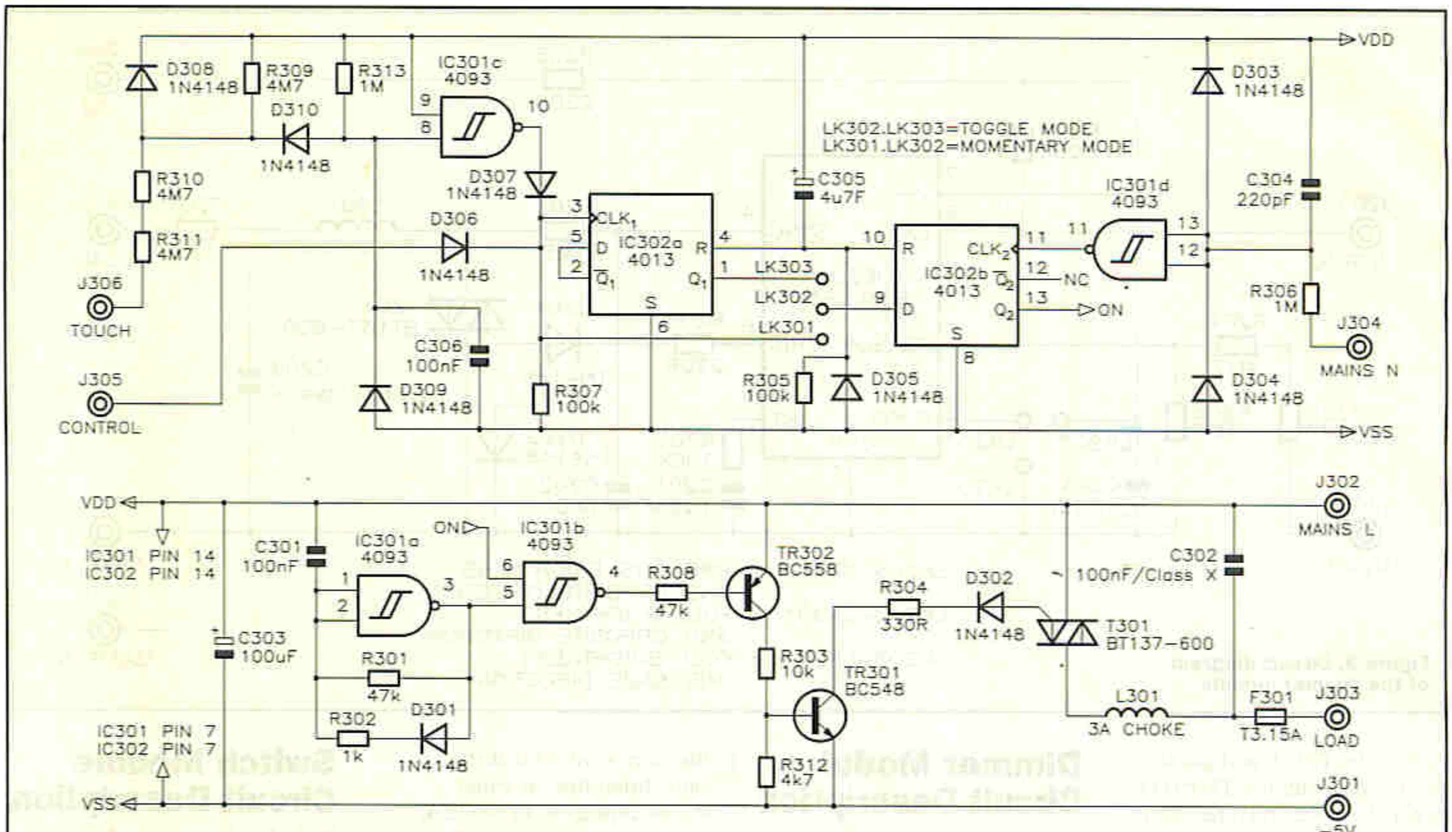
Switch Module Circuit Description

With the dimmer module described previously, the triac is triggered just once in each half cycle of the mains. Although the trigger current is about 20mA, it only occurs for a brief period so the average current consumption of the circuit remains low.

The Switch Module, the circuit diagram of which is shown in Figures 4a and 4b, is designed to drive inductive and capacitive loads, as well as resistive. Therefore, the triac ideally needs to be driven continuously for the complete mains cycle. The current required for this would be 20mA per module, giving a total of 80mA if four switch modules were fitted. This sort of current cannot be obtained from the basic mains derived power supply arrangement used, so a method of reducing the average current consumption is needed.

The solution is very similar to that employed in the remote control handset. A fast chain of brief pulses are used to drive the triac, such that when the triac switches off (due to the load current passing through zero), it is almost immediately retriggered.

Referring to the circuit diagram in Figure 4b, IC301a is configured as a free running oscillator at a frequency of about 4kHz. R302 and D301 set the mark-space ratio so that the output is high for 20μs and low for 230μs. When pin 6 of IC301b (ON) is high, the pulsed signal is passed to the triac via TR302 and TR301. The triac therefore receives 20mA trigger pulses



Figures 4a and 4b. Circuit diagrams of the switching module.

while the average current consumption is under 1mA. C303 decouples the supply and supplies the brief current pulses, while C302 and L301 are EMI suppression components.

IC301d and IC302b form the zero-crossing detector. The mains is squared by IC301d, the output of which is a 50Hz square wave. R306 and C304 filter out any high frequency noise on the mains that might otherwise cause erratic triggering. IC302b is a D-type flip-flop, the Q output of which latches to the logic state on the D input when the CLK input receives a rising edge. Thus, when the D input changes state, the change is transferred to the Q output on the next falling zero-crossing point. The circuit ensures that the load is only switched at the zero-crossing point to minimise interference, and that the load always receives an equal number of positive and negative half cycles to avoid magnetising the core of inductive loads.

If LK301 is connected to LK302, the circuit is in momentary mode. The control input is then passed directly to IC302b, so that the load is only powered when the remote control button is pressed.

When LK303 is connected to LK302, IC302a is bought into the circuit. By connecting the NOT-Q output to the D input, the device acts as a divide-by-two circuit. Thus, the output (Q) changes state each time the CLK input receives a rising edge. The result is that the load is switched on by the first button press, off by the second, etc. C305, R305 and D305 ensure that both halves of IC302a are reset when the power is switched on, so the circuit always starts with the load turned off.

The circuit around IC301c is the touch sensor input. The high impedance 50Hz signal caused by grounding J306 via the human body, is rectified by D310 and smoothed by C306. This signal is sufficient to drive the high impedance input of IC301c. The output of this circuit is combined with the remote control input (J305) by the diode OR gate (D306, D307 and R307). R310 and R311 limit the touch sensor current to about 25μA, which is so low that it cannot be felt. For safety, the two separate resistors must not be replaced by a single component.

Handset Construction

The circuit is constructed on a single-sided PCB (see Figures 5a & 5b), which is designed to fit into the recommended case. The four corner holes may need to be enlarged to accommodate the fixing screws, and the two corners closest to the LEDs may need to be chamfered slightly.

The PCB construction is generally straightforward, but the following points should be noted. C1 and C2 must be laid flat against the PCB as shown, and may be held in place with a small amount of suitable glue (e.g. Evostick) to stop them rattling. The ICs may be fitted in sockets if desired, although these were not used on the prototype. The links should be made with 24swg tinned copper wire or component lead offcuts.

The four switches must be fitted on the solder side of the PCB. Depending on the type of switches used, it may be necessary to raise the edges of the switches closest to the LEDs slightly away from the PCB to ensure they are operated positively by the buttons fitted into the case. The three LEDs protrude through holes in the case, so it may be easier to fit them after the case has been drilled. One hole should be central, and the others 10mm either side. The hole diameter is 5mm. The LED cathode is normally indicated by a flat on the side of the body and/or a shorter lead.

Photo 3. Completed transmitter handset.

The battery lead should be soldered to the 'BAT' terminals, with the red wire to the positive terminal and black to negative. The lead is then knotted around one of the PCB mounting pillars in the case, when the PCB is being fitted.

The case is supplied with button assemblies for one, two and four button systems. Normally, the four button assembly would be used, but if you are building a one or two channel system, you could use a suitable button assembly and omit the appropriate switches on the PCB. The PCB is fitted into the case with the screws provided. If the screws are too long, they an easily be shortened with a large pair of wire cutters. Finally, fix a thin piece of foam into the case to prevent the battery from rattling, and screw the back in place.

Handset Testing

Clip one battery lead clip onto one battery terminal. Connect a test meter, set to the 200mA DC range, between the other battery lead clip and the other battery terminal, so that the meter is in series with the battery. After an initial surge, the meter should read zero, or possibly 1mA. Switch down to the 2mA range to obtain a more precise reading, which should be less than 0·010mA (10μA).

The reading may initially be higher than this, and gradually reduce as the chemical composition of C2 reforms.

Set the test meter back to the 200mA DC range, and press one of the remote control buttons. With a fresh alkaline battery, the reading should be between 40 and 60mA. If the readings obtained vary greatly from these, the cause should be investigated. If all is well, the battery may be fitted properly and the cover clipped into place.

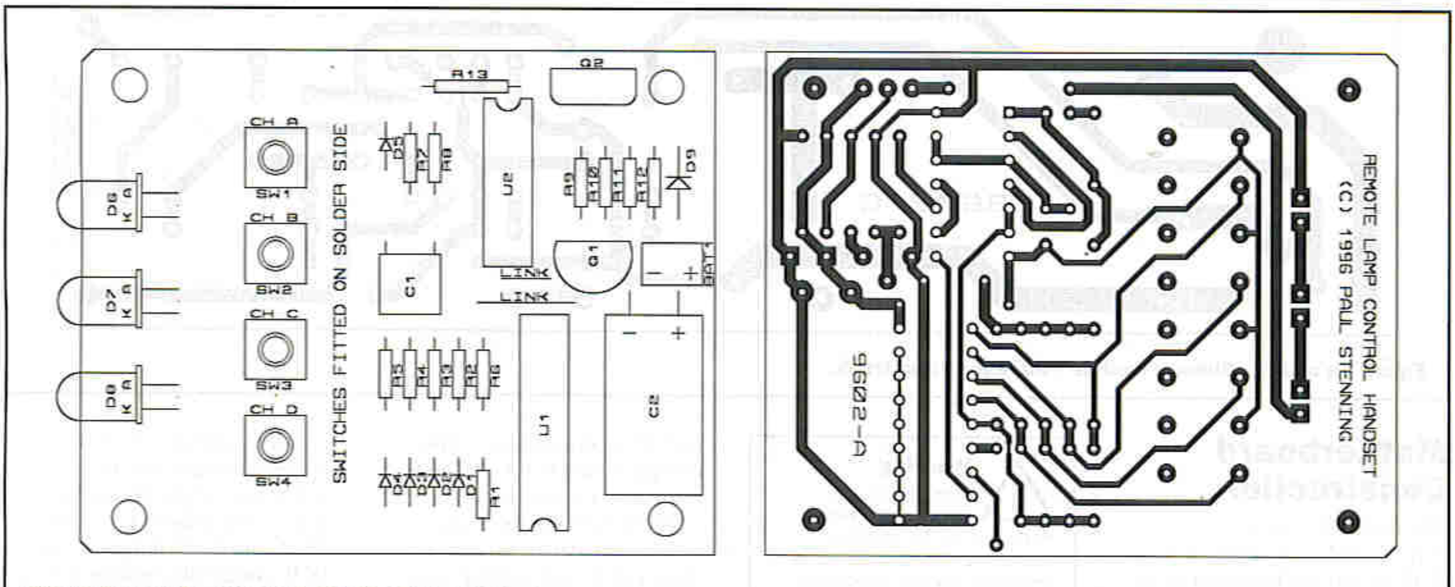


Figure 5a and 5b. Handset PCB legend and track.

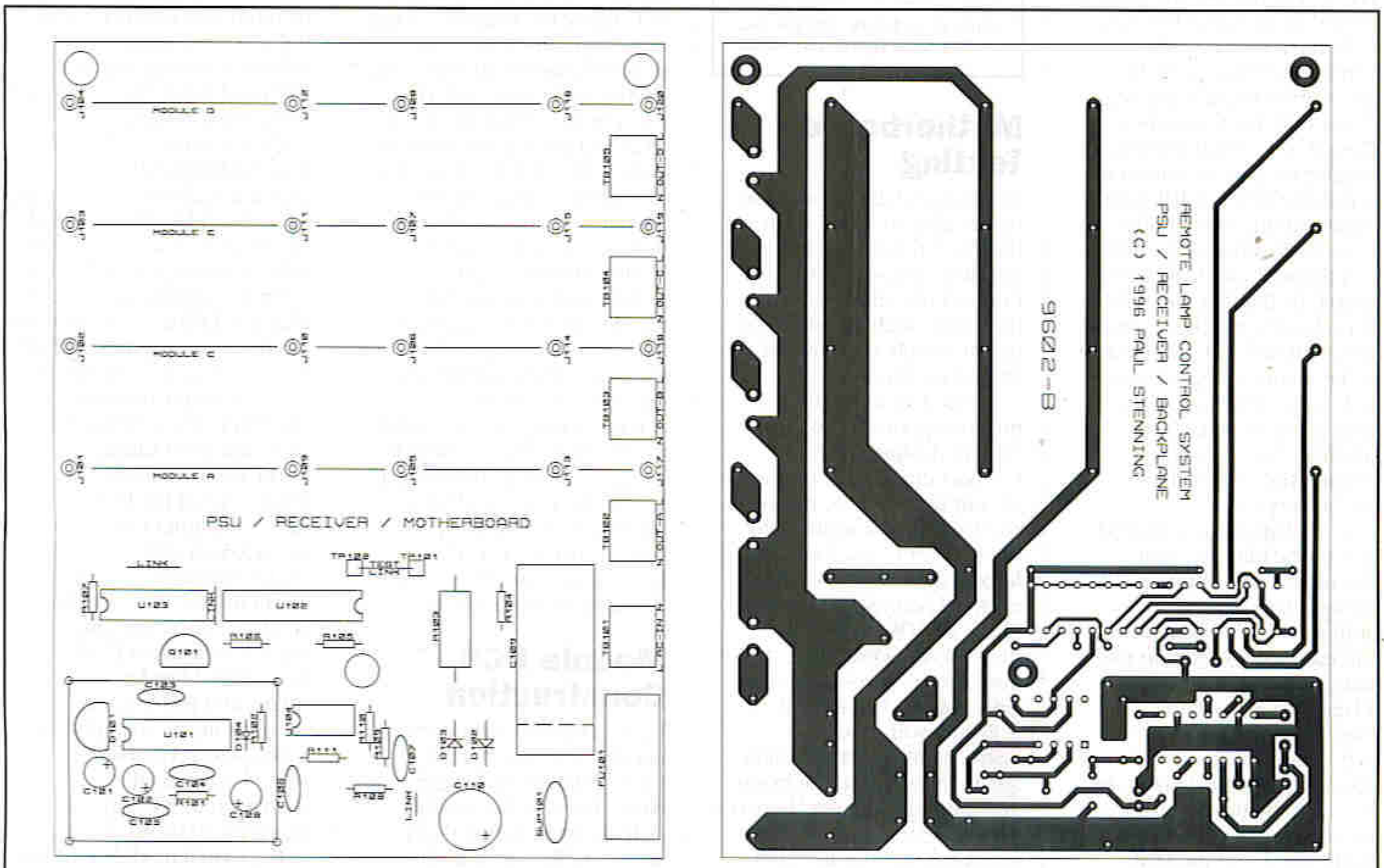


Figure 6a and 6b. Receiver/PSU/motherboard PCB legend and track.

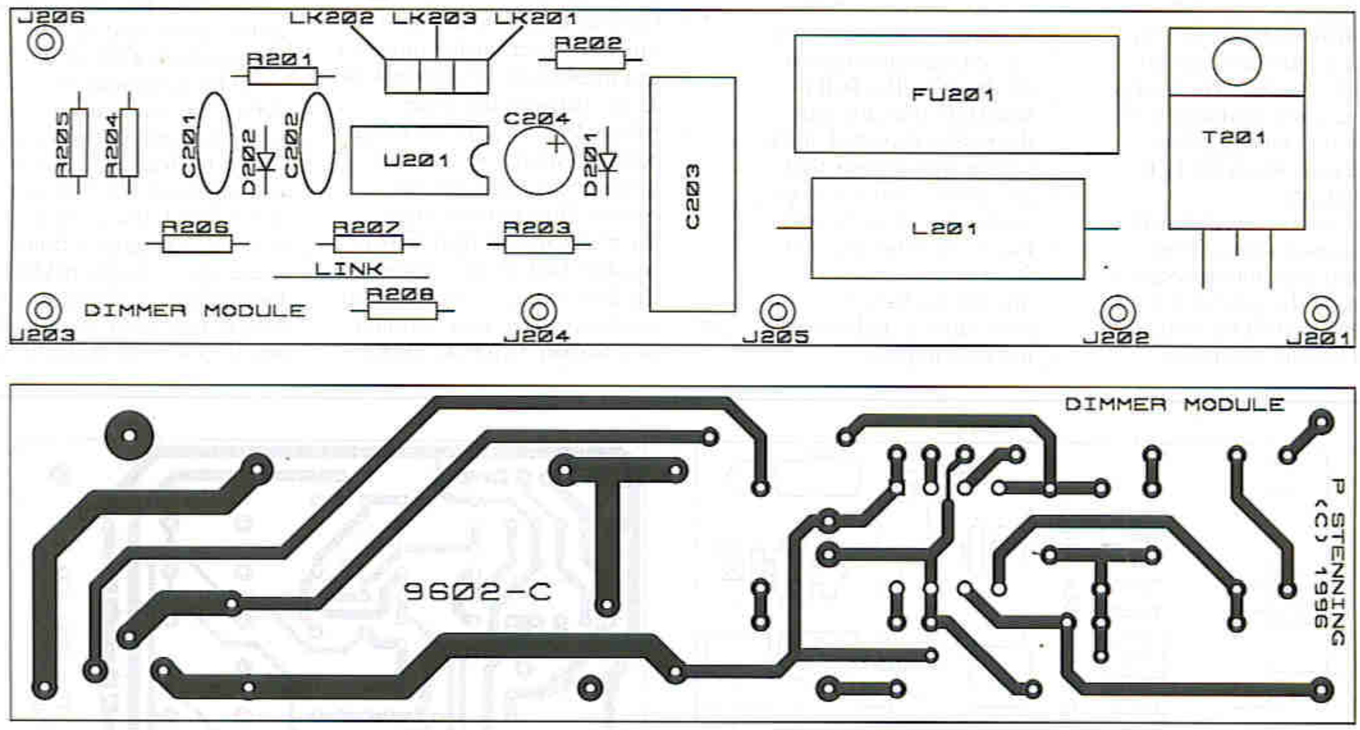


Figure 7a and 7b. Dimmer module PCB legend and track.

Motherboard Construction

The motherboard is constructed on a single-sided PCB, shown in Figures 6a & 6b. Do not fit anything into the module positions (pads J101 to J120), or in the test link position (TP101 to TP102) at this stage.

Fit the terminal blocks (TB101 to TB104) with the wire entries towards the edge of the PCB. C109 must be a Class X or X2 rated component, suitable for direct connection across the mains. D101 is be fitted with the curved side towards the edge of the PCB.

A terminal pin (Veropin) should be fitted in the pads at each corner of the rectangle around IC101 and surrounding components. These are used to hold a screening can made from a 30mm wide strip of tin sheet. Take care when cutting this, as the edges can be very sharp.

A small aperture is needed so that the infra-red light can reach D101. It may be easiest to join the tin sheet at this point. The tin plate can easily be soldered to the terminal pins and itself with a larger soldering iron (above about 30W).

It is advisable to fit a lid to the screening can. Do not do this until the unit has been tested, in case you need to get inside! Clean the PCB with suitable solvent to remove any flux residues.

Warning

During the testing procedure the entire motherboard is live at mains potential. Switch off at the mains before touching the motherboard, test meter or anything else connected to it. Failure to heed this warning may result in a potentially fatal electrical shock. The use of a residual current circuit breaker (the type used for garden power tools) is recommended.

Motherboard Testing

Connect a length of two core mains cable to TB101, with the live (brown) wire to the terminal closest to F101. Connect the other end to the mains, such that it can be readily switched on and off. Do not switch on yet.

Solder a short piece of tinned copper wire to TP101 (one of the test link pads). Connect the positive terminal of your test meter to this wire, and the negative terminal to the screening can. Test leads fitted with crocodile clips are essential here. Set the meter to the 20V DC range. Place the PCB on a clean dry insulated surface – a plastic videocassette box is ideal.

Ensure you cannot inadvertently touch anything, and then switch on the mains. The meter should read between 4·7 and 5·5V. Switch off, and wait a few seconds for C103 to discharge. The meter may continue to read a voltage, or may drop slowly, due to the charge stored in C110. This is not cause for concern.

Fit the test link between TP101 and TP102. Solder short pieces of tinned copper wire into the pads marked J101, J102, J103 and J104. Connect the positive meter terminal to J101 (leave the negative on the screening can). When you switch the mains on, the meter should read below 0·5V. Hold the remote control about 2m away and point it towards the curved face of D101. Push the left button and the meter should read at least 4·5V. Release the button and the reading should drop back to below 0·5V. Repeat this for the other three channels. Remember to switch off at the mains when transferring the meter connections.

If these tests are successful, the motherboard assembly is working correctly. Disconnect it from the mains and remove the pieces of tinned copper wire in J101 to J104. The test link between TP101 and TP102 must remain fitted.

Module PCB Construction

Up to four module boards are needed, and they may be any mix of dimmer and switch types. The dimmer module PCB layout and artwork are shown in Figures 7a & 7b, while the switch module PCB is shown in Figures 8a & 8b.

Construction is mainly straightforward, but the following points should be noted. The triacs (T201 and T301) are laid flat against the PCB (metal tab towards the board), and are held in place with M3 × 6mm panhead screws and nuts. The fuseholders may be fitted with covers if required, but these will make it more difficult to change the fuses. C203 and C302 must be Class X or X2 rated components.

On the switch module, a link must be fitted either between LK302 and LK303 (toggle mode) or between LK301 and LK302 (momentary mode). The module will not operate if no link is fitted.

On the dimmer module, join LK203 to LK202 on the PCB for mode A or join LK203 to LK201 for mode C. If mode B is required, leave LK203 unconnected. The three different modes were discussed earlier.

The five pads along the lower edge of the PCB (J201-J205 on dimmer module and J301-J305 on switch module) are for connection to the motherboard. They should be fitted with single pins separated from a 0·1" SIL right-angled header strip.

J206 and J306 are the connections for the optional touch plates. The PCB pads should be fitted with terminal pins if touch plates are to be used.

The switch module PCB has a number of fine tracks passing close to pads, so extra care should be taken to avoid inadvertent solder bridges. When construction is complete, the boards should be cleaned with a suitable solvent.

Dimmer and Switch Module Testing

Note that each of the four module positions on the motherboard relates to a separate button on the handset. Module A is closest to the IR receiver, and is the left handset button.

The module boards are fitted to the motherboard simply by inserting the five pins through the relevant holes and soldering it in place. The modules will only fit one way round, and should be mounted at 90° to the motherboard.

When a module board is fitted, connect a lamp to the appropriate pair of output terminals. The neutral terminal is the one closest to the mains input terminals. Connect the system to the mains and test the module using the remote control handset.

With the dimmer module, briefly pushing the button should turn the lamp on and off, while holding the button for a longer period will cause the brightness to vary up and down. When the button is released, the lamp should remain at the brightness set.

With the switch module, the results depend on the link setting. In toggle mode, the lamp should alternately turn on and off each time the button is pressed. In momentary mode, the lamp should stay on only while the button is held.

The final test in each case is the touch sensor input. Set your test meter to the 2mA AC range and with the mains off, connect it between J206 or J306 and earth. When you switch on, the meter should read about 0·025mA (25μA). If it reads above 0·030mA (30μA) the cause must be investigated.

To avoid the risk of accidentally touching live terminals, do not be tempted to touch the touch sensor inputs until they have been connected to suitable plates on the outside of an assembled enclosure.

Final Assembly

The prototype was assembled in a plastic case 165 × 67 × 190mm, and was not fitted with touch sensors. This case is not stocked by Maplin, but Stock Code CW25C is similar, except it has metal front and rear panels. If this case is used, the touch sensors (if fitted) would have to be mounted on the top plastic surface.

The outputs were bought to four IEC sockets fitted onto the rear panel. The live and neutral to these sockets are connected to the terminals on the motherboard, and the earths are connected directly to the incoming earth. The wiring diagram is shown in Figure 9. Any exposed metal parts (apart from the touch sensors) must be securely connected to earth.

The mains input cable and the connections to the sockets must be made with 6A (0·75mm²) wire. The unit should be fitted with a 13A plug, fitted with a fuse not exceeding 5A. If the unit is being used to control small loads such as table lamps, the plug fuse should be reduced to a more suitable value, such as 3A.

The PCB is mounted in the case using insulated stand-offs. For safety reasons, do not use metal spacers to mount the PCB. A suitable cutout should be made in the front panel to allow the infra-red light to reach the sensor. This opening must be covered with a piece of red filter material (e.g. FR34M), glued securely to the inside of the case. Remember that the screening can is at mains live potential.

If touch sensors are used, they should be mounted on the case so that the mounting screw penetrating into the case does not come close to the PCB assembly or any live terminals. Solder tags should be positioned under the mounting screws, and connected to the PCB with insulated flexible wire. Ensure the soldered joints are secure, as a hazardous situation could occur if a wire should come adrift and make contact with a live terminal.

Another option might be to use push switches in place of the touch sensors (this would allow a metal case or panel to be used). These switches must be rated for use at mains voltages, even though the current is

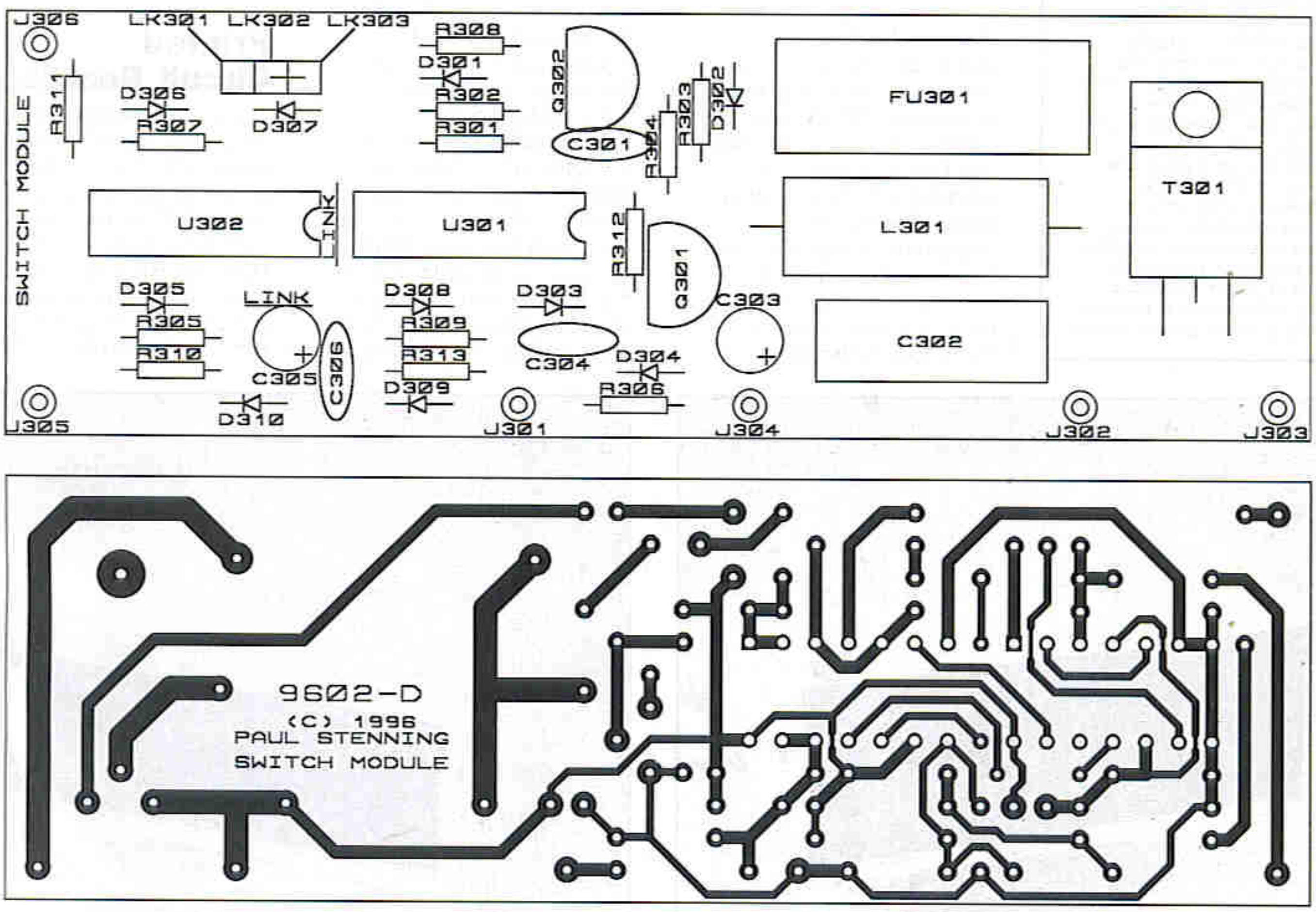


Figure 8a and 8b. Switch module PCB legend and track.

minimal. One side of the switch is connected to the touch sensor terminal, and the other side is connected to neutral.

Installation and Use

The loads to be controlled should be fitted with IEC plugs, and connected to the appropriate sockets on the back of the unit. If any cables need to be extended, use proper enclosed connectors – not 'choc-block' or insulation tape!

The unit should be positioned so that the remote control can be pointed towards it from the usual sitting position. If touch sensors have been used, the unit will need to be accessible.

Remember that this unit does not provide isolation from the mains. Even when a channel is switched off, there may be sufficient current passing through the filter capacitors to give an electrical shock. Always disconnect the unit from the mains before altering the connections or replacing light bulbs.

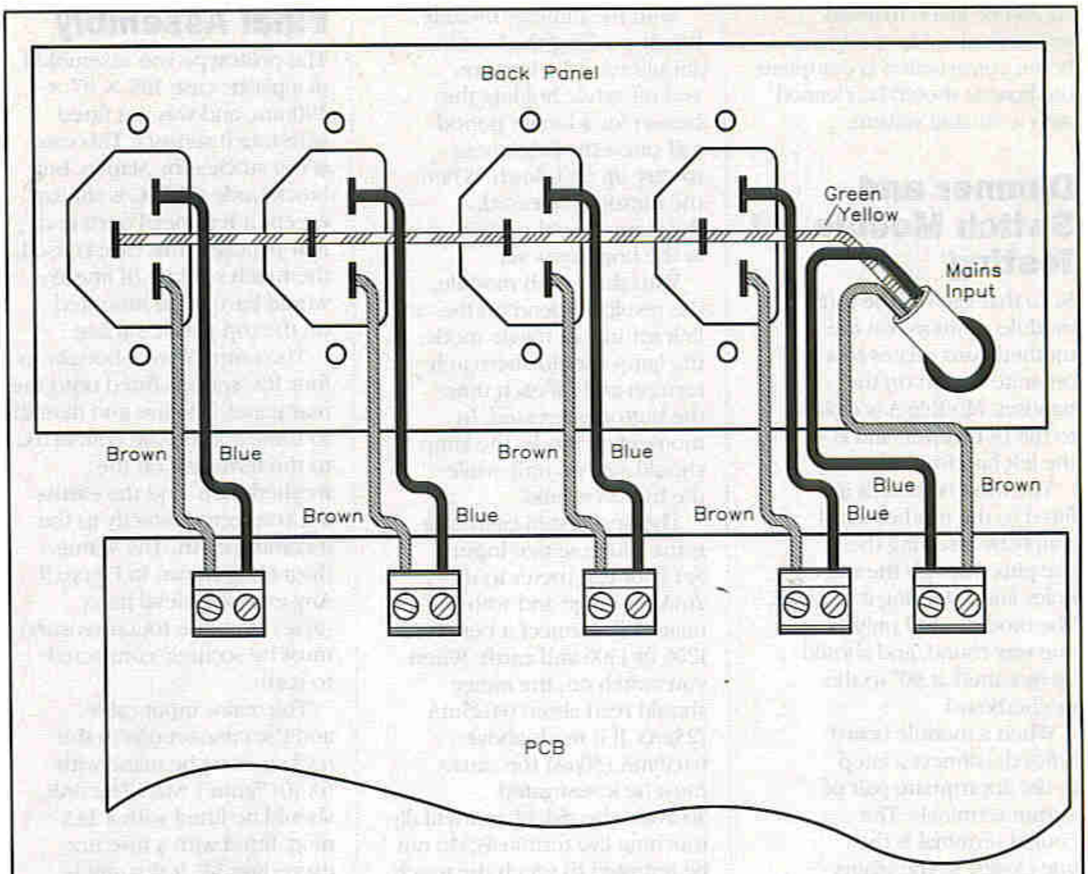


Figure 9. Wiring diagram.

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 engineer.

Alternative Arrangements

Some constructors may wish to incorporate the unit into the household wiring. Before carrying out such an installation, it is essential to determine whether this will contravene the relevant wiring regulations and any local planning and fire regulations. Remember that such contravention may affect your home insurance and any building warranties. Advice on such matters is beyond the scope of this article.

The wiring arrangements would be similar to that shown in Figure 7, although there would obviously be no IEC sockets. It will probably be necessary to provide a separate mains isolator for the unit, for safety when replacing light bulbs.

The neutral connection to the lights will probably take a different route in the household wiring, in which case, only the live connection to the lights should be connected to the unit. It is still necessary to bring a single neutral connection to the unit to power the electronics.

The unit itself does not require an earth connection, but any exposed metal parts (apart from the touch sensors) must be properly earthed.

Printed Circuit Boards

The four PCBs required for this project are available from the author. For ordering information and prices, please write, enclosing an SAE (UK) or IRC (overseas), to: Paul Stenning, 1 Chisel Close, Hereford, HR4 9XF, England.

All other components are available from Maplin, see the Parts List for details.

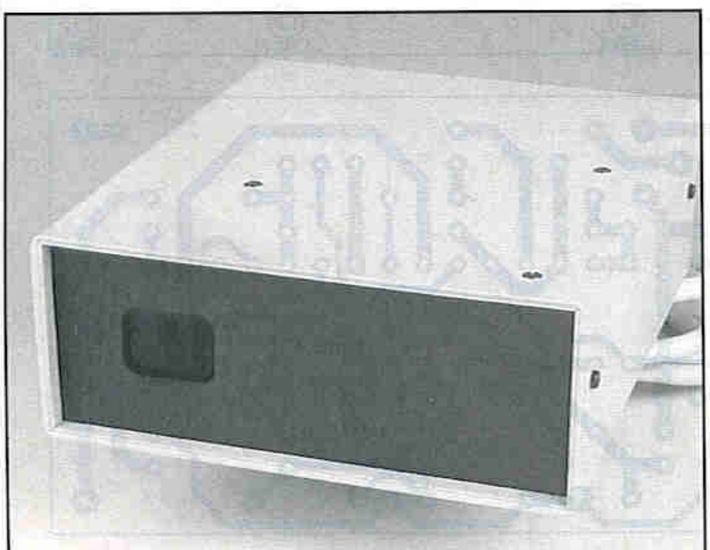


Photo 4. Frontal view of completed receiver unit.

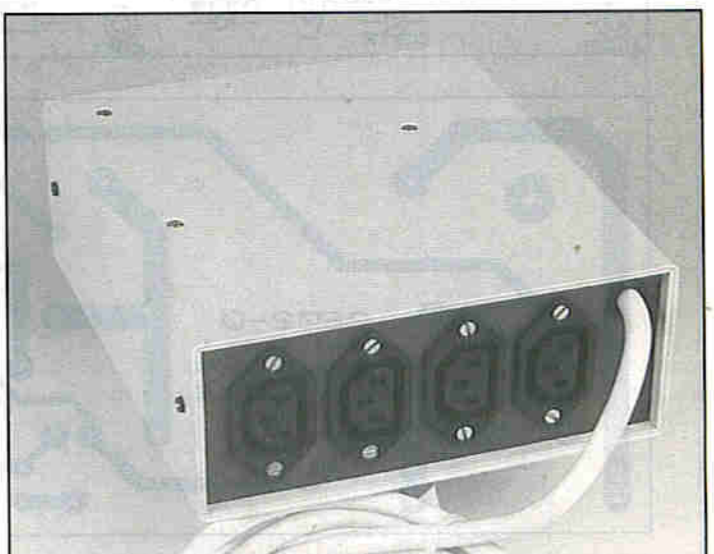


Photo 5. Rear view of the completed receiver unit.

PROJECT PARTS LIST

Remote Control Handset

RESISTORS (All 0·6W 1% Metal Film)

R1	1M0	1	(M1M0)
R2-6	100k	5	(M100K)
R7	10k	1	(10K)
R8	47k	1	(M47K)
R9	4k7	1	(M4K7)
R10	1k0	1	(M1K0)
R11	470Ω	1	(M470R)
R12	100Ω	1	(M100R)
R13	1Ω0	1	(M1R0)

CAPACITORS

C1	4n7F Ceramic	1	(WX76H)
C2	1,000μF 16V Radial Electrolytic	1	(AT44X)

SEMICONDUCTORS

IC1	HT12E	1	(AE17T)
IC2	4093	1	(QW53H)
TR1	BC558	1	(QB73Q)
TR2	ZTX651	1	(UH47B)
D1-5	1N4148	5	(QL80B)
D6-8	IR LED	3	(YH70M)
D9	1N4001	1	(QL73Q)

MISCELLANEOUS

SW1-4	Miniature Keypad Switch	4	(DC70M)
BAT1	PP3 Alkaline Battery	1	(FK67X)
	PP3 Battery Clip	1	(HF28F)
	Case	1	(CW26D)
	PCB (9602-A)	1	

Motherboard

RESISTORS

R101	100Ω	1	(M100R)
R102	390k	1	(M390K)
R103	100Ω 2W	1	(D100R)
R104	470k	1	(M470K)
R105,107	47k	2	(M47K)
R106	100k	1	(M100K)
R108	180k	1	(M180K)
R109	220k	1	(M220K)
R110	10M	1	(M10M)
R111	1M0	1	(M1M0)

CAPACITORS

C101	22μF 16V Radial Electrolytic	1	(AT37S)
C102	2μ2F 63V Radial Electrolytic	1	(AT75S)
C103,104, 106	470pF Ceramic	3	(WX64U)
C105	100nF Polyester	1	(CX21X)
C107	10nF Polyester	1	(CX18U)
C108	10μF 63V Radial Electrolytic	1	(AT77J)
C109	470nF 275V AC Class X2	1	(JR36P)
C110	470μF 10V Radial Electrolytic	1	(AT33L)

SEMICONDUCTORS

IC101	TBA2800	1	(JU36P)
IC102	HT12D	1	(AE18U)
IC103	4001	1	(QX01B)
IC104	CA3160 or CA3140	1	(QH29G)
TR101	BC548	1	(QB73Q)
D101	IR Photodiode	1	(YH71N)
D102	BZX61C5V6 Zener	1	(QF47B)
D103	1N4007	1	(QL79L)
D104	1N4148	1	(QL80B)

MISCELLANEOUS

F101	T6·3A 20mm Fuse	1	(DA03D)
TB101-105	2-way 5mm PCB-mounting Terminal Block	1	(JY92A)
SUP101	Transient Suppressor 250L	1	(HW13P)
	20mm PCB-mounting Fuseholder	1	(DA61R)
	PCB (9602-B)	1	

Dimmer Module

RESISTORS (All 0·6W 1% Metal Film)

R201,207	100k	2	(M100K)
R202	1M5	1	(M1M5)
R203,208	220Ω	2	(M220R)
R204,205,206	4M7	3	(M4M7)

CAPACITORS

C201	100nF Polyester	1	(CX21X)
C202	6n8F Ceramic	1	(RA43W)
C203	100nF 275V AC Class X2	1	(JR34M)
C204	100μF 10V Radial Electrolytic	1	(AT30H)

SEMICONDUCTORS

IC201	SLB0586A	1	(UL43W)
D201,202	1N4148	2	(QL80B)

MISCELLANEOUS

F201	T2A 20mm Fuse	1	(CZ99H)
L201	3A Choke	1	(HW06G)
T201	BT137-600 or T410-600T Triac	1	(AH66W)
	20mm PCB Fuse Holder	1	(DA61R)
	PCB (9602-C)	1	

Switch Module

RESISTORS (All 0·6W 1% Metal Film)

R301,308	47k	2	(M47K)
R302	1k0	1	(M1K0)
R303	10k	1	(M10K)
R304	330Ω	1	(M330R)
R305,307	100k	2	(M100K)
R306,313	1M0	2	(M1M0)
R309-311	4M7	2	(M4M7)
R312	4k7	1	(M4K7)

CAPACITORS

C301,306	100nF Polyester	2	(CX21X)
C302	100nF 275V AC Class X2	1	(JR34M)
C303	100μF 10V Radial Electrolytic	1	(AT30H)
C304	220pF Ceramic	1	(WX60Q)
C305	4μ7F 63V Radial Electrolytic	1	(AT76H)

SEMICONDUCTORS

IC301	4093	1	(QW53H)
IC302	4013	1	(QX07H)
TR301	BC548	1	(QB73Q)
TR302	BC558	1	(QQ17T)
D301-310	1N4148	10	(QL80B)

MISCELLANEOUS

F301	T3·15A 20mm Fuse	1	(DA01B)
L301	3A Choke	1	(HW06G)
T301	BT137-600 or T410-600T Triac	1	(AH66W)
	20mm PCB Fuse Holder	1	(DA61R)
	PCB (9602-D)	1	

General Parts

MICELLANEOUS

Case	1	(CW25C)
Red Display Filter	1	(FR34M)
Touch Sensor Pad	4	(HY01B)
IEC Panel Mount Socket	4	(FT63T)
IEC Free Plug	4	(FT64U)
Tin Sheet	1	(HZ95D)
6A 3-core Mains Flex	2m	(XR04E)
13A Plug	1	(RW67X)
5A 25·4mm Fuse	1	(DK19V)
Cable Clamp	1	(JH23A)
1mm Single-ended PCB Pin	1 Pkt	(FL24B)
SIL Right-angled Header Strip	1	(JW60Q)
M3 × 10mm Countersunk Screw	1 Pkt	(LR57M)
M3 × 6mm Panhead Screw	1 Pkt	(JY21X)
M3 Nuts	2 Pkts	(JD61R)
Tag M3	1 Pkt	(LR64U)
10mm Insulated Spacer	1 Pkt	(FS36P)
Wire 24/0·2mm Brown (10m)	1	(BA37S)
Wire 24/0·2mm Blue (10m)	1	(BA36P)
Tinned Copper Wire 24swg	1	(BL15R)

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

FLAT SCREEN DEVELOPMENTS

by Reg Miles

From the very earliest days of television, inventors have dreamed of producing a flat screen that could be mounted on the wall. Unfortunately, the only place where the fabled wall screen has appeared is in science fiction films. In the real world, announcements have proved to be premature and the box continues to rule, with the only wall screens of a practical size being those used for video projection. But now, wall screens are expected in two or three years, and flat screen TVs are already becoming available to those who can afford them.

Wide and Flat

The thing that has most galvanised the latest research and development work on flat screens is 16:9 widescreen TV. The Cathode Ray Tubes (CRTs) used in the present day widescreen sets are large and heavy. Up to now, this has not been a cause for concern because it has been a niche market, particularly in Britain, where suitable programming has been confined to a limited number of letterbox films on laser disc and videotape, together with terrestrial, cable and satellite channels, and even fewer PALplus programmes broadcast by Channel 4.

However, the imminent launch of digital TV and the Digital Video Disc is set to change that; widescreen programmes can be shown as easily as the normal 4:3 aspect ratio ones, so there is suddenly the potential for a mass market. The greater quality of digital video, together with the potential for high definition makes larger screens desirable – 40-50in. is being suggested for domestic use.

Multimedia probably does not require such an increase in size, due to the relatively close viewing distances, but it would obviously be an advantage to have monitors that are flat, lightweight and less power hungry, with no susceptibility to external magnetic fields, and a distortion-free fixed geometry. Actually, if computers are going to converge with television as many people predict, then 40-50in. screens may become universal. Nevertheless, the price that has to be paid for flatness is a considerable increase in complexity by comparison with the relatively simple CRT.

Liquid Crystal Displays (LCDs)

The one flat screen technology that is familiar to us all is the Liquid Crystal Display (LCD). Liquid crystals are mostly organic compounds, with the optical properties of crystals and the fluid properties of a liquid. They are slightly viscous, appear almost transparent, and have long rod-like molecules which naturally arrange themselves with their long axes in parallel. When a voltage is applied, the orderly arrangement of the molecules is disrupted and the passage of plane polarised light is affected.

In a twisted nematic (TN) display (see Figure 1a), the liquid crystal is sandwiched between two transparent grooved plates with the grooves at 90° to each other, which forces the molecules to twist into a helix between them as they attempt to align with the grooves. Light that has passed through a polarising filter is directed by the molecules through a second polarising filter, perpendicular to the first. Applying a voltage (see Figure 1b) causes the molecules to line up and provide a straight path for the light, which is then blocked by the lower polarising filter. This turns the screen from white to black (or vice-versa if the polarising filters are arranged with their axes in parallel rather than crossed).

Of course, in practical devices, the screen is a dot matrix, with each individual dot formed at the site where the transparent electrodes cross and controlling the light in the aforementioned manner (Figure 2 shows the structure of a basic passive matrix drive system). To achieve a colour display, each individual dot, or pixel, is covered with a red, green or blue filter to form a pixel triplet. The RGB filters are generally arranged in a delta pattern for displaying video and in vertical stripes for displaying graphics.

In the now more commonly used active matrix drive system shown in Figure 3, thin film transistors (TFTs) are attached to each pixel to individually control their switching. The switching signals are applied to the X electrodes and video signals to the Y electrodes, both of which share the substrate with the TFTs. The varying voltage of the video signal determines the degree to which the liquid crystal molecules twist and thus, the quantity of light that is transmitted by each pixel, producing the differences in brightness necessary to achieve an adequate grey scale and range of colours (this is possible because polarising filters are not perfect in their operation; they let through more than just a single plane of light, with the amount diminishing as the plane moves away from the axis of polarisation).

Many companies are working on LCDs, but the one that has made the greatest progress towards large screens is Sharp. Last year, the company demonstrated a prototype 21in. screen, and then used two of those fitted together to fabricate a 28in. screen. The junction between the panels matches the refractive index of the glass and the pixel pitch at the junction is maintained at 0·88mm, thanks to high precision glass

Photo 1. Sharp's 28in. Liquid Crystal Display (LCD).

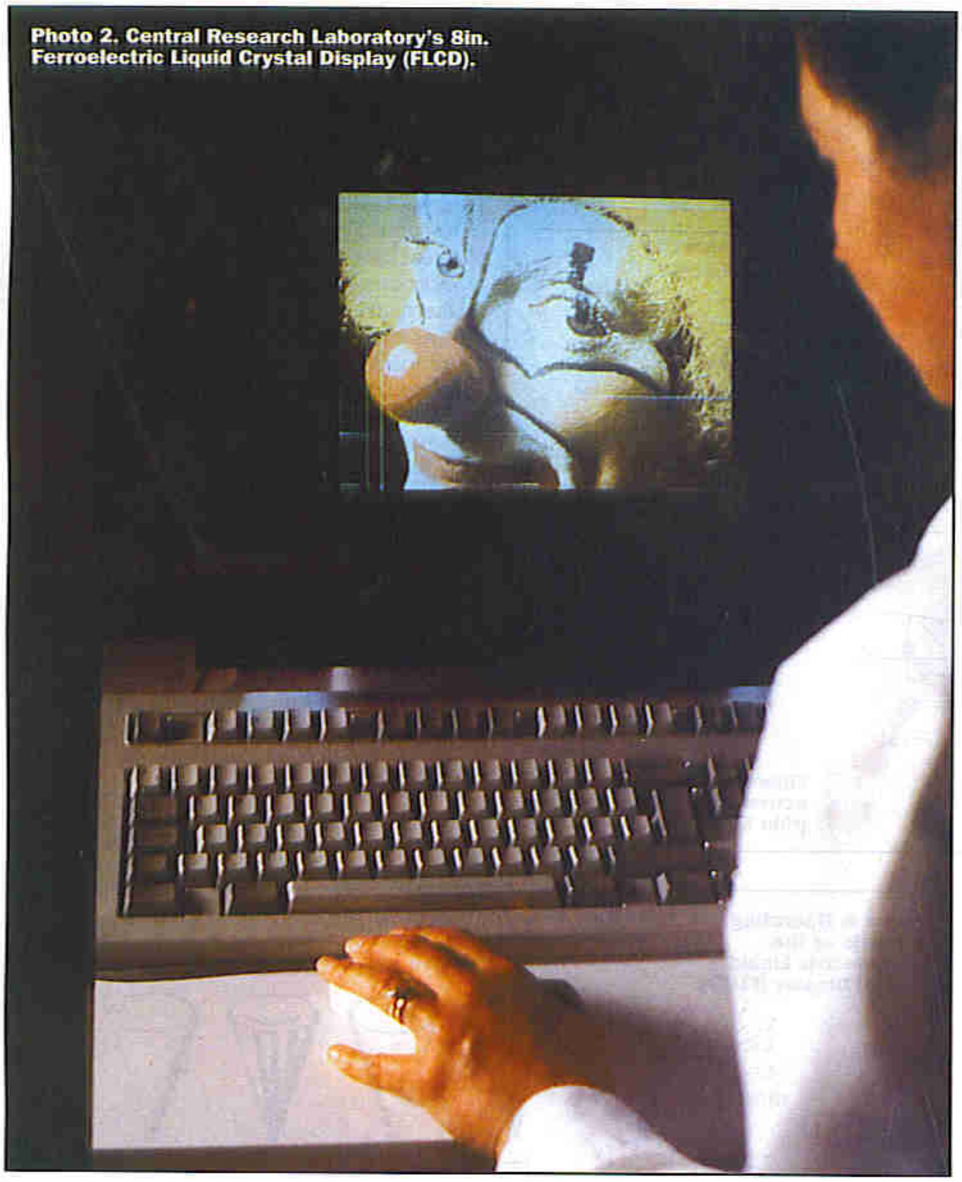


Photo 2. Central Research Laboratory's 8in. Ferroelectric Liquid Crystal Display (FLCD).

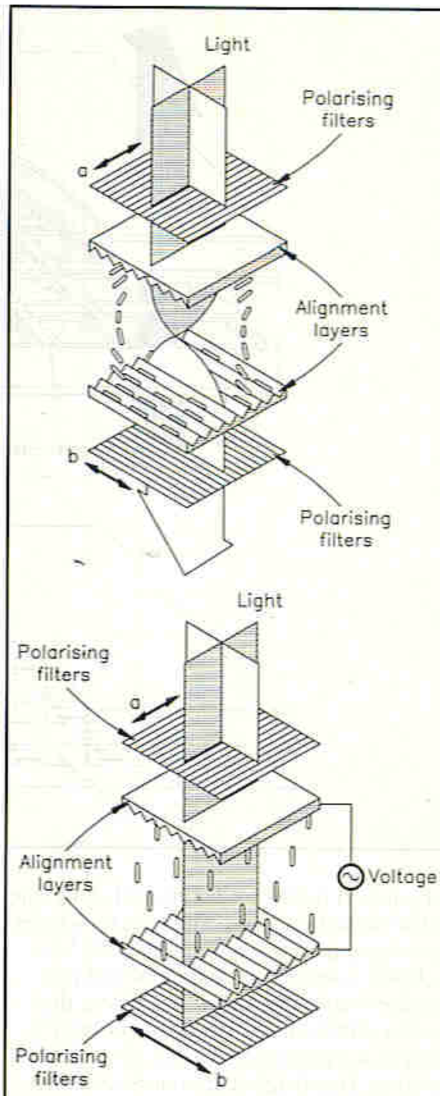


Figure 1. Twisted nematic (TN) Liquid Crystal Display (LCD).

cutting and new very thin film seals of just 0·15mm width. However, the complexity of construction with TFT screens means that large sizes are difficult to manufacture and will, therefore, be costly. Other disadvantages of LCD screens – brightness, contrast, response times and viewing angle – have been addressed with rather more success recently. The best examples are now on the verge of displaying video with sufficient quality to make the technology a serious contender in the coming flat screen market.

As a variation on LCD screens, Sanyo has produced experimental 3D versions which do not require special glasses. These use a very fine lattice on the screen, which Sanyo has called an 'Image Splitter', to direct the left and right images to the appropriate eyes. However, the 3D effect is only apparent over a very limited viewing angle and distance, therefore restricting the system to applications with one viewer, such as multimedia and games, as well as medical, educational and commercial uses.

Ferroelectric LCDs

There is also a variation on the basic LCD technology, in the form of Ferroelectric LCD (FLCD). In this case, the liquid crystal molecules have a permanent dipole with two stable undriven states, and the crossed

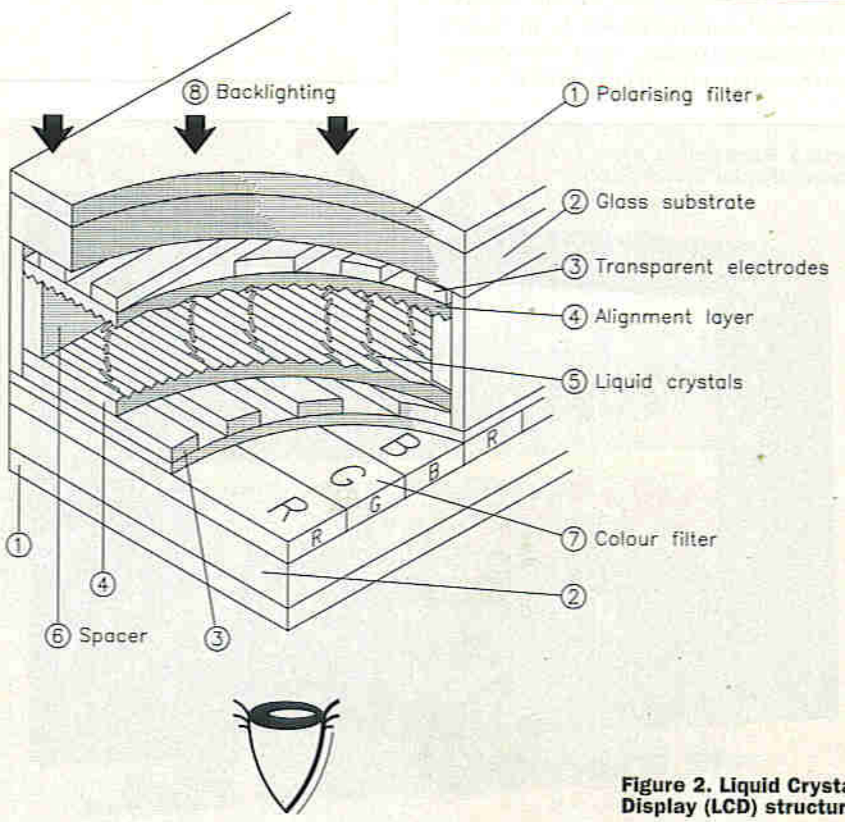


Figure 2. Liquid Crystal Display (LCD) structure.

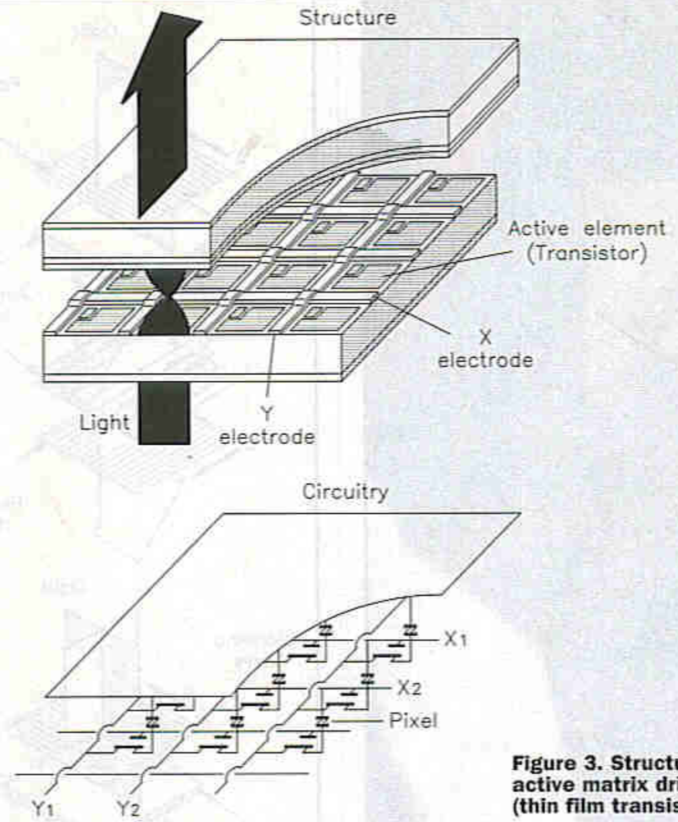


Figure 3. Structure of active matrix drive system (thin film transistors – TFT).

FLCD also has a faster response rate and a wider viewing angle. Additionally, it requires only a passive matrix drive, which as Figure 5 illustrates, uses only X and Y electrodes laid on the lower and upper substrates to switch the appropriate pixels, obviating the need for a transistor to control each one. This should make large FLCD screens much more cost-competitive with the alternative flat screen technologies.

As with basic LCD, a number of companies are working on the technology and a limited range of medium size screens have been available for several years. Incidentally, one of the companies is Central Research Laboratories (formerly known as EMI Laboratories), who were responsible for developing the BBC 405-line black & white TV system 60 years ago, in conjunction with Marconi.

The Cathode Ray Tube Lives On

Despite being in service all those years, there is still development life left in the old CRT, and there have been a number of attempts to reinvent it as a flat screen. One of those attempts was Panasonic's

(or parallel) polarisers are aligned along one of the stable directions. The long molecules are in smectic phase and tilted in the layer. As Figure 4 shows, a voltage pulse of one polarity rotates the molecules, where they remain until a pulse of opposite polarity is applied and they rotate back to their original position. The image is, therefore, retained with the power off. Quite an advantage when used on a portable computer, with battery power only being required to change the data (although the backlight will continue to consume power). The non-volatile memory also allows the number of scanning lines to be increased without sacrificing contrast, which is intrinsically higher than conventional LCD anyway.

Figure 4. Operating principle of the Ferroelectric Liquid Crystal Display (FLCD).

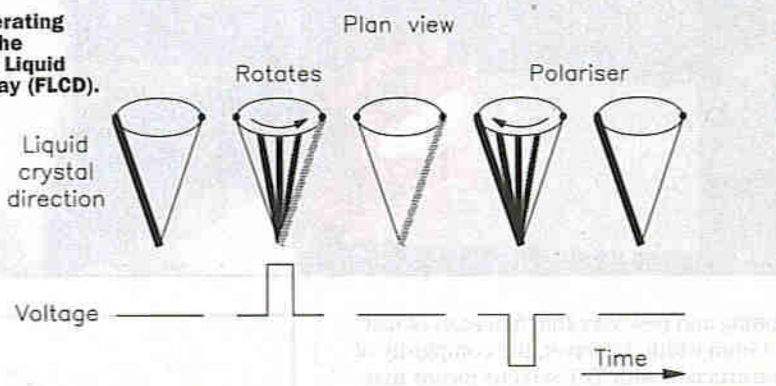
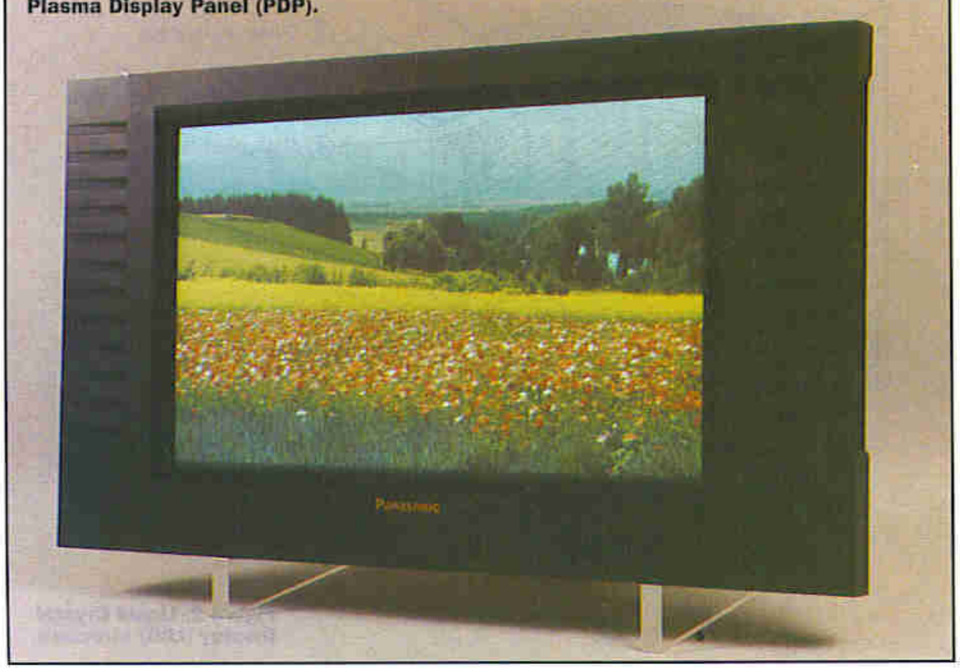


Photo 3. Panasonic's 26in. Plasma Display Panel (PDP).



Flat Vision (or beam matrix display). The difference between it and the conventional CRT was that instead of using one electron gun assembly to scan the whole screen, Flat Vision had a matrix of ten thousand guns, each scanning a small portion of the screen. Each gun used a flat cathode, with the beam deflected electrostatically over a narrow angle (eliminating the convergence, focus and geometric errors that dog conventional electromagnetic deflection), with pulse width modulation used to vary the brightness of the sequentially scanned red, green and blue pixels. Digital signal processing ensured that the individual sections appeared as a seamless whole. A 14in. 4:3 model was launched in Japan in 1994, which was about one-quarter the depth of conventional models and about five times the price. However, although larger prototypes were constructed, difficulties were apparently encountered and Panasonic has since decided to follow the plasma route to large screens (to which I'll return).

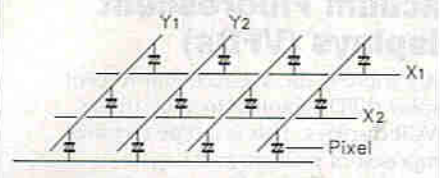


Figure 5. Circuitry of passive matrix drive system.

Field Emitter Displays (FEDs)

The idea of reinventing the CRT has not gone away, and the concept of multiple electron emitters is being taken a stage further by a number of companies as well as the Department of Materials at Oxford University, who are working on Field Emitter Displays (FED). With this, each individual pixel has its own source of electrons in the form of an array of emitters (up to 1,600 in some designs), consisting of wells with conical microtips (see Figure 6). The voltage difference produces a strong electric field that extracts electrons from the microtips which are projected onto the phosphor screen. Control is provided by a simple matrix addressing scheme that is similar to the passive matrix drive used for FLCD. Because of the proximity of emitters to phosphor, the FED needs only to be evacuated to low pressures rather than the high vacuum of a CRT. This allows a thinner and lighter faceplate to be used, with bending in large displays being prevented by spacers, although only smallish monochrome and colour displays have been demonstrated.

Alternative Display Technologies

Presumably, the FED concept pushes the original CRT technology as far as it can go whilst retaining the basic principle of phosphors and electron emitters? Whether it will be the one that takes the place of the box remains to be seen; the only certainty is that it will face stiff competition for that honour – quite possibly from the Plasma Display Panel (PDP), which has popular support at present.

The Japanese have even formed a PDP Consortium consisting of the Japanese broadcaster NHK and 25 other companies, and other major companies around the world are also working on it. Plasma technology has been around for some years, in laptop computers and outdoor signs, but it is only now that it has become suitable for quality, full colour displays. Figure 7 shows the PDP construction, which consists of two sheets of glass with electrodes on their inner surfaces, forming a matrix with the intersection of each electrode corresponding to a pixel, and ribs to achieve pixel separation. An inert, charged gas is sealed in the cavity. When this is discharged by a current across the electrodes, it produces ultra-violet light which is directed onto phosphors coated on the front glass (the same principle as a fluorescent lamp).

Control of the current for each individual cell is provided by an ultra high-speed pulse drive, which is capable of starting and stopping the discharge within one-millionth of a second to achieve a proper grey scale and full range of colours. Already, some 20-26in. 16:9 models have been launched in Japan, at prices about five to six times that of conventional high quality TVs, and 40in. models are expected over the next twelve months.

Photo 4. Sony's 30in. Plasma Addressed Liquid Crystal (PALC) display.

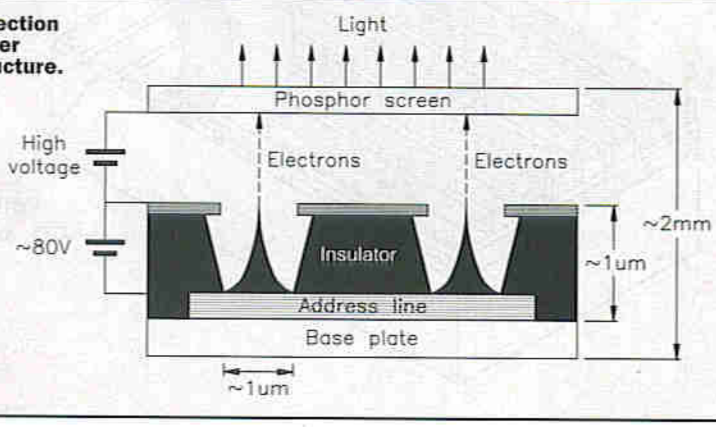


Figure 6. Cross-section of the Field Emitter Display (FED) structure.

Plasma Addressed LCDs

Sony and Tektronix have taken a different approach to plasma, by combining it with LCD to produce the Plasma Addressed Liquid Crystal (PALC) display – invented by Tektronix. Unlike PDP, this does not use the plasma discharge to excite phosphors, but the equivalent of transistors to control the switching of LCD pixels. The plasma section is between the rear polarising filter and the LC layer, and acts as a conducting channel across the screen to enable the video signal to be input as complete lines to the pixels, through transparent column electrodes in front of the LC layer. It does not, however, provide the illumination; this comes from a normal backlight. The result combines high brightness and contrast with high resolution. The use of plasma in place of transistors reduces the cost of production by comparison with conventional LCD screens. Sony has already shown 30in. 16:9 prototypes, and production models are expected to be launched in Japan sometime in the next twelve months.

Light Emitting Polymer (LEP) Displays

There are also other technologies that do not rely on backlighting or the excitation of phosphors to achieve a display. One such is the Light Emitting Polymer (LEP) display, employing conjugated polymers. This is the brainchild of Cambridge Display Technology, and it combines the light emission characteristics of the Light Emitting Diode (LED) with the easy customisation of the LCD. Figure 8 shows the basic structure

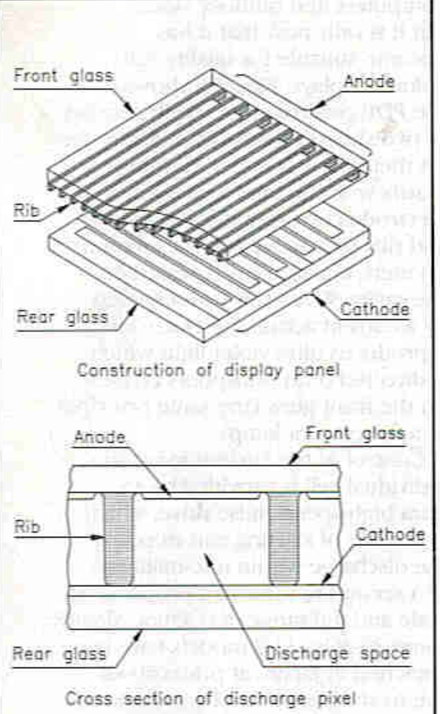


Figure 7. Plasma Display Panel (PDP) structure.

for a simple dot-matrix display. Because the LEP material is non-conducting laterally, the two polymer layers forming the p-n junction equivalent are simply coated on and the pixels are formed where the Aluminium and transparent Indium Tin Oxide electrodes cross (the latter coated onto the glass or plastic substrate). Each pixel is individually addressable using inexpensive passive matrix driving techniques, and the brightness is varied by the current. The range of pixel sizes achieved so far range from 5μm to 50mm, so there is obviously considerable scope for all types of display, and depending on the polymers used, a wide range of colours can be obtained.

However, CDT has only shown demonstration models of simple, monochrome display devices, and the leap from those to computer and TV screens is going to take a lot of work, but that is the long term goal. The response is fast enough for video and the contrast is high. Red, green and blue can be achieved n several ways, such as polymers laid down in stripes like a Trinitron, although large screens will probably require active matrix drivers.

LED Screens

Significant strides are also being made in LED technology. Many people believe this will eventually prove to be the best route to take to flat screens, with good brightness, contrast and response. But, although individual LEDs are cheap, the need for a million-plus will make TV screens expensive. The technology is very similar to LEP, converting a flow of electrons into light when a current is applied, using organic or inorganic materials – or a combination of both – to achieve the effect.

Already, LEDs have been experimentally produced that can be made to change colour by adjusting the voltage, and the aim is to produce one that can combine red, green and blue. This could either be used to cut the cost of displays or to increase their resolution by comparison with discrete RGB pixels (although, presumably, white and grey would still have to be achieved by temporarily returning to the triplet configuration, with single pixels each displaying one of the three colours). Meanwhile, the recent development of an LED that produces white light by emitting red, green and blue light simultaneously creates the alternative possibility of using them as individual backlights behind a mosaic of colour filters. Alternatively, there is always the conventional approach of employing individual red, green and blue LEDs (although blue is expensive to achieve at present).

Electroluminescent (EL) Panels

Yet another contender in the flat screen stakes is the Electroluminescent (EL) panel, which is used for Space Shuttle displays, as well as more mundane applications. It consists of luminescent phosphor layers between transparent dielectric layers and the ubiquitous matrix of row and column electrodes. When an electrical pulse is produced by the drive circuitry across the electrodes, the phosphors emit light. Chemical vapour deposition is used to apply the phosphor layers in thin films on a glass substrate. The panels can provide high resolution, good contrast and brightness, a good response, a wide viewing angle and low power consumption; everything, in fact, except full colour at present.

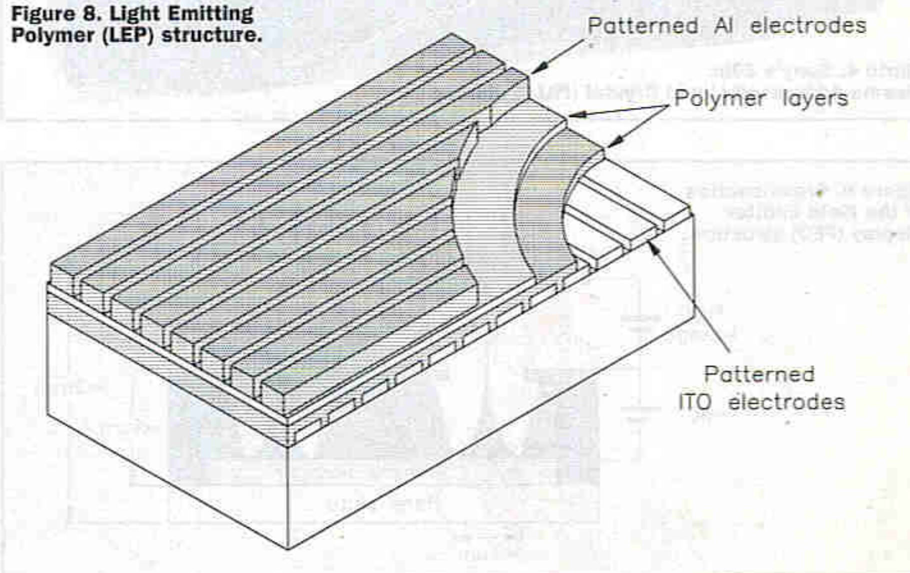
Vacuum Fluorescent Displays (VFDs)

Lastly, there is the Vacuum Fluorescent Display (VFD), familiar in such things as VCR displays. This is a type of valve composed of positive and negative electrodes with a grid between them. Electrons emitted from the negative electrodes are accelerated by the grid and hit the positive electrodes, causing the fluorescent display material in front of them to be illuminated. At present, the technology is limited in its scope: the brightness and contrast are good and the response and cost are okay, and it is suitable for large screens. Where the VFD falls down is in its resolution and its ability to achieve full colour and variable brightness.

Summary

At this stage, it would be fair to say that all the contending technologies have advantages and disadvantages by comparison with each other. Whether this will result in a multiplicity of technologies becoming the norm, or one or two will prove to be more acceptable for various reasons and the others will fall by the wayside or be confined to niche markets, remains to be seen. It would be confusing to consumers and professionals alike, if they were faced with a choice of LCD, LEP, PDP, etc., and also to salespeople trying to explain the differences between them. One difference that would be apparent is colour balance, which is bound to vary between the technologies, given the different methods employed to produce the images. However, this will be academic to the majority of people if all the technologies are priced more-or-less beyond their means. In this case, the CRT will continue to lead the market for some years to come, only relinquishing its position when either the cost of producing flat screens drops sufficiently or a new and particularly cheap technology is developed.

Figure 8. Light Emitting Polymer (LEP) structure.



COMMENT

by Keith Brindley

The BBC has warned that digital television services in the UK will be developed incoherently unless some form of standardisation is agreed upon. John Birt, the BBC's director general, replied to the government's consultation paper on digital television with proposals that the telecommunications watchdog body Oftel should perhaps be the regulatory source of maintain standardisation between the various broadcasters.

Without such standardisation between terrestrial broadcasters such as the BBC and the independent broadcasters, and satellite services such as British Sky Broadcasting's proposed digital television system, and any others which come along, then users will be faced with yet another variety of set-top boxes to decode the digital signals.

On the face of it, this seems a good stance. After all, if terrestrial and satellite services were to start up without standardisation then there is a good chance that they will choose different systems, or at least different variations of systems. That would be only natural, as they each have their own interests at heart.

Doubtless, enterprising decoder manufacturers will be able to combine any number of different methods of encoding into a single set-top decoder box (much as they have already done with the many variations of satellite television encoding systems currently used). But costs would be at a minimum if the broadcasters got their act together at this early stage and agreed on a common system for the whole of the UK. Better still, what about a common system for the whole of Europe?

But the BBC's argument breaks down, of course, in that under no common circumstances is the mixed bag of broadcasters likely to agree a single standard. They have never done it in the past, have they? And without agreement, the only course of action is to impose a standard. Problem is, the only way to impose a standard is to do it governmentally. An unlikely scenario given recent political history.

All this is a pity, because digital television services are planned to be starting sometime next year from satellite by BSkyB, and sometime the year after by the BBC. Putting it metaphorically, this really is the last ditch where standards could be created. Once any broadcaster jumps the ditch, only the consumer gets to pay the cost.

PCTVs

The drive by computer manufacturers to combine the functions of television display inside a computer might be about to take a new turn. You'll have seen the Fujitsu PCTV in the shops, no doubt. It's a personal computer cum television, in one box, intended for the home market. Being a cross between the two functions it was a bit of a problem tax-wise. Trouble is, till a recent ruling, it was not known whether the thing was a computer with television bits inside (which is what Fujitsu say it is), or a television with computer bits inside (which is what HM Customs & Excise say it is).

The difference between the two is critical, because import duty on computers is at a rate of 4.4%. Import duty for televisions is, on the other hand, 14%. By classifying the device as a television therefore, an extra almost 10% can be levied.

At a recent tribunal, Fujitsu argued that the PCTV is a composite machine, so should be classified on its main role as a computer. Customs & Excise won the ruling, however, arguing that the PCTV's main role could not be clearly identified therefore it is within its right to impose the television import duty.

All it means, of course, is that it won't be financially viable for computer manufacturers to produce PCTVs, because a cost margin of 10% will make a PCTV commercially unsuccessful. Nice one, Customs & Excise.

Losing our memory

The price of computer memory is at an all-time low. It's happened dramatically over the last few months too. A year ago you could pick up a 16Mb single in-line memory module (SIMM) for the (then) cheap price of £350. The same SIMM at the time of writing can be located for £69 – less than a fifth of its price twelve months prior. Everyone it should seem is happy. Users are happy. The modern computer with its expanding operating system and gargantuan applications, needs mountains of memory to cope with its everyday life at anything other than the speed approaching that of a drunken snail. Computer manufacturers are happy. When you're selling a computer at a price which must interest users, and your base parts cost too high a percentage of the total then any reduction in part price means only good news. On the face of it, too, the memory manufacturers should be happy. Cheaper product prices mean greater sales, which in turn means greater turnover, which in turn if handled properly should mean greater profits.

Yet, actually, the memory manufacturers are not happy. It appears that there has been a price war between manufacturers which, while not only causing stimulation of the market, has meant that manufacturers have been forced to decrease their profit margins. Profit margins on memory a year ago, for example, were over 60%. Now, they tell us, margins are down to near zero. To counter this the apparent glut of SIMMS will have to be stemmed.

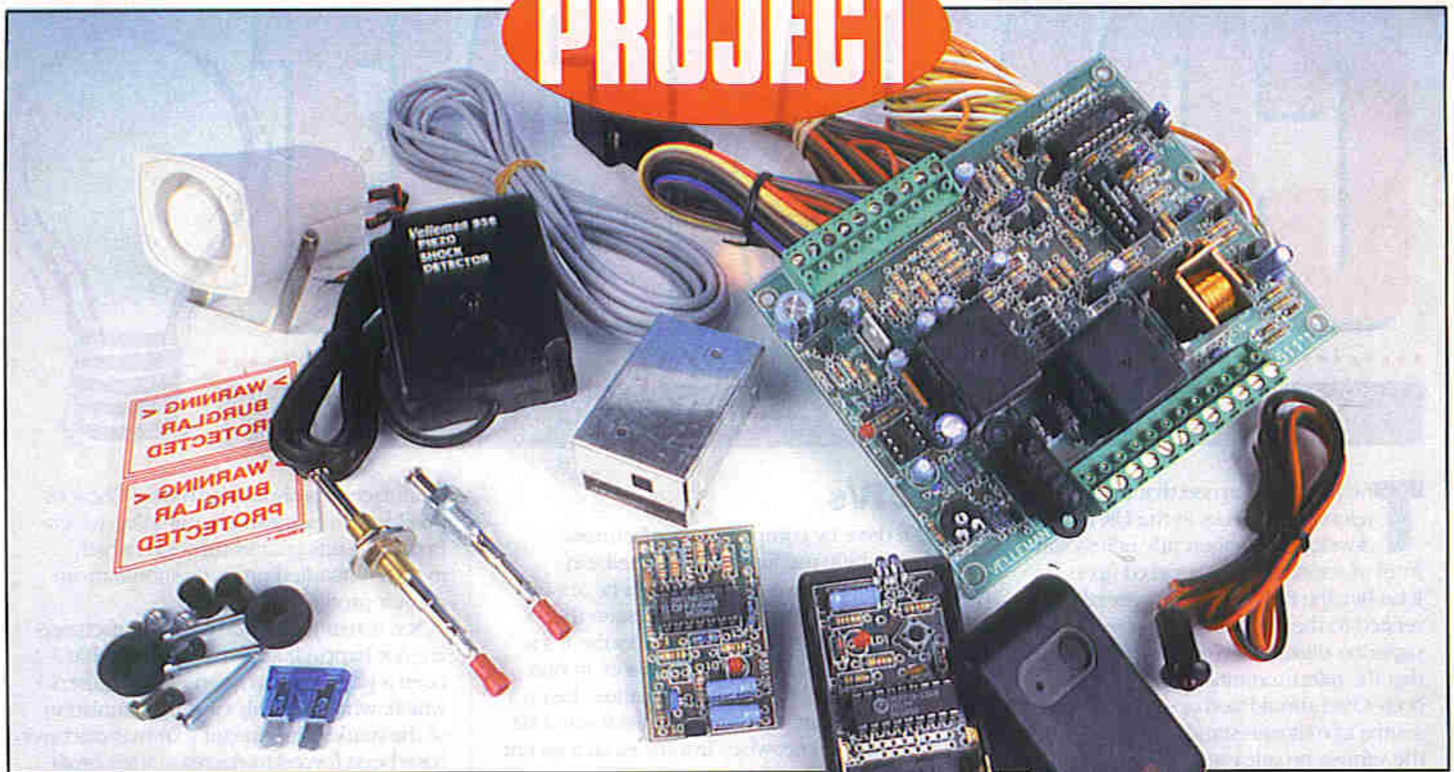
As a result, there is a growing trend in manufacturers to slow production. Companies like Fujitsu, Hitachi, Hyundai, LG Semicon, Mitsubishi, NEC, Samsung, TI-Acer and Toshiba are scaling back manufacturer of memory. Reports of other slowdowns are regular occurrences. This is all with the intent of artificially manipulating the market to put the stop on any further fall in memory prices.

The problem with such a technique is that the cause can drastically underestimate the effect. That, after all, is what happened in the first place. Retailers of memory, it could be argued, created the current problem themselves by forcing prices down to be ever more competitive. Manufacturers had to lower their profit margins to be able to supply at the prices the retailers wanted in order to keep the retailers' customers happy. While the bandwagon was rolling everyone was happy.

But now the bandwagon is grinding to a halt. Once there is anything suggesting a memory shortage, the market will jump to the obvious conclusion and prices will once again rise. Given the nature of the market, prices can be expected to rise beyond what they should too.

All this means then, that if you fancy some more memory in your computer, get it now! It surely can't get any cheaper, and will probably only get rapidly more expensive. This time next year, I'll probably be reporting on the highest memory prices in computing history. I'm joking, of course. At least I hope I am.

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



PROJECT RATING 3

Kit Available
Order as VF76H
Price £101.99

FEATURES

- PIC-microcontroller based main unit
- Multifunction infrared remote control operation
- Door, bonnet and bootlid switches and piezo shock sensor inputs
- Voltage drop detection
- Outputs for hazard lights, central locking and immobiliser
- Dashboard warning LED
- Interior and exterior siren outputs
- Diagnostic function
- Expandable system

APPLICATIONS

Protection of cars and vans (suitable for negative earth electrics only)

Infrared REMOTE CONTROLLED CAR ALARM

Text by Maurice Hunt

Last year, there were 1·4 million car-related crimes in England and Wales, with a car being stolen, on average, every thirty seconds – statistics that are likely to worsen as more vehicles, with increasing average values, take to the streets each year. The unlucky victim of car crime ultimately ends up having to pay heavily for the criminal's actions, even if they were adequately insured – in terms of the time spent trying to retrieve and repair their vehicle (assuming it's ever recovered), and the loss of no-claims bonus making it more costly to insure again. This doesn't take into account the sheer nuisance factor of having to deal with the aftermath of a vehicle break-in or theft, and the upset you would feel if you had any sentimental attachment to the vehicle – after all, most owners have some pride in their car, even if they wouldn't readily admit to it.

It is worthwhile to take every possible precaution to make your vehicle less of a likely target for unwanted attention – a recent government advertising campaign actively promotes motorists to take steps to avoid them becoming yet another statistic of car crime. One of the most obvious and effective solutions is to install a good alarm system, which is why manufacturers are now fitting them as standard to almost every new car. However, many vehicles in use are older models, many of which are poorly equipped as regards security – it is, therefore, sensible to fit an alarm system to protect what may be an extremely valuable item of your property, not just from a monetary point of view.

An alarm and immobiliser system, which prevents the vehicle's engine from being started, such as described in this article, presents a strong deterrent from car crime, particularly from the likes of joyriders or 'casual' thieves. In addition, an alarm with shock detection can alert you to clumsy parkers bumping into your vehicle when it is parked in the street or car park – the damage they cause can be considerable and surprisingly costly to repair, and many don't bother to inform you about the results of their ineptitude. If you hear your alarm sounding, you can investigate and quite possibly catch the culprit before they have time to leave the scene, and greatly increase your chances of recovering your costs if damage has indeed been inflicted. You only need one such incident to occur, and the alarm will probably have paid for itself.

Circuit Description

Refer to Figure 1, showing the block diagram of the alarm system. There are three main parts to the system, these being the infra-red transmitter (a separate battery-powered key-fob unit), the infrared receiver module, and the main control board. The circuit diagrams of these are shown in Figures 2, 3 and 4, respectively.

The transmitter utilises the UM3758 Encoder/Decoder chip (IC1), which includes both the encoder and decoder for a coded transmission (remote control) system. When the code preset on the decoder – another UM3758 mounted on the main board (IC2) – matches the code transmitted from the encoder (transmitter), pin 17 of IC2 goes low for 128ms. If a further match is received within that time, the output stays low for another 128ms, and so on. A total of 8,748 different codes are possible, and are set by means of links bridging the coding islands adjacent to the UM3758 chips on the transmitter and main PCBs.

The coded information is transmitted by the modulated infra-red light emitted from LD2 and LD3, on depression of the transmitter's push switch, SW1. The transmitter is powered by a 12V type 23A lighter battery.

The receiver unit, which is mounted remotely from the main board within the vehicle's glazed area, consists of an infrared photodiode (D1) and amplification and filtering by means of IC1, an LM324N quad op-amp chip. The filtering removes spurious signals caused by ambient light changes, while amplification boosts the received encoded signal, for passing on to the main board decoder (IC2). LED LD1 on the receiver board indicates when a signal of the correct modulation frequency is being detected.

The main control board is based around the pre-programmed PIC16C54RCE microcontroller, IC3. It is programmed to react to the inputs received from the various sensors, and to respond to commands made by means of the key-fob transmitter. All inputs and outputs to/from the microcontroller are buffered by the transistors T1 & T5-14. Further buffering for high current outputs to control the indicators lamp flashing, external siren/pager and immobiliser facilities is provided by relays RY2, RY3 and RY1, respectively.

IC1 on the main board is an LM158/258, RV4558 (or equivalent) dual op-amp, one half of which is used in differential mode to detect a voltage drop that would occur as a result of opening one of the vehicle's doors, thus turning on the interior light and placing a load on the vehicle battery. Preset potentiometer RV1 is used to set the voltage drop level at which the alarm is triggered. LD1 indicates when the voltage drop detector is triggered, i.e., when a door has been opened on the vehicle.

The operation of the voltage drop detector is configurable by means of jumper links JP1 and JP3. JP1 activates or deactivates the voltage drop detector, while JP3 sets whether it is active immediately after switching on the alarm or 5 minutes after switching the alarm on – this is in case the vehicle has an electric cooling fan fitted but the fan sensor input has not been connected for whatever reason.

The other jumper links, JP2 and JP4, are set to inform the microcontroller whether or not a security code module (optional), and electric cooling fan with negative or positive supply switching are connected to the alarm system.

Power to the main board is derived from the vehicle's battery (nominal 12V, wired negative earth), and is regulated by VR1 and VR2 to produce +9V and +5V DC, respectively. Decoupling is provided by capacitors C3-5 (high frequency decoupling) and C11, C12 & C20 (low frequency decoupling). Diode D7 protects against accidental reverse polarity, choke L1 suppresses the unit against spikes appearing on the 12V supply (produced by the vehicle's ignition system and other high power electrical switching), and fuse F1 protects against overcurrent.

PCB Construction

The three PCBs – for transmitter, receiver and main control board – should be built in that order, largely because the passive components are supplied on a bandolier in the order that they will be required if the boards are built up in this order. Also, it makes sense to start with the smaller boards, to 'get into the swing' of PCB assembly, and getting the transmitter completed provides a useful psychological boost to help you build the other two boards!

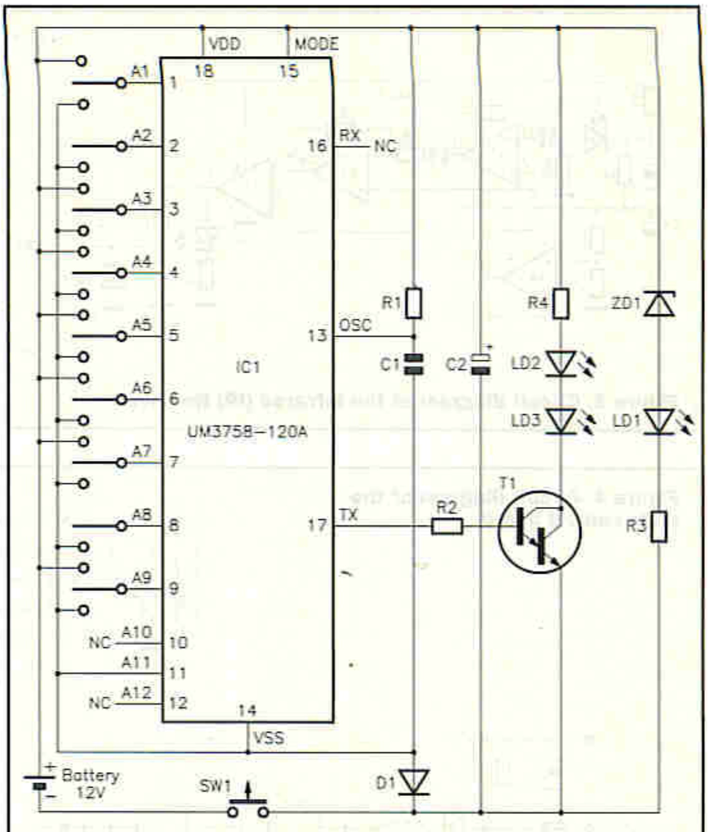


Figure 2. Circuit diagram of the infrared (IR) Transmitter.

SPECIFICATION

Operating voltage:	12V DC nominal, negative earth vehicle wiring 12V lighter battery (type 23A) in transmitter
Transmitter PCB dimensions:	41 × 30mm
Transmitter key-fob dimensions:	36 × 15 × 62mm
Receiver PCB dimensions:	49 × 30mm
Main PCB dimensions:	125 × 102mm

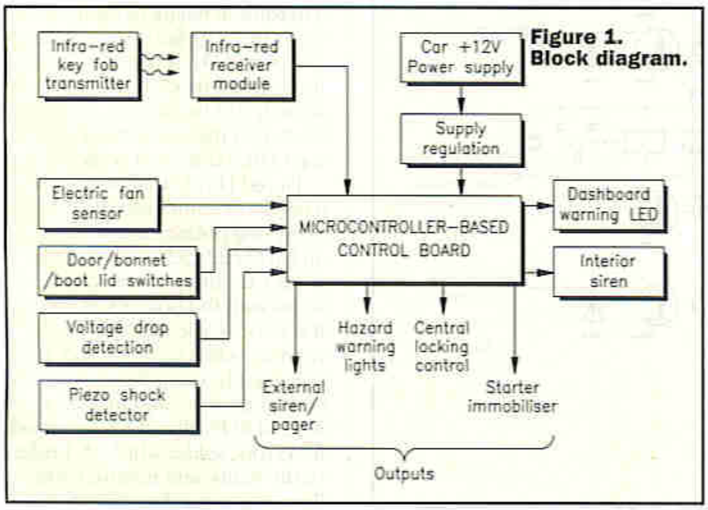


Figure 1. Block diagram.

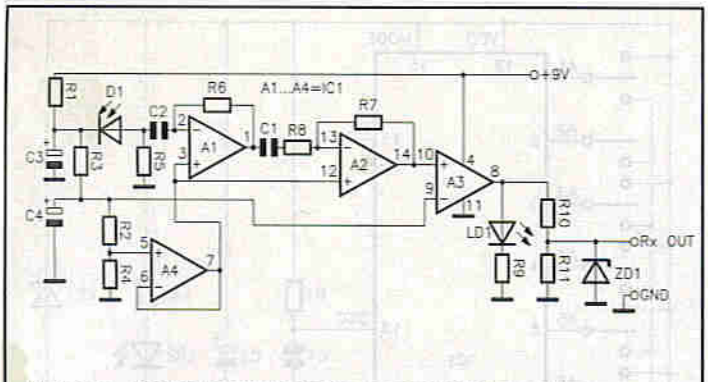


Figure 3. Circuit diagram of the infrared (IR) Receiver.

Transmitter PCB

The transmitter PCB is very similar in size to the receiver PCB, but is identified by the label "P6708'1". Start by installing the resistors R1-4, followed by the diode D1 and Zener diode ZD1 (these are identical in appearance, so read the numbers printed on their bodies before fitting them – D1 is a 1N4148, ZD1 a 4V3). Also ensure their correct polarity, with the black band aligning with the white band printed on the PCB legend. Using either component lead offcuts or the wire links supplied, fit links into the coding islands to set the code of your choice.

Next, fit the miniature push switch SW1, ensuring its four pins are aligned with the PCB legend (noting the difference in distance between pins on the switch) and that it is fitted as closely to the board as possible.

Fit one of the 18-pin DIL holders onto the board, with its end notch aligning with that shown on the legend. Install the capacitors C1 (a ceramic disc type) and C2 (an electrolytic – observe polarity), pre-bending C2's leads so the capacitor can be fitted on its side. Follow this by fitting transistor T1, a BC517, so that it is at a maximum height of 7mm from the board. Next, fit the red LED LD1, so that its tip is at a height of 10mm from the board. Also fit the two blue transparent infra-red emitting LEDs, LD2 & LD3, so that the 'waistband' of each device is flush with the edge of the PCB. Observe the correct polarity with each LED.

Solder on the two brass battery terminals, using the tabbed one for the '+' and the dimpled one for the '–' terminal. Plug one of the UM3758 ICs into the DIL holder, ensuring its end notch aligns with that of the holder. Finally, check your work for mistakes, solder whiskers, bridges or dry joints, and clean excess flux off the board using a suitable solvent.

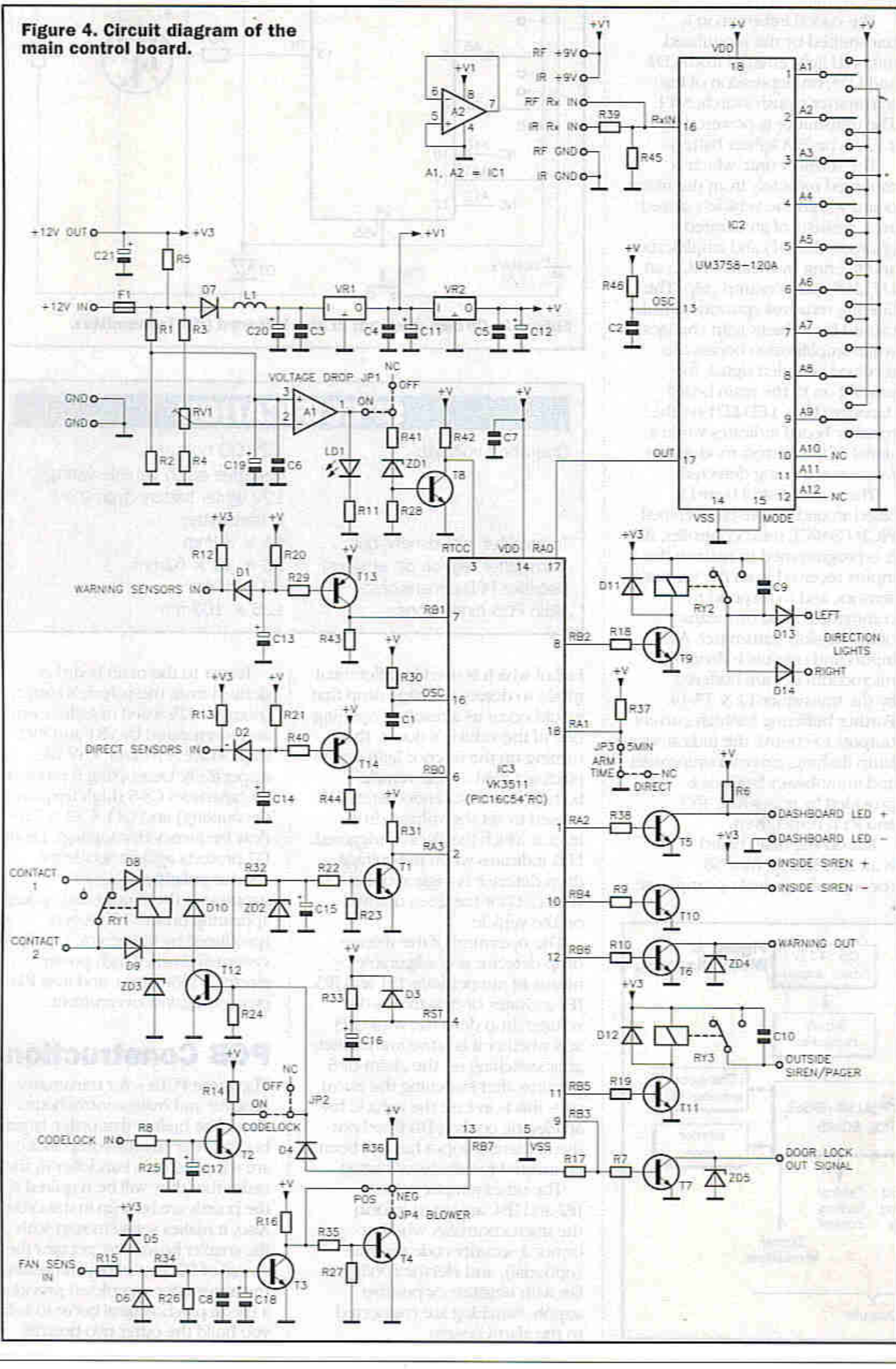
Receiver PCB

The infra-red receiver module is built onto the other small board, labelled "P3512R'1". Commence by installing the resistors R1-11, followed by Zener diode ZD1 (a 4V7), observing polarity. Fit the 14-pin DIL holder, aligning its end notch with that of the printed legend. Next, fit capacitors C1 & C2 (non-polarised) and C3 & C4 (electrolytics – observe polarity), pre-bending the leads so that the latter so that the capacitors can be fitted on their sides.

Infra-red photodiode D1, a BPW41, may be fitted in either of the two positions marked D1 on the PCB legend, observing polarity. If fitting it near the edge of the board (facing sideways), it should be fitted flush onto the PCB, while if it is to be mounted inboard (facing upwards), its legs should be pre-bent at 90° so its face sits at a maximum height of 9mm from the board's surface. The choice of position of D1 depends on where the receiver module is to be mounted in the vehicle, i.e. at the top of the windscreen or on top of the dashboard, respectively.

Fit red LED LD1 so its tip is at a height of 8mm from the board, observing polarity. Plug IC1, an LM124/224/324 into the DIL holder, ensuring its end notch aligns with the holder's. Solder the 3-core cable supplied to the receiver board's '+', '–' and 'RX' solder pads, using the colour code of your choice – and making a note of it! Finally, check your work for errors, solder whiskers, bridges or dry joints, and remove excess flux using a suitable solvent.

Figure 4. Circuit diagram of the main control board.



Main Control Board PCB

The main board is, unsurprisingly, the largest in the kit, and is labelled "P3511'1". Commence its construction by installing the wire links (marked 'J' on the PCB legend); there are eleven of them, not including the coding island links. The coding island links must be set to the same pattern as you chose for the transmitter board – else the remote control facility won't work!

Next, fit the resistors (R1-4 are 1% types, the others are 5% ¼W type), followed by silicon diodes D1-6 (1N4148), D7-12 (1N400X), Zener diodes ZD1 (2V4), ZD2 (4V7), and ZD3-5 (18V), ensuring their correct polarity. Fit the inductor L1, which looks like a large resistor. Next, fit the DIL holders for IC1 (8-pin) and IC2 & IC3 (18-pin), ensuring their end notches align with those of the printed legend. Install preset potentiometer, RV1, followed by LED LD1 (ensuring correct polarity).

Fit the non-polarised capacitors C1-10 (C1 & C2 are 100pF, C3-10 are 100nF), then the many (14) transistors. Separate these into their three types before fitting; T1-8 are BC547, T9-12 are BC337 and T13 & T14 are BC557. Don't get them mixed up!

The terminal blocks are fitted next. These are supplied in component form, so you have to clip the pin strips (one 10-pin, the other 12-pin) into the corresponding terminal block bodies before soldering them into place (you can push the bodies on after soldering the pin strips in place if you prefer).

The jumper links JP1-4 all require a 3-pin length of the one-piece pin strip that is supplied; it is easily snapped into 3-pin lengths by gripping with thin-nose pliers and breaking at the scored grooves. There is some spare length in case you accidentally snap a piece in the wrong place. Place the jumper bridges (again, supplied in one length, to be snapped into pieces as required) onto the jumper pins to configure the main board settings – see Figures 12 and 13.

Install the electrolytic capacitors C11 and C19-21, ensuring their correct polarity (these stand vertically, unlike the other two boards). Next, fit the large power diodes, D13 & D14, observing polarity, followed by the voltage regulators VR1 (7809) & VR2 (7805).

Fit the base of the fuseholder in the F1 position, bending over its tags after passing it through the holes but before soldering it in. Fit the 15A blade-type fuse into the holder, then clip the cover on.

Install the relays RY1 & RY2 (plastic-cased type FRA2C), then RY3 (V23033 exposed type or FRA2C). Plug the ICs into their holders; IC1 is an LM158/258 or RV4558, IC2 is an UM3758, and IC3 is the PIC microcontroller (labelled VF3511). Take suitable anti-static precautions when handling this device.

Having completed the board assembly, check your work carefully for mistakes, solder whiskers, bridges and dry joints, then clean off excess flux using a suitable solvent.

Testing

Infrared Transmitter

Fit a fresh type 23A lighter battery between the battery terminals, observing correct polarity; '+' should contact the tabbed terminal, '–' to the dimpled one.

Press the button SW1, whereupon LED LD1 should light. You won't see any light from LEDs LD2 & LD3 because they emit infrared light – invisible to humans, unless you know different, of course! Release the button and LD1 should go off. As a further test, you could try connecting an infra-red photodiode to a multimeter or oscilloscope set to a very low voltage range; then shine LEDs LD2 & LD3 at the photodiode from a few centimetres away while holding SW1 down, whereupon a reading should be observed, confirming that the signal is being transmitted in infrared light.

Receiver

With the 3-core cable (supplied) connected to the board, connect a 9V DC supply between the board's '+' and '–' terminals, observing correct polarity. The photodiode, D1, reacts to both visible and infrared light, so when it is in the light, LED LD1 should be on, and in darkness, LD1 should be off. Position the photodiode in a shaded place, so that LD1 is off. Point the completed infrared transmitter (with fresh battery fitted) towards the photodiode D1 and press the button. LED, LD1 on the receiver board should light in response to presses of the transmitter's button, confirming that infrared light is being emitted and received.

You could also connect a multimeter set on the 20V AC range across the receiver board's output terminals ('RX' and '–'); the voltage reading should change in response to the activation of the transmitter, confirming that the encoded signal is being received and amplified. Alternatively, use a crystal earpiece or high impedance headphones connected to the receiver output, and you should be able to hear the code being transmitted, as a buzzing sound.

Main Control Board

The only way to fully test the main control board is to connect it up to all the sensors and set the jumper links as for your chosen system configuration, and to activate the alarm by means of the remote control transmitter, activate each sensor in turn and ensure that operation is as expected.

However, basic testing of the system can easily be carried out on the workbench. As an initial test, set jumper link JP1 to the 'ON' position (activates the voltage drop sensing circuit), jumper JP2 to 'OFF' (optional security code module not connected), jumper JP3 to 'DIR' (which activates the voltage drop sensing circuit immediately after switch-on) and JP4 to 'POS' (electric fan sensor disconnected).

Apply a 12V DC supply across the terminals labelled '+12V IN' and 'GROUND' (see Figure 5). By adjusting the potentiometer RV1, you should be able to make the LED LD1 go on and off – set the potentiometer so the LED is on the verge of lighting, but not quite. Now lower the power supply voltage a fraction (or put a load across it, such as a 12V lamp). The LED should now light, indicating that the voltage drop detection circuitry works.

Disconnect the supply and connect the various sensors and output devices to the main board, as indicated in Figures 5 to 9. (Ignore the electric fan detection and central locking and immobiliser facilities). Take care to ensure correct polarities. Reapply the power, and check each sensor/output device in turn.

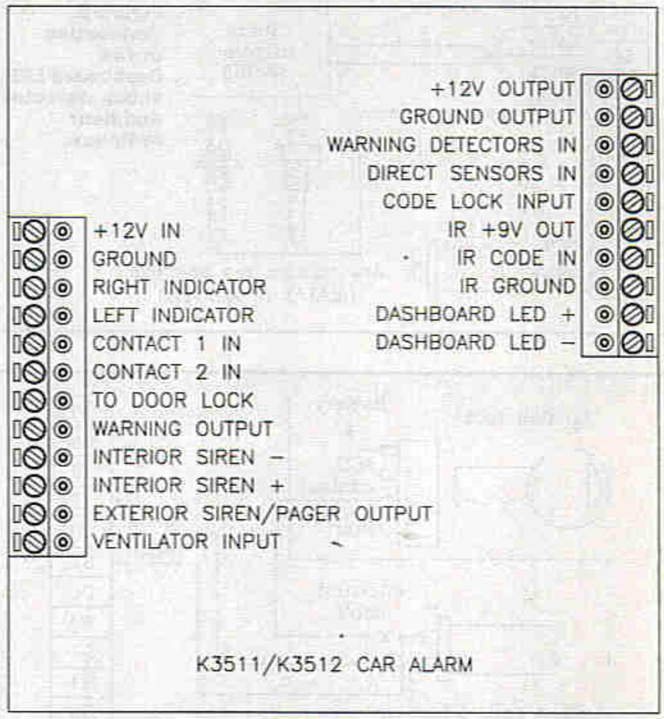
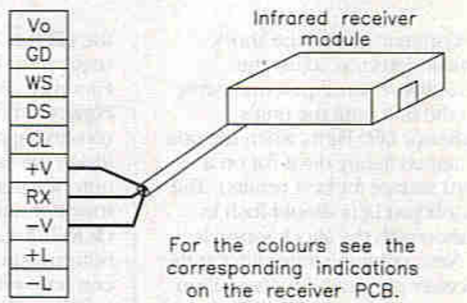


Figure 5. Control board terminal block connections.

Figure 6. Connection of the IR receiver module.



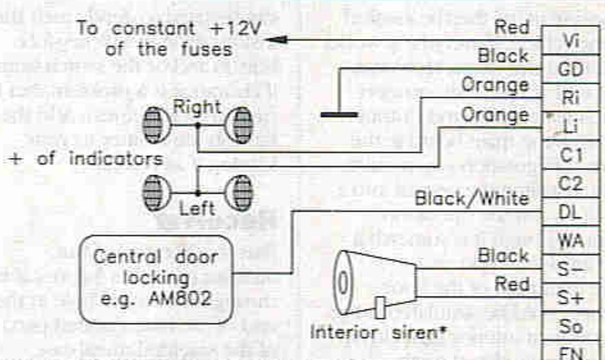


Figure 7. Connection of supply, interior siren, hazard warning lights and central locking system.

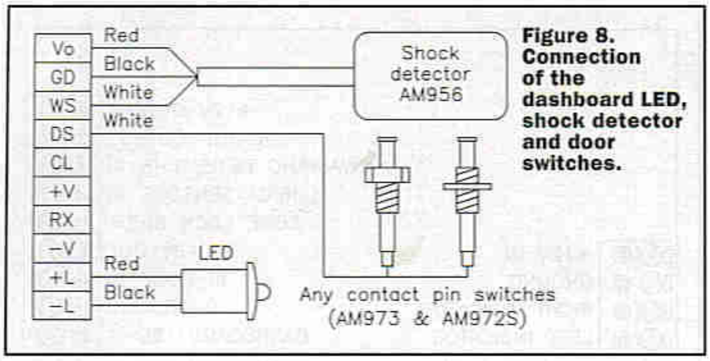


Figure 8. Connection of the dashboard LED, shock detector and door switches.

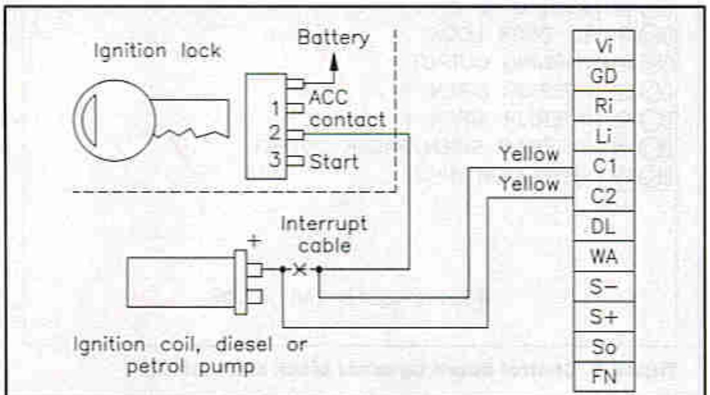


Figure 9. Connecting the starter immobiliser (ignition or fuel pump).

Commence with the shock sensor detector; adjust the sensitivity control potentiometer on the unit until the unit's indicator LED lights when the unit is tapped lightly (lie it flat on a hard surface for best results). The dashboard LED should flash in unison with the shock sensor's.

Next, point the transmitter at the receiver photodiode, whereupon the receiver board LED, LD1 should flicker, indicating that a code is being detected.

The system can then be installed into the vehicle, if everything works correctly at this stage. However, you could, if you wish, connect other sensor inputs and output devices to the main board in the system configuration you require, before installing the system into a vehicle, to test the operation further, although it is somewhat more involved to do so.

The operation of the door switches could be simulated using an equivalent interior light circuit (with normally closed earth switching of a 12V lamp), and the boot/bonnet switches could be simulated using cables to 0V (Ground). The interior and exterior sirens can be connected to check they sound when the alarm is armed then a sensor activated.

Also test for various settings of the jumper links, to check the operation of the 5-minute voltage drop sensing activation delay timer, etc.

Final Assembly

Transmitter

Simply clip the assembled, tested transmitter board into the base of the key-fob casing, as far down as it will go. (Some manipulation of the LEDs LD2 & LD3 may be required to fit into the end slot.) Fit a type 23A lighter battery between the battery terminals (observing polarity – moulded inside the casing). Clip the lid onto the casing and press together until the two halves click shut. Check that the push-button switch SW1 operates correctly when the plastic key-fob button is pressed, and that the red LED goes out when it is released (a soldering iron can be used to gently melt the inside of the plastic key-fob button and/or the switch button if clearance is a problem, but take care to avoid fumes). Add the key-fob transmitter to your keyring if all is well.

Receiver

Pass the free end of the receiver module's 3-core cable through the round hole in the end of the base (tabbed part) of the shielded metal case. Pull the cable through (slight filing of the hole may be required), until the receiver board sits inside the base, track side facing up. Check that the photodiode D1 will align with either of the two square holes in the lid or base of the casing, depending on the position chosen for it. The perimeter track of the board must be slid beneath the tabs protruding into the metal case, to which it is then soldered at the points where the track meets the tabs. The lid of the metal casing (dimpled part) is then clipped onto the base to create an enclosed, shielded receiver housing.

Main Control Board

A suitable plastic housing (not supplied) should be selected to house the main board, leaving some room inside for the cables. A watertight casing must be used if the main board is to be installed under the bonnet – or in a convertible car!

Drill a hole or holes (depending on how many of the supplied cables will be needed for your chosen installation) in one side of the box and fit one (or more) of the rubber grommets supplied. Also drill four holes in the base (or lid) of the box, corresponding to those in each corner of the main board. You may also wish to drill holes to attach brackets to mount the box beneath the dashboard or under the bonnet.

Connect as many wires as are needed for your chosen installation (see Figures 5 to 11) to the terminal blocks on the main board, pass the cables through the grommet(s), then fit the board into the casing using the four plastic spacers, bolts and screws supplied. Secure loose cables together using the cable ties provided.

The main board's jumper links JP1-4 must then be configured to set the alarm system up in accordance with the sensors installed and the switching method for the voltage drop/electric cooling fan detection – see Figures 12 and 13.

A touch of silicone sealant can be used around the grommet hole(s) to give added waterproofing if the unit is to be fitted in an exposed location.

Installation

Important Safety Note

Before starting work, consult owners manual regarding any special precautions that apply to your vehicle. Since a car battery is capable of delivering extremely high currents, it is imperative that every possible precaution is taken to prevent accidental short circuits occurring. Remove all items of metal jewellery, watches, etc. Before connecting the module to the car electrics, the battery should be disconnected. Helpful hint – Remove ground connection first, to prevent accidental shorting of the (+) terminal to the bodywork or engine, assuming negative earth vehicle. It is essential to use a suitably rated fuse in the supply to module. The wire used for the connections should also be rated to safely pass the required current. If in any doubt as to the correct way to proceed, consult a qualified automotive electrician.

Comprehensive installation instructions are given in the leaflets supplied with the alarm kit. Before starting to install the alarm, please read the safety warning

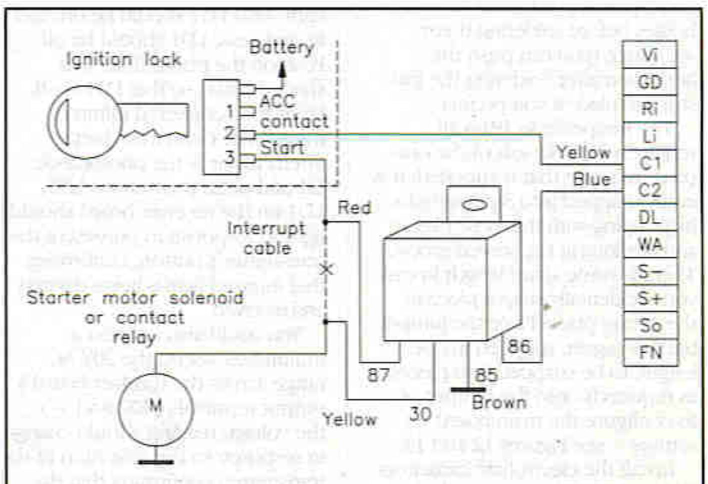


Figure 10. Connecting the starter immobiliser (starter motor).

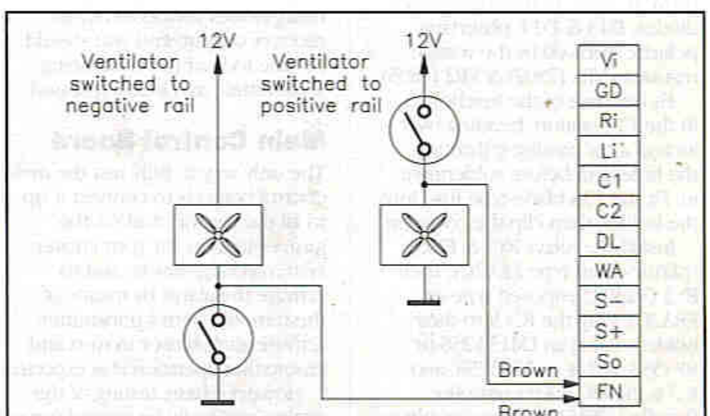
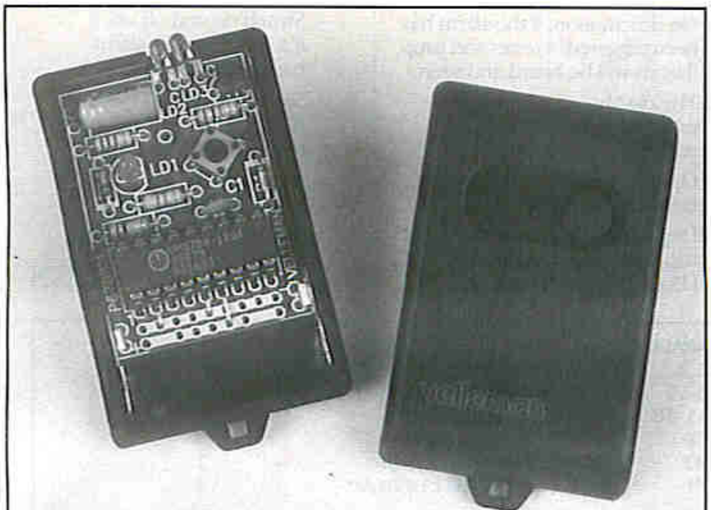


Figure 11. Connecting the electric fan detection.



Close-up of transmitter PCB.

printed in this article. Refer to Figures 5 to 11, showing the various connections to be made, depending on the facilities you require from the system, the vehicle to which it is being fitted, and the jumper link settings shown in Figures 12 & 13.

The main control unit should be mounted below the dashboard, or in a sheltered place under the bonnet (water-resistant housing needed here). Always use grommets where cables are passed through bulkhead panels, to prevent chafing. Also ensure that cables do not stray near hot or moving parts of the vehicle – secure them out of the way using cable ties or similar. It is sensible to label the cables (or at least note the colour codes) for future reference, in case maintenance/alteration of the system is required.

The receiver module should be mounted in a discrete position either on top of the dashboard, or at the top of the windscreen, so that its photodiode has a clear 'sight' through the glass. The module can be held in place either using self-adhesive double-sided pads, or using suitable bracketry. If required, the (matchbox-sized) metal casing can be disguised with a suitable covering (e.g. vynide covering cloth, Order Code XS05F), ensuring that the photodiode can still 'see' out.

Note that cable of a sufficient quantity and current rating is supplied in the kit, as are the necessary fuses, bonnet and bootlid pin switches (one of each supplied), starter motor immobiliser relay and other fixing hardware. The piezo shock detector is supplied as a ready-built unit, as is the interior siren, and the dashboard-mounted warning LED is also supplied ready to fit.

The shock detector must be bolted firmly onto one of the metal panels of the vehicle – not a trim panel, else it won't work effectively. It has an adjuster knob on for setting the sensitivity to shocks. Mount the unit so that the adjuster is readily accessible but not so accessible that it can be de-sensitised by a potential car criminal!

The interior siren should be mounted in a position where it will not be muffled; the idea is to make it painful for a thief to sit inside the vehicle when the siren is activated.

Fit the dashboard LED in a prominent position (8mm hole required), preferably as high as possible in the centre of the dashboard, where it will be most visible from outside the vehicle.

The exterior siren and type 23A lighter battery for the key-fob transmitter are not supplied, but are available separately (see optional parts list).

A final touch is to affix the self-adhesive warning stickers in a prominent position on the inside of your vehicle's windows, to inform the world at large that you have an alarm system installed, and thus act as a deterrent against unwanted attention.

Summary of Operation

Using the Remote Control

Use the right-hand button if the supplied key-fob casing has two buttons. The operation of the transmitter is as follows:

1. Push button once – alarm activate/deactivate with beep signal.
2. Keep button pressed in – alarm activate/deactivate without beep signal.
3. Press button twice within 5 seconds of the alarm being activated – switches the warning sensor(s) off, with confirmation beep.

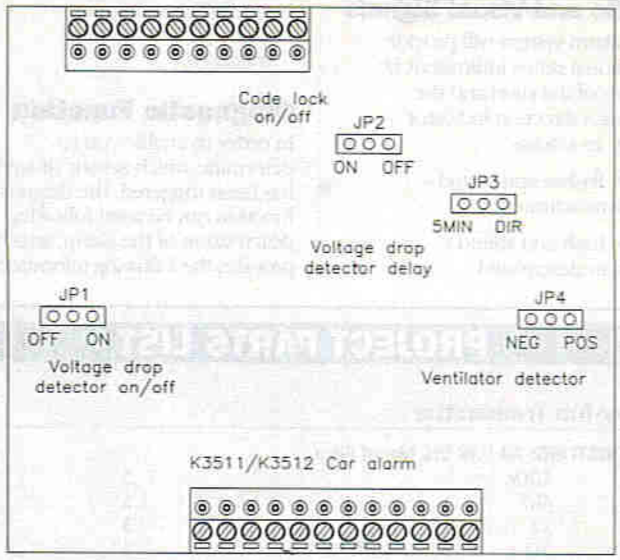


Figure 12. Positions of the onboard shunts.

Voltage drop detector active	JP1 OFF ON
Voltage drop detector not active	JP1 OFF ON
Security code module connected	JP2 ON OFF
Security code module not connected	JP2 ON OFF
Voltage drop detector active directly after switching on alarm	JP3 5MIN DIR
Voltage drop detector active 5 mins after switching on alarm (prevents triggering by the ventilator if this is not connected)	JP3 5MIN DIR
Ventilator with positive contact	JP4 NEG POS
Ventilator with negative contact	JP4 NEG POS
Ventilator with detector not connected	JP4 NEG POS

Figure 13. Shunt settings.

Notes

- 5 seconds must be waited between activating and deactivating the alarm.
- The alarm only becomes active 5 seconds after switch-on.
- When deactivating the alarm after the siren has been triggered, keep the transmitter button pressed down until the siren stops.

Dashboard LED Operation

The dashboard LED indicates the alarm status as follows:

1. LED off – alarm deactivated.
2. LED slowly flashing – alarm activated.
3. LED rapidly flashing – automatic reset of alarm after deactivation; 60 seconds entry delay in operation.

Function	activate	deactivate	warning sensor	warning sensor ×2	direct sensor
Dashboard LED	Flashing	Rapid Flash			
Interior siren	2× beeps	1× or 4× beeps	1× beep	ON	ON
Hazard lights	2× flashes	1× or 4× flashes	1× flash	Flash	Flash
Vehicle starting	Not possible	Possible	Not possible	Not possible	Not possible
Siren/pager	OFF	OFF	Short ON	ON	ON
Central locking	Locked	Open	Locked	Locked	Locked

Table 1. Operation overview.

Audio and Visual Signals

The alarm system will provide additional status indications by means of the siren and the vehicle's direction indicator lights, as follows:

1. 2× flashes and sound – alarm activated.
2. 1× flash and sound – alarm deactivated.
3. 4× flashes and sound – alarm off and has been triggered.

Diagnostic Function

In order to enable you to determine which sensor (if any) has been triggered, the diagnostic function can be used following deactivation of the alarm, which provides the following information:

- On deactivation, if the alarm has been triggered, 4 tones and lamp flashes will be heard and seen.
- The dashboard LED will flash rapidly, indicating automatic reset after 60 seconds.
- Open a door or switch on the ignition to interrupt the reset.
- Depending on the cause of the triggered alarm, the dashboard LED and internal siren will:
  - Switch on and off once if a direct sensor alarm has been activated
  - Switch on and off twice if a delayed sensor alarm has been activated
  - Switch on and off three times if the voltage drop detector has been activated (i.e. a door has been opened).

PROJECT PARTS LIST

Key-fob Transmitter

RESISTORS: All ¼W 5% Metal Film

R1	100k	1
R2	4k7	1
R3	1k	1
R4	1Ω	1

CAPACITORS

C1	100pF Ceramic Disc	1
C2	10µF 35V Radial Electrolytic	1

SEMICONDUCTORS

D1	1N4148	1
ZD1	4V3 Zener	1
T1	BC517	1
LD1	3mm Red LED	1
LD2,3	3mm Infra-red LED	2
IC1	UM3758	1

MISCELLANEOUS

	18-pin DIL Socket	1
	Miniature PCB-mounting Push-to-make Switch	1
	Battery Terminals	2
	Key-fob Casing	1
	Wire Links	9
	PCB	1

Receiver Module

RESISTORS: All ¼W 5% Metal Film

R1,2	47Ω	2
R3,4	10k	2
R5	100k	1
R6,7	1M	2
R8	33k	1
R9	1k	1
R10	2k2	1
R11	4k7	1

CAPACITORS

C1	4n7F Ceramic Disc	1
C2	100nF Polyester	1
C3,4	22µF 25V Radial Electrolytic	2

SEMICONDUCTORS

ZD1	4V7 Zener	1
D1	BPW41 Infra-red Photodiode	1
LD1	3mm Red LED	1
IC1	LM124/224/324	1

MISCELLANEOUS

	14-pin DIL Socket	1
	Screened Casing	1
	3-core Cable	1 length
	PCB	1

Main Control Unit

RESISTORS: All ¼W 5% Metal Film (Unless Stated)

R1-4	100k 1% Metal Film	4
R5	1Ω	1
R6	220Ω	1
R7-10	4k7	4
R11-19	1k	9
R20-28	47k	8
R29-44	10k	16
R45,46	100k	2
RV1	4k7/5k Horizontal Preset Potentiometer	1

CAPACITORS

C1,2	100pF Ceramic Disc	2
C3-10	100nF Polyester	8
C11-18	1µF 50V Radial Electrolytic	8
C19	22µF 25V Radial Electrolytic	1
C20	220µF 16V Radial Electrolytic	1
C21	1,000µF 16V Radial Electrolytic	1

SEMICONDUCTORS

D1-6	1N4148	6
D7-12	1N400X	6
D13,14	6A2/6A6 Power Diode	2
ZD1	2V4 Zener	1
ZD2	4V7 Zener	1
ZD3-5	18V Zener	3
LD1	3mm Red LED	1
T1-8	BC547	8
T9-12	BC337	4
T13,14	BC557	2
VR1	7809	1
VR2	7805	1
IC1	LM158/258 or RV4558	1
IC2	UM3758	1
IC3	PIC16C54RCE Pre-programmed Microcontroller	1

MISCELLANEOUS

L1	100µH Choke	1
J1	10-pin PCB-mounting Terminal Block	1
J2	12-pin PCB-mounting Terminal Block	1
JP1-4	3-pin Terminal Pins	1 strip
F1	15A Blade-type Fuse	1
RY1,2	FRA2C PCB-mounting 12V Relay	2
RY3	V23033 or FRA2C PCB-mounting 12V Relay	1
	12V 20/30A Bulkhead-mounting Relay	1
	Relay Plug and Connecting Cables	1
	Connecting Cable	6 lengths
	Dashboard-mounted Red LED & Cable	1
	12V Interior Siren	1
	Piezo Shock Detector	1
	Bonnet Pin Switch	1
	Bootlid Pin Switch	1
	Plastic Spacers	4
	M2·5 × 20mm Bolts	4
	M2·5 × 6mm Bolts	3
	M2·5 Nuts	4
	7mm Self-tapping Crosshead Screws	4
	14mm Self-tapping Crosshead Screws	2
	Rubber Grommets	3
	Cable Ties	10
	PCB-mounting Blade-type Fuseholder	1
	8-pin DIL Socket	1
	18-pin DIL Socket	2
	Jumper Links	1 strip
	Wire Links	20
	Self-adhesive Window Warning Stickers	4
	PCB	1
	Instruction Leaflets	3

OPTIONAL (Not in Kit)

Power Siren	1	(ZC46A)
Electronic Sounder	1	(YZ03D)
ABS Box Type MB7	1	(KC89W)
Medium Waterproof Box	1	(YM91Y)
Medium Waterproof Box with Clear Lid	1	(YM93B)
Type 23A 12V Lighter Battery	1	(JG91Y)

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 in kit form only.

Order As VF76H (K3512 IR Car Alarm) Price £101.99

Please Note: Some parts, which are specific to this project (e.g., PCB), are not available separately.

ELECTRONICS and Beyond

next issue

ESA/NASA

EURECA!

Douglas Clarkson, describes the EUropean REcoverable CArrier, a reusable scientific space platform from which out of this world experiments can be conducted.

Signal Activated Amplifier

A useful amplifier project that only switches on when it is required, with the application of an input signal. It switches into standby state to conserve power when the signal input is removed.

Audio/Video Monitor

A handy adaptor to superimpose video and audio signals onto an RF (UHF) carrier wave, suitable for connection to the aerial input of a domestic TV set.

Loop Alarm

A dual protection alarm system designed for easy, installation into sheds, garages, outbuildings or greenhouses, using a loop cable to protect items with an entry/exit detector sensor.

PLUS Brian Adams tunes you into Radio Cracker, a charity community radio stations organisation which aims to raise awareness of third world issues and generate funds for relief and development work.

The AC Power Supply by Ray Marston explains the mains supply distribution principles and looks at practical domestic AC wiring circuitry.

Part 2 of Introduction to Touch Key Technology from Tony Ellis demonstrates the many practical security applications for the new encoded electronic key technology.

Part 2 of PIC Programming by Stephen Waddington looks at PIC microcontrollers in detail and examines the characteristics which make them ideal for the first time designer.

Inside next month's issue there'll be another voucher worth £2 to save on your next order from Maplin

Issue 108 on sale Friday 1st November

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.

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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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E-mail your views and comments to:
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Write to:
Electronics and Beyond,
P.O. Box 777,
Rayleigh,
Essex SS6 8LU

TV Dimmers

Dear Sir,

I recently received issue 104 of *Electronics*, and feel I must congratulate you on a very well balanced monthly magazine, which covers the ever-increasing range of electronic subjects. Since I first took your magazine in August 1992 (No.92), I have always found something of particular interest. Just prior to receiving No.104, I had been looking up old circuits for drill controllers and lamp dimmers, and with this issue came a brand new circuit. My interest was not principally in a drill controller or a lamp dimmer, but I have in my workshop at present, a TV receiver with a S.O.P.S. power supply – with a fault. The manufacturer recommends that in the event of a fault in the power supply (the 2A fuse blows and the power transistor is the S/C to all 3 electrodes), the set should be operated from an isolating transformer and variac, and the voltage gradually increased whilst the power transistor base voltage is monitored. I have, therefore, ordered one of your toroidal isolating transformers, but have been thinking that an 'electronic variac', similar to the Drill Speed Controller in issue 104, or one of Ray Marston's Brightness Control Circuits would be suitable. An old lamp dimmer circuit using a triac came to light in my junk box, and after testing it with a 100W bulb, I tried it on a working TV. The TV didn't start, however, and when I checked the triac circuit, it had failed. I should be interested to hear your views on the feasibility of an 'electronic variac'.

Vic Rolfe, Earley, Reading

Paul Frost, Technical Assistant replies: **The operation of a variac is quite different to that of the Drill Speed Controller (Order Code VE90X). Essentially, a variac is a big potentiometer, which allows an attenuated version of the input signal to reach the output. The level of attenuation can normally be continuously adjusted between 0 and 270V. The Drill Speed Controller circuit works by rapidly switching the applied power. The resulting waveform is substantially different from the original, as indicated in Figure 1 on page 24 of issue 104. An electronic variac could not be produced using a triac. One method to produce such a device would be to use an inverter circuit and attenuate the signal applied to the output drivers, prior to it being stepped back up to 240V with a suitable transformer.**

C.T.F. Collett, of Waterlooville, Hants, wins the Star Letter Award of a Maplin £5 Gift Voucher, for writing in to 'gas' about the technology of yesteryear.

£5 MAPLIN GIFT VOUCHER

Star Letter

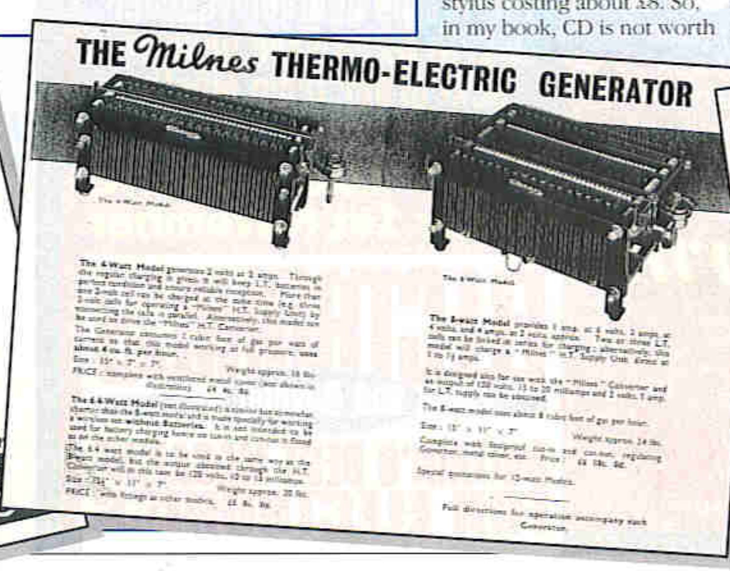
Dear Sir,

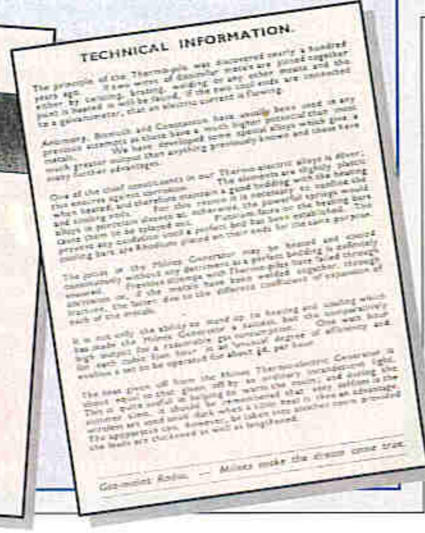
Firstly, I should like to congratulate you on an excellent magazine, with emphasis on the audio subjects, and the resurrection of valves, with the Millennium 4-20. As a schoolboy of 12 (in 1931), I was constructing battery powered amplifiers for record reproduction using a P.U. weighing about half a pound, screwed to the board of a wind-up gramophone, hence my love of valves.

I built my first mains amplifier in 1939, having entered the radio trade upon leaving school in 1933, I now being, as you have gathered, 77 years old. I read with great interest, the article on 'CD Versus Vinyl' by Mike Meechan, also your readers' comments, so there's no point in my making further comment, suffice for me to say that if the choice were available today, I would buy vinyl. To qualify that remark, at the inception of CD, vinyl was providing very good reproduction, and CD was introduced to 'prop up' a flagging industry. I concede that CD has improved the signal-to-noise ratio, but taking into account that 90% of the British public have hearing deficiencies, the cost is wasted. There is also the higher maintenance cost of a laser replacement and its setting-up, against the householder plugging in a new diamond stylus costing about £8. So, in my book, CD is not worth the outlay. The main objective of this letter is to clarify the subject of 'Gas Radio'. I feel sure you will find the enclosed extracts of an original brochure collected by myself at the radio exhibition held at Olympia in 1934 to be of interest, as it gives the full technical specification of the Milnes Thermo-electric Generator, that could be used to power battery-operated valve radio receivers – from a domestic gas supply!

Thank you for your comments regarding the magazine and articles. As is often the case when comparisons are made between a technology and its predecessor, the two types of sound reproduction media, CD and vinyl, have their respective pros and cons. However, with the prices of CD players continuing to fall, the value for money/playback performance ratio of CD players is becoming very favourable, with some quite reasonable CD players now available at well under £100. Even the CDs themselves are obtainable new for under a fiver, if you know where to look! In theory, the laser unit should never need replacement, since it does not come into contact with the moving CD. It is fascinating to see the Milnes brochure extracts (printed below and left) for the thermopile generator units, which are claimed to provide 1W power output when consuming 1ft.^{3} of gas per hour (available in 4, 6·4 and 8W versions), with a running cost of around ¼d per hour (in old money!). It is no less impressive that you have retained the brochure intact for so many years.

Milnes brochure extracts.





Flattery *(and Trafficmate)* will get you everywhere!

Dear Sir,

This week, I was very fortunate to receive a *Trafficmate* receiver from *Traffic*master in response to my winning a second prize in the recent *Traffic*master/*Electronics* magazine competition. I am very grateful for receiving this prize and thank you very much for running the competition.
I am about to embark on a degree in Electronic and Electrical Engineering at Birmingham University, and will have to travel frequently on many miles of motorway between home and university. I'm sure that the Trafficmate receiver will be a fantastic aid to my journeys these coming four years. May I congratulate you and your team at *Electronics* for producing a fantastic magazine. May I also forward praise for the new look of the magazine, the more modern layout works very well indeed. Thank you once again.

Andrew Evans, Llangynidr, Powys

Thank you for your letter, and we are very pleased that the prize has gone to such a deserving and needful winner. Good luck with the degree course.

Seeing the Light

Dear Editor,

As a retired professional engineer, I enjoy reading *Electronics* each month – now that I'm without the old workplace inputs, it's an excellent medium for keeping abreast of the latest developments in the electronics and related worlds. However, the odd error creeps into even the best article occasionally; in the 'Lamp/LED Brightness Control Circuits' feature in issue 104, two items are misleading. First, we read (on page 58), "...the lamp power dissipation (and thus, its brilliance) can be varied over an approximately 12:1 range", which implies that brilliance is proportional to power dissipation. But filament lamp brilliance varies much more markedly than this. The power (P) change calculation from P=IV is complicated by the reduction in filament resistance as the voltage V is lowered, and the current I therefore reduces at a lower rate than V; a rough rule is that the rate of I change is half that of the V change. Considering, say, a reduction of 10% in V, I reduces by about 5% and P is thus about 15% less (90% × 95%). Visible light output from a filament lamp varies in proportion to about the fourth-power of the voltage V (more accurately, the $3\frac{1}{2}$-power) around its normal operating value, so a 10% V drop decreases light output by about 30% – twice the reduction in power dissipation P. Well, why don't we take advantage of this fourth-power relation between V and light output, by running the bulb at a slightly higher V than normal to get much more light? We come up against another filament lamp expression, that the average life expectancy varies inversely as the twelfth power of V – surely the highest-power relation in technology! So, if V is increased by say, 6%, the light output goes up by a quarter, but at the expense of a halved life expectancy ($(^{1}/_{1.06})^{12} = 50\%$); not a good trade-off. Conversely, of course, a slight reduction in V will materially increase lamp life with a not very obvious reduction in light output. One suspects that the so-called 'long-life' bulbs work on this basis – designing them as if for 250V supply and under running them on a typical 230-240V mains supply will give a genuine life increase without anybody noticing that the light output is a bit down. By charging much more for these, there is no loss of profit in spite of reduced sales from the longer life.
Returning to the article, the hot-to-cold resistance ratio of the average filament bulb is usually 12:1 – much larger than the 4:1 quoted (also page 58). For example, the cold resistance of a new 60W 240V bulb is typically 70-75Ω, only $^{1}/_{13}$th of the resistance of the 960Ω hot resistance (from $R=V^2/P$). This ratio also holds for low voltage bulbs as used in cars, etc. The high turn-on current has to be allowed for with solid-state switching – a 12V 25W yacht navigation light takes an initial current of at least 25A. The filament is highly stressed at switch-on by the rapid temperature change and the distortion from the magnetic field produced by this large surge, and a 'soft start' action with a solid-state switch materially increases bulb life – a bonus if its operation is vital for safety but the lamp is way up a mast!

Mr. D. Becker, St. Albans, Herts

The cold and hot resistance ratio varies according to the bulb voltage and type of bulb. For example, measuring a couple of lamps found in the Maplin lab, a conventional 12V 5W lamp had a cold resistance of 3Ω yet a calculated hot resistance of 28·8Ω (from $R=P/I^2$); a ratio of 9·6:1. A 240V 60W lamp had a cold resistance of 68Ω; as you say, the calculated hot resistance of 960Ω is at least thirteen times greater (actually over 14 times in this case). Admittedly, the 4:1 ratio mentioned in the article is rather low, but if it was a halogen lamp (the exact type of lamp measured isn't stated), the ratio is probably correct, since these do have a far lower switch-on resistance than a normal tungsten lamp. The 4:1 ratio is, however, certainly not "typical of all tungsten filament lamps" as the article misleadingly states. Thank you for pointing this out, together with the method of determining brilliance and life expectancy. It should be remembered, however, that the lamp brilliance also depends on the design of the bulb's glass envelope/lens, the type of filament winding (e.g. coiled, coiled-coil, etc.) and on its colouring – a transparent bulb would appear brighter than a colour tinted lamp of the same power rating. Similarly, the life expectancy of a lamp also depends on many factors, such as the type of bulb enclosure (and whether it can dissipate heat effectively), the level of vibration the bulb is subjected to, the frequency of switching on and off, etc.

The Prevention of Hiss

Dear Sir,

I'm an electronics enthusiast reading popular electronics magazines published in the UK and USA for several years. My interest is in building household projects containing available components that can be affordable and useful. There are several insect killer circuits, such as mosquito repeller, rodent deterrent modules, etc. But I've never seen a device capable of keeping reptiles (especially the snake) away. I'm eager to build and utilise a snake repeller (I call it the venom repeller) that drives any kind of snakes several metres away to avoid encountering such poisoned species. It's true in tropical countries like ours that the danger of snake bites are obvious and lethal. If you or anyone can design such a device, it would be very helpful and the device could even be commercially successful in tropical countries.

A regular reader, in a tropical country
(no name or address supplied)

A great project idea! Development of such a project here in Britain could be tricky due to the scarcity and lack of diversity of snakes to test the effectiveness of the project. Are there any snake experts reading who know how best to go about repelling these creatures in an electronically realisable way? We would be interested to hear of possible solutions!

Electronic FILTER CIRCUITS

PART 3

by Ray Marston

Ray Marston takes an in-depth look at active C-R filter circuits in the concluding part of this 3-part series.

C-R Active Filters

An active filter is a circuit that combines passive C-R networks and one or more amplifier or op-amp stages, to form a filter that can either out-perform normal C-R filters or can give a performance that is unobtainable from purely passive networks. A good selection of practical test-gear-orientated active filters are described in the next few pages. All these circuits are shown designed around standard 741 op-amps and operated from dual 9V supplies, but they will, in fact, work with virtually any normal op-amp, and from any supply voltages within the op-amp's operating range. If the circuits are to be used above a few tens of kHz, wide-band op-amps should be used.

The two most basic types of active filter are the 1st-order low-pass and high-pass types shown in Figures 1 and 2. These are simple adaptations of the passive types shown in Part 1 of this series, but each have their output buffered by a unity-gain non-inverting amplifier, to give a low-impedance output with a –3dB crossover frequency (f_c) of $^1/_{(2\pi RC)}$, and an output slope of 6dB/octave (= 20dB/decade). With the component values shown, each circuit has an fC value of 1kHz. Note that the input signal to the low-pass circuit must provide an effective DC path to ground.

Each of the above two filter circuits uses a single C-R stage, and is known as a '1st-order' filter. Figure 3 shows the practical circuit and formula of a maximally-flat (Butterworth) unity-gain 2nd-order low-pass filter with a 10kHz break frequency. Note that the '2C' capacitor is subjected to unity-gain bootstrapping from the op-amp's output. This circuit's output falls off at a rate of 12dB/octave beyond 10kHz, and is thus about 40dB down at 100kHz, and so on. To alter the break frequency, change either the R or the C value in proportion to the frequency ratio relative to Figure 3; reduce the values by this ratio to increase the frequency, or increase them to reduce the frequency. Thus, for 4kHz operation, increase the R values by a ratio of 10kHz/4kHz, or 2·5 times.

A minor snag with the circuit shown in Figure 3 is that one of its 'C' values should ideally be precisely twice the value of the other, and this can result in some rather odd component values. Figure 4 shows an alternative 2nd-order 10kHz low-pass filter circuit that overcomes this snag and uses equal component values. Note here, that the op-amp is designed to give a voltage gain of 4·1dB via R1 and R2, and thus gives greater than unity bootstrapping to one of the filter's capacitors.

Figure 5 shows how two of these 'equal component' filters can be cascaded to make a 4th-order low-pass filter with a slope of 24dB/octave. In this case, gain-determining resistors $^{R1}/_{R2}$ have a ratio of 6·644, and $^{R3}/_{R4}$ have a ratio of 0·805, giving an overall voltage gain of 8·3dB. The odd values of R2 and R4 can be made by series-connecting standard 5% resistors.

Figures 6 and 7 show unity-gain and 'equal component' versions, respectively, of 2nd-order 100Hz high-pass filters, and Figure 8 shows a 4th-order 100Hz high-pass filter. The operating frequencies

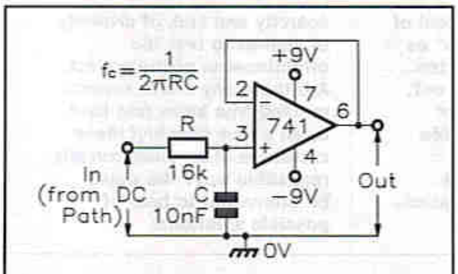


Figure 1. 1st-order 1kHz low-pass active filter.

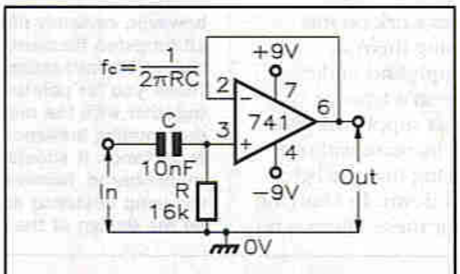


Figure 2. 1st-order 1kHz high-pass active filter.

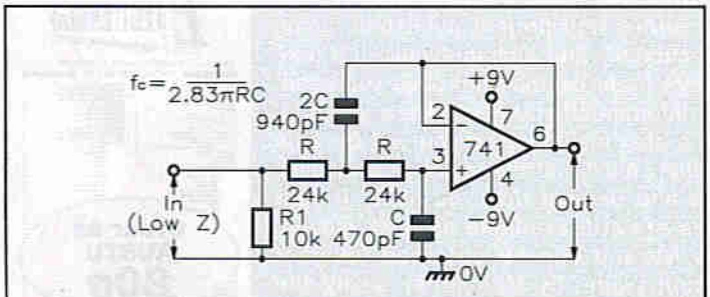


Figure 3. Unity-gain 10kHz 2nd-order low-pass active filter.

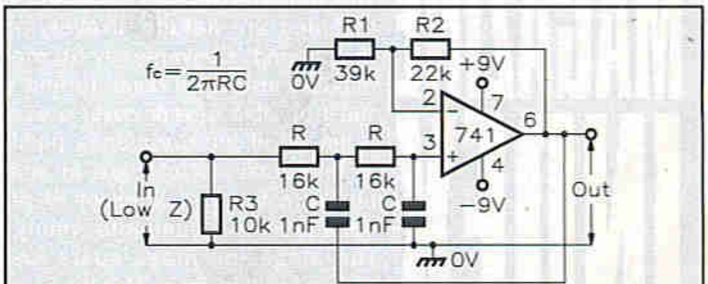


Figure 4. 'Equal components' version of the 10kHz 2nd-order low-pass filter.

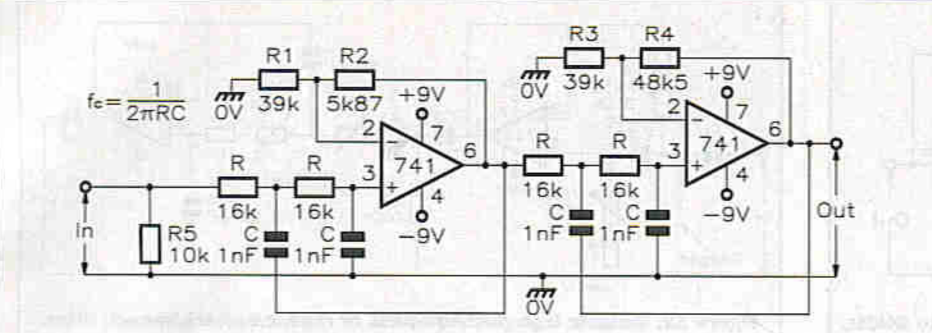


Figure 5. 4th-order 10kHz low-pass filter.

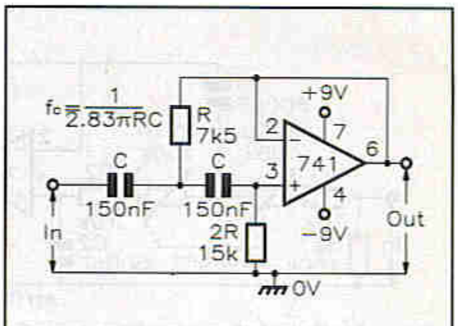


Figure 6. Unity-gain 2nd-order 100Hz high-pass filter.

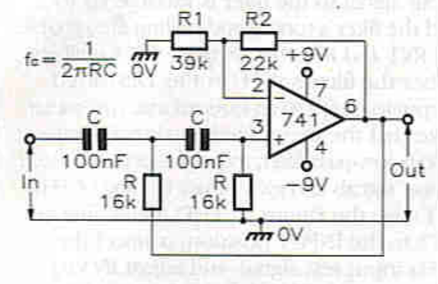


Figure 7. 'Equal components' version of 100Hz 2nd-order high-pass filter.

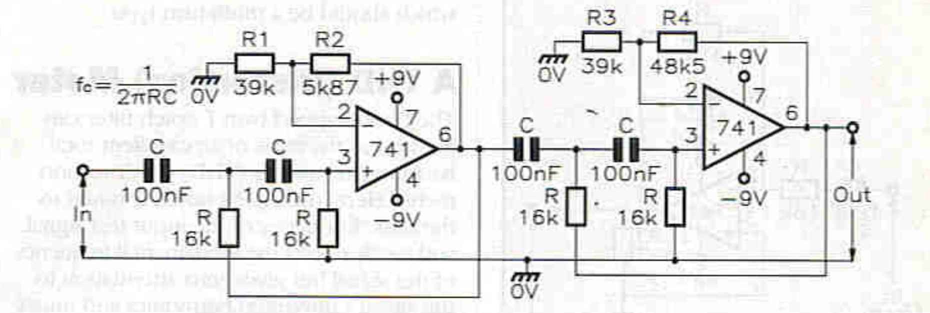


Figure 8. 100Hz 4th-order high-pass filter.

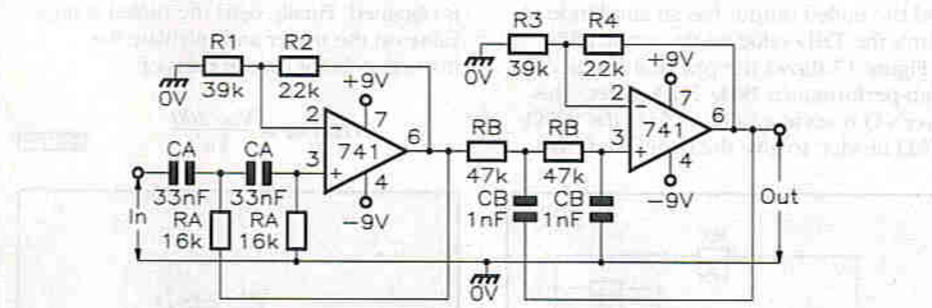


Figure 9. 300Hz to 3·4kHz band-pass filter with 2nd-order response.

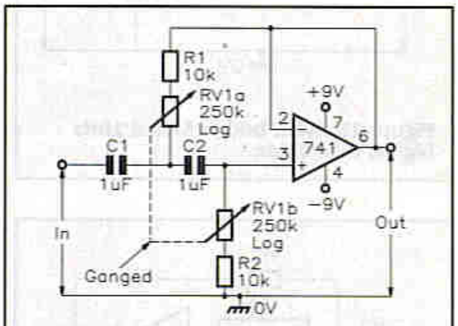


Figure 10. Variable high-pass filter, spanning 23·5 to 700Hz.

of these circuits, and those of Figures 4 and 5, can be altered in exactly the same way as in the Figure 3 circuit, i.e., by increasing the R or C values to reduce the break frequency, or vice-versa.

Finally, Figure 9 shows how the Figure 7 high-pass and Figure 4 low-pass filters can be wired in series to make (with suitable component value changes) a 300Hz to 3·4kHz 'speech' range bandpass filter that gives 12dB/octave of rejection to all signals outside of this range. In the case of the high-pass filter, the 'C' values of Figure 7 are reduced by a factor of three, to raise the break frequency from 100 to 300Hz, and in the case of the low-pass filter, the 'R' values of Figure 4 are increased by a factor of 2·94, to reduce the break frequency from 10 to 3·4kHz.

Variable Active Filters

The most useful type of active filter is that in which the crossover frequency is fully and easily variable over a fairly wide range, and Figures 10 to 12 show three practical examples of 2nd-order versions of such circuits.

The circuit shown in Figure 10 is a simple development of the high-pass filter of Figure 6, but has its crossover frequency fully variable from 23·5 to 700Hz via RV1. Note in this circuit, that the resistive arms of the C-R networks have identical values (unlike Figure 6), so this design does not give maximally-flat 'Butterworth' operation, but nevertheless, gives a very good performance. This circuit can, in fact, be used as a high quality turntable disc (record) 'rumble' filter; 'fixed' versions of such filters usually have a 50Hz crossover frequency.

The Figure 11 circuit is a development of the high-pass filter of Figure 3, but has its crossover frequency fully variable from 2·2 to 24kHz via RV1, and again, does not give a maximally-flat 'Butterworth' performance. This circuit can, in fact, be used as a high quality 'scratch' filter; 'fixed' versions of such filters usually have a 10kHz crossover frequency.

Figure 12 shows how the above two filter circuits can be combined to make a really versatile variable high-pass/low-pass or rumble/scratch/speech filter. The high-pass crossover frequency is fully variable from 23·5 to 700Hz via RV1, and the low-pass value is fully variable from 2·2 to 24kHz via RV2.

Tone and Notch Filters

Excellent active C-R tone filters, with very high effective 'Q' values, can be made by using twin-T or Wien networks in the feedback loops of suitable op-amp circuits. A 1kHz twin-T design has already been described in Figure 15 of Part 1 of this series. Figure 13 shows the practical circuit of a 1kHz Wien bridge based tone or 'acceptor' filter. The Q of this circuit is variable via the 10kΩ variable resistor, R2. Note that this circuit becomes an oscillator if R2 is reduced too far (to less than twice the R1 value).

The basic twin-T notch filter has a very low Q. The filter's Q, and thus, the notch 'sharpness', can be greatly increased by incorporating the twin-T in the feedback network of an active filter. There are two standard ways of doing this. The first way is to use the shunt feedback technique shown in Figure 14, in which the input signal is fed to the twin-T via R1, and an amplified and inverted version of the filter's output is fed back to the filter's input via R2, which has the same value as R1. Figure 15 shows the practical circuit of a 1kHz version of this type of active filter.

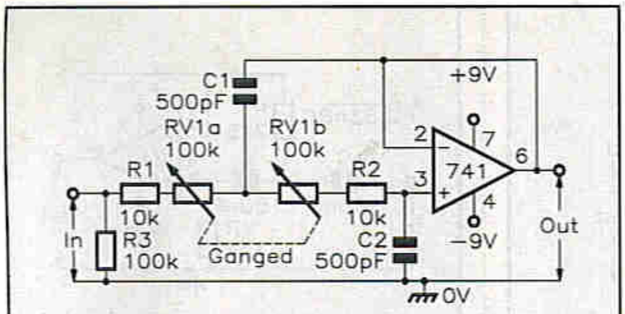


Figure 11. Variable low-pass filter, spanning 2·2 to 24kHz.

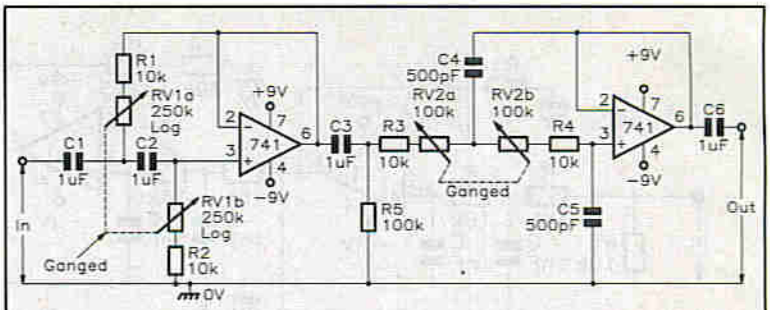


Figure 12. Variable high-pass/low-pass or rumble/scratch/speech filter.

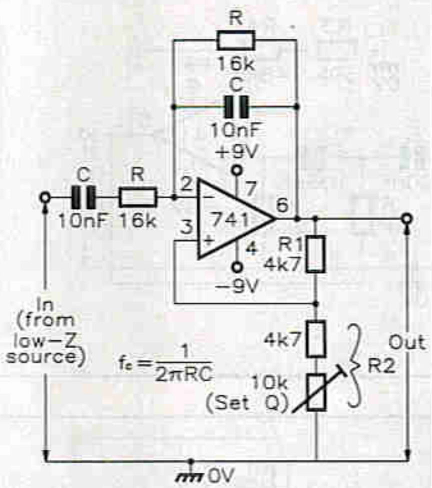


Figure 13. Wien bridge based 1kHz high-Q tone filter.

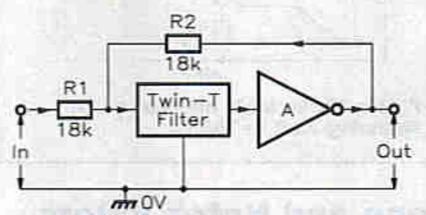


Figure 14. Basic twin-T notch filter using shunt feedback.

The network's null point can be adjusted via the 1kΩ variable resistor.

The second (and more modern) Q-boosting method is the bootstrapping technique, which has already been described and shown in basic form in Figure 12 of Part 1 of this series. Figure 16 shows a practical example of a 1kHz variable-Q version of such a circuit. The twin-T's output is buffered by the upper op-amp (a unity-gain voltage follower), and part of the buffered output is tapped off via RV3 and fed to the bottom of the twin-T (as a bootstrap signal) via the lower op-amp (another unity-gain voltage follower). When RV3's slider is set to the lowest (ground) point, the network has zero bootstrapping, and the circuit acts like a standard twin-T filter with a Q of 0·24. When RV3's slider is set to the highest point, the network has heavy bootstrapping, and the filter has an effective Q of about 8 and provides a very sharp notch. The filter's centre-frequency can be trimmed slightly via RV1, and the null point can be adjusted via RV2, which should be a multi-turn type.

A THD (Distortion) Meter

The bootstrapped twin-T notch filter can be used as the basis of an excellent total harmonic distortion (THD) or 'distortion' meter. Here, the filter's notch is tuned to the basic frequency of the input test signal, and totally rejects the fundamental frequency of the signal but gives zero attenuation to the signal's unwanted harmonics and mush, etc., which appear at the filter's output; the output signals must be read on a true rms volt or millivolt meter. Thus, if the original input signal has a rms amplitude of 1,000mV, and the nulled output has an amplitude of 15mV, the THD value works out at 1·5%.

Figure 17 shows the practical circuit of a high-performance 1kHz THD meter. This filter's Q is set at a value of 5 via the 820Ω-10kΩ divider, to give the benefits of easy tuning combined with near-zero second harmonic (2kHz) signal attenuation. The input signal to the filter is variable via RV3, and the filter's tuning and nulling are variable via RV1 and RV2, respectively. SW1 enables either the filter's INPUT or its DISTorted output to be fed to an external true rms meter; note that the meter feed line incorporates a 10kHz low-pass filter, to help reject unwanted 'noise' signals and give a truer reading of THD.

To use the Figure 17 THD meter, first set SW1 to the INPUT position, connect the 1kHz input test signal, and adjust RV3 to set a convenient (say 1V) reference level on the true rms meter. Next, set SW1 to the DIST position, adjust the input frequency for an approximate null, then trim RV1 and RV2 alternately until the best possible null is obtained. Finally, read the nulled voltage value on the meter and calculate the distortion factor on the basis of:

$$THD\ (\%) = \frac{V_{DIST}\ 100}{V_{IN}}$$

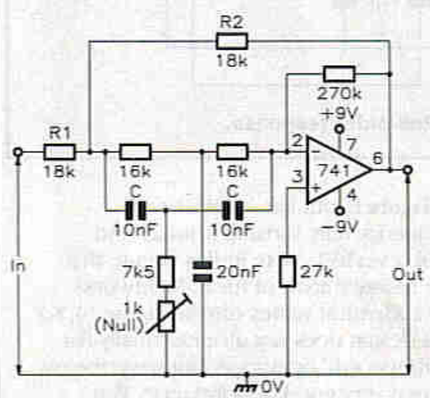


Figure 15. Practical 1kHz twin-T notch filter with shunt feedback.

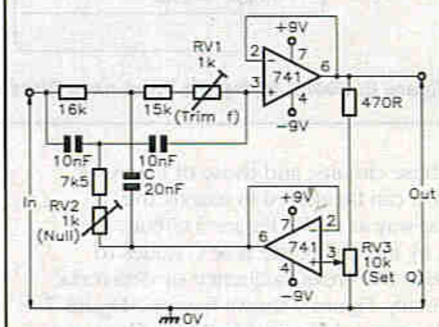
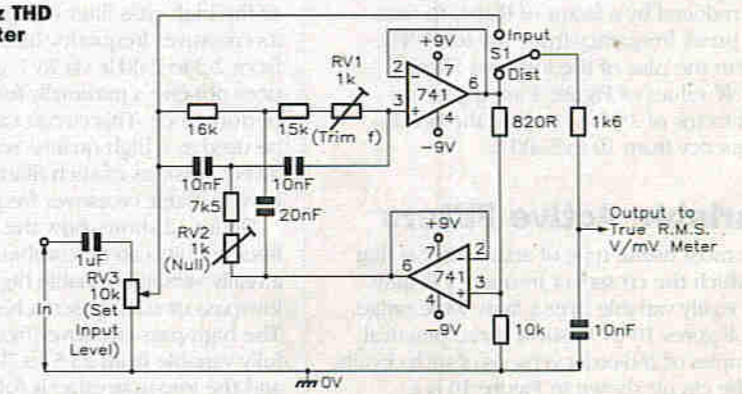


Figure 16. 1kHz variable-Q bootstrapped twin-T notch filter.

Figure 17. 1kHz THD (distortion) meter circuit.



DEVELOPING APPLICATIONS AROUND THE PIC ARCHITECTURE

PART 1

Microprocessor Basics

by Stephen Waddington

Stephen Waddington claims that developing projects around an embedded microprocessor is no more complex than any other design strategy. In the first part of this series, he introduces the key elements of a microprocessor.

At university, within the second week of the first term, Digital Electronics students are taught how to build nested sequential logic circuits. By the fifth week, they're designing control systems for major traffic junctions. Week six is nuclear reactors. I'm exaggerating of course, but not that much.

I spent eight weeks learning how to build NAND gate state machines. I knew Moore's Law backwards. And then, lecturers introduced the concept of a microprocessor. Suddenly, a four tier logic circuit with a multiplexer, numerous flip flops and a clock could be replaced by a single microprocessor device, and few lines of code. Here lies the beauty of microprocessors. They are inexpensive and relatively simplistic in design terms.

The PIC family, in particular, are ideal for the designer or hobbyist looking to produce a single-shot design. The cost of programming, de-bugging and prototyping tools for devices such as the 8086 or the Z80 make them unsuitable in this market. These devices are typically used in consumer applications with production runs in the order of tens of thousands.

Before we dive into the theory of PIC development, we'll spend the first feature in this series examining the basics of microprocessors. The PIC family of microprocessors or more accurately, microcontrollers, is only one family in a classification that includes ARM, Motorola, AMD and Hitachi.

The microprocessor market is segmented into the three main areas of embedded control, desktop PC and high-end work station. Increasingly, the margins between each segment are blurring. For instance, it used to be the case that the 8-bit Z80 dominated the embedded control market, while the Intel 8086 was king of the desktop, and the Digital Alpha or MIPS microprocessors occupied the high end.

Ten years ago, the rules changed. Users started to demand the power of a mainframe at the desktop, and a control system with the complexity of a desktop PC in their car. Mobile phones, TV games consoles, personal digital assistants such as the Apple Newton as shown in Photo 1, all require the functionality of a 486, but at the price of an 8-bit microprocessor.

In response, microprocessor designers have developed 16- and 32-bit technologies that can be mass produced, such as the ARM710 shown in Photo 2, and the Hitachi H6, for the embedded market. Meanwhile, Intel continues to climb the price performance curve, and push its technologies towards the high-end workstation market.

The PIC family falls into the low 8-bit category. While you might struggle to achieve the performance required for a Personal Digital Assistant (PDA), PIC devices are ideal for simple control applications such as input/output (I/O).

In its simplest form, a microprocessor is constructed from three components, as shown in Figure 1: the central processing unit (CPU); memory; and input/output. The engine of the microprocessor and indeed, any computer, is the CPU. This handles instructions and data or words in 4-, 8-, 16- or 32-bit formats, depending on the type of device.

The three key elements of the microprocessor are connected together by a series of parallel wires, known as the data bus. These wires are used to transmit data internally between the CPU, memory and I/O. The number of parallel data wires which make up the data bus is governed by the CPU instruction and data width. In the case of the PIC family, the microprocessor instruction width and consequently, the data bus, is typically 8 bits wide.

But the PIC chip is more than simply a microprocessor. Each device typically includes additional functions beyond those of a microprocessor, such as a system oscillator, EPROM, I/O buffers and A/D converter. For this reason, PIC devices are commonly referred to as microcontrollers. These devices are designed to stand alone, and require minimal additional circuitry.

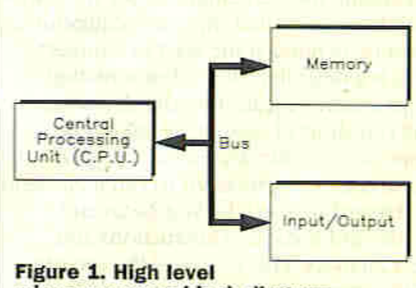


Figure 1. High level microprocessor block diagram.

	Memory Contents	Machine Code Representation	Assembler Mnemonic	Instruction
Intel 8086	11110100	F4H	Halt	Causes CPU to cease operation
PIC	1000000010	202	Move X,Y	Move contents of X to Y

Figure 2. Binary representation of microprocessor program for both Intel 8086 and PIC family.

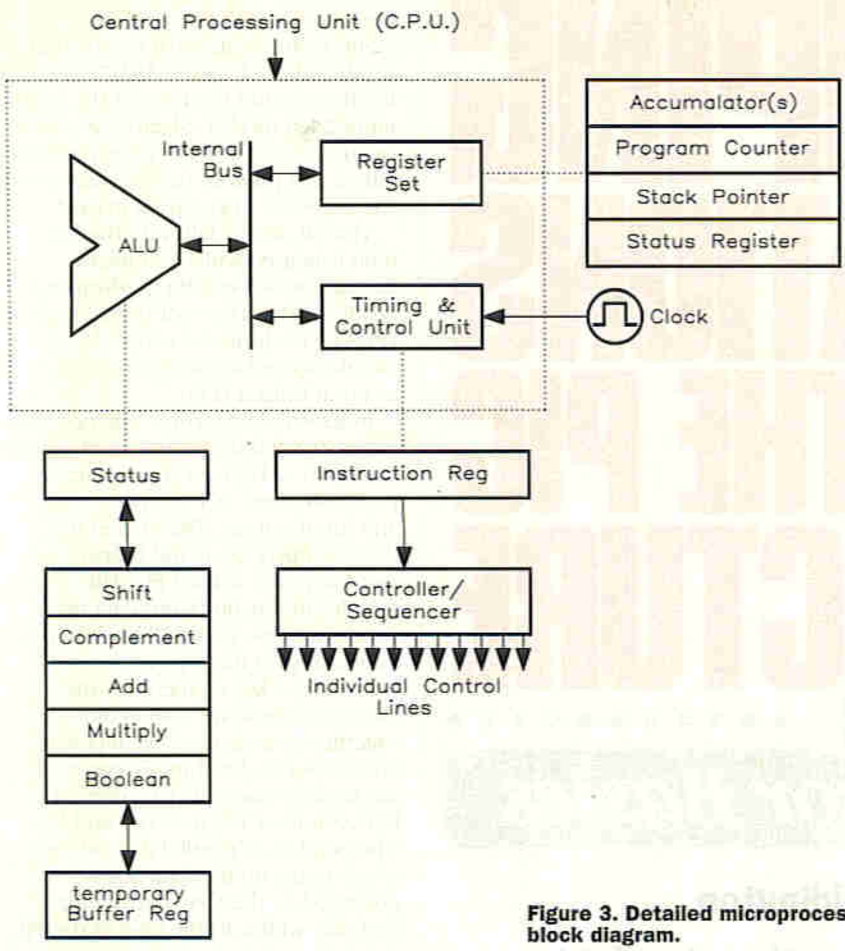


Figure 3. Detailed microprocessor block diagram.

Program counter

Points to the memory location where the next sequential instruction is to be found. Updated automatically by the CPU following the execution of the current instruction.

Instruction Register (IR)

Temporarily stores instructions etched from memory, and forwards them on to be decoded by the control unit.

Stack Pointer (SP)

Pointer to an area of memory reserved for the temporary storage of variables.

Accumulator

Intermediate storage register, used to transfer data from memory to CPU and vice-versa.

Status Register

Reflects the current status of the CPU. Instruction fetched from memory are passed to the control unit for decoding and subsequent execution via the instruction register, as shown in Figure 4. The instruction decoder determines what function or operation needs to be performed. The actual operation is executed by the control unit, which selects the appropriate combination of individual control lines.

Table 1. Reserved CPU registers.

Architecture

Figure 3 delves a level deeper into the core elements of a microprocessor introduced in Figure 1. Contained within the CPU is a set of registers, an arithmetic and logic unit (ALU) and a control unit. These three elements are connected together by an internal bus. Photo 3 shows the block diagram of the 64-bit IDT79R4600, with the key elements highlighted.

Harvard versus Von Neumann

Programs, consisting of a list of instructions for the CPU, are stored in memory. The CPU carries out operations based on these instructions on data which is also stored in memory. In the original computer architecture proposed by Von Neumann in 1945, there is no distinction between the memory for programs and data – they are both stored in the same block of memory.

Utilising the same memory for programs and data means that memory requirements must be defined at the start of a project. This is a difficult task. Underestimating requirements means that the developer will run short of memory, while in the opposite extreme, excess memory will cause the microprocessor to run inefficiently.

Harvard adapted the Von Neumann model and separated instructions and data memory. This increases the security of the microprocessor, but also gives the developer greater flexibility in the management of instructions and data. By splitting the two types of memory, the data word can be longer than the instruction word. Similarly, it means that other elements of the microprocessor are not restricted to pure multiples of the data word length. The PIC, like Intel or Motorola devices, is based on the Harvard architecture.

Within a microprocessor, a program is stored in binary form as a list of sequential instructions, as shown in Figure 2. The CPU executes the program by fetching individual instructions from memory for decoding and execution.

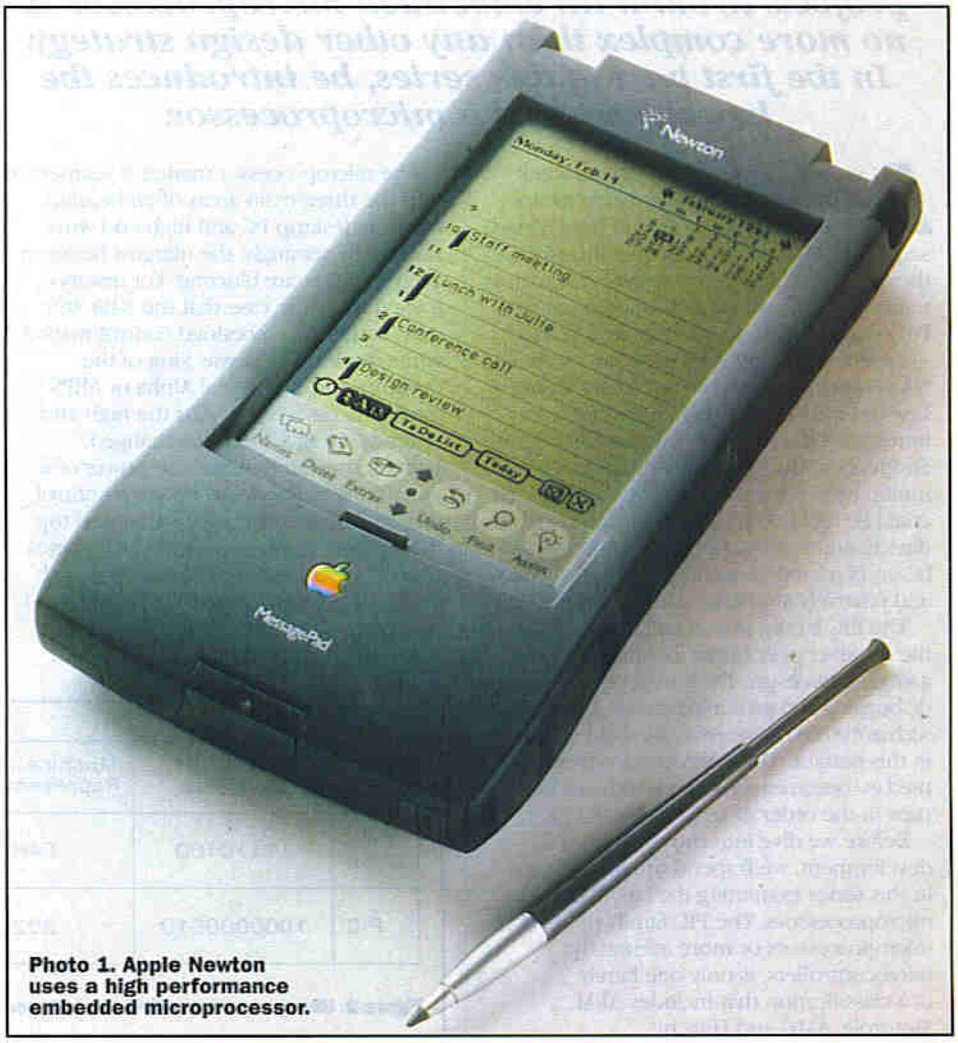


Photo 1. Apple Newton uses a high performance embedded microprocessor.

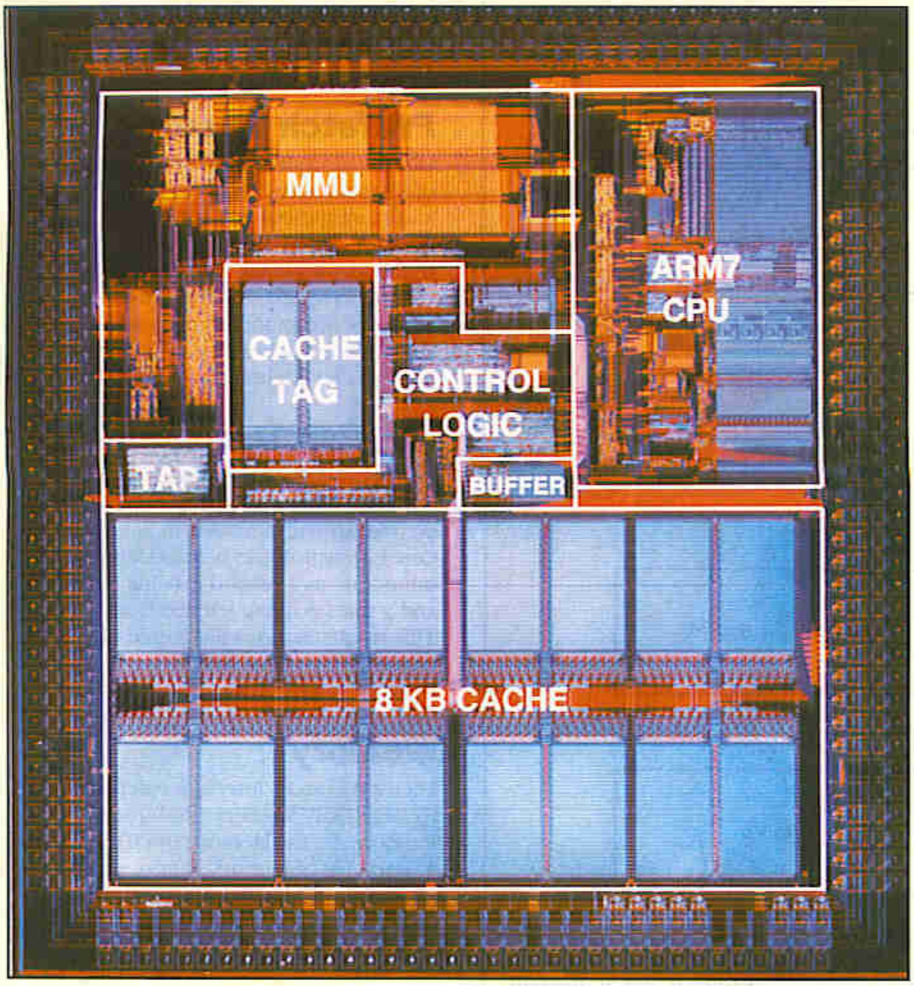


Photo 2. ARM710 from Advanced RISC Machines (ARM).

The Program Cycle

Every job a microprocessor does is broken down into a sequence of simple tasks. The sequence of tasks – or programme – is stored in memory. An electrical code of binary digits is assigned to each task or instruction. Instructions will take up different amounts of storage space depending on what the instruction actually does.

Fetching different instructions from memory takes varying numbers of system clock cycles dependent on the level of complicity of the action required. In the case where an instruction requires data from two different areas of memory, additional external fetches are needed as part of the instruction decoding process. Memory read and writes may take several clock cycles to execute. Consequently, the execution times for different instructions will vary.

The program counter always points to the memory location where the next instruction is to be found, and is automatically updated as part of the fetch-decode-execute cycle. Usually, the program counter will point to the next sequential memory location, but this is not always the case.

When the microprocessor executes a BRANCH or JUMP instruction, the program counter will be set to point to a non-sequential address. Alternatively, when the CPU is interrupted by an external device, the contents of the program counter will always be overwritten with the starting address of the appropriate interrupt service routine.

Program execution consists of repeated fetches, decodes and executions, as shown in Figure 5. Once an instruction has been read from memory, it is passed to the control unit for decoding. This decoding process requires the CPU to consult a lookup table in order to determine the sequence of microinstructions needed to perform the desired function.

Another function of the decoding process is to generate any addresses required, such as in which location data is located or where the result of an operation is located. Additional external reads from memory may be required to locate additional data. Once all relevant information has been collected by the control unit, it sets the appropriate control lines to allow the instruction to take place.

The CPU register set comprises both general purpose and special purpose types.

General purpose registers can be manipulated by the developer. They are used to store data on a temporary basis during the execution of a program. Special purpose registers are reserved and used only by the CPU. Details of the reserved register set is shown in Table 1.

The control unit itself can be either hardwired or microprogrammed. Some of the earlier 8-bit processors used a combinational logic circuit. Here, output lines are activated according to the combination of input signals. The control unit outputs are individual dedicated control lines, used to activate other sections within the CPU. For example, one line would enable the ALU for addition and another would enable SR for read onto the data bus.

Using the hardwired approach, only one control function can be activated at any one moment in time. Control of the CPU is achieved using a synchronised sequence of instructions, and resultant control functions. A downside of this approach is that unused binary combinations – or instructions – are permissible and cannot be trapped. Using these undefined functions can lead to bizarre and apparently unexplainable results.

Modern microprocessors such as the PIC family avoid this problem by employing a microprogrammed control unit. This is effectively a microprocessor within a microprocessor, consisting of a Microinstruction Address Register (MAR), Microinstruction Data Register (MDR) and a micro sequencer. Each incoming machine level instruction is decoded by an inbuilt routine which consults a microinstruction look up table in order to convert the instruction into a sequence of one or more microinstructions. Each microinstruction triggers individual control lines within the CPU.

The third component of the CPU is the ALU (Arithmetic Logic Unit). The ALU performs both mathematical functions such as add, subtract, multiple and divide as well as logic operations such as NOT, AND and OR.

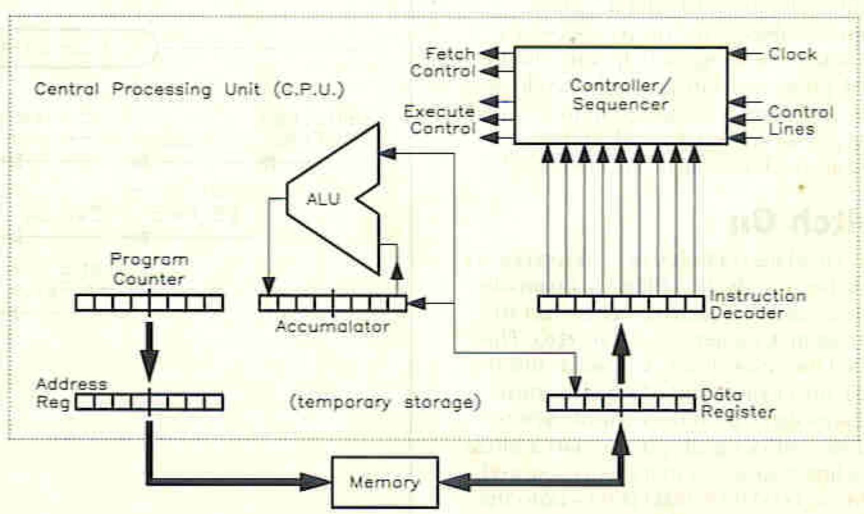


Figure 4. Instruction decoding with the CPU.

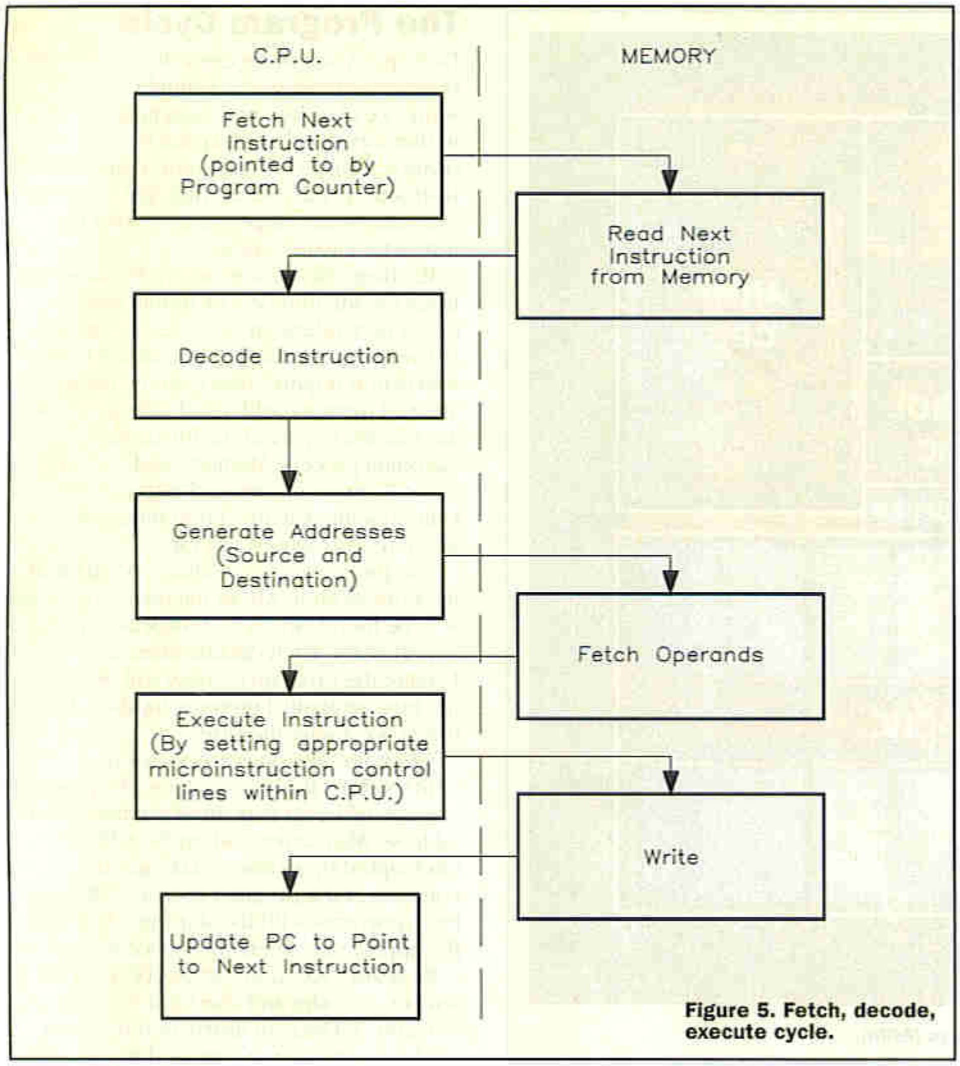


Figure 5. Fetch, decode, execute cycle.

Clocking

As we have seen, every action within a microprocessor is triggered by a control signal. The control signals themselves are triggered by the microprocessor or system clock linked to a thin slice of quartz crystal. The clock circuitry may be on the microprocessor or microcontroller as in the case of the PIC family, or on a separate chip. The quartz crystal is always separate because it is usually as large as the chip itself.

When an electric current is passed through the quartz crystal, it vibrates at a very precise and regular rate. The clock circuits use these vibrations to send a regular stream of pulses to the microprocessor's control unit. Nothing can happen without a clock pulse. The rate at which the clock sends out pulses is measured in millions of cycles per second (MHz) and controls the speed at which the microprocessor works.

Switch On

When a machine controlled by a microprocessor is switched on, the first thing that happens is that an electrical signal is sent direct to the Program Counter to set it to zero. This is called the reset signal. As soon as this is issued, the clock is started which in turn generates signal from the control circuits. The first control signals put the start address of the first instruction in memory – stored at address 0000 0000 0000 0000 – onto the address bus and fetch the byte stored at that address into the instruction register.

Speedup Techniques

Instruction execution speed can be improved by incorporating techniques such as internal concurrency, a pre-fetch instruction queue and pipelining.

Internal Concurrency

This is the ability of different sections within the CPU to perform their tasks at the same time. For example, the program counter could be loading the address register simultaneously with the ALU performing a calculation, the instruction decoder passing an instruction onto the controller and the data register being loaded with the next instruction.

Prefetch Queue

Use of prefetch queue involves fetches of several instructions in a single instance and storing them in a buffer within the CPU. External bus cycles are not required with every instruction fetch, leading to reduced execution times. However, if a branch is encountered, a completely new instruction sequence needs to be fetched.

Overlap Techniques

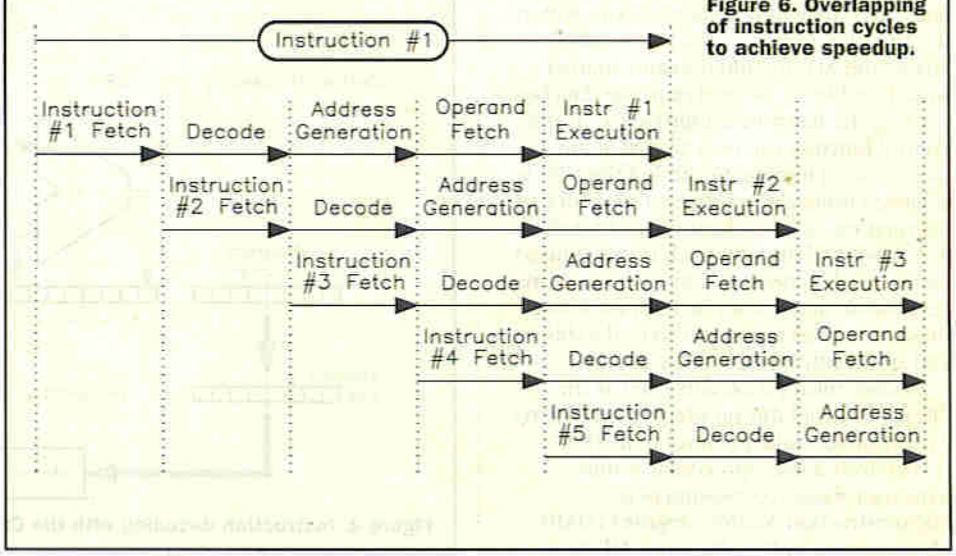
The instruction fetch-decode-execute cycles of successive instructions can be overlapped, as shown in Figure 6. One instruction can be executing at the same time as a second is being decoded and a third is being fetched from memory. This results in a certain degree of concurrency which in turn leads to a higher system throughput.

Memory

Microprocessors interface externally to Read Only Memory (ROM) and Random Access Memory (RAM) using a sequence of control address and data lines. The PIC family of microcontrollers includes memory on-chip. Figure 7 shows the interface signals between the CPU and memory. Memory locations are accessed via the address bus, while the contents of each memory location are transferred over the data bus, as shown in Figure 8.

Both the address and data buses are comprised of parallel wires running across the surface of the PCB between the CPU and the memory array. This can be either on-chip as in the case of the PIC family, or mounted together on a PCB, as in the case of a large system such as a PC. The number of parallel wires that constitute each bus varies with the word size of the CPU. In the case of the PIC, this is typically 8-bits wide, but can be 16-bit for a 16-bit processor such as the Intel 8086, 32-bit or 64-bit.

Figure 6. Overlapping of instruction cycles to achieve speedup.



The Outside World

The reason that we're looking at microprocessors and more particularly, the PIC family, is so that we can build useful applications and devices. It is no use creating complex programs to run on a microprocessor without the ability to send and receive signals for the outside world. A microprocessor controlling a machine such as a dishwasher or vehicle braking system must issue control signals to achieve a desired reaction and respond to what the machine is doing.

To enable the microprocessor to exchange information and react to external signals, I/O devices are assigned a memory location. Each I/O device is given its own address and is linked to the address, data and control buses. In this way, I/O devices are handled by the microprocessor in exactly the same manner as memory locations.

Input and output (I/O) devices are connected to the microprocessor via a bus. Again, this can be on-chip as in the case of a microcontroller such as the PIC family, or across a PCB. The majority of I/O devices work at different signal levels to the microprocessor. For this reason, interface devices are used, as shown in Figure 9, to translate signals between the I/O devices and the microprocessor.

There are three different types of I/O device used to translate data to and from a microprocessor. These are outlined below:

Analogue to Digital

The signals within a microprocessor are completely different to those produced by a heat sensor, or required to drive a motor. The microprocessor operates at two signal levels, high and low, typically 0V and 5V. An analogue device, meanwhile, constantly varies between two levels, typically 0V and 12V. For an analogue device, any voltage between these two levels is possible.

As the microprocessor can only handle digital signals with no intermediate states, analogue information from a device such as a heat sensor must be converted into a digital format. Similarly, before a microprocessor can drive a motor, its digital signal must be converted into a suitable format. This is achieved by using an analogue to digital converter or digital to analogue converter for the reverse operation.

As Figure 10 shows, a digital-to-analogue converter converts a string of binary signals from a microprocessor into a corresponding voltage relative to value of the binary input. Similarly, an analogue-to-digital converter transforms an analogue signal into a corresponding binary output. Again, the value of the digital output is relative to the magnitude of the analogue signal. Photo 4 shows an 8-bit analogue-to-digital converter from Philips, capable of sampling an amazing 600 million times per second.

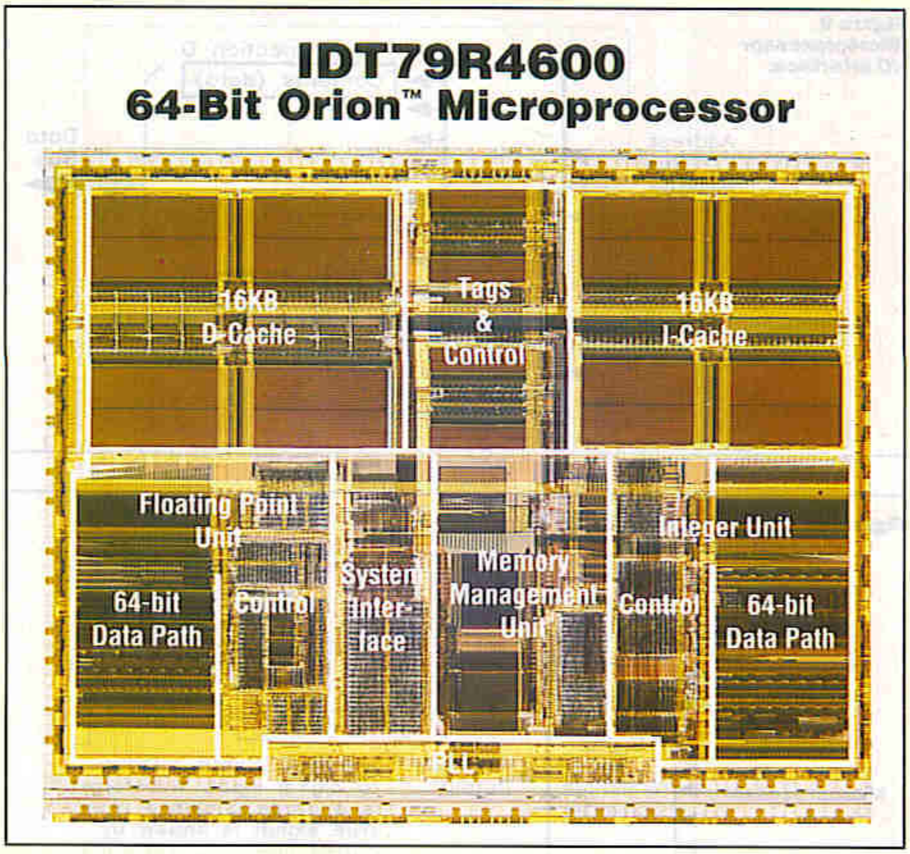


Photo 3. Key elements of 64-bit IDT79R4600.

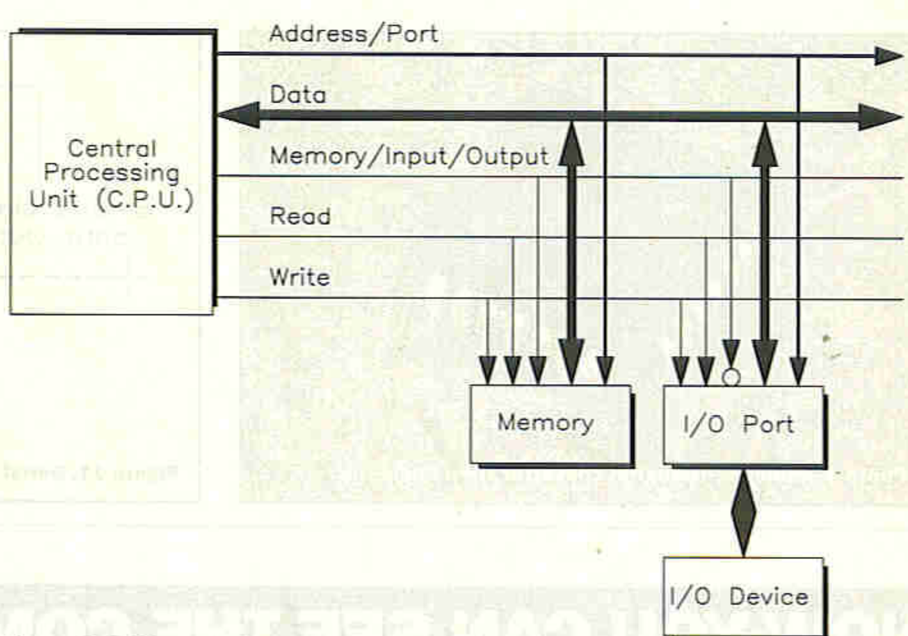


Figure 7. CPU/memory interface.

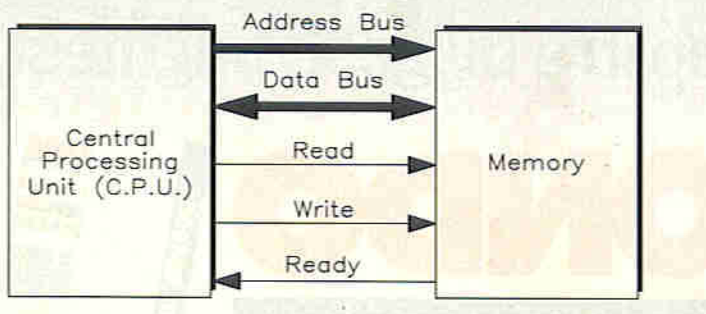


Figure 8. Memory access.

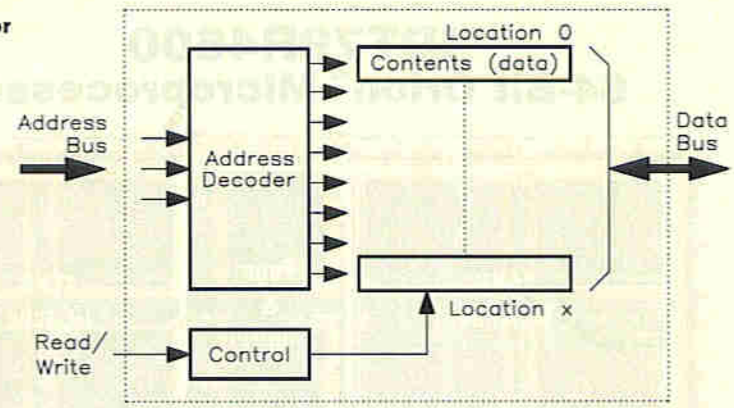
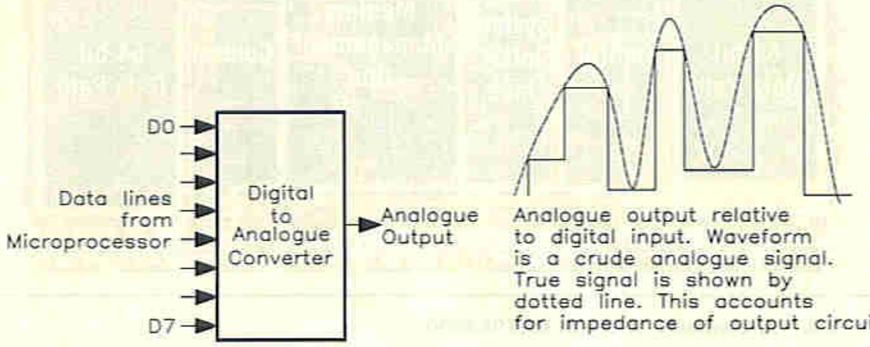


Figure 9. Microprocessor I/O interface.

Figure 10. Digital-to-analogue I/O converter.



Serial to Parallel

Electronic signals move round the microprocessor in parallel. Typically, the I/O bus of the PIC family of microcontrollers is 8- or 16-bits wide. Some peripherals such as a mouse, keyboard or tape stream, however, can only receive or transmit data in a serial format, one bit a time. In this case, a serial-to-parallel or parallel-to-serial interface device is used to convert signals, as shown in Figure 11.

In the case of the serial-to-parallel device, serial data is stored in a buffer by the interface chip until 8- or 16-bits are received. At this point, the buffer is emptied and its contents delivered to the microprocessor. A similar arrangement applies for a parallel-to-digital converter. Parallel data is stored in a buffer and delivered bit-by-bit to the output peripheral.

Buffering

The peripherals linked to a microprocessor often work much slower than the device itself. For example, a microprocessor could send 10,000 characters a second to a printer, but it takes a printer a minute or two to actually print them. To allow for this, additional memory devices are used to store the character codes while they are waiting to be printed.

In the next issue, we'll look at the PIC family in detail and examine the characteristics which make it ideal for the first time designer.

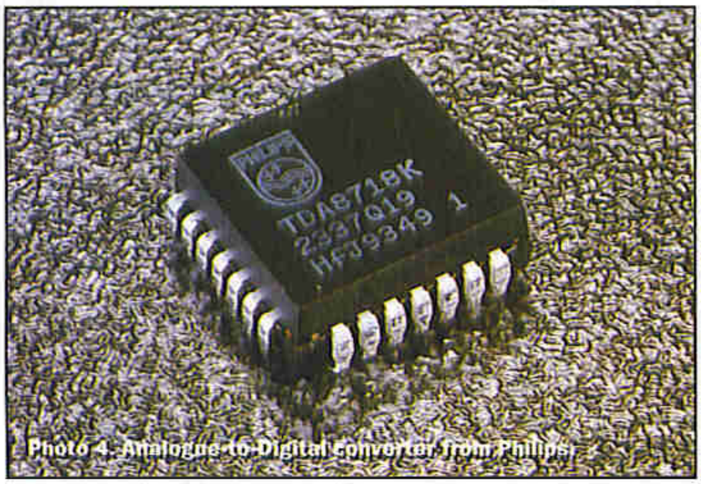


Photo 4. Analogue-to-Digital converter from Philips.

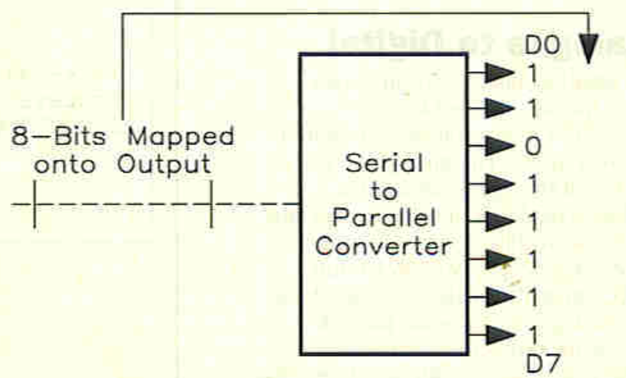


Figure 11. Serial-to-parallel I/O converter.

TECHNOLOGY WATCH

with Martin Pipe

Hello and welcome to this month's Technology Watch. Don't forget that you can e-mail me, at `whatnet@compulink.co.uk`, with your comments and suggestions for developments that you would like to see featured. This month, we'll be looking at light-emitting polymers (LEPs), and how they are set to revolutionise the display industry.

On 5th September, the components division of Philips signed a non-exclusive agreement which will give the giant corporation access to a revolutionary new type of low-cost display developed by a small start-up company based in Cambridge. The 21-strong company in question, Cambridge Display Technologies (CDT), holds a total of 26 patents in the field of LEPs, and shows all of the signs of being a British success story.

The original pioneering work on LEPs took place at Cambridge University's Cavendish Laboratory over seven years ago. Two scientists, Professional Richard Friend and Andrew Holmes, discovered that light emitting structures could be made from polymers – as opposed to traditional semiconductors (such as LEDs).

The discovery was, as with so many others, made by accident. While the scientists were investigating polymer transistors, they noticed that the device would glow whenever the current was applied. By 1992, the discovery's commercial implications had become clear and CDT was formed as a partnership between the university and a venture capitalist.

LEP displays are constructed by applying a thin film of the electroluminescent conjugated polymer (the original work used a compound known as poly p-phenylene vinylene) onto a glass or plastic substrate, which is coated with a transparent indium tin oxide electrode. An aluminium electrode is deposited on top of the polymer.

Applying an electric field between the two electrodes causes the polymer to emit light. Modifications to the chemical allow different colours to be emitted. If the chemical is arranged in isolated patterns – such as the seven segments of a numeric display, icons, or a series of individual pixels – characters and graphical symbols can be formed. LEPs offer many advantages over other display technologies, such as LEDs, LCDs and the fragile vacuum fluorescent displays. They offer a bright and readable display that can be viewed over a wide angle, unlike LCDs. Most LCDs – in particular those used on portable computer displays – need some kind of backlight to make the characters visible. These backlights, which consume power, are not required with the self-emitting' LEP-based displays.

LEP displays only require a low voltage – typically 5V, and at an extremely low current – to goad the material into emitting light. Current consumption is a tiny fraction of that needed to energise a LED of the same size. LEPs are therefore a logical device for battery-powered equipment, such as PDAs, cellphones and notebook PCs.

Another advantage of this type of display for computer use is the extremely fast response time. A rival development by Pioneer Corporation and Eastman Kodak, known as the Organic EL (electroluminous) display, claims a response time that is 50 times better than that from LCDs. Imagine – no more waiting for cursors to catch up with mouse movements!

The minimal depth, low material costs and mass-producibility of LEDs will allow displays to be used where they couldn't previously. On Philips' corporate web site, a section called Vision of the Future' `http://www.philips.com/design/vof` tantalises visitors with new and spectacular product ideas, such as video postcards and emotion containers.

LEPs could bring some of these ideas closer to reality, as well as making VR headsets practical (there are probably more sci-fi novels on VR than there are users at present!). Initially, though, Philips will probably use the devices in boring old CD players and car stereos. Pioneer has confirmed that its first product to use the similar EL display will be a car audio product.

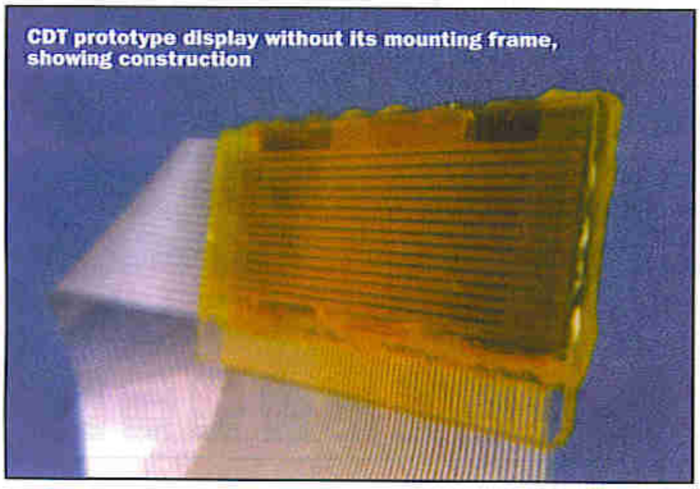
LEP displays do have a significant disadvantage when compared to other types. Operational lifespan is limited to 20,000 hours, although Philips and CDT are investigating ways of extending this to 50,000 hours before commercial production begins. Compare this figure with that obtainable from LEDs, LCDs and fluorescent displays.

I have an old Hitachi VCR, the fluorescent clock display of which has been working continuously for over 130,000 thousand hours. Clearly, LEPs may prove unsuitable for such applications – unless lifespan is to be deliberately engineered into a product (Hitachi, in 1981, probably didn't expect its VCR to still be in use 15 years later). It must be said that all previous generations of display suffered from short lifespans in their infancy, and improved gradually. LEPs will, no doubt, follow suit.

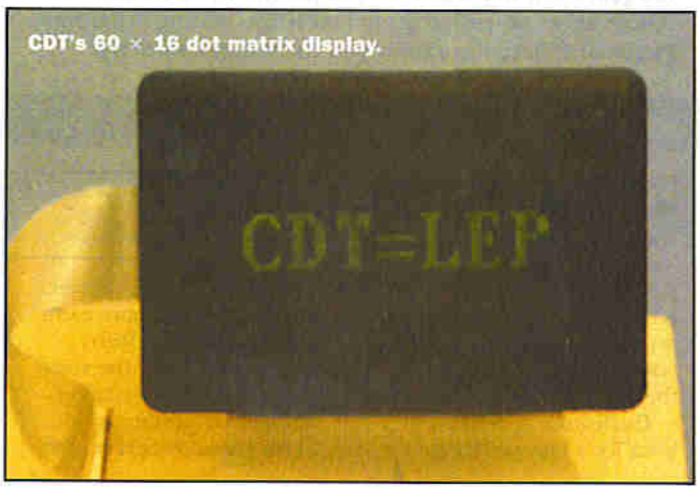
According to a spokesman, CDT is working on LEP displays that can display a variable brightness – in other words, greyscale. A rectangular mass of red, green and blue LEP pixel sequences could be formed, in a similar fashion to the coloured phosphors of a colour CRT, on the substrate.

The result of this would be a colour display that is incredibly cheap to manufacture. Pioneer claimed that it would have a small colour EL display prototype ready by the end of 1995, but nothing has since been heard.

When the colour displays are finally ready, though, notebook computers, PDAs and pocket TV sets would all benefit. Brightness, low power consumption and wide viewing angles are all tremendously important criteria for such applications.



CDT prototype display without its mounting frame, showing construction



CDT's 60 × 16 dot matrix display.

@Internet

If you want to take an early peek at one of the coolest programs ever to grace your computer screen, download a public beta of Adobe's PageMill version 2 from the main Adobe site (see Site Survey). It is a time-limited version, but till it expires in October, you will have the greatest, neatest and simply the most incredible way to design and create your own World Wide Web pages. At the time of writing Mac versions were on-line, and a Windows '95 version was due to appear shortly.

PageMill version 1 brought the simplicity of a what-you-see-is-what-you-get interface to Web page production, much as you get with any modern, decent desk-top publishing application used for creating the dead-tree, non-electronic counterparts. You could (and still can) enter your text to the styles you want, import graphics, and create complex forms for use on the Web, all in a simple, straightforward way.

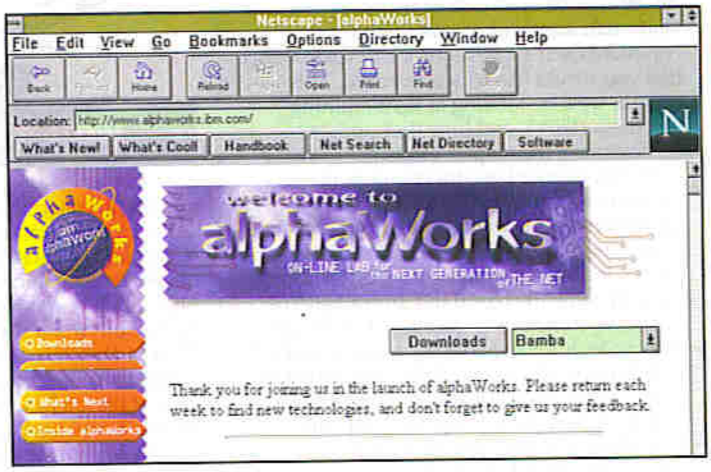
Die-hard HTML authors who had slogged for ages writing HTML coded pages either loved it or loathed it. Some simply said that you could not take the hard work out of Web page design, and that HTML code should never be constructed in such a way. Others, on the other hand, saw the sheer potential – coupled with the writing on the World Wide Web wall – and flocked to PageMill. After all, what's the point of grappling with code when you can do the job graphically. In a way, the whole argument encapsulates the difference between writing the low-level computing code to create a program to do a specific task, instead of using an off-the-shelf program which does the task for you. That's what the computer's there for after all. The day of good design, rather than good programming, came to the Web.

Nevertheless, version 1 was limited in its ability, not even trying to follow complex HTML variances such as frames and tables, not to mention Java applets and other goodies seen on the Web these days. However, this beta of version 2 of PageMill begins to take them in its stride, happily in the same overall and user-friendly interface designers accustomed to PageMill version 1 want. If the final release of PageMill 2 does not pull all the stops out of HTML file production, nothing will. Its ability to let a designer do the biz is going to be simply unrivalled. Other HTML production programs such as HoTMetaL Pro and the various awkward (and some downright user-unfriendly) filters for word processors don't hold a candle. Try it yourself and see.

Particularly nice is the method of creating a frame. You just drag the frame to the position you want. Unlike other so-called graphical HTML editing programs, PageMill 2 actually shows you the frames directly.

Business Encyclopaedia

Brainwave, at **http://www.n2kbrainwave.com** is a consumer and business information research service, that allows users to tap into more than 250 commercial databases, including access to trademarks and patents, worldwide company profiles such as credit reports, biographical information, financial news, professional journals, industry newsletters, engineering and scientific research, and international trade and marketing data.



IBM Opens Online Laboratory

IBM has thrown open the doors of its research labs to the Internet world, putting its hottest new Web technologies into users' hands months before they will become products and services. AlphaWorks, a combined online laboratory and Web site, provides the Internet community and software developers with free access to a wealth of advanced software technologies.

Located at **http://www.alphaworks.ibm.com**, AlphaWorks gives visitors the opportunity to preview, use and experiment with next-generation Internet technologies still under development. These include sophisticated Java programming tools and simple applets that make the Web experience more enjoyable.

Available initially on the site are:

- Applet Development Kit for Windows 3.1 – a development kit installed base of Windows 3.1 users.
- Bamba – an advanced audio and video streaming technology.
- NetRexx – a scripting language that lets Java applets to be written and run up to one-third faster.
- PanoramIX – a program enabling Web users to easily create and view 3-D images such as rooms or landscapes.
- ShockAbsorber – a TCP router which links different-sized Web servers and balances unpredictable traffic loads.
- WBI – an electronic Internet 'buddy' that helps users track and manage their Web surfing activities.

Contact: IBM, Tel: (0171) 202 3744.

Web Calling

New software from VocalTec allows users to initiate a voice conversation while viewing a Web site. For instance, a person scanning a clothing retailer's Web site could click on a 'phone call' icon, and connect directly to someone at the company via the Internet.

The feature is included in VocalTec's Internet Phone Telephony Gateway Server. PC owners must have extra software for their Web browsers to make the voice link work. A free version is available for testing at **http://www.vocaltec.com**.

Site Survey

The month's destinations

See page 80 for this month's destinations

Turn of the Century

With the coming of the next millennium, the computer industry is facing a double digit date dilemma. Until recently, to save precious storage space, computer programmers have used only the last two digits of the year to signify a date – 1996 is shown as 96, for instance. The year 2000 poses a problem for these systems, which will read '00' as 1900.

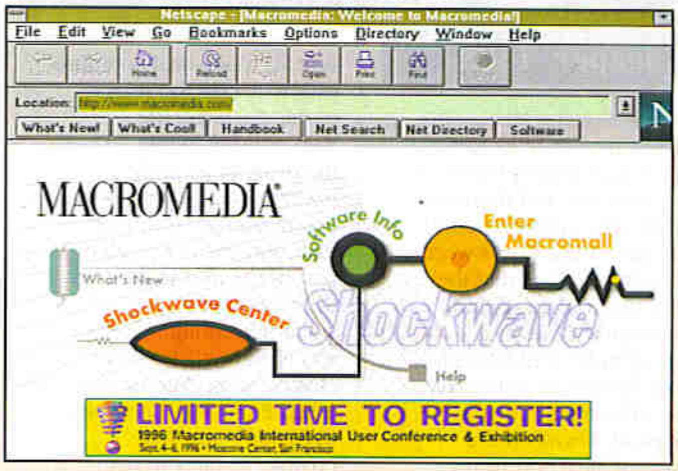
Industry analysts anticipate mayhem, while programmers scramble for a solution. The Year 2000 Resource Page at **http://www.deweerd.org/year2000** offers links to information and resources on the millennium date crisis, including descriptions of the problem, solution providers, vendor compliance statements, conference and seminar information, and a bibliography.

CD Quality Audio over the Web

The latest version of shockwave from Macromedia brings voice- and CD-quality streaming audio and up to 176:1 compression to the Web for the first time.

Web developers, traditionally limited by the bandwidth-intensive nature of digital audio, can now deliver streamed, compressed, up to CD-quality audio files using standard Web servers such as Netscape SuiteSpot server suite or Microsoft Internet Information Server. A number of Web sites have already committed to the audio standard, including Warner Brothers Records, Capitol Records, CNN Interactive, MCI, 2-Lane Media, IUMA (Internet Underground Music Archive), Addicted to Noise, MNI Interactive, and Musicnet. This can all be accessed from the Macromedia home page. The new Shockwave plug-in is available for free from Macromedia's Web site, at **http://www.macromedia.com**, for Windows '95 and NT, Macintosh PowerPC.

Contact: Macromedia, Tel: (01344) 761111.



BT Backs Microsoft Explorer

BT has teamed with Microsoft to package Internet Explorer 3.0 with its Internet suite. BT Internet customers will now be offered a complete Internet software solution comprising Internet Explorer 3.0 as well as Microsoft's companion e-mail, news and chat applications, communication stack and dialler facilities.

BT Internet carries a one-off registration charge of £20, and a flat monthly subscription fee of £15, giving unlimited use of all BT Internet services and applications.

For further details, check: **http://www.bt.com** or **http://www.microsoft.com**.

Contact: BT, Tel: (0171) 356 5369; Microsoft, Tel: (01734) 710021.

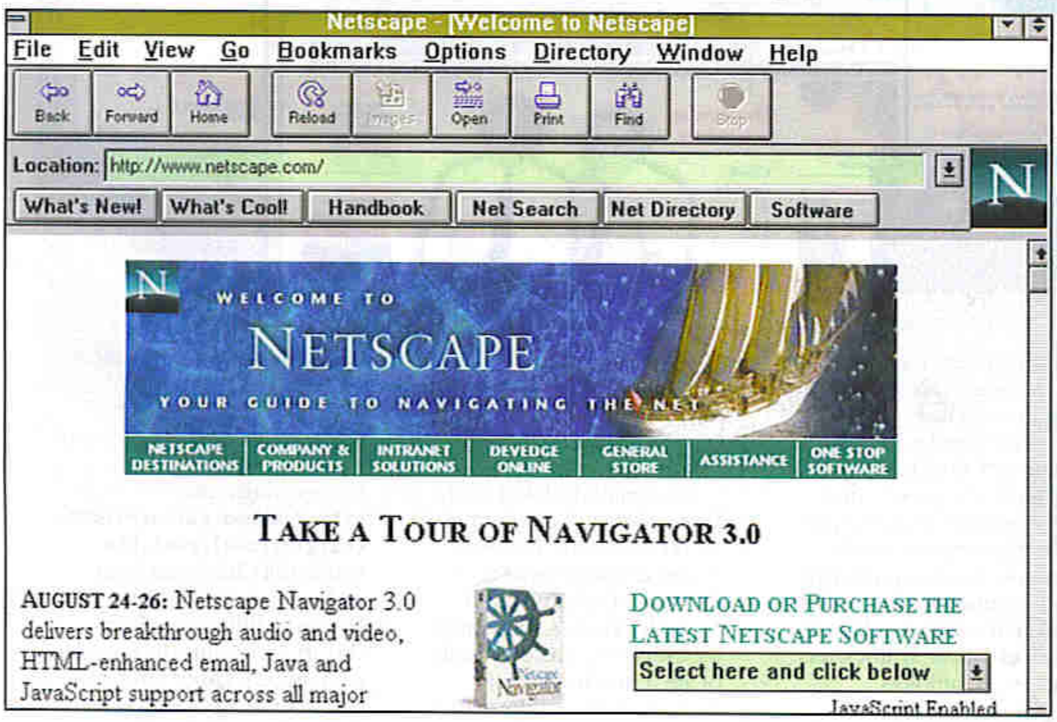
Browser Battle

For months, Internet rivals Netscape and Microsoft boasted about the technical advances they were making to their applications for viewing information on the Web.

However, when the new versions came out, they appealed to consumers, lauding instead their programs' free access to multimedia news, sports and entertainment on the Internet.

Analysts said neither Netscape's Navigator 3.0, nor Microsoft's Internet Explorer 3.0, was clearly better than the other.

To download a copy of either browser, check: **http://www.netscape.com** or **http://www.microsoft.com**.



Internet Can be as Addictive as Alcohol

According to a researcher at the University of Pittsburgh, surfing the Internet can be as addictive as drugs, alcohol or gambling. In a study of almost 400 men and women, researchers found Internet addiction hooked people into spending 40 hours or more a week online, most often involved in role-playing games or engaging in chat room discussions.

Psychologist Kimberly Young, assistant professor of psychology at the University of Pittsburgh's Bradford campus found that 76% of the subjects in the study spend an average of 40 hours a week on the Internet. Of the 396 people who met Young's criteria for addicted Internet users, 157 were men, while 239 were women.

The men were younger, with an average age of 29; the women averaged 43 years of age. The largest group of addicted users of the Internet were people who were not working outside the home, such as students or retired individuals.

@Internet

Cheaper ISDN

If you're using Microsoft's latest version of its Web browser Internet Explorer – version 3 – (and there are well over a million people already using it), it's worth bearing in mind that there is a bug in the program. Normally, a bug in a program's no big deal, but this one is potentially so important that you should download the official Microsoft fix for it as soon as you can. Apparently the bug means that computer hackers can access a personal computer via the Internet. All they need to do is set up a Web site and wait for a personal computer user to access the pages of the site using the Web browser. While the browser is on the hacker's site the hacker can download the computer's data, and even erase all or part of the information on the computer.

Funnily enough, the bug was found only by sheer chance, when Microsoft asked Princeton University to examine the Web browser's ability to use Java applets. While doing the work the university found the bug and notified Microsoft. The bug fix also clears up a few other (less potentially serious) known bugs.

Search Engine Pairing

Partnerships are the vogue at the moment in Silicon Valley. Big companies want access to hot technology, while start-ups want the customer base of their larger counterparts.

The latest pairing in the Internet market sees Yahoo and Digital announce the signing of a letter of intent to provide Digital's Alta Vista Web search service to users of Yahoo's Internet guide. Upon signing the agreement, Yahoo would ditch its own search engine, and feature Alta Vista as its preferred choice, with results displayed on the Yahoo Web site.

Yahoo users would continue to experience Yahoo's look and feel, directory services, content and search results, while gaining the benefits of Alta Vista's powerful, comprehensive performance for searching the Web.

For further details, check **http://www.yahoo.com** or **http://www.digital.com**.

Site Survey

The month's destinations

Above: Cool Web design page.

Above Left: CyberSound™ home page.

Left: Adobe home page.

Above: The Rayburn Piano Tuner.

The Adobe Web site can be reached at **http://www.adobe.com**. It's an invaluable site for anyone who uses Adobe computer software, and is a useful source of other information too.

Checkout **http://www.cybersound.com/** for all things in electronic music production. The site is run by InVision Interactive, Inc. which has established its position as a leading provider of sound libraries to the entertainment and professional recording industries. Musicians, producers and audio engineers already know InVision as a good source for wavetable audio samples that the company usually designs, records, publishes and distributes on CD-ROM and audio compact discs, for use with music synthesizers and audio samplers.

With the launch of its CyberSound™ technology, InVision created the first software audio architecture for leading PC platforms. You can read all about it and locate samples on the site.

You can find a lot of really fascinating stuff out on the World Wide Web. It never ceases to amaze what a diversity of information is available. There's something for everyone, whatever walk of life. Piano tuners, for example, can get information about computer software at **http://www.reyburn.com/**.

Meanwhile, Web page designers, hot from their flushes after downloading and trying out PageMill version 2 for free, might like to look at **http://cameo.softwarelabs.com/gini/cool/cool.htm** where Bill Chin's site is up and running for clip art. However, Bill's no ordinary clip art merchant. His is cool stuff indeed. Other links take you to other cool Web sites. Definitely worth a visit.

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