ETI
ELECTRONICS TODAY INTERNATIONAL

HEDGELINK!
Infra-red link
Hedgehog
detector

MISSIONS TO MARS
Science in the
lap of the Gods

COMPUTER RADIO CONTROL
for home
automation

Fader-Fuzz
Controllable
guitar distortion

PLUS
- New! Fast Fivers
- New! SPICED Circuits
- Review: Low cost pro PCB CAD

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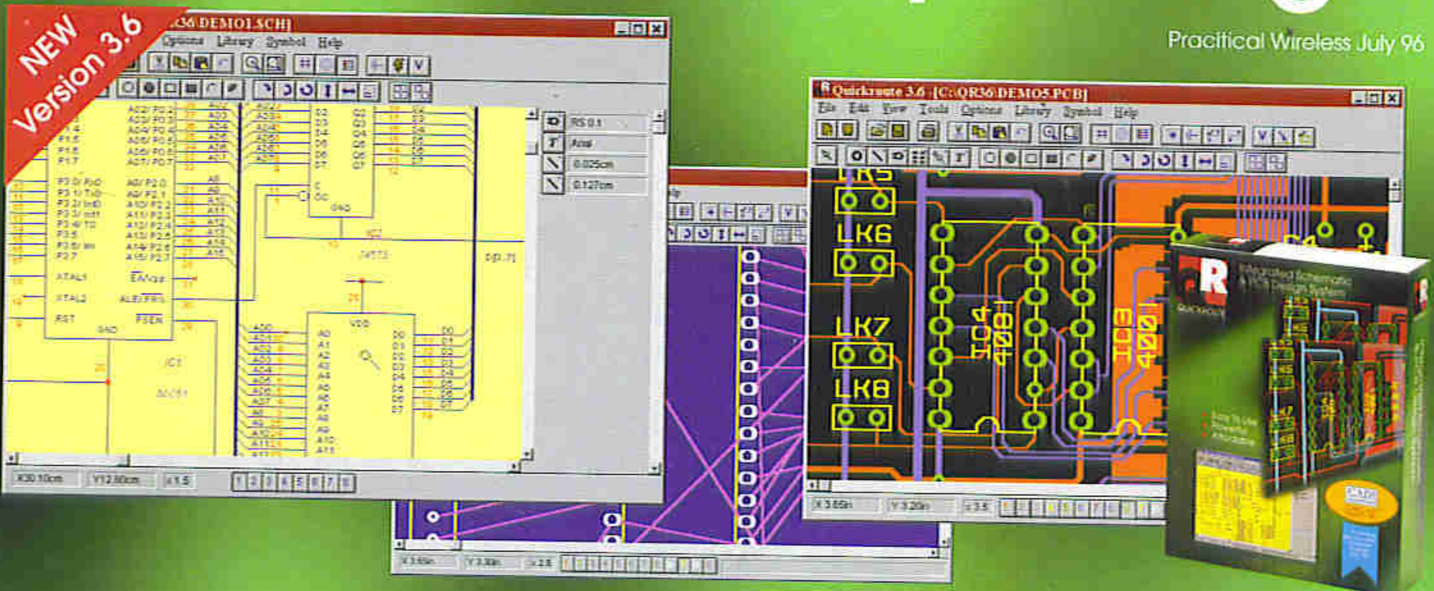
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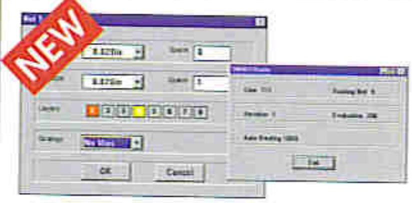
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& Features & Projects

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ETI "Hedgelink" Infra-red detector **19**

Asked how to detect our prickly friends late at night, Terry Balbirnie came up with an infra-red link from garden to house, and an ingenious switching suggestion. "Call home, Mrs. T!"

Spiced Circuits **31**

Starts this month: Owen Bishop presents an introduction to SPICE circuit simulation through SpiceAge, with exercises.

The "Fader-Fuzz" **35**

Subtlety is the magic of even the heaviest guitarists - Robert Penfold's Fader-Fuzz lets you fade in the fuzz, and fade it out again at the touch of a switch.

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Andrew Armstrong looks at the new low-cost EDWin package - a professional PCB CAD package now available at a constructors' price.

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In the third part of the series, Robin Abbott concludes the circuit of a PIC-controlled multi-pattern video mixer/fader. Plus: controlling the fader over a serial link.

The Little Mule electric fence controller **52**

Tired of the local wildlife cleaning out your garden pond? Bob Noyes has devised an electric fence controller than works with pulses for longer battery life.

Computer Radio Control for Home Automation **57**

Using radio link modules and a Turbo Pascal demo program, Dr. Pei An shows how his computer can control up to 255 receivers for domestic control

ETI 1996 Project and Feature Index **70**

To help you locate the project you want to build, and get the information.

Regulars

ETI
ELECTRONICS
TODAY INTERNATIONAL

News...

"Tardis" telephone box defies foes in downtown Brompton

To the callbox that knows it all, it must be a far cry from patrolling the shores of time and space to monitoring London's Earl's Court tube station.

Unlike it famous fictional relative, the Tardis-style police watch box is fitted outside as well as inside with the latest in vandal-proof communications technology. It has been used over 1,000 times by members of the public seeking police assistance since its installation twelve months ago. Supplied by Racal Acoustics, a member of the Racal Electronics Group, the Vandal Resist Telephone was modified for use by the Metropolitan Police and linked to a wide-angle covert camera mounted above the telephone. Pressing the button that automatically dials the switching centre via the PSTN (public switch telephone network) also activates the camera. The 'phone also incorporates a sensitive microphone that enables with switching centre to monitor sounds up to 30 feet from the watch box. The camera's-eye view of the caller and the surroundings is recorded as a digital image that can be stored for later inspection if necessary.

As the telephone is constructed on a single sheet of good, old fashioned stainless steel with no protruding wires or parts, it is highly resistant to assault by human or alien foes, and will simply switch itself off after a minute if triggered by anything that declines to speak to it.

The traditional-style watch box was installed after a survey showed that 66 percent of crime in the central sector of the Brompton division of the Metropolitan Police occurs around the Earl's Court Road underground exit - not such a far cry from the furthest reaches of the galaxy, after all.

A police spokesman said: "We required a telephone which is easy to use in an emergency situation, as well as being easy for tourists to operate." Perhaps the watch box made famous internationally by the BBC's Doctor Who give a clear signal that it is on the side of the time's law as well as that of the Time Lords. Racal telephones are to be found in locations ranging from the deep mines of Africa to hospital operating theatres in Southampton - but, unlike their time-travelling counterpart, they stay there. We hope...

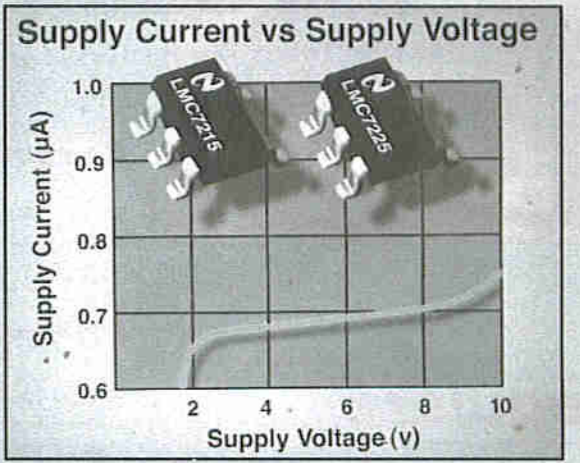
Tinypak comparators with rail-to-rail input

National Semiconductor have brought in two cmos comparators that combine rail to rail input stages and a guaranteed low 1 microamp maximum supply current over a wide 2V to 8V supply voltage range.

The ultra-low-power LMC7215 and LMC7225 introduce design flexibility to power-supervising and analogue conditioning applications in important consumer and industrial devices such as laptop computers, cellular phones, metering systems, hand-held electronics, and alarm and monitoring circuits. The LMC7215 has a push-pull output stage that allows operation with a minimum amount of power when driving any load. Using the LMC7225's open-drain outputs, designers can connect an external resistor so that the output can be used as a level-shifter to any desired voltage up to 15V.

Other significant features are input common mode voltage that exceed supply voltage rails for systems needed to monitor large input signals or operate from single supplies, minimum operating voltage at +2V (guaranteed at +2.7V and +5V) for systems with low voltages or multiple supply voltages, and a low typical supply current of 0.7uA for battery-powered devices. Both components are supplied in SOT23.5 TinyPak format as well as a standard SO-8 package.

For more information contact the National Semiconductor European Customer Support Centre tel. 00 49 180 5327 832 Fax 00 49 180 5121 215 (from UK).



Radio spectrum pricing receives support

Science and Technology Minister Ian Taylor has announced that proposals for the management of the radio spectrum based on market forces have received "strong backing" in the form of responses to the Government's White Paper on radio spectrum management (Spectrum Management: into the 21st Century, Cm 3252, 17 June 1996).

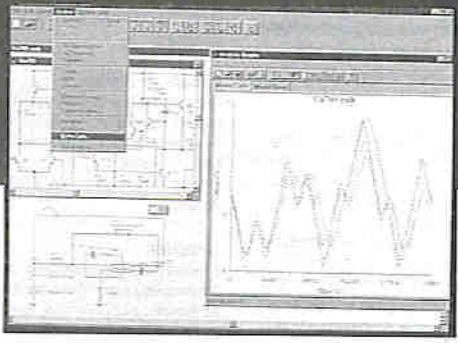
Mr. Taylor told the UK Radio Spectrum Conference in London in January: "Demand for this important resource is outstripping supply and its effective management is crucial to continued growth and success. I congratulate the radio industry on its impressive contribution to wealth creating, competitiveness and jobs ... 86% support for the White Paper proposals on spectrum pricing demonstrates widespread acceptance by the industry of the need for new spectrum management tools. I am delighted with the high level of support for our plans to introduce the new, market-based spectrum management methods, such as spectrum pricing and auctions, that are now needed to meet the challenges that lie ahead. The Radiocommunications Agency is now working with the industry to refine our proposals in preparation for legislation."

The White Paper attracted 120 responses from radio users, manufacturers and others. 86% expressed a definite view supported spectrum pricing. 87% supported administrative pricing and 49% the selective use of auctions as proposed in the White Paper. Copies of the analysis can be seen on the RA's web site at www.open.gov.uk/radiocom/rahome.htm or from the Radiocommunications Agency - tel. 0171 211 0211.

Electronics Workbench EDA for mixed-signal circuit simulation

Robinson Marshall (Europe) have announced Electronics Workbench EDA, a Spice simulation tool (based on the Berkeley Spice 3F) that offers established speed and features at a price level (below £800 in the UK) that will make it more widely available to design engineers. Over 10 times faster than the previous version, the new simulation package has 14 types of analysis to give more comprehensive investigation of the behaviour of circuit designs on-screen. Click-and-drag schematic control is used with 8,000 analogue component device models and more than 200 digital components and ICs in TTL and cmos, to simulate analogue, digital and mixed analogue/digital circuits, export to standard pcb layout packages and import and export standard Spice netlists.

Designers can use the Monte Carlo features to perform statistical analysis of circuit response to random variations of device parameters within a distribution of tolerances. This allows engineers to simulate the effects of real-world device tolerances on circuit designs before the design is built or manufactured. The package also has distortion and Fourier analysis features. The Distortion analysis calculates the magnitude of the harmonic components and allows the observation of the AC spectral distortion at any point in the circuit. The Fourier analysis calculates the spectral components of the transient response, including magnitude and phase. The data can be used for analysing networks and other frequency-dependent systems.



Other analysis tools include transient, DC operating point, AC frequency, noise, temperature sweep with transient, DC and AC response, model parameter sweep likewise, DC sensitivity, pole-zero, transfer function and worst case.

It is interesting that the availability of ever more powerful tools for PC use represent a shift from Unix-based systems to desktop PCs in engineers. Robinson Marshall sees this as part of a "revolution in the way electronics designers work ... comparable to the way PC-based word processing and spreadsheet programs revolutionised writing and accounting tasks in the early 1980s." In part that revolution was the start of a move away from centralised or dedicated systems to the flexibility of desktop systems and networking. Many designers, of course, have been working on small PC systems since cad first became available to them, and are also beneficiaries of gradually falling prices throughout the industrial software sector.

Electronics Workbench EDA runs under Windows 95, NT or 3.1 with Microsoft compatible mouse, 8MB of ram (12MB for Windows NT) (16MB ideally) and 5MB of hard disk space.

For information contact Robinson Marshall at Nadella Building, Leofric Business Park, Progress Close, Coventry CV3 2TF. Tel. 01203 233216 Web www/info@rme.co.uk email sales@rme.co.uk.

Overseas Readers

To call UK telephone numbers, replace the initial 0 with your local overseas access code plus the digits 44.

MODSMODSMODSMODSMODSMODS

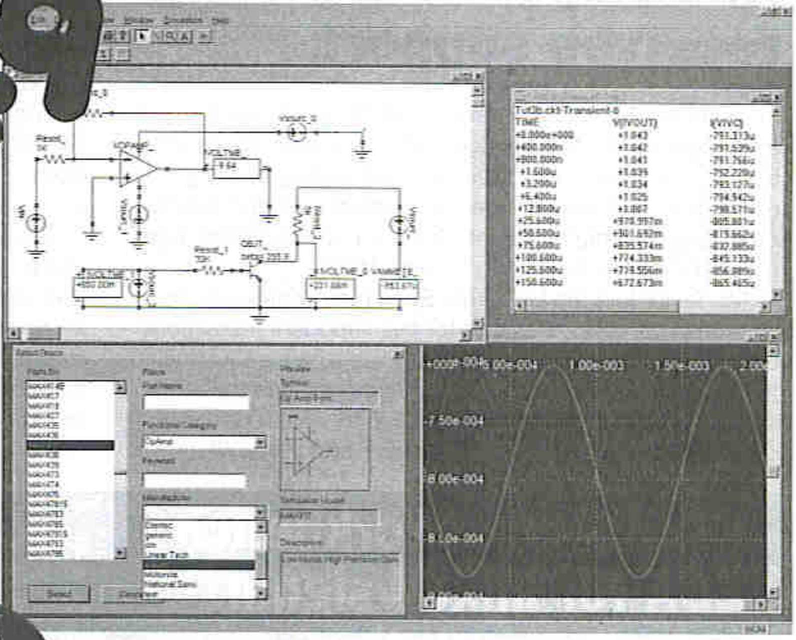
Variped ETI Vol.26 No. 2

For constructors who experience difficulty in obtaining the 27C16, the 27C32 can be substituted. The pin connections are almost identical, but pin 21 is A11 instead of programming voltage. In the Variped this pin is connected to Vcc, so that addresses 800H to FFFH will be addressed instead of 000H to 7FFH. Therefore the data must be programmed into this range.

New B^2 Spice V2

£149

Professional SPICE software at an unbeatable price



B^2Spice is the new SPICE simulation package offering a complete range of features and simulation options at a truly unbeatable price.

The SPICE 3F5 engine in this powerful 32 bit package makes light work of even the most complex designs and there is "no" limit on maximum circuit size.

Fully integrated and interactive B^2 Spice is the new choice for circuit design and simulation. Try it for 30 days with complete confidence and if your not impressed then return it

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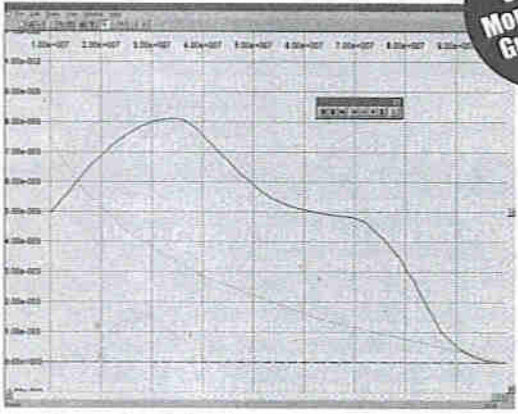

- Includes a complete and dedicated model editing package
- Fast 32 bit SPICE 3F5 engine
- Windows 3.X, 95 & NT
- CD ROM or 3.5" disk

Here is what some of those who have already tried B^2 Spice have to say about it

"B^2 Spice offers outstanding value for money. I can highly recommend it." Mike Moore CRI UK

"This professor and his students really appreciate the ease of use with which a schematic can be entered and a design simulated B^2 Spice is remarkable." Professor Richard Sandige, University of Wyoming

"B^2 Spice is easy to use and the graphics are excellent." Ray Lewis, Carter Burgess Consultants

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email: rd.research@paston.co.uk

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Just some of what B^2 Spice has to offer

Fully integrated and interactive
Build the circuit on the screen and set up the simulations by choosing options from menus and dialogues. Run the simulation and view your results without leaving the program.

Flexible visualisation of results
Results can be displayed in graphs, tables or directly in voltmeters and ammeters. Change from typical to worst case analysis and include the effects of temperature on components. You can customise everything, right down to the colour of an individual trace so you see just what you need.

Versatility
A plethora of components include resistors, capacitors, inductors, mutual inductors / transformers, controlled sources, bipolar junction transistors, zener diodes, power MESFETs, JFETs, MOSFETs, voltage regulators, operational amplifiers, opto-couplers, voltage comparators, quartz crystals, IBIS I/O buffers and switching matrix connectors and much more ***All devices and model parameters can be edited to suit your needs.*** You can also mpliment hierarchical circuits in your designs.

Power
The only limit on circuit size is available RAM. With B^2Spice there is no limit on the number of components or nodes in the circuit.

Models
There are literally thousands of them... The complete Berkeley SPICE model library as well as commercial libraries from manufacturers such as, **Motorola, Texas Instruments, Burr-Brown, Maxim, National Semiconductor, Comlinear, AMP, Elantec, Linear Technology, APEX** and many more. Included with B^2Spice is a complete model and symbol editing package. You will be able to create, import and edit your own custom models.

Commands
AC frequency sweep.
DC operating point.
Transient analysis.
Fast fourier
Noise.
Sensitivity
Distortion.
Tf (small signal transfer).

Simulation Options
Added facility for sub-circuits (macro-models).
You can set all simulation options.
Allows you to set initial conditions at all nodes.
Allows you to set initial guess at nodes for simulation.
Allow "not given" state for all values.
Full access to Berkeley SPICE simulation control options is provided. For example you can set global defaults for transistor channel lengths and widths! Plus much more.

Waveform Analysis
Display and compare multiple response curves in a single graph at the same time. B^2Spice simulation results can be selectively displayed and analysed graphically and in numerical format as well as exported to other applications. All of B^2Spice's display capabilities are completely flexible.

Devices & Stimulus for Simulation
Sinusoidal, constant, periodic pulse, exponential, single frequencyFM, AM, DC voltage, AC voltage, VCO, Vcc, piecewise linear, exponential, polynomial /arbitrary source, voltage-controlled voltage, voltage-controlled current, current-controlled voltage, current-controlled current, Lossy and ideal transmission line, MESFET uniform RC, current and voltage controlled switches are all available.

Cross Probing
Cross probing allows you to display waveform results simply by marking pins, wires and devices on the circuit drawing.
Monitor results while the simulation is in progress then plot the results on linear or log scales.

Graphs
Traces may be displayed as raw voltages and current values or further processed using arithmetic expressions, functions and Fast Fourier Transforms. View plot values corresponding to the cursor position on the graph and get data from multiple simulations in one graph. Split windows to allow multiple graphs to be horizontally aligned and compared.

Data Analysis
Position detection with mouse for data points. Import and export data to and from other industry standard SPICE programs. Polar Smith and Nyquist charts are all supported.

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BUILD YOU OWN WINDFARM FROM SCRAP New publication gives step by step guide to building wind generators. Armed with this publication and a good local scrap yard could make you self sufficient in electricity! £12 ref LOT81

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WIRELESS VIDEO BUG KIT Transmits video and audio signals from a minature CCTV camera (included) to any standard television! All the components including a PP3 battery will fit into a cigarette packet with the lens requiring a hole about 3mm diameter. Supplied with telescopic aerial but a piece of wire about 4" long will still give a range of up to 100 metres. A single PP3 will probably give less than 1 hours use. **£99** REF EP79. (probably not licensable!)

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CCTV CAMERA MODULES 46X70X29mm, 30 grams, 12v 100mA, auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm). Works directly into a scart or video input on a tv or video. IR sensitive. £79.95 ref EF137.

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UNIVERSAL SPEED CONTROLLER KIT Designed by us for the C5 motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 **REF: MAG17**

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Mission to Mars

Last month, Douglas Clarkeson scanned the Martian geology and the space missions of the last 35 years. In this second part, the roving machines of Pathfinder, and the ill-fated Mars-96 are the focus.

The Mars Pathfinder Mission is a radical development from the previous Mars Viking Lander mission. The key role of Pathfinder is to land and establish a base observational site with also the added scientific value of a 'rover' vehicle that can scout round the main base station. Mars Pathfinder was scheduled for launch from the Kennedy Space Centre, Florida between December 5th 1996 and January 3rd 1997.

The keynote of the Mars Pathfinder mission as part of the Discovery Programme is 'faster, better and cheaper'. The cost of the mission will be within $280 million - at around one tenth or less of the cost of the Viking twin lander mission. A lot of research and development, however, over a long period of time has gone into the technology of this mission - especially of the rover vehicle. Unlike the Viking missions which each had separate landers and orbiter vehicles, Pathfinder has no supporting orbital craft.

The landing site

The specific landing site for the Pathfinder landing was selected after an intense process of scientific consultation and review. One problem with Mars landings is that sites require to be at a sufficiently low height to ensure sufficient braking effect using parachutes in the thin atmosphere. Thus landings on high points of Mars would have to be undertaken solely with rocket braking.

Figure 11 shows the complex descent mode of the Pathfinder Spacecraft. The thin atmosphere of Mars implies that even with parachutes deployed, the craft will still be travelling relatively rapidly - around 50 metres per second at a height of 60 metres above the Martian surface. The braking rockets will quite literally fire at the last possible moment to achieve a touchdown at around 0.25 m/s on the surface. At a height of around 300 m a clutch of airbags will be inflated to cushion the moment of impact.

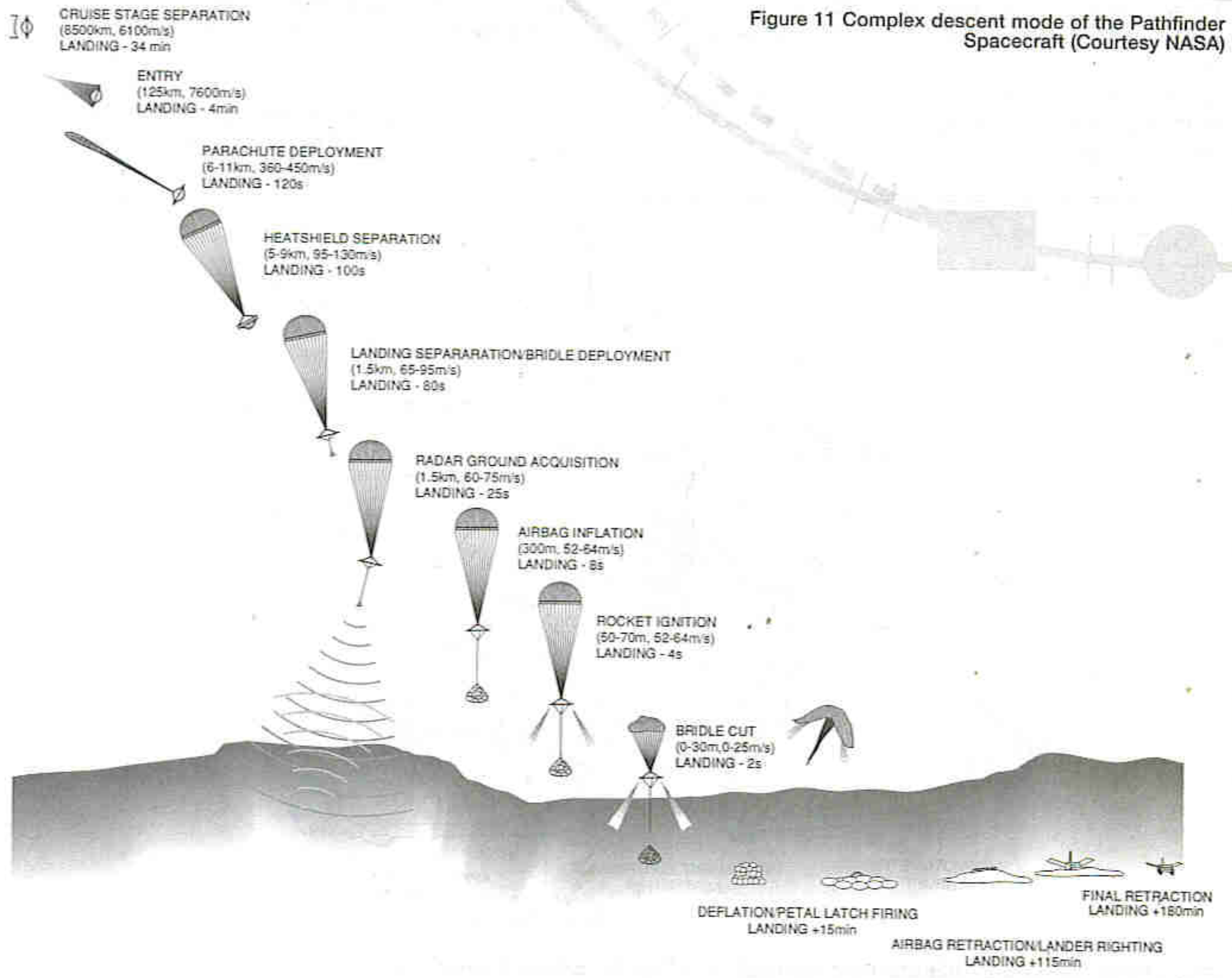

Figure 11 Complex descent mode of the Pathfinder Spacecraft (Courtesy NASA)

Table 5: Key parameters of the Mars Pathfinder craft

Launch mass	890 kg
Mass at entry to Mars	570 kg
Mass at landing	360 kg
Diameter of craft on surface	2.75 m
Mast height above ground	1.5 m

The choice of landing site is also influenced by the consideration of maximising the available solar radiation. At the anticipated July 4th landing date, the sun should be directly overhead.

The landing site selected is near the mouth is what is considered to be a giant catastrophic outflow channel at a location called Ares Vallis some 527 miles south east of the site of the Viking 1 Lander of 1976. It is anticipated that this site will contain a wide range of material including debris from old impact craters. It should be possible, for example, to analyse material from the reworked channels that would have been disturbed at some time in Mars's geological past.

The 'eye' of the Pathfinder probe will be a state of the art stereo vision CCD camera system that will allow vision of + 180 degrees in the horizontal plane and + 83 to -72 degrees in elevation. Each image provides data on an array of 256 x 256 active elements. Just as with the Viking lander, the visual data of surface details, evidence of wind activity, etc. is a key requirement of the mission. A filter wheel incorporated into the imaging assembly allows selection of up to thirteen filters to characterise a range of geologic categories. In addition, a lens in the sub system can be selected to image any wind blown deposits that come into contact with a small magnet on the lander assembly.

While the atmosphere on Mars is very thin, it is planned to determine wind patterns by monitoring wind socks at various heights above the lander.

Atmospheric Structure Instrument/Metrology package (ASI/MET)

The hallmark of the Mars Pathfinder mission could be described as 'more for less' with experiments reflecting improved sensitivity and function against a background of reducing costs. The ASI/MET package has a main function of providing meteorological data at the landing site for the duration of the mission. In addition, a sensitive accelerometer with a wide dynamic range will monitor the acceleration experienced by the craft as it descends towards the surface in the last 100 km of its approach. At initial entry into Mars's thin atmosphere, the braking acceleration will be in the micro-g region, while the landing event is likely to occur in the range 30 to 50g. The on board monitoring of the dynamics of the craft will also provide information to determine how well the modelled descent conformed to its actual descent.

The package includes also a Tavis magnetic reluctance diaphragm to measure pressure during descent and also after landing. An array of thermocouples will be used to measure temperature at various heights above the lander surface after landing. One sensor will be available to monitor temperature during the descent.

A wind sensor is designed to operate at the top of the mast on the craft and consists of an array of six hot wire elements. Increasing wind speed will characteristically cool the elements. Also, a series of three wind socks will be deployed at various heights above the surface. The craft imaging system will repeatedly image the orientation and angle of these devices in order to record variation in wind speed above the Martian surface. The dynamics of surface wind has a key role in the erosion of surface features of Mars.

Figure 12 gives an idea of the design of the Mars Pathfinder craft deployed on the surface.

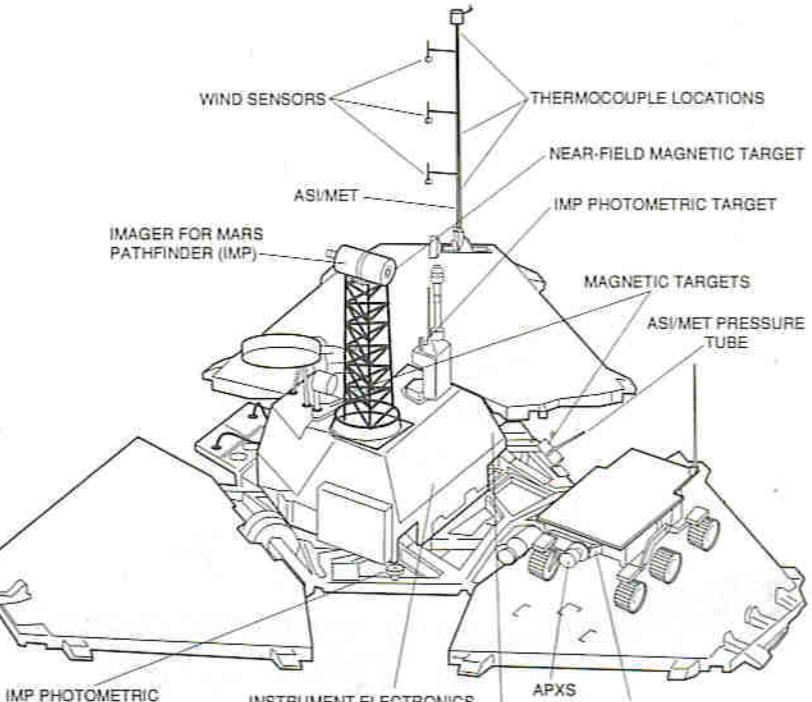

Figure 12 Design of Mars Pathfinder Craft deployed on the Martian surface (Courtesy NASA)

Rotational and orbital dynamics

Once the Pathfinder craft has landed, a ranger code sent to the craft from earth will activate a radio ranging code of precise and constant frequency. By measuring time of flight (ranging) and frequency shift (doppler) the absolute motion of the Pathfinder site on the Mars surface will be determined at any one time with an accuracy of a few metres. This in turn will provide details of any precessional 'wobble' that Mars may have. This could provide a relevant clue in the process of unravelling previous climate changes of the planet.

The Mars microrover

The key feature of the Pathfinder mission is the increased scope for observation provided by its 'microrover', called Sojourner, illustrated in figure 13. A key constraint in the design of such a vehicle has been its weight. NASA scientists have succeeded in designing it successfully within its weight limit of 11.5 kg.

The vehicle is designed with independent high gear ratios of 2000:1 on each of its six wheels in order to allow it to negotiate difficult terrain and in particular soft sandy deposits.

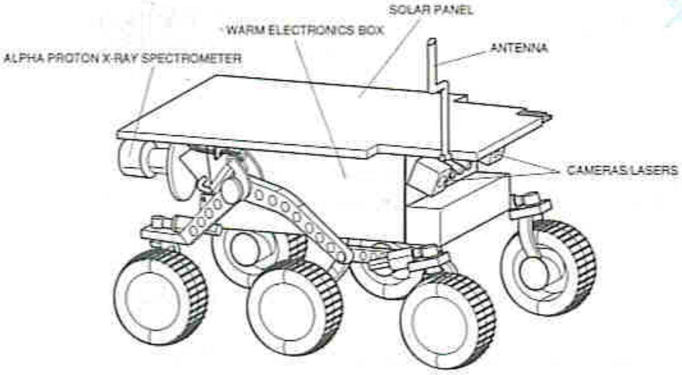

Figure 13 Above Diagram of 'Sojourner', the Mars rover of the Pathfinder mission (Courtesy NASA)

Figure 14 indicates one of the prototype six wheel rovers developed previously by scientists at JPL. Note the independent steering on rear and front ends.

The rover is essentially powered by means of a solar array of gallium arsenide on germanium which will provide a maximum of 16 watts of power at a voltage of around 16 V. A lithium battery of 150 watt-hours' capacity will provide reserve power for in flight checks and also for activities at times when no solar power is available.

The microrover is only 630 mm by 480 mm in size, has wheels 13 cm in diameter and has a top speed of 0.4 m/s with normal driving power requirement of 10 W. Sojourner will probably only travel a few metres from the main station in order to achieve its key goals.

The microrover is designed to withstand the extreme cold (-110 C) of a Martian night. Sensitive electronic components are housed within a 'warm electronics box' which utilises primarily heat insulation and resistive heating components (active during the day) to maintain component temperatures within the range - 40 C to + 40 C during the Martian 'day'.

The microrover is characterised by a complex electronics sub system for computer control of data capture from an array of instruments and also control of power distribution. For its diminutive size, the microrover is an exceedingly smart vehicle. The actual vehicle is controlled and guided by switching its set of wheels independently and also controlling rear and front steering motors. For a specific excursion, the rover is provided with information about its end point co-ordinates though will autonomously use laser striping and camera system to determine the presence of obstacles in its path and hence 'think' for itself.

Advanced software techniques is the key to command and control of the micro rover. The key part of the system is a Silicon Graphics workstation which acts as the micro rover control station. Back at base at Pasadena, a 'Mars room' filled with sand and rocks is being set up to practice operations with duplicate systems. This is to bring the operations team up to speed when the time comes to direct and control the micro rover for real.

The Rocker bogie system provides excellent mobility. While the technology of the Mars rover is considerable bearing in mind the specialist tasks it has to undertake, the wide availability of state of the art technology in theory allows other teams of technology players - such as in universities and colleges - to replicate their own autonomous rover

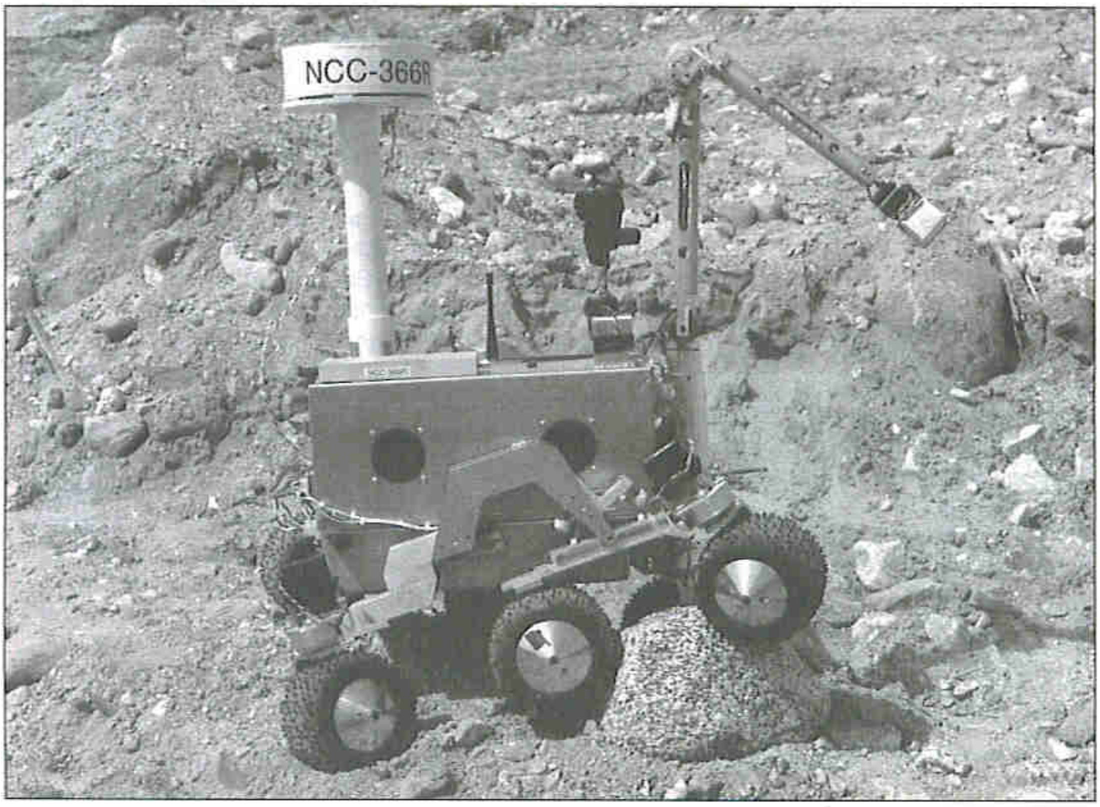

Figure 14 NASA prototype of present Sojourner vehicle using rocker bogie design and with six wheels (Courtesy NASA)

Figure 15 View of prototype rover 'Robbie' - a considerably more massive vehicle weighing 2 tonnes (Courtesy NASA)

vehicles. It would be quite a spur to innovation to organise a Mars race across some inhospitable corner of our planetary surface.

For those science fiction fans who are aware of the film 'Forbidden Planet', there is in figure 15 possibly a passing resemblance to Robbie, the wizard robot who starred in the film. In our figure 15, Robbie, or big Robbie as may be more apt, weighs about 2 tonnes and is 4 metres long and two metres wide. This was obviously a design for a 'get away from it all' excursion from a main Mars landing site.

Alpha Proton X-Ray Spectrometer (APXS)

One of the key scientific experiments implemented on the Rover is designed to locally characterise the elemental composition of material on the surface of Mars. The Alpha proton x-ray spectrometer used to determine this data is one of a design which previously was developed for the Russian Vega and Phobos missions.

It operates by irradiating specimens with alpha particles in order to interact with the nuclei of the atoms which in turn produce characteristic x-ray spectra and also protons. Analysis of the returned x-ray spectra, scattered alpha particle spectra and protons can identify elements present with and also provide information on their relative abundance.

Elements with atomic numbers 9 to 14 (fluorine, neon, sodium, magnesium, aluminium and silicon) provide very characteristic proton spectra, while scattered alpha particle spectra provide better detection of lighter elements such as lithium, beryllium, boron, carbon, nitrogen and oxygen.

The APXS head is deployed on a mechanism that allows selection of sampling site. The sensitive electronics of the equipment is housed within the Rover in a temperature controlled unit. The data from this probe will certainly be of interest to scientists engaged in the current and future study of Mars originating meteorites since this will give a base line on the typical composition of Mars rocks.

Table 6: Key parameters of the Mars-96 craft

Orbiter mass	6000 kg
Orbiter cross section	3 x 3 m
Orbiter height	9 m
Scientific instruments	17
Planned orbit height	300 km
Small station mass	50 kg
Small station cross section	1.08 x 1.08 m
Height	0.6 m
Penetrator mass	65 kg
Penetrator length	2 m
Penetrator diameter	0.6 m
Mission lifetime	700 days

The Mars-96 mission

The efforts of Russia in solar system studies over the next 10 to 15 years will be directed towards Mars. The Mars-96 project was the first major mission in this series. Mars-96 had planned to deploy an orbiter, two small autonomous stations and two penetrators to investigate underlying surface composition. The Russian mission was to be an 'experiment rich' mission with 23 separate experiments, many of them developed in the UK. The launch of Mars-96 mission took place on November 16th 1996 from the Baikonor cosmodrome and was due to arrive at Mars during September 1997.

After an apparently successful launch by a Proton rocket with first stage separation at 165 km, booster rockets failed to engage to lift the craft out of Earth's gravity. Controllers briefly regained contact with the craft though this was lost after some three minutes. The craft fell into the deep waters of the Pacific Ocean near Easter Island. This is both a major blow to the scientific investigation of Mars and to the Russian Space Programme, which badly needs some successful missions. It is felt, however, that much of the resources and expertise of the Russian Space Programme is tied up with the development of the Space Station - leaving insufficient to properly configure and validate the function of other complex missions such as Mars-96.

UK groups active in developing instruments for Mars-96 include Imperial College London (magnetic field measurement), Mullard Space Laboratory Holmbury (investigation of ancient water flow) and Kent University (soil composition and water detection).

It is important, however, to appreciate the wide scope and complexity of the instrument-load of Mars-96. Also, Russia is developing a rover vehicle such as the Pathfinder 'Sojourner' for inclusion in future missions to the red planet.

Mars-96 was very much an Alladin's cave of scientific instrumentation with a high degree of international co-operation in many of the items which involves most of the states of the European Union, especially France, Belgium and Germany. A significant number of projects also involve co-operation between Russia and the USA.

The spacecraft has been manufactured by the Lavochkin Association, based in Moscow. Key Russian scientific groups

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BU184	100P	BU508VF	100P	IRF740	400P	OC28	350P
BU204	65P	BU801	70P	IRF820	150P	OC29	250P
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BU209	90P	BU2520DF	225P	IRF9640	375P	2N3054	40P
BU225	120P	BU2525AF	325P	IRFBC30	200P	2N3055	38P
BU226	120P	BUH315	200P	IRFC40	400P	2N3055H	50P
BU312	90P	BUH515	200P	MJ2501	100P	2N3440	45P
BU325	55P	BUH517	275P	MJ2955	55P	2N3441	175P
BU326A	75P	BUH715	425P	MJ15003	250P	2N3442	85P
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BU406D	85P	BUT12	80P	MJ15015	250P	2N3772	90P
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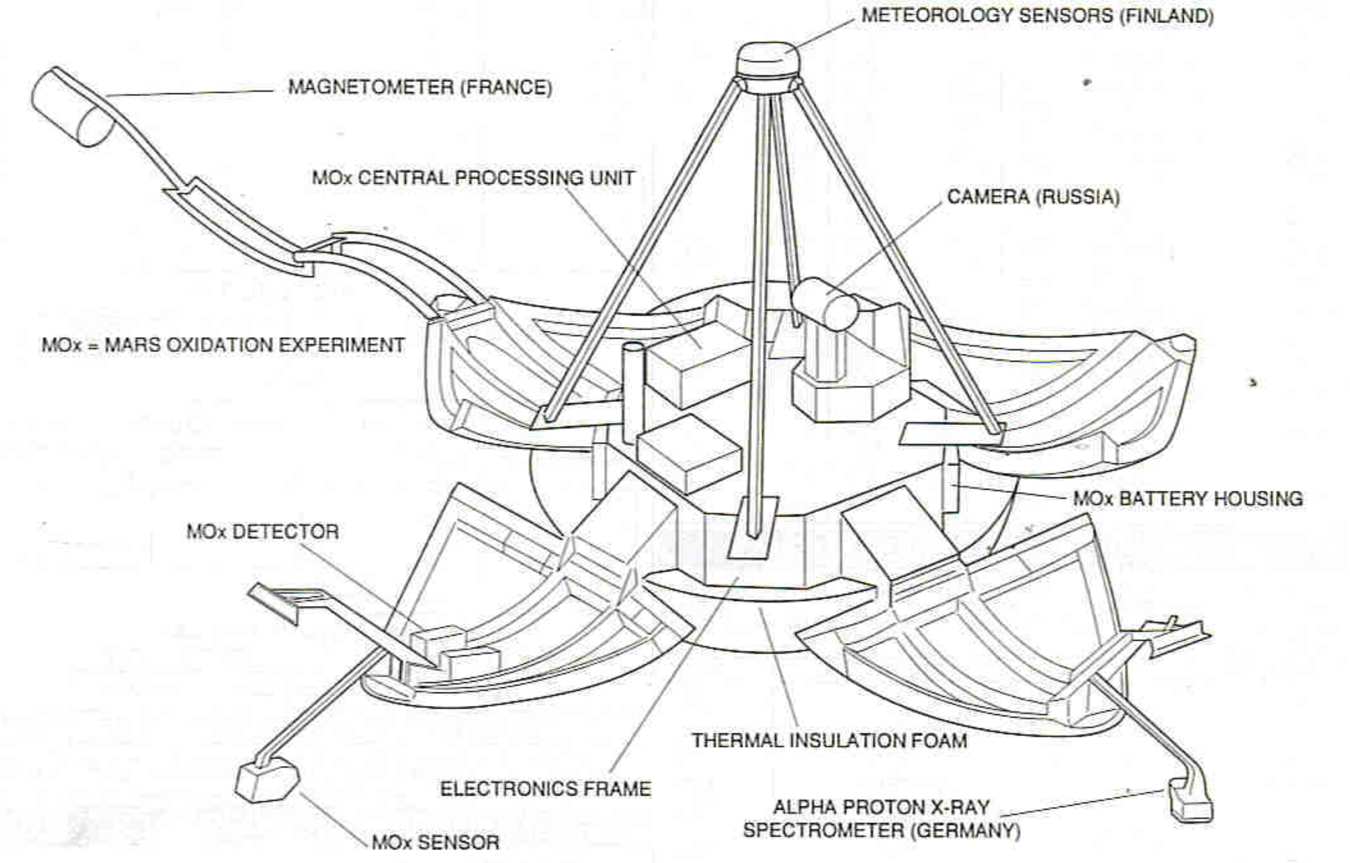

Figure 16 Design of the small station lander of Mars-96 project (Courtesy NASA)

involved in directing the mission include the Space Research Institute, the Institute of Geochemistry and the Analytic Chemistry of the Russian Academy of Sciences. Scientific experiments are summarised in the following table 7.

The penetrator experiments would probably have been related closely to the form of experiment planned for the previous Phobos missions. A wide range of detailed experiments were also planned for analysis of the plasma environment at the orbiter. The design of the small station is indicated in figure 16.

Thus, like Pathfinder, Mars-96 was configured with a sophisticated stereo camera system. Mars-96 had planned to carry more, however, in terms of instruments to measure the spectrum of radiation from the sun and also background of gamma and neutron radiation.

The IR-Radiometry and Photometer experiment was designed to determine the thermal inertia of the Martian surface within daily and seasonal temperature regimes. Such studies would have provided insight into the origin of local and regional winds and the occurrence of associated dust storms. The system would have been able to map surface conditions with an accuracy of 0.5 degree and with a spatial resolution between 0.1 and 1 km per pixel. The instrument would have been able to detect concealed heat sources as may occur in the vicinity of areas of historic volcanic activity.

The wide angle stereoscopic TV camera was built around 3 CCD arrays and had a spatial resolution at 300 km orbit of 96 m. It was specifically designed to look at larger time-varying phenomena such as dust storms and cloud activity.

Table 7: Summary of Orbiter experimental packages of the Russian MARS 96 mission

Description	Function
ARGUS	Stereo spectral imaging system
PFS	Planetary IR Fourier spectrometer
TERMOSCAN	Mapping radiometer
SVET	Mapping high resolution spectrophotometer
SPICAM	Multichannel optical spectrometer
UVS-M	Ultraviolet spectrophotometer
LWR	Long wave radar
PHOTON	Gamma spectrometer
NEUTRON	Neutron spectrometer
MAK	Quadropole mass spectrometer
ASPERA-S	Energy/mass ion spectrograph
FONEMA	Fast omnidirectional non-scanning energy/mass ion analyser
DYMIO	Omnidirectional ionospheric energy-mass spectrometer
MARIPROB	Ionospheric plasma spectrometers
MAREMF	Electron analyser and magnetometer
ELISMA	Wave complex
SLED-2	Low energy charged particle spectrometer
PGS	Precision gamma spectrometer
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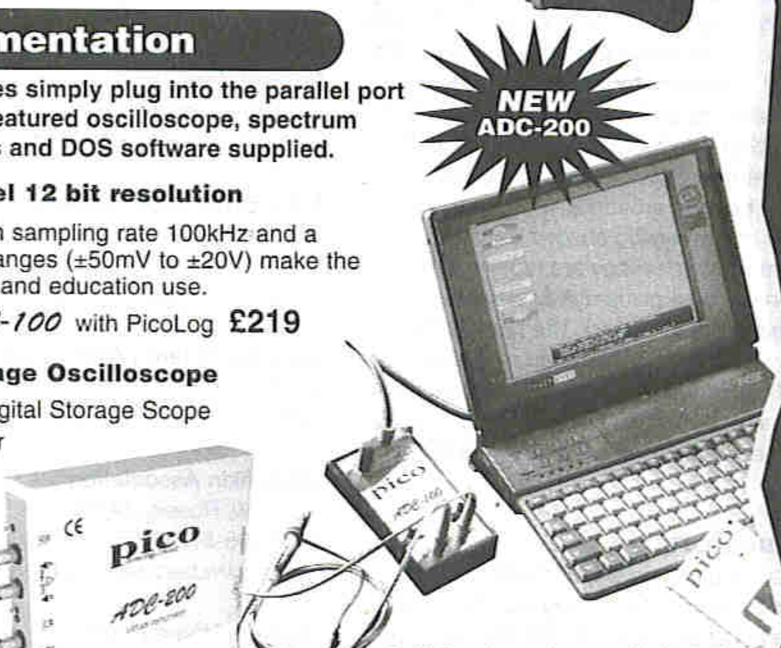

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The multifunctional high resolution stereoscopic TV camera was to provide imaging to spatial resolution of 12 m over wavelength bands from 400 nm to 1000 nm. The highest imaging resolution of the Mars-96 orbiter would have been about three times better than the Viking resolution, but ten times poorer than that of the Mars Global Surveyor. Conversely, however, it could have scanned the surface faster.

An ultra compact quadropole mass spectrometer had been implemented to analyse the ion and neutral atom composition at the orbit of the satellite. This would have provided general data on a range of parameters and included data on the relative Isotopic ratios of isotopes of oxygen, neon and argon and also hydrogen and deuterium.

One unique experiment on board Mars-96 was a neutron spectrometer to detect neutrons emitted as a result of interactions of galactic and solar cosmic rays with surface material of Mars. On earth, cosmic rays are largely absorbed within the atmosphere but on Mars the surface is exposed directly to cosmic ray bombardment. The detector sensitivity would have allowed water to be detected under layers equivalent of 100 g/cm2 and measure ice thicknesses up to 250 g/cm2 at the polar cap. The detector itself would have detected neutrons by the interaction with a Helium isotope to release gamma rays.

On a similar theme, the gamma-spectrometer would have used a range of gamma ray detection systems to measure the natural radioactivity of surface rocks and also the induced gamma ray emissions arising from cosmic ray bombardment of the surface.

Of key interest to Mars scientists is to determine the extent of occurrence of ice-bearing rocks under the Martian surface. The GRUNT long-wave radar experiment would have probed the Martian surface with pulsed radio frequencies in the frequency range 0.17 to 5 MHz. This experiment would have determined both the depth of occurrence of ice-bearing rocks and their geographic distribution. This experiment could provide useful insight into where the water on Mars has gone.

A multichannel optical spectrometer would have allowed analysis of variation of water, carbon monoxide and ozone in the Martian atmosphere with also temperature profiles and aerosol profiles being determined. The spatial resolution of imaging data would have been at around 8 km.

Minerals tend to have characteristic absorption bands within the solar spectrum so that as they are receive light from the sun, absorption will take place at key wavelengths - enabling specific minerals to be identified. The high resolution mapping spectrometer would have undertaken mapping of the Mars surface over 14 spectral bands and 32 tracks, each of which on the surface would be 0.75 km wide. The instrument would have been able to scan 40% of the planet's surface in a year.

A word to our educators

The current round of Mars exploration is being used by educators in the USA as a means of engaging the interest of young people in science in general. After all, people put more effort into things that they find stimulating and interesting. As a parallel, is there any intention to include these new developments in science education in the UK?

Comment

With the advent of Surveyor and Pathfinder, the degree of knowledge of Mars will - if all goes well - increase significantly. Recent developments in analysis of Martian meteorite samples will act to force the pace of an automated sample recovery mission where a lander can select samples for recovery to earth.

A manned landing on Mars, while technically possible, would at present be so expensive that it is at least 20 years off and dependent on a successful outcome to the International Space Station. It would clearly, however, be a mission with a high level of international cooperation. With the debate of European Monetary Union in play, the huge budget deficit of the USA, and the continuing political and economic uncertainty in Russia, the main current players will no doubt seek sources of new funding - such as the emergent economies of the Pacific Rim.

It is perhaps, also, just the time for Hollywood to fall to earth with a Mars exploration blockbuster.

References

Mars: The Next Step, AE Smith, Adam Hilger, 1989

1996 Mars Missions, NASA Press Kit, November 1996.

The Mars Global Surveyor Mission: Return to the Red Planet, NASA, ref JPL 400-551 8/95

Search for Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001: McKay et al in Science, 16th August 1996, 273(5277):924-930
http://www.eurekalert.org/Elert/current/public_release/mars/924/924.html

NASA Ames Space Science Discoveries
http://www.space.arc.nasa.gov/division/discover.html

Points of Contact

NASA-Ames Research Center, MS-239-4, Moffett Field, CA 94035.

Public Information, Jet Propulsion Laboratory, California Institute of Technology, NASA, Pasadena, California 91109, USA. Tel 001 818 354 5011

Mars Exploration Office, Jet Propulsion Laboratory, MS 180-401, 4800 Oak Grove Drive, Pasadena, California, 91109-8099, USA. Tel 001 818 354 6277
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http://www.berc.rssi.ru/LA/frames4.htm

Mars-96 Home Page
http://www.iki.rssi.ru/mars96/mars96hp.html

Mars Global Surveyor Home Page
http://mgs-www.jpl.nasa.gov/mgs-home.html

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Cover Image: Mars Global Surveyor being tested in thermal vacuum chamber (Courtesy Lockheed Martin.)

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Infrared "Hedgelink"

Want to detect wildlife in the garden? Terry Balbirnie's infra-red link creature-detector will be on the alert - especially for hedgehogs.

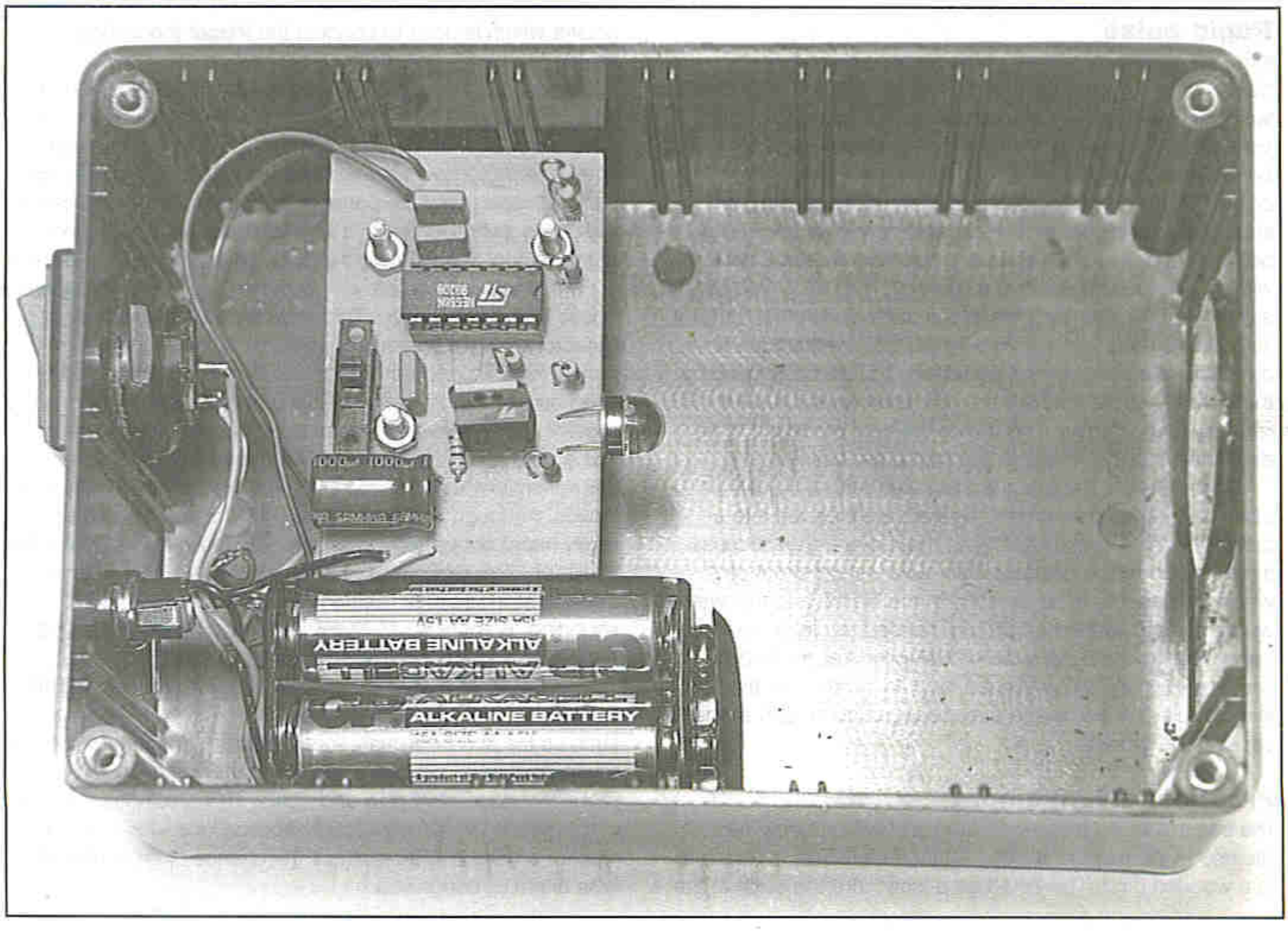
This infra-red link detector circuit, nicknamed the "Hedgelink", was produced in response to a request from a hedgehog lover. He needed a circuit that would provide a signal inside the house to inform the family that one of their favourite prickly prowlers might be paying them a visit. This would avoid the children having to take it in turns to keep watch over the garden every night.

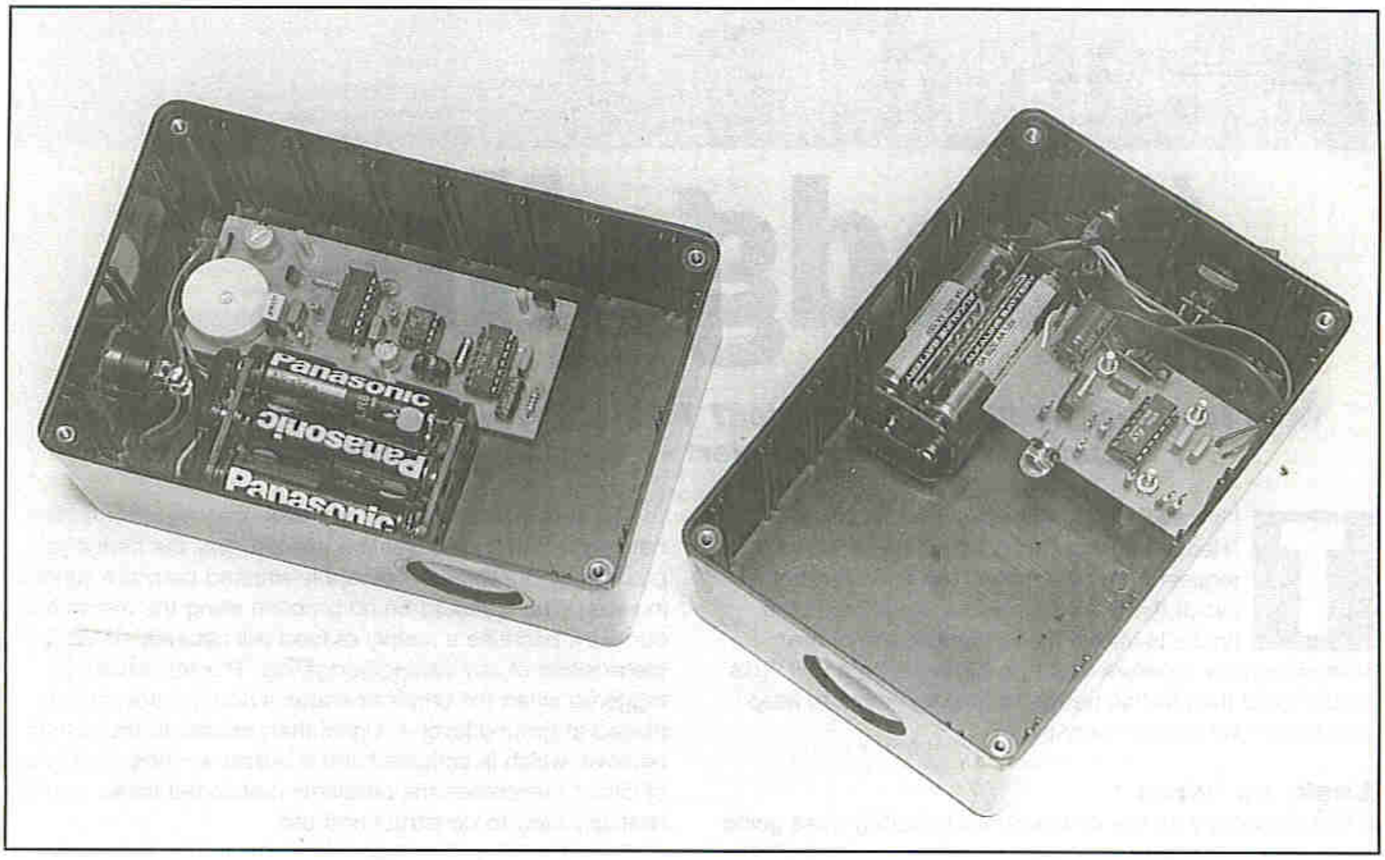
Look, no wires

It was necessary for the system to avoid trailing wires going to the house. He also wanted an alternative to a radio link, as radio links can be expensive to build into a smallish project these days. It had to be reliable and needed to operate over a sufficient distance for the purpose.

The circuit developed for the task uses an infra-red link between a transmitter section (placed near the hedgehog position) and a receiver (probably situated behind a window indoors). There should be no problem siting the transmitter correctly, because a supply of food will naturally determine the position of any visiting hedgehog. The transmitter is triggered when the critter operates a home-made switch placed at ground level. A signal then passes to the distant receiver, which is activated and a buzzer sounds. This type of circuit overcomes the problems mentioned earlier and is relatively easy to construct and use.

Before building the HedgeLink, check that there are suitable locations for the units. They should be no more than about 10 to 15 metres apart and with no more than one pane of window glass separating them. It is important





for there to be a clear line of sight between the transmitter and receiver. Obviously, the closer the two sections are placed, the easier they will be to align later.

Rapid pulse

Infra-red may be produced at the required low power by means of an infra red light-emitting diode (LED). These devices work in a similar way to the familiar visible-light LEDs often used as indicator lights. However, although infra-red LEDs may be fed with a continuous current as with their visible-light counterparts, in practice they are often operated with very short pulses of high current - possibly several amps. Using pulses provides a much greater range than could be obtained with a continuous current. In this circuit, the LED is pulsed with a current of 3A approximately (compare this with the 20mA or so normally used with a visible-light LED). Continuous operation at such a current would lead to rapid destruction of the device - hence the need for very short on states with relatively long off ones. This allows the heat produced to be dissipated into the air before the next pulse arrives.

In this system, the range is increased further by using a plastic lens at the transmitter to direct the infra-red into a parallel beam. A matching lens at the receiver then focuses the beam on to the detector. Over a very short distance it would be possible to dispense with the lenses and the system would operate with very little care needed to direct the transmitter towards the receiver. Using lenses, the two sections will need to be aligned fairly accurately but this is a fairly simple procedure and may be regarded as part of the fun of using the project.

Practical arrangement

The transmitter is battery-operated and will probably be situated in the garden. A good method would be to attach it to a wooden post. This could be pushed into the earth at the correct angle so that the beam is picked up by the detector inside the house. As well as the on-off switch, the transmitter has a test switch which is used to make the unit work continuously for setting-up purposes. There is also a small socket which is used to connect the trigger (hedgehog) switch.

The transmitter uses a 6V supply and needs about 1mA while on standby. When triggered, it draws some 3A but only in very short bursts and only for about half a second each time. The prototype used a battery pack consisting of 4 "AA" size cells and these are perfectly adequate for the purpose. If the unit is switched on for a few hours every night and not triggered too often, they will provide several months of service.

The receiver is likely to be placed on a windowsill inside the house facing the garden. This section contains a photo detector which is particularly sensitive to infra-red of 950 nanometres wavelength (so-called 'near infra-red') which is used here. No more than one pane of glass should be present, since infra-red is absorbed and reflected by this to some extent and so the range is reduced. When a signal from the transmitter is detected, a circuit is activated and a buzzer bleeps. Although not loud, the sound is distinctive and will be easily heard above other noises in the house such as from the television. The receiver uses a 9V supply and draws some 5mA on standby. This rises a little while the buzzer is sounding. A set of six "AA" cells was used in the prototype and these should give several months of service.

A valuable feature of the system is that it will work correctly even when there are strong alternative sources of infra-red, such as the sun or security lights, reaching the detector. False triggering is rare, although such random operation will probably occur every now and again. This precludes the use of this circuit for serious security applications - for example, to monitor a garden shed - unless the chance of an occasional false alarm is recognised.

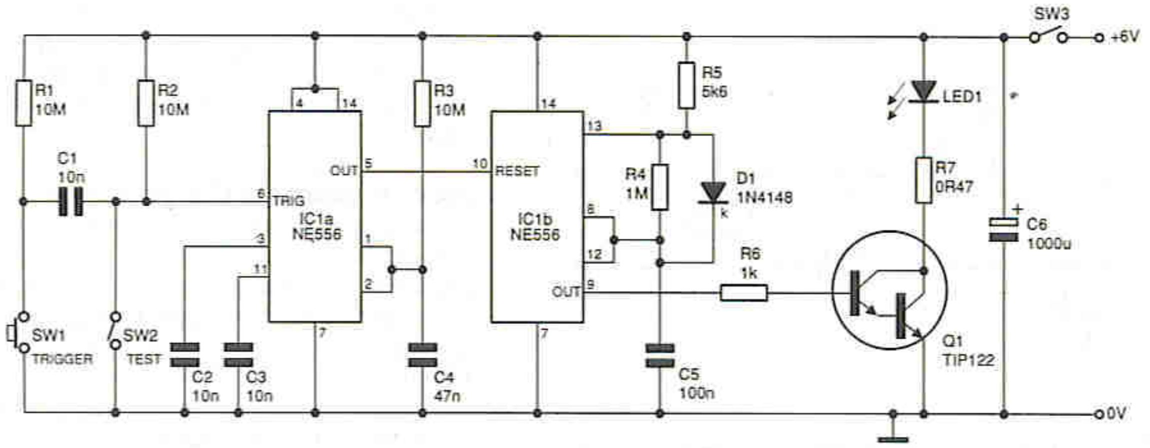
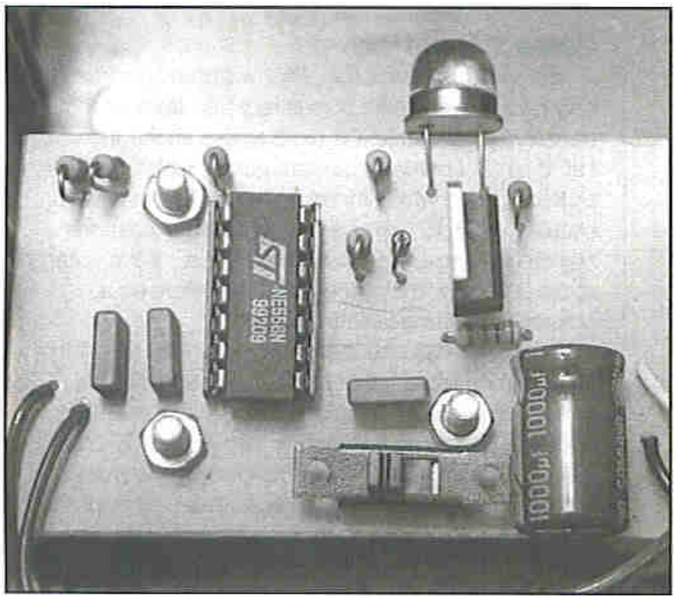


Figure 1: the Hedgelink transmitter - circuit diagram

The trigger switch is home-made and will have a very light action. There should not be too much of a problem making the hedgehog operate such a switch and some ideas on how one might be constructed are given at the end. It will be more difficult trying to prevent cats and possibly other animals from operating it. The user will need to be aware of this. Some readers will be able to exercise their expertise at making some device which will allow a hedgehog to operate it while preventing a cat from doing so. This is all part of the fun of hedgehog hunting!

How it works - the transmitter

The circuit for the infra-red link is shown in figure 1 (transmitter) and figure 2 (receiver). Consider the transmitter section first. IC1 is a NE556N dual timer consisting of two identical sections IC1a and IC1b. IC1a is configured as a monostable, while IC1b is used as an astable. Taking the monostable IC1a first: when switch SW1 (hedgehog switch) closes, a low pulse is transferred via capacitor C1 to the trigger input, pin 6. The output (pin 5) will then go high for a certain time then revert to low. The period of operation depends on the values of resistor R3 and capacitor C4 and with those specified will be 0.5 seconds approximately. Since the exact timing is not crucial, the components are fixed in value.



Should switch SW1 be left in a closed condition, this will not affect operation. This is because capacitor C1 only allows a momentary pulse to flow. It would be necessary to open the switch contacts and allow C1 to discharge through R1 and R2 then close them again for a further cycle to be initiated. Pin 6 is kept normally high through resistor R2 and this prevents the false operation which is likely to occur otherwise. When test switch SW2 is closed, it will allow a constant trigger signal to be applied to IC1 pin 6. The monostable will then operate continuously and this will be useful for alignment purposes at the end.

Returning to the astable based on IC1b: as long as its reset input, pin 10, is kept high, the device will be enabled and provide a string of pulses at the output, pin 9. With IC1a at standby, pin 5 and hence pin 10, will be low and the astable will be disabled. With IC1a triggered, pin 5 will go high for 0.5 seconds and IC1b pin 10 will be kept high for this time. A burst of pulses will then be produced at pin 9. The rate at which these are given depends on the values of resistors R4, R5 and capacitor, C5. Since it is not particularly important, no adjustment is provided.

Diode D1 modifies the action of IC1b. Without it, the circuit would provide pulses with approximately equal on and off states. Here, short pulses with relatively long spaces are required for the reason mentioned earlier. With the diode connected, capacitor C5 charges quickly only from the supply via R5, since, in effect, R4 is bypassed by the forward-biased diode. This gives the short high state. Pin 13 then goes low to allow the capacitor to discharge ready for a further cycle. This will occur slowly because the current must now flow through R4. This is because the diode is reverse biased and therefore behaves as an open circuit.

Amplified pulses

The pulses supplied at pin 9 allow base current to flow to Darlington transistor Q1 with the current limited by resistor R6. Amplified pulses of current will then flow through the infra-red light-emitting diode, LED1, in the collector circuit. The current here is limited by R7. Since this has a very low value, the current will be around 3 to 4 amps.

A bipolar dual timer (NE556) should be used for transmitter-section IC1, rather than the cmos type (ICM7556). The bipolar variant is robust and more appropriate to this type of circuit. In theory, capacitors C2 and C3 should be included to decouple

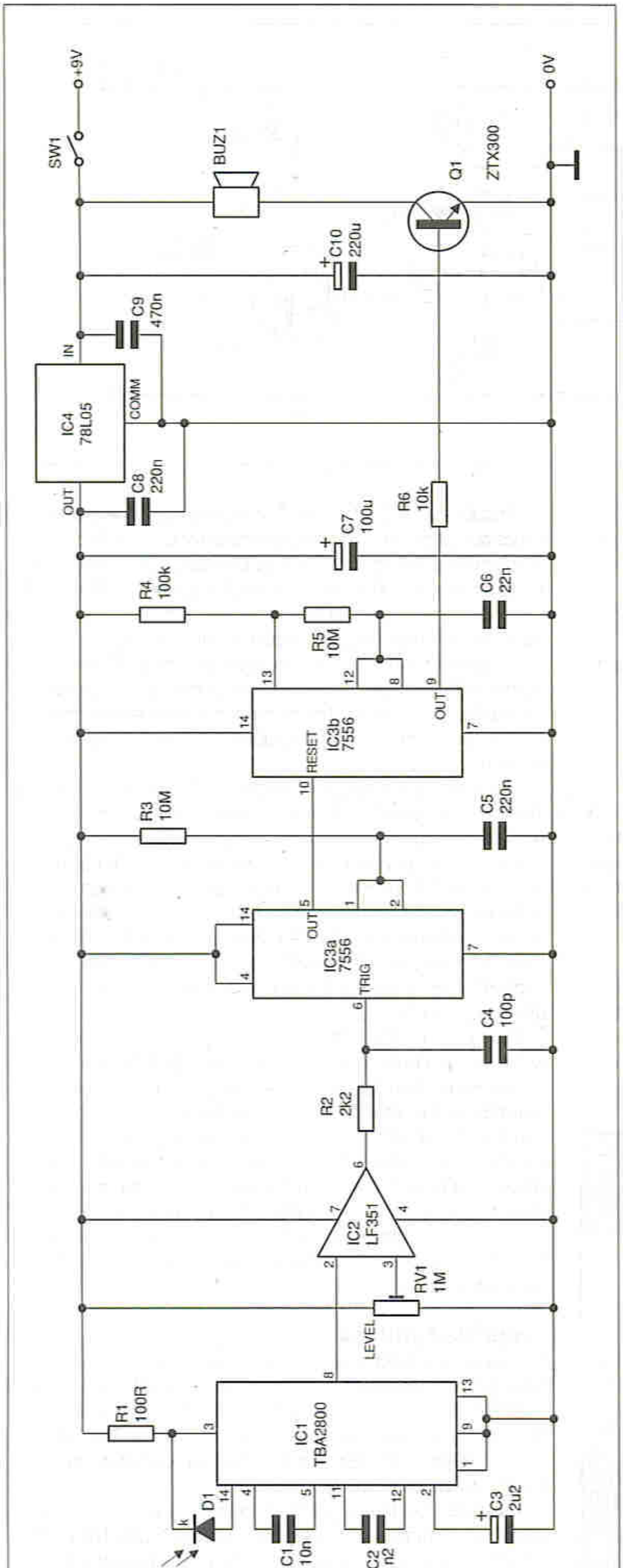


Figure 2: the Hedgelink receiver - circuit diagram

the unused "control voltage" pins. Tests on the prototype showed that it works perfectly well without them but to avoid any possibility of instability, they should be included. Capacitor C6 provides a reserve of energy. This will allow the necessary high-current pulses to be produced even when the battery is becoming weak.

How it works - the receiver

Referring to the receiver circuit diagram in figure 2, the infra-red is picked up by infra-red photodiode D1. As is usual with devices of this type, it is used in reverse bias. High gain amplifier IC1 is used to boost the pulses derived from D1 output to a level which can be processed by the rest of the circuit.

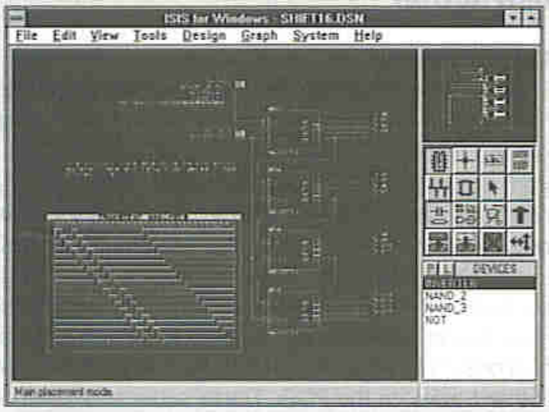
IC1 is a sophisticated device which not only contains three stages of amplification but has sections which reject signals which have been picked up from infra-red sources other than the transmitter. It rejects, for example, the mains flicker from filament light bulbs which has a different modulation from the pulse signal. Most of the processing takes place within the chip, so very few external components are required. IC1 needs a 5V supply yet the main battery line is at a nominal 9V. Voltage regulator IC3 with associated capacitors C8 and C9 provide a 5V output for the entire circuit apart from the buzzer. IC1 has twin outputs - one (pin 8) provides a positive output when a pulse is detected and the other (pin 9) a negative one. Only the positive output is used here.

The next section of the circuit centres on IC2 which is an operational amplifier (op-amp) used as a voltage compactor. This behaves as a level detector, and its action is as follows. When the voltage applied to pin 3 (the non-inverting input) exceeds that at pin 2 (the inverting input) the output, pin 6 will be high. In other cases it will be low. Pin 3 receives a certain voltage which depends on the adjustment of preset RV1. In the absence of pulses, IC1 pin 8 will be low so the op-amp inverting input will be at a lower voltage than the non-inverting one. In the standby state, IC2 pin 6 will therefore be high and will have no effect on following sections. When pulses are detected, IC2 pin 2 voltage will exceed that at pin 3 and the output will go low in sympathy.

False triggering

At the end of construction, RV1 will be adjusted so that only relatively powerful pulses received from by the transmitter will cause IC2 pin 2 to rise above the voltage set at pin 3. Low-level random pulses which may be picked up and which manage to bypass the rejection circuitry within IC1 will be insufficient to exceed the standing voltage and will have no effect. If the voltage at pin 3 is set too low, there may therefore be a possibility of some false triggering.

Dual timer IC3 operates in a similar way to IC1 in the transmitter section - that is, there is a monostable (IC3a) which, while activated, enables an astable (IC3b) to generate pulses. In the receiver circuit, the CMOS variant is used. With IC2 pin 6 providing low pulses, IC3a trigger input, pin 6, will be activated when the first one arrives. The output, pin 5, will therefore go high for a certain time which is set by the values of resistor R3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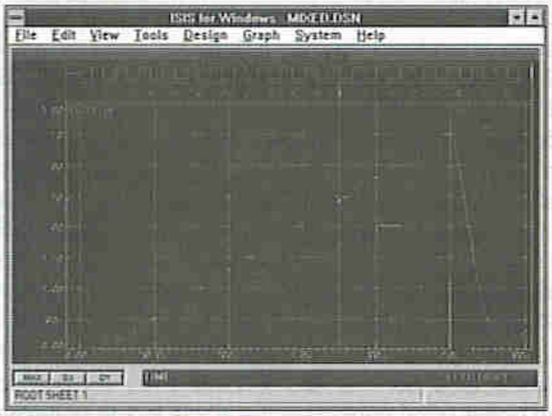
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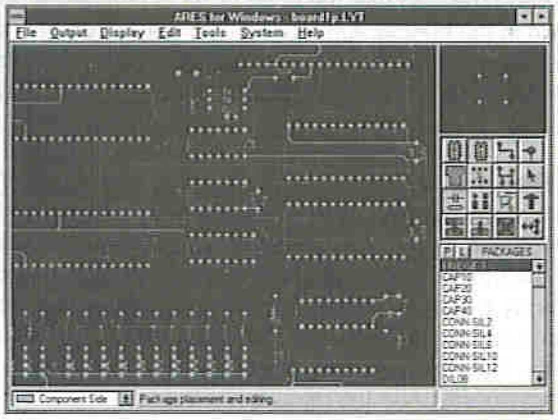
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CONN-SIL12
DIL08
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Package placement and editing

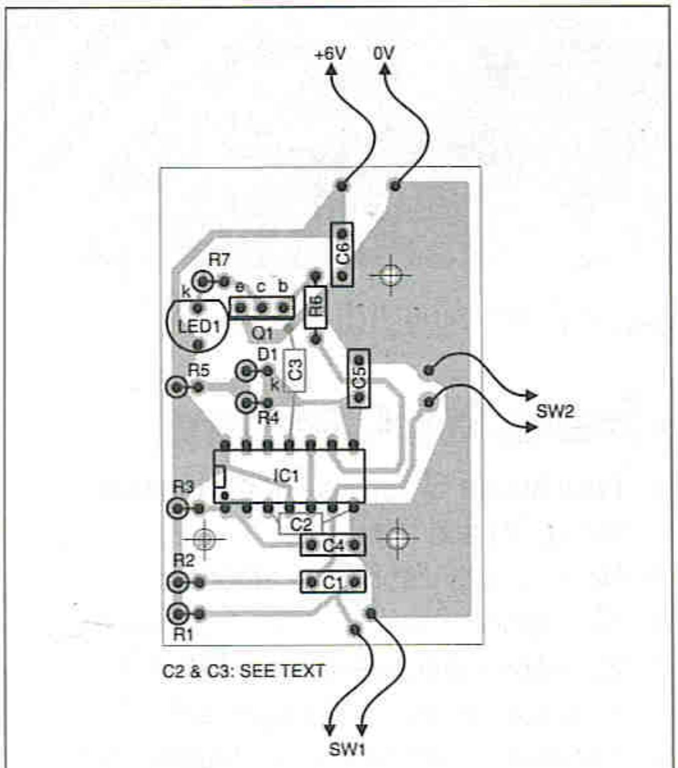

Figure 3: the Hedgelink transmitter - component layout

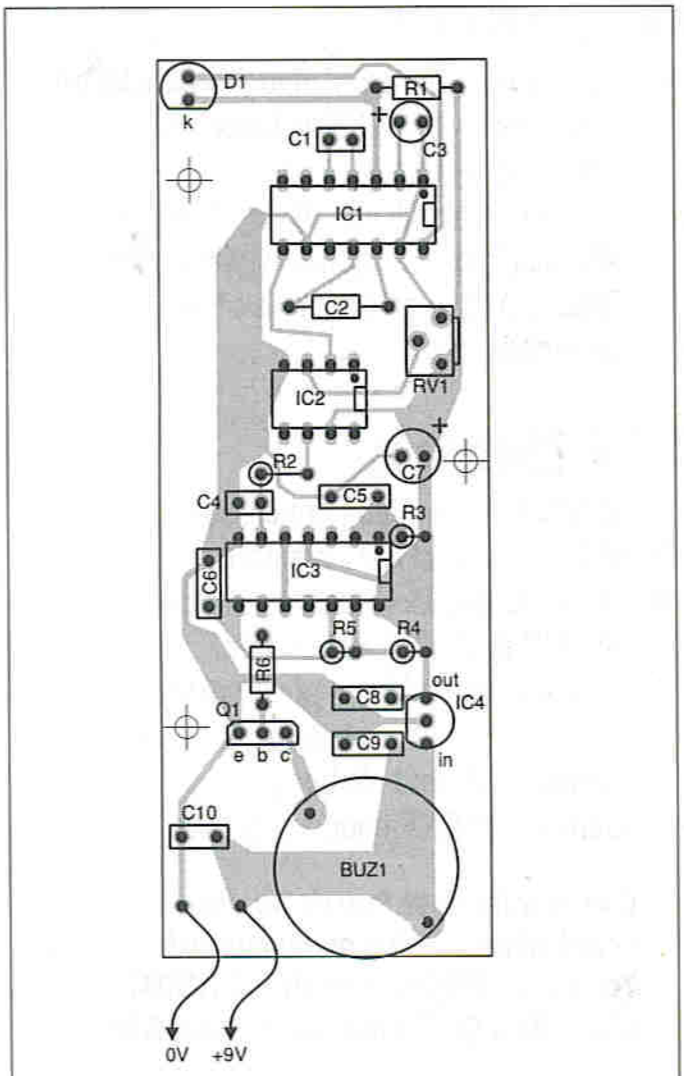

Figure 4: the Hedgelink receiver - component layout

and capacitor C5. With those specified it will be a little more than two seconds. This timing could be easily changed if required by increasing the value of R3 or C5 in proportion and this alters the buzzer operating time. While IC1a output pin 5 is high, the astable section is enabled and provides pulses at a rate of about 5 per second. Here, it is resistors R4 and R5 in conjunction with capacitor C6 which provide the timing. The current pulses are applied to the base of transistor Q1 with current limited by R6. Amplified pulses will then flow through piezo buzzer, BUZ1 in the collector circuit. This will then sound with a warbling tone.

Construction

1. Transmitter

The topside component layout is shown in figure 3. Begin by drilling the three fixing holes in the PCB and soldering the ic socket and test switch SW2 in position. Follow with all resistors and capacitors. Note that C6 is of the electrolytic type and must be soldered with the correct polarity (this is clearly marked on its body). Mount capacitors C2 and C3 on the underside of the PCB - these are shown in dotted lines. Sleeve their end wires using pieces of insulation stripped from connecting wire allowing only 1mm at each end to make the connections. This will prevent short-circuits being caused with other tracks on the PCB. These capacitors were omitted in the prototype and readers may wish to check that the circuit works before using them. @B:One end of each capacitor is soldered direct to IC1 socket pads at pins 3 and 11. The other ends are soldered to the large 0V land area. Mount diode D1 - it is very important that the cathode (striped) end is soldered to the lower pad - that is, the one connected to IC1 pins and 8 and 12. Solder the Darlington transistor in position - the metal tab must face the ic position (see photograph). Solder the negative (black) wire of a PP3-type battery snap to the point labelled "0V" and a 10 cm piece of light-duty stranded connecting wire to that marked "+6V". Solder similar pieces of wire to the "SW1" pads. Mount the infra-red LED. The tab on the metal base denotes the anode (positive) end lead and this is the one connected to the upper (+6V) track. Use the whole length of the leads and bend them so that the body projects horizontally as shown in the photograph. Attach it so that it may be moved a little allow for some adjustment later. Insert the ic into its socket taking care over the orientation. Set the test switch to the left (test position).

2. Receiver

The topside component layout is shown in figure 4. Begin by drilling the three mounting holes. Add the three ic sockets and the buzzer. The positive pin of the buzzer is marked on the body and must be soldered to the large copper land area which connects to +9V. Add all resistors and capacitors. C3, C7 and C10 are electrolytics and must be connected with the correct polarity. Add the regulator taking care that the flat face is towards C8/C9. Solder the infra-red detector, D1, with the flat face points towards C1. Adjust RV1 approximately three-quarters of its total rotation clockwise (as viewed from the upper edge of the PCB). Solder the negative (black) battery snap wire to the "0V" pad and a 10 cm piece of stranded connecting wire to "+9V" one. Insert the ics making sure they are the right way round. These are all cmos, so observe anti-static precautions by touching something earthed (a water tap, for example) before handling the pins.

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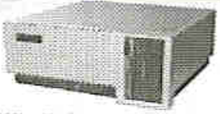

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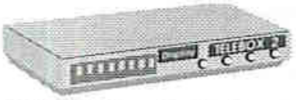

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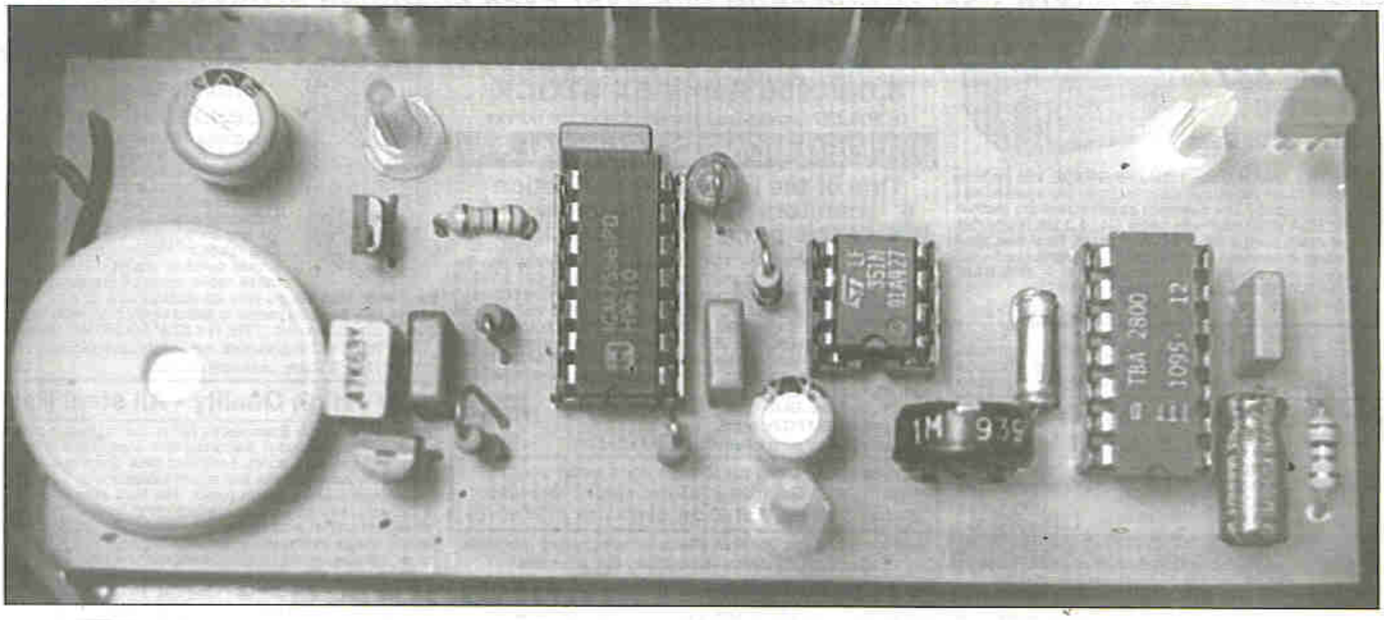


Testing

At this stage, it would be a good idea to carry out a test to confirm that both units are working correctly. Make a twisted connection between the positive (red) battery snap wire on the receiver and the +9V wire already soldered to the circuit panel. Connect the 9V battery pack (six cells) taking care over the polarity. The buzzer will probably bleep as the connection is made. Connect the 6V battery pack (four cells) to the transmitter in the same way. With the LED on the transmitter pointing towards the detector on the receiver, the buzzer should bleep. After a short time check that the metal backing of the LED and that of the transistor in the transmitter remain cool. The LED must not be allowed to become hot in operation. If it does, check the circuit - particularly at the connections to the diode and the orientation of this component.

If nothing happens it is easy to check if the receiver section is working by pointing an infra-red TV remote control at it and pressing a channel selection button. If the buzzer now bleeps, the fault is in the transmitter. You cannot check the transmitter by pointing it at the TV and seeing what happens - TV remote control systems use a digital code and this transmitter uses no code - nothing will happen.

Little boxes

The boxes for the transmitter and receiver section are identical although, if using the specified components, the arrangement of the parts inside is different (see photographs).

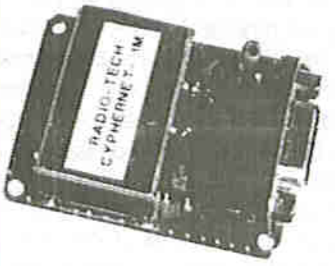
Begin with the transmitter. Make holes for the on-off switch and for the socket which will be used to connect the trigger switch. In the prototype, a 2.5mm "power" type socket was used. However, any small socket such as a 3.5 mm mono jack type could be used. Hold the circuit panel in position using a few pieces of scrap wood or cardboard so that it is raised about 20mm above the base of the box and with the LED about 80mm from where the lens will be. The battery pack should fit snugly alongside (see photograph). Measure the exact position of the LED and mark the front of the case directly in line with it. Using this as the centre of a circle, mark out the large hole which will be used for the lens. The specified lens has a rim which is used to secure it in position. The hole should therefore be that of the diameter of the lens part itself - that is, 30mm approximately. The best way to cut this is to drill a series of small holes on the inside of the line, joining them using a small hacksaw and cutting the hole to size by filing it up to the line. File away any PCB slots on the case in the vicinity of the lens position so that the surface is flat, and attach the lens using a little quick-setting epoxy resin adhesive around the rim. Take care not to get any on the actual lens or the efficiency of the system will be impaired.

In-line

Position the circuit panel so that the base of the LED is 80mm behind the lens. Check that it is in line with the centre of the lens and mark the base of the box through the mounting holes in the PCB. It would be a good idea to make elongated holes so that the position of the LED may be adjusted in the direction of the lens for best effect at the end. Secure the circuit panel using plastic stand-off insulators (spacers) of the correct length on the bolt shanks. Small adjustments to the alignment may be made by bending the LED leads as required. Since the infra-red is emitted through an angle of only 20 degrees, the lens "catches" most of it. If a different lens is used, it must be transmissive to near infra-red, and the LED must be placed the distance of its infra-red focal length away. With the battery pack supported between the side of the box and the circuit panel, no further support should be needed. Attach the on-off switch. Mount the trigger switch socket and wire it up.

Mount the on-off switch on the receiver case. Drill some holes in the lid above the buzzer position for the sound to pass through. Mount the PCB as for the transmitter with the infra-red detector taking up a position 80mm behind the lens and in line with its centre. Again, elongated holes may be made in the case so that the exact distance may be adjusted at the end. The battery pack should fit between the circuit panel and the case, using adhesive fixing pads if necessary. For both sections, solder the positive (red) battery snap wire to one terminal of the on-off switch. Connect the other terminal to the positive wire already soldered to the PCB. The lids of the case may be left off while tests are made.

Carry out some trials to gain practice at aligning the two sections. Note, however, that excessive testing with the transmitter in continuous mode will soon run the batteries down. Fix the transmitter in position and walk slowly backwards holding the receiver and trying to keep the buzzer bleeping. Decide on a suitable position for each section.



Monitoring
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Irrigation
Environmental

For best results, the infra-red should pass through the window at right-angles. Of course, if glass can be avoided so much the better. Attach the transmitter to a piece of wood or other support. With both units switched on and with the transmitter switch in the test position, carefully align them so that the buzzer continues to bleep. If aiming for maximum range, it will be necessary to take great care over alignment and RV1 will need to be adjusted for maximum sensitivity. It may also be necessary to alter the relative position between the LED and/or detector and the respective lens. To adjust RV1, rotate the slider slightly clockwise. This may increase the tendency towards false triggering although in the prototype this was still extremely rare. Note that maximum sensitivity is not obtained by adjusting RV1 fully clockwise. This is because the "off" voltage at IC1 pin 8 (and therefore at IC2 pin 2) is about 0.15V. If RV1 is adjusted fully clockwise, 0V will appear at pin 3. The op-amp will then be normally off and will trigger IC2 once only. It will then be incapable of triggering again. For maximum effect, RV1 should be adjusted clockwise up the point when it will not trigger then slightly anti-clockwise. Switch off the transmitter, set the on-board switch to the right (operating) position and attach the lids.

Foiled again

Attention may now be given to the switch which will be triggered by the hedgehog. Parents with children of school age will find that designing and trying various types of switch is an excellent application of the National Curriculum in both Science and Design & Technology (in practice, almost all children follow these subjects). Some of the simplest ideas involve using pieces of aluminium foil (cooking foil) kept slightly separated. The hedgehog on its visit will stand on these and push these together. Suitably-placed pieces of springy foam plastic will also allow the "switch" contacts to part when the hedgehog leaves. Another idea would be to use a non-mercury position switch. If this were to be set just off, any slight movement would trigger it. There are many solutions and a lot of fun may be gained by constructing a switch which behaves best for the purpose - particularly trying to make it selective against other visiting animals. Connect it to the plug using a piece of twin wire.

It may be possible to operate the receiver section using a plug-in mains power supply unit with an output of 9 to 12V dc. However, there are "spikes" produced on the mains due to the operation of equipment nearby. This may cause false triggering. One particular problem is the switching on of fluorescent lights. Note that the transmitter must not be used under damp conditions unless care is taken with waterproofing, since moisture reaching the circuit panel will cause problems.

Happy hunting!

PARTS LIST for the "Hedgelink"

Transmitter section:

Resistors: All 0.6W 1% metal film

R1, R2, R3	10M
R4	1M
R5	5k6
R6	1k
R7	0.47R

Capacitors:

C1, C5	100n metallised polyester - 5mm pin spacing
C2, C3	10n ceramic (if required - see text)
C4	47n metallised polyester - 5mm
pin	spacing
C6	1000u 10V radial electrolytic

Semiconductors

IC1	NE556N dual bipolar timer
D1	1N4148
Q1	TIP122 power darlington
LED1	high-power infra-red LED (see below)

Miscellaneous

SW2	Miniature SPDT slide switch
SW3	SPST toggle or slide switch

14-pin dil socket, 2.5 mm power type plug and socket (or other small plug and socket), holder for 4 AA size cells and alkaline cells to fit, PP3-type battery connector, small nuts and bolts. Infra-red transmissive lens. Plastic case size: 150 x 100 x 60mm external.

Receiver section:

Resistors: All 0.6W 1% metal film

R1	100R
R2	2k2
R3, R5	10M
R4	100k
R6	10k
RV1	1M sub-min preset

Capacitors

C1	10n min metallised polyester 5mm pin spacing
C2	1n2 (1200pF) 1% polystyrene
C3	2.2u 63V radial electrolytic
C4	100pF polystyrene
C5, C8	220nmin metallised polyester 5mm pin spacing
C6	22n min metallised polyester 5mm pin spacing
C7	100u 10V radial electrolytic
C9	470n min metallised polyester 5mm pin spacing
C10	220u 10V radial electrolytic

Semiconductors

IC1	TBA2800 infra-red pre-amplifier
IC2	LF351 op-amp
IC3	NE 556 bipolar dual timer
IC4	MC78L05ACP regulator
D1	Infra-red photodiode
Q1	ZTX300

Miscellaneous

SW1	SPST toggle or rocker switch.

2 off 14-pin dil sockets, 8-pin dil socket. PCB mounting piezo buzzer suitable for dc operation, PP3 battery connector, holder for 6 AA size cells and alkaline cells to fit, infra-red transmissive plastic lens. Plastic case size: 150 x 100 x 60mm external.

All components for the Infra Link are available from Maplin. The infra-red LED was type KW66W.

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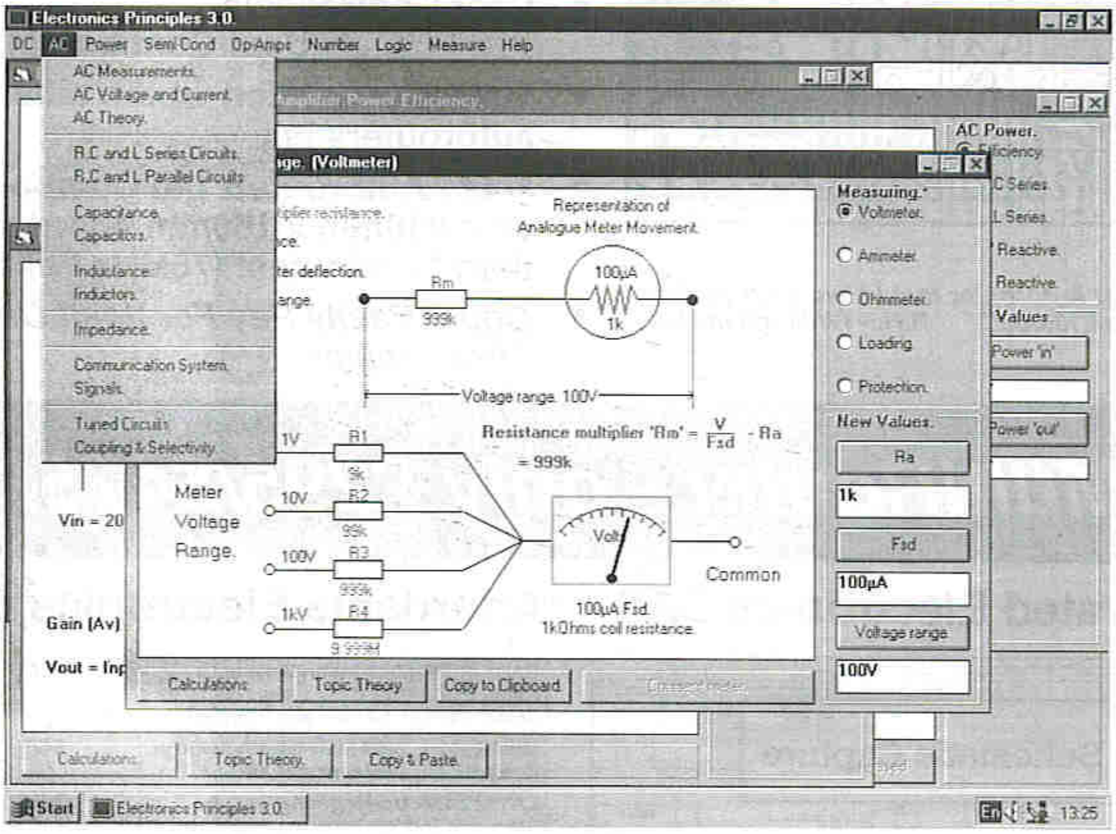

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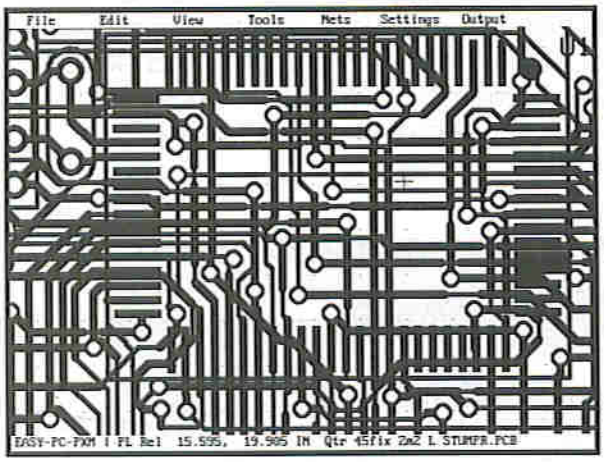

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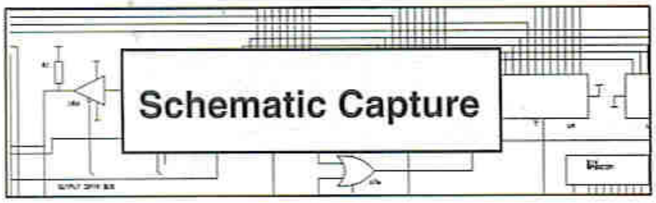

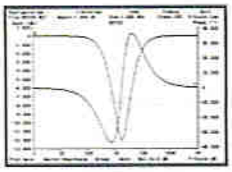

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SPICED CIRCUITS

By Owen Bishop

An introduction to the circuit simulation with software - the "soft breadboard" for designers.

Part 1 - What is SPICE?

SPICE is a computer program that was originally intended for designers of integrated circuits. Circuits built from discrete components are easily assembled and tested on a breadboard. If it does not operate exactly as intended, components and connections can be changed until it is running satisfactorily. This technique is no use for designing ics -manufacturing an ic involves many complex (and expensive) stages and it is important to know that the design is correct and that component values are suitable before making the masks for even the first chip. Using a computer to simulate circuit action is an essential prelude to ic manufacture. So, the Simulation Program with Integrated Circuit Emphasis was born, and became known as SPICE. The centre for development of SPICE was the University of California at Berkeley, USA, beginning in the 1960s and producing numerous versions during the next three decades. Once developed, the applications of SPICE for designing non-ic structures became obvious and the demand for it grew.

SPICE itself is in the public domain, so its routines are not copyright and provide an ideal starting point for writers of electronic simulation software. Proprietary SPICE simulators tend to be enhanced versions of SPICE, with the fundamental SPICE routines as their core, but with better facilities for entering the circuits and data, and they present the calculated data in more sophisticated graphic routines than were available in the original SPICE. (The University of Berkeley at California is one of the best-known SPICE suppliers.) There are now many successful SPICE-based simulators, some of which we shall look at later in this series. One of these is SpiceAge, which has probably departed further than most other simulators from the original SPICE format in the direction of greater user friendliness, an increasing number of extra analytical routines and superior flexibility and clarity in the display routines. Yet it still retains SPICE compatibility. To see what SPICE and SpiceAge can do, we will take a working example, based on a simple constant current generator (figure 1).

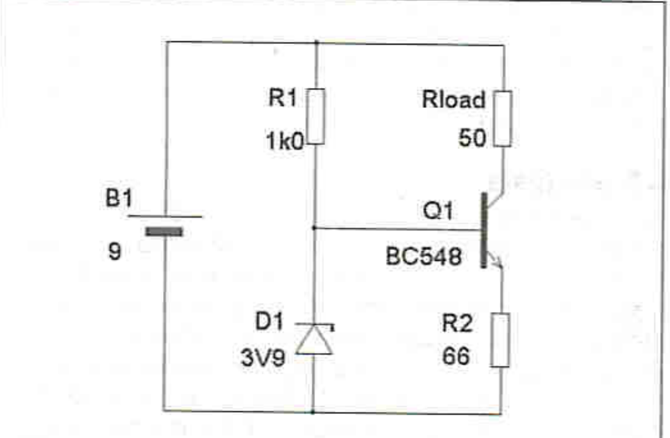


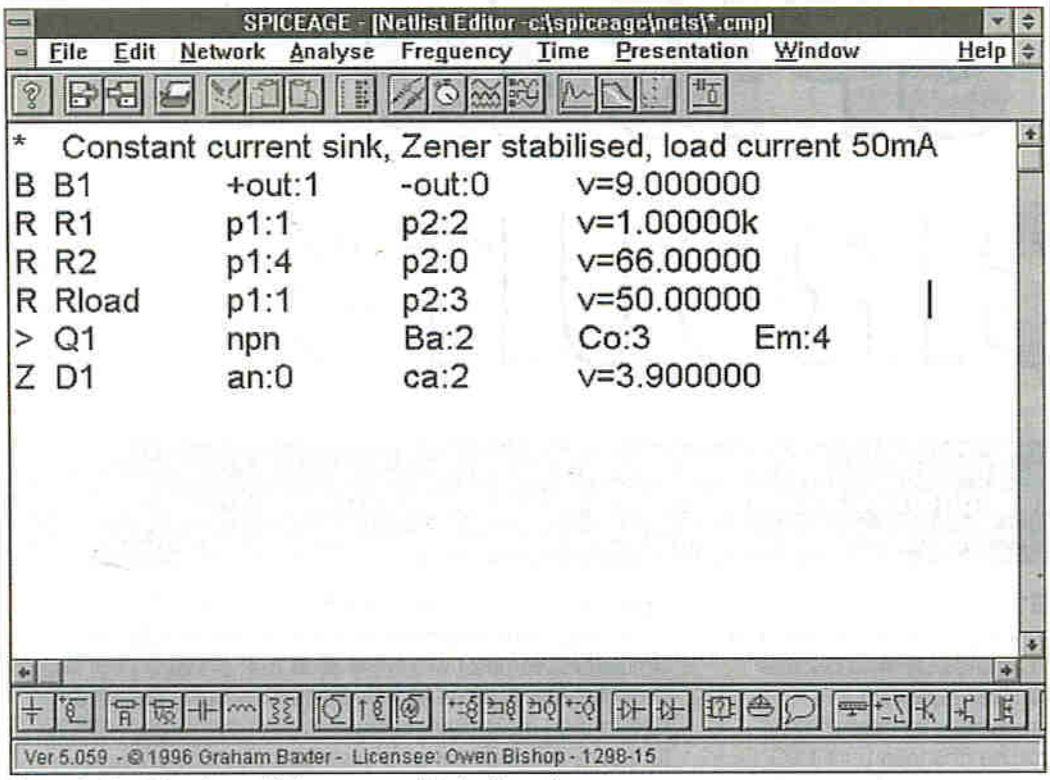
Figure 1: simple constant current generator circuit

Netlists

All SPICE analyses are based on a netlist, which is the way we inform the computer of the nature of the circuit it is being asked to analyse. A netlist is simply a list of the components, their values, and the electrical connections between them. Figure 2 shows the SpiceAge netlist of the current generator in figure 1. There are two ways of obtaining the netlist. The simpler of these (and the one I have found easier) begins with a sketch on paper, like figure1 but not necessarily so neatly drawn! Next, number the nodes, which are the points to which the components are connected. You can give the nodes names instead of numbers if you prefer. We use numbers here, and adopt the SPICE convention of allocating '0' to the 'ground' or 0V node. Figure 2 is the result of running through the components and typing in their details on the screen as you might do in an ordinary word-processor. The order in which you list the components does not matter to the computer, though some sort of system is helpful if you need to refer back to the netlist later. We tend to work to the order: power sources, resistors, capacitors, inductors, discrete semiconductors, ics.

The other way of obtaining the netlist is to begin with the schematic circuit diagram. You draw the schematic on screen, using a special graphics program, after which the program works out the netlist for you. The schematic capture program that operates with SpiceAge is called Geseca, and we shall see this in action next month.

The SpiceAge netlist format is very similar to that used by SPICE, though there are small points of difference. For instance a SPICE netlist begins with a one-line title statement, whereas in SpiceAge we can have any number



```
*  Constant current sink, Zener stabilised, load current 50mA
B B1        +out:1      -out:0      v=9.000000
R R1        p1:1        p2:2        v=1.00000k
R R2        p1:4        p2:0        v=66.00000
R Rload     p1:1        p2:3        v=50.00000
> Q1        npn         Ba:2        Co:3        Em:4
Z D1        an:0        ca:2        v=3.900000
```

Figure 2: the SpiceAge netlist corresponding to figure 1

of lines beginning with an asterisk (*), which are reserved for headings and remarks. The lines listing components begin with a letter to indicate component type. For example, 'R' indicates a resistor, and 'B' indicates a constant voltage source (battery). Following the component type is a number or name to identify which particular component is being described (for example, R1, Rload). Then come its pin connections. For example, '+out:1' indicates that the positive terminal of the battery is connected to node 1. Component values are defined by the 'v = ' statements. Here we have a 9V battery (the volt unit is assumed by default), and a 1kR resistor (the 'k' is necessary to specify kilohms instead of the default unit, ohms, defined by the its scientific designation of a capital Omega). The values were calculated on paper before typing in the netlist. R1 is set as 1kR so as to allow a current of about 5mA to flow to the zener (R1 = (9 - VZ)/0.005). This puts the base of the transistor at the zener voltage, VZ, which is 3.9V. To just turn on Q1, we need a base-emitter voltage of 0.6V, so we make R2 = (VZ - 0.6)/iload). Rload is arbitrarily set at 50W, a value within the range that we want the circuit to be able to regulate the load current.

The '>' symbol indicates that the parameters of the component are defined in a library file, one among many provided with simulators such as SpiceAge. Here the full filename is 'npn.lib', and this file listed under subdirectory 'libs' in the 'spiceage' directory. 'npn' is what is known as a generic model of an npn transistor. It is a simple model which is reasonably accurate for most transistor-based simulations. Because few parameters are being taken into account, it has the advantage that the analysis runs quickly. The three statements completing this line define the node connections of base, collector and emitter.

The symbol 'Z' indicates a generic zener diode model, a component that is not available in SPICE. Here we have specified the zener voltage as 3.9V. We can give it with any value we like, including values not normally available from suppliers. This illustrates one of the advantages of simulators: you do not need a vast stock of components in all possible manufactured values - no need to try to obtain that 'odd' value until you have checked with the simulator that it actually works and that one of the more readily available values will not serve just as well. Also, you can never burn out or damage the components.

On the breadboard

Just to check that the simulator gives the right results, set up the same circuit on a breadboard. We do not usually do this but, when you are first using a simulator, it is often a good idea to run it alongside a real, breadboarded circuit. It confirms that you are using the simulator correctly and helps you understand what its results mean. Use 56 ohms in series with 10 ohms to obtain R2. For Rload, use a 220R (or 250R) variable resistor (preset or pot) adjusted to 50R, measured with a multimeter. It is not as easy as it sounds to set the pot to exactly 50R, which illustrates another advantage of simulators - components can be given exactly the right values, including non-standard ones. For the transistor, we used a general purpose low-signal transistor, a BC548, but any similar transistor would do. The zener is a BZX79C, 3.9V, with a tolerance of +/- 5%.

To measure the load current, place a testmeter in series with the load. When the circuit is switched on, the meter shows a load current of 44.3mA instead of the intended 50mA. Further measurement shows that the base voltage is only 3.71V instead of the theoretical 3.9V. This is within the 5% tolerance limits and you may obtain results closer to the expected values with your circuit. But the emitter voltage is 2.97V, so this still provides a base-emitter voltage drop of 0.74V, sufficient to turn Q1 on. However, the emitter voltage in theory should have been 3.9 - 0.6 = 3.3V, corresponding to a current of 50mA through R2. With a pd of only 2.97V across R2, the load current is reduced to 2.97/66 = 45mA. Could we increase the current by reducing R2? Or would we do better to select another zener?

DC analysis

SpiceAge provides a mode of analysis known as DC quiescent. It calculates the steady-state voltages at all nodes and the steady-state currents in all branches. In doing this, it takes non-linear components such as transistors and diodes into account. In these instructions we use arrows (=>) to indicate a sequence of button-clicks. First click on Time => Probe nodes ... (or click on the 'Probes' button) to display the Probe Control Panel. Click to select Probe 1 and then select node 4 as the Output node and node 0 as the reference node.

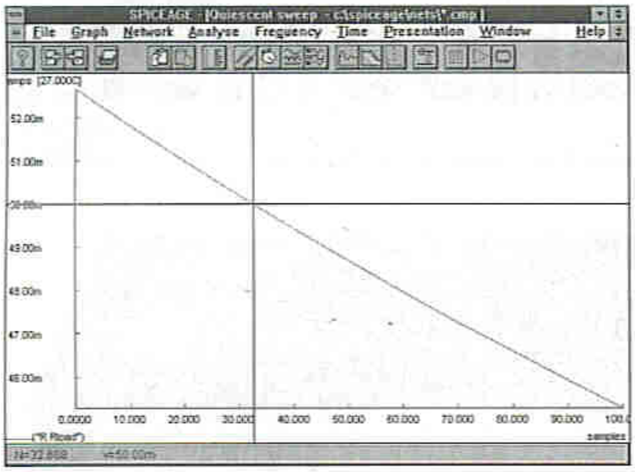


Figure 3: the graph of current versus the value of R2

Make sure the v (voltage) option is selected (there should be a dot inside the diamond shape). Click on OK. To initiate the analysis click on Analyse => DC quiescent. A table of results appears, showing the voltages at all nodes 1-4, relative to the reference node, node 0. The base voltage is 3.94V, and the emitter voltage is 3.12V. Return to the Probe Control Panel, and select the current (i) option for Probe 1. Repeating the DC quiescent analysis displays a table of currents through the branches of the network. For Rload, we find the current is 44.3mA. Although the zener (base) voltage is correct in the simulation, the load current is low, roughly the same as on the breadboard.

Perhaps we can do better by substituting a more precise model for the transistor, one that takes account of more parameters; this takes longer to analyse but, with only one transistor in the circuit, the increased time is immaterial. Return to the netlist (click Window => 1 Netlist). Replace 'npn' with 'BC548BP.lib'. Re-running the tests shows results similar to those already obtained, the load current increasing slightly to 46.76mA. Even though, with a full SPICE model, we are working with about 40 parameters, we still do not get the required load current. Perhaps the simple equations we used for calculating the original component values (especially R2) were not sufficiently precise.

A better value for R2 can be looked for by sweeping its netlisted values over a given range. Amend the netlist to include the range. After the other entries for R2, type 'vs=60 vf=70'. These are starting and finishing values for the sweep. Click on Analyse => Tolerances and Temp... . Under Function, select Value sweep, under Mode select Linear and make N=11. This gives R2 eleven steps from 60R to 70R. Select Analyse => Quiescent sweep, and SpiceAge performs a DC quiescent analysis for eleven evenly spaced values of R2, displaying the results as a graph (figure 3). We can see that load current falls with increasing R2. Positioning the cross-hairs as shown reveals that to obtain 50mA requires the sample number to be N = 32.7. On a 100-step scale from 60R to 70R, this corresponds to a resistance of 60 + N/10 = 63.9R. Knowing that the zener has 5% tolerance, there is no point in obtaining a resistor of this exact value. Instead, use the nearest standard value (62R) or, for greater precision, a 56R fixed resistor in series with a 10R multi-turn pot. The pot allows the circuit to be aligned for a given zener diode. You could try this with the breadboarded circuit to see how close you can get to 50mA. On the simulator, altering R2 to v=63.9 gives Rload = 49.97mA, which is close enough.

Compliance

The circuit is intended to give a constant current even when the resistance of the load varies. It is important to know the compliance of the circuit, the range of values of Rload over which iload remains close to 50mA. A quiescent sweep tells us this. On the Rload line of the netlist, type 'vs=50 vf=250'. Set the sweep values as before. The quiescent sweep provides figure 4, in which current is constant (at 49.97mA) up to sample number 30. To obtain a smoother curve, this sweep was done for 101 steps instead of 11. Current is constant until N = 30. With a resistance range of 50R to 250R, this corresponds to 50 + 2 ◊ N = 110R. This is the maximum load resistance for absolute compliance. The cross-hairs indicate the point where the current has dropped by 5% to 47.5mA, sample number N = 35.176, equivalent to a load of 50 + 2 ◊ N = 120R. This result compares very well with a breadboarded trial, in which you vary the pot until the current begins to fall and then measure its resistance.

The minimum compliant value is found in a similar way, using 'vs=0 vf=20'. Current is constant down to N = 1, equivalent to a resistance of 0 + 0.2 ◊ N = 0.2W. Thus the circuit is compliant over the range 0.2W to 120W . Check this on the breadboarded circuit.

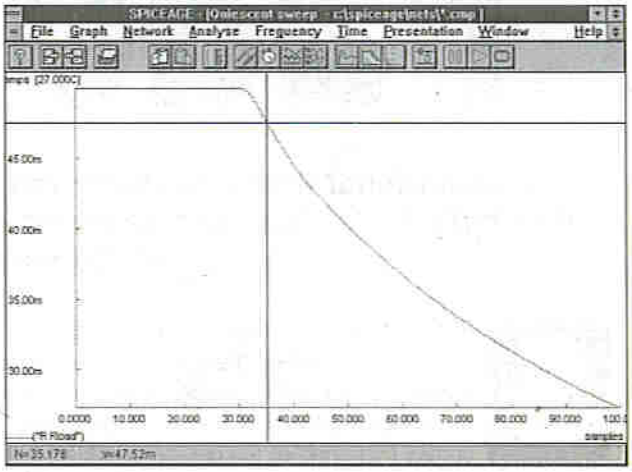


Figure 4: the graph showing load compliance at an aiming current at 49.97 milliamps.

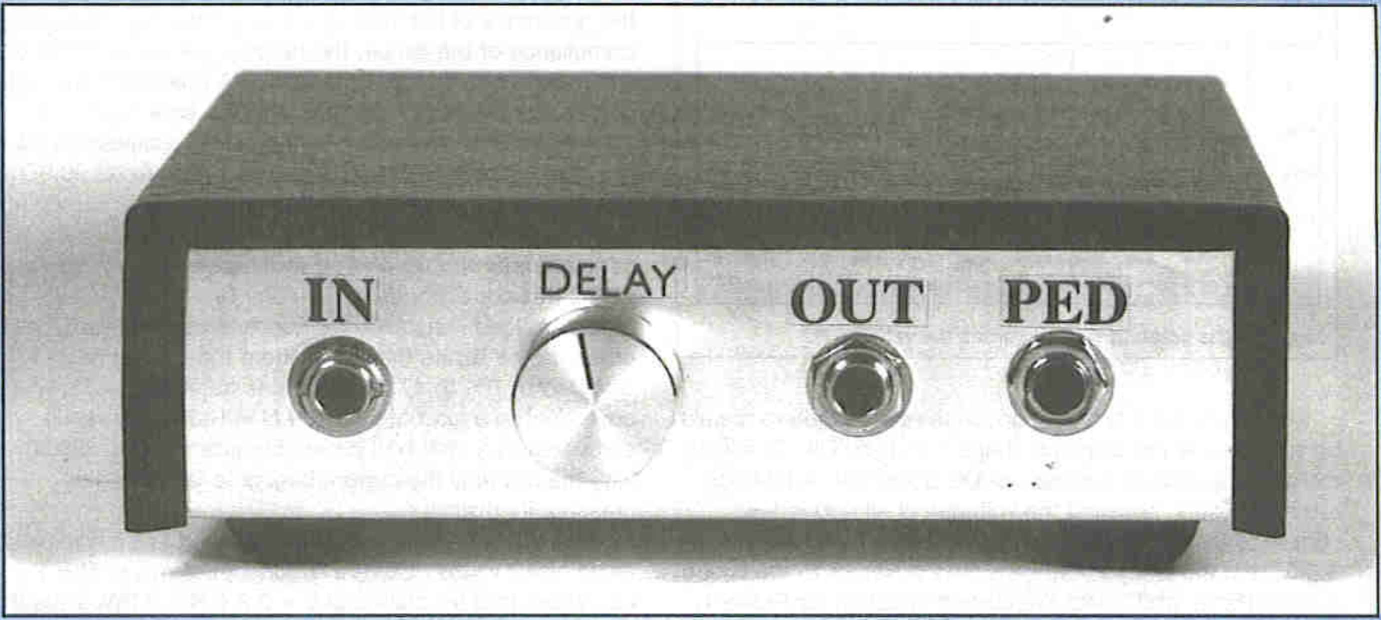
Projects: (Use a breadboarded circuit and/or SpiceAge or other simulator. Answers next month.)

1) Plot various node voltages, while sweeping the value of Rload, to find out why compliance ceases when the current exceeds about 110 ohms.

2) Design a constant current circuit based on figure 1, but using a 5.1V zener, and to sink a current of 10mA. Over what range is it compliant to 2%?

SpiceAge is available from Those Engineers Ltd., 31 Birkbeck Road, London NW7 4BP. Tel 0181 906 0155 Fax 0181 906 0969. Prices for SpiceAge simulation software are from £85 plus VAT upwards. A demo kit is available.

Music Enhancement!



Fader-Fuzz

Conventional fuzz and distortion effects are either "on" or "off", but Robert Penfold's Fader-fuzz can be faded gently in or out on command, with traditional value-overdrive style distortion.

Standard distortion ("fuzz") musical effects are produced by clipping the input signal to produce a harsher sound with containing a large number of harmonics. Some units offer a distortion level control that enables the degree of added "fuzz" to be preset. However, it is not normally possible to control the distortion level while actually playing the guitar. The effect can only be switched on and off with a footpedal. This does not allow the effect to be varied in an expressive fashion, like, for example, the waa-waa effect, which can be varied by pedal during the course of each note. This is not of much use when playing "machine gun" fashion, but with skilful use it can greatly enhance slower "mood" pieces using suitably sustained notes.

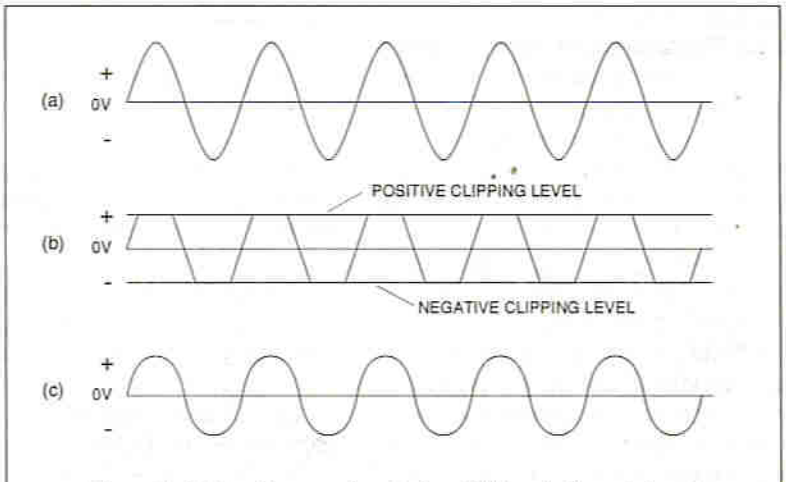


Figure 1: (a) the sinewave input signal (b) hard clipped signal c) soft clipped signal

The Fader-fuzz distortion effect offers some degree of control over the effect during performance. To simplify the mechanical side of construction, it uses a foot-operated switch rather than a pedal. When the switch is pressed down, the distortion effect is "faded" in. Releasing the switch results in the effect being "faded" out again. The attack/decay time can be varied from a few milliseconds to one second or so. This method of control is fairly basic, but it allows the player to control the effect with a fair degree of precision, and enables the distortion to be used in a more subtly artistic manner than usual.

Hard or soft

There are two types of clipping: hard and soft. Broadly, hard clipping is tends to be produced by

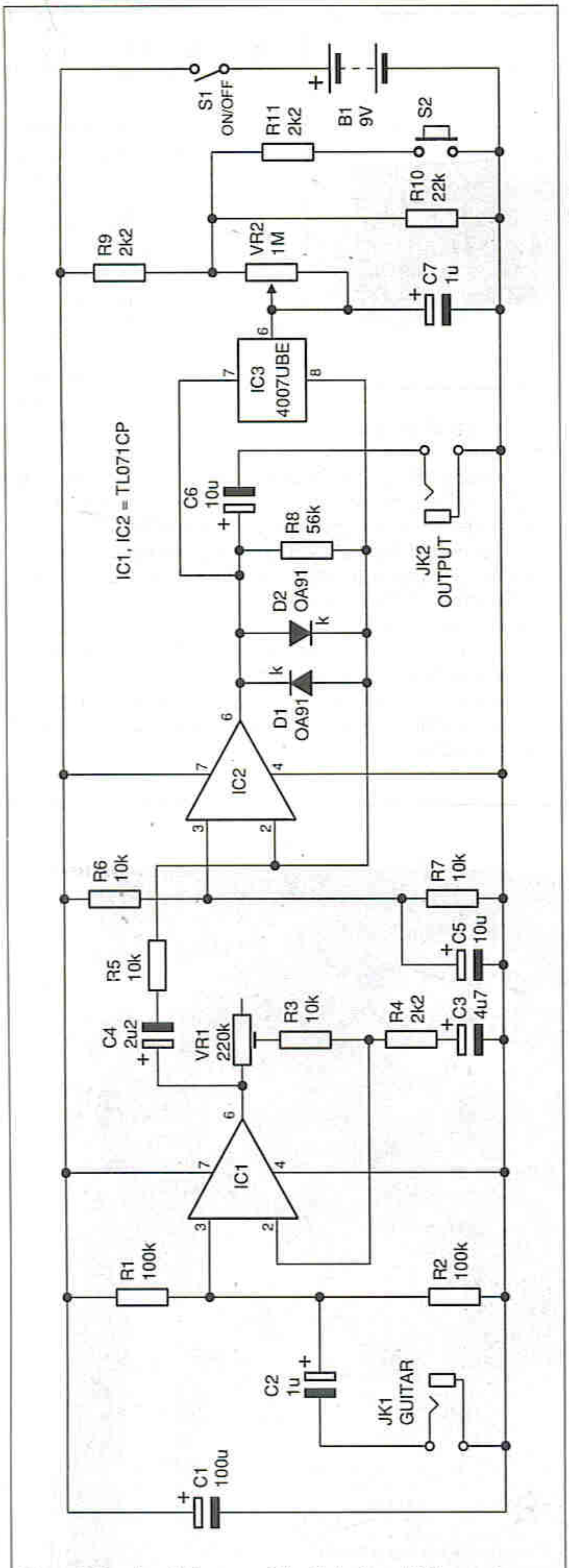


Figure 3: the circuit diagram of the Fader-fuzz. IC3 is used an an n-channel mosfet

overdriving a semiconductor amplifier, or a clipping amplifier which uses silicon diodes. Soft distortion tends to be produced by overdriving a valve amplifier, or a clipping amplifier based on germanium diodes. Figure 1 shows the difference between the two types. Waveform (a) represents a sinewave input signal, and waveform (b) shows the result of subjecting this to mild hard clipping. With hard clipping there are well defined positive and negative clipping thresholds. No matter how strong the input signal is made, the output signal will not go significantly beyond the clipping levels.

Soft distortion does not provide well defined clipping levels, and there is no true clipping level at all. As the output signal voltage rises, the gain of the circuit decreases, and the tops of waveforms become rounded.

Figure 1(c) shows the effect of strong soft clipping on a sinewave signal. Hard distortion tends to produce a squarewave or pulse output signal regardless of the input waveform. Soft distortion tends to retain the original wave shape to some degree. It still generates strong harmonic distortion, but the higher frequency harmonics are less strong than with hard distortion. This gives a less "bright" sound, and what is generally called a "thicker" fuzz effect.

The original "fuzz" effect was produced by soft clipping, and it is this version that seems to be back in fashion. Jimi Hendrix (with Marshall amps)-style soft distortion is perhaps more musical than the hard variety, and it has the advantage of producing much less intermodulation distortion. The importance of this becomes apparent if you play more than one note at a time. With soft clipping this is quite acceptable, but with hard distortion the result is usually very discordant. The unit featured here provides variable soft distortion.

How it works

Figure 2 shows the block diagram for the fader distortion unit. The input signal is fed to an amplifier which has adjustable voltage gain, and then to the clipping amplifier.

In order to give good results the clipping amplifier must be fed with a high signal level, otherwise the introduction of the distortion will produce a large rise in the output level, plus what might be only limited distortion. The gain of the amplifier is adjusted to suit the guitar pickup in use. The circuit can accommodate low output pickups, high output types, and anything in between.

The distortion level is governed by a voltage controlled resistor connected in the feedback loop of the clipping amplifier. With a strong positive bias fed to the voltage controlled resistor it has a fairly low resistance, and there is only low voltage gain through the clipping amplifier. The clipping diodes are also in the feedback loop, but they have little influence on the voltage gain of the circuit as they are virtually short circuited by the voltage controlled resistor.

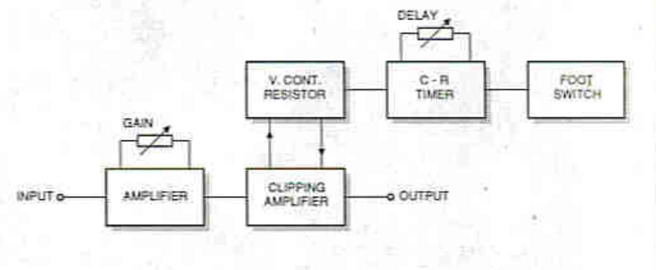
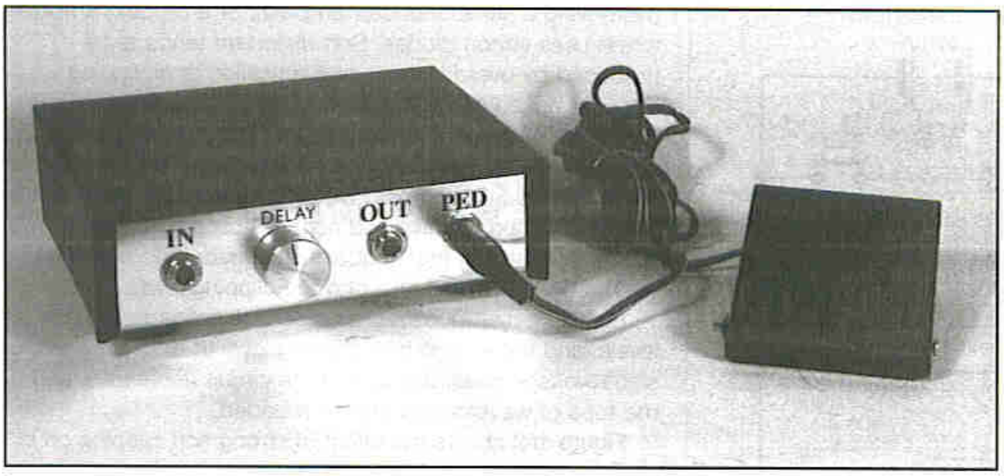


Figure 2: the block diagram of the Fader-fuzz



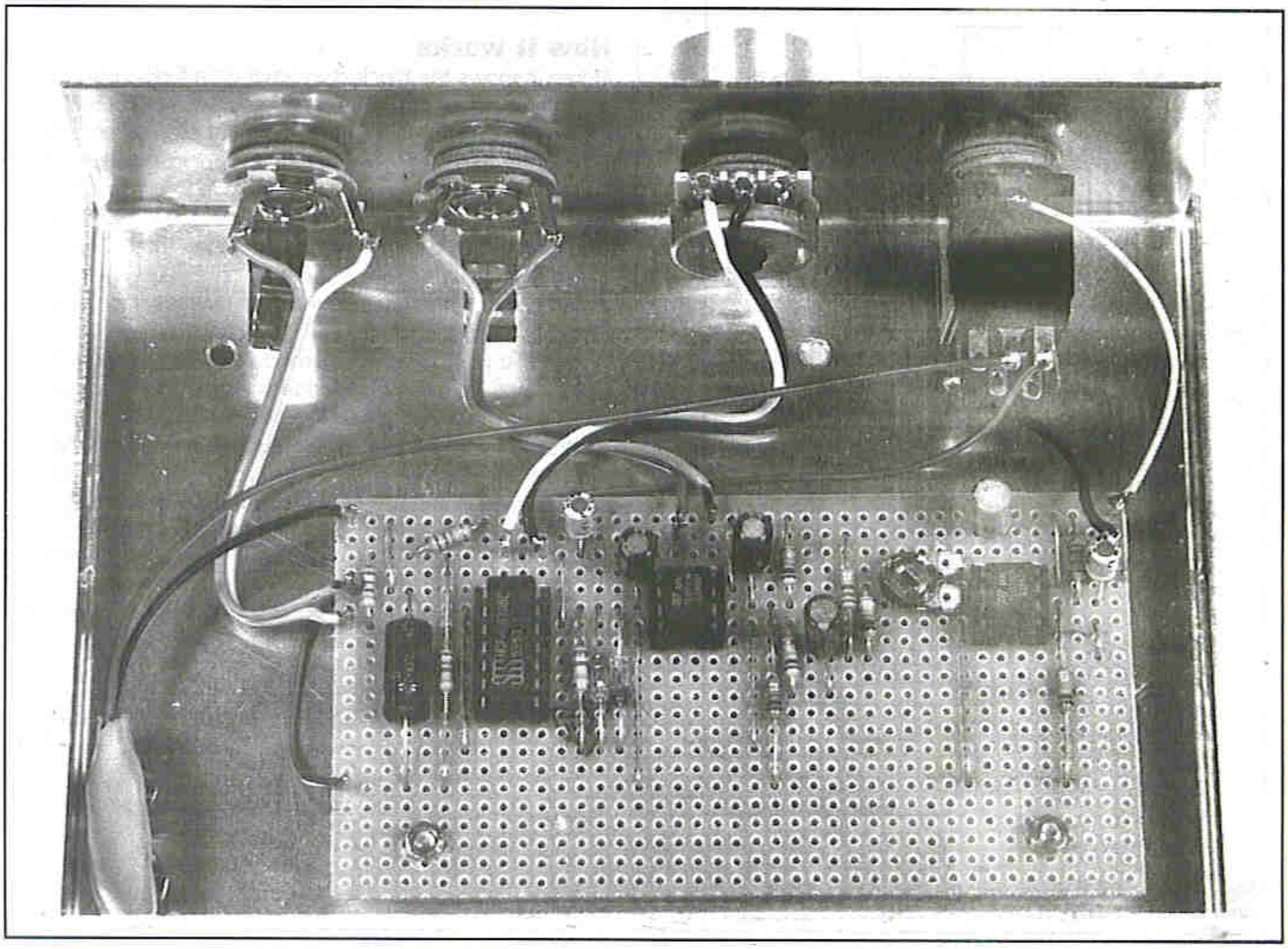
If the bias voltage to the voltage controlled resistor is steadily reduced, its resistance rises and the voltage gain of the clipping amplifier steadily increases. As the gain increases, the diodes have greater influence on the voltage gain of the circuit, and produce stronger distortion.

The control potential for the voltage controlled resistor is produced by a simple C-R timing circuit. Pressing the foot switch causes the charge on the capacitor to diminish and the distortion to rise. Releasing the foot switch results in the charge voltage on the capacitor returning to its original level, and the distortion fading out. A potentiometer controls the charge/discharge rate of the capacitor, and this is used to set the fade-in and fade-out time.

The circuit

Figure 3 shows the circuit diagram for the fader distortion unit. The input amplifier is based on IC1, which is used in a standard non-inverting mode circuit. R1 and R2 bias the non-inverting input of IC1, and set the input impedance at 50k. VR1 enables the closed loop voltage gain to be varied from about five to just over 100. C4 couples the output signal from IC1 to a simple inverting mode clipping amplifier based on IC2. D1 and D2 are the clipping diodes, and these are germanium diodes. D1 conducts on positive output half cycles, and D2 conducts on negative half cycles. R5 and R8 set the closed loop voltage gain of IC2 at 5.6, but this is reduced by the shunting effect of the diodes when they are biased into conduction.

The forward threshold voltage of a silicon diode is well defined, and occurs at about 0.6 volts. The turn-on voltage of a germanium diode is rather vaguely defined. A germanium diode starts to conduct at quite a low voltage, but exhibits a high resistance. The forward resistance falls somewhat as the applied voltage is increased, and it reaches a very low resistance at around 0.2 volts. This gives the required rounding rather than flattening of clipped output signal, and a good soft distortion effect.



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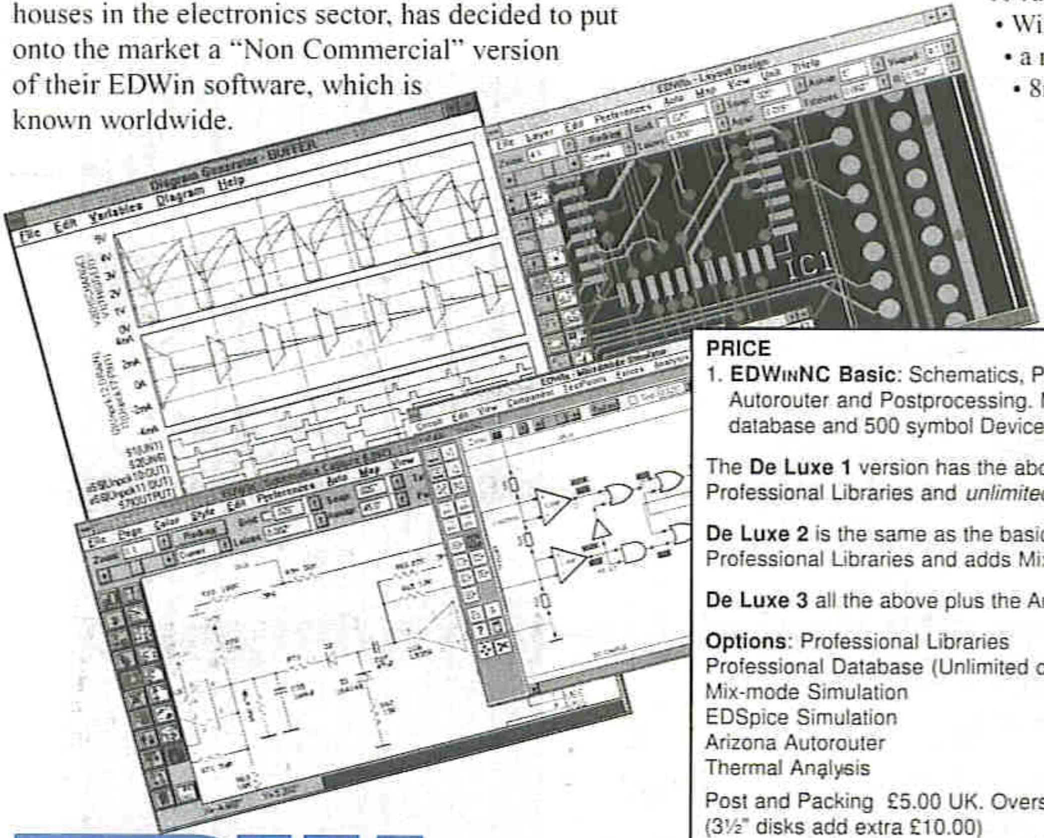

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IC3 is a cmos dual complementary pair and inverter.

In this circuit it is only the N channel mosfet of one complementary pair that is utilised, and no connections are made to the other pins of IC3. This mosfet acts as the voltage controlled resistor, and it is connected in parallel with R8. The source and drain terminals are at pins seven and eight respectively, and the resistance between these is controlled by the voltage applied to the gate terminal at pin six. The mosfets used in cmos logic devices are enhancement types, which means that they are normally switched off and require a forward bias in order to bring them into conduction. In this respect they are more like a bipolar transistor than a junction gate fet. such as the 2N3819. A junction gate fet. is a depletion mode device which is normally switched on and requires a reverse bias in order to switch it off. A junction gate fet. can not be used in place of IC3.

Under standby conditions R9 and R10 bias the gate of IC3 to almost the full supply voltage. The forward bias voltage fed to IC3 is much less than this because the source terminal is at the half supply bias level at the output of IC2. However, the forward bias is strong enough to produce a low resistance through IC3, and minimise the effect of the clipping diodes. The voltage gain of IC2 is well under unity with IC3 biased hard into conduction. Operating S2 reduces IC3's gate voltage to a little under half the supply voltage, which means that the gate is taken slightly negative of the source terminal. IC3 is then cut off, and exhibits a drain-to-source resistance of many megohms. The clipping amplifier then works normally, giving the soft distortion effect. The gain of the circuit is largely controlled by D1 and D2 rather than R8, giving what is effectively still less than unity voltage gain.

With VR2 at minimum resistance S2 provides almost instant but "click" free switching between zero and maximum distortion. At higher resistances VR2 and C7 provide a simple delay circuit which results in the distortion being "faded" in and out. A delay of a second or so is achieved with VR2 at maximum resistance. The circuit has been designed to minimise any increase in the output level as the distortion is introduced, but the peak output level still increases by a few dB. It would probably be possible to remove this built-in swell effect using a compressor circuit, but this is not really worthwhile as it seems to enhance the effect rather than detract from it.

The current consumption of the circuit is approximately 4 milliamps, increasing to about 6 milliamps when SW2 is closed. A PP3 size battery is therefore adequate to power the unit.

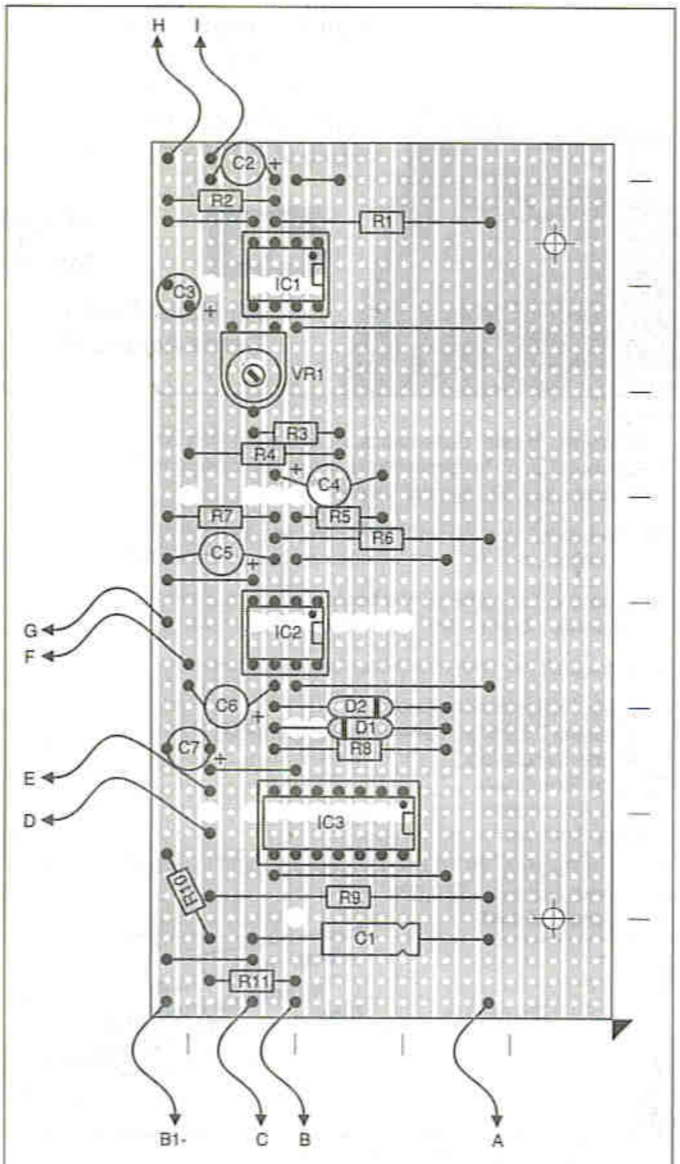


Figure 4: details of the stripboard component layout

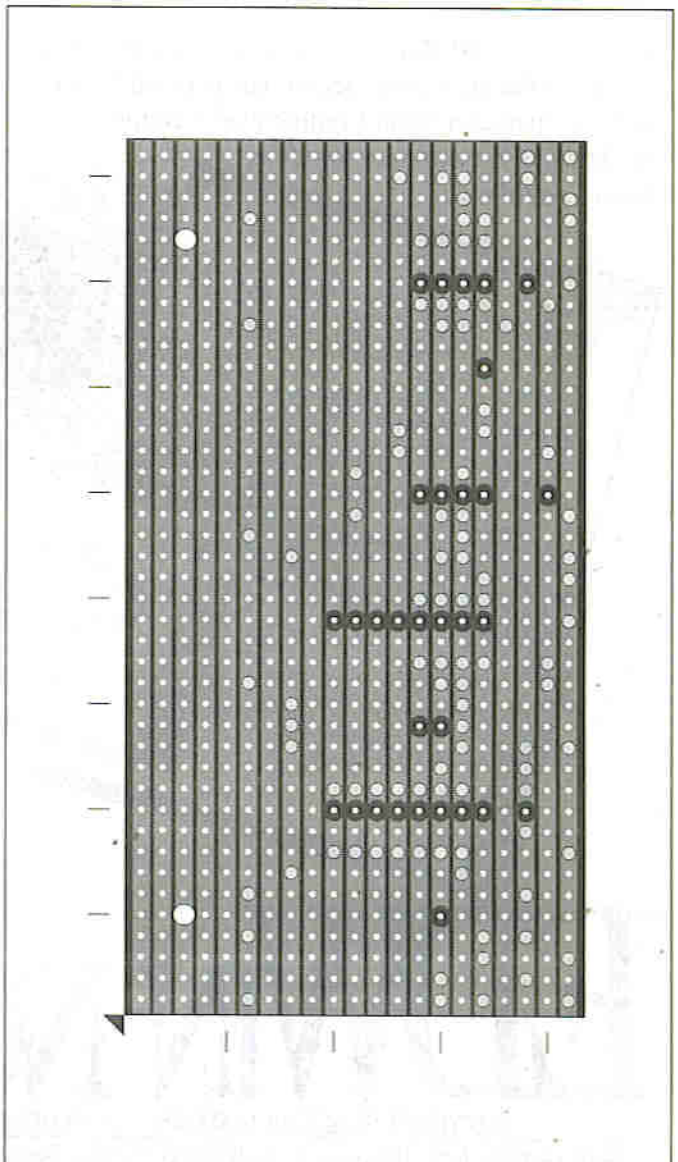
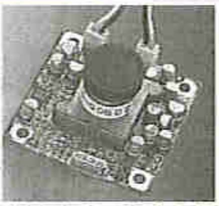
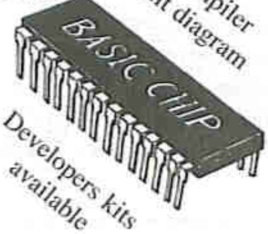
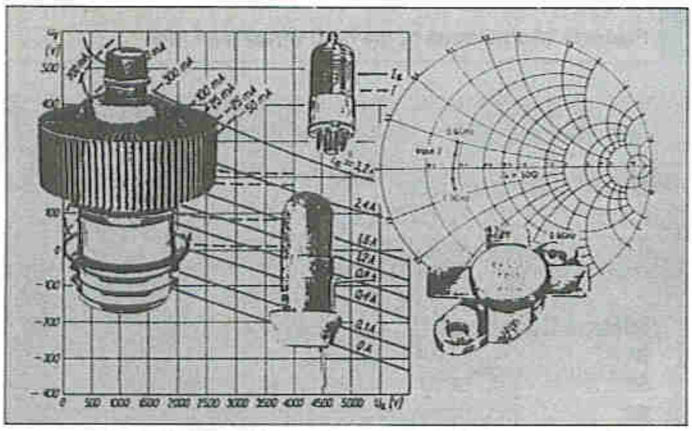


Figure 5: the underside of the stripboard panel




BASIC CHIP



Construction

Details of the stripboard layout are provided in figure 4, with the underside of the board shown separately in figure 5. The board measures 41 holes by 21 copper strips. Once the board has been trimmed to the correct size, make the breaks in the copper strips and drill the two 3.2 millimetre diameter mounting holes. The 4007UBE used for IC3 is a cmos device, and it therefore requires the standard anti-static handling precautions. Use a holder for this device and do not plug it into place until the board and the hard wiring have been completed.

The TL071CP is not a static-sensitive component, but I would still recommend the use of holders for IC1 and IC2 as well. Germanium diodes are more vulnerable to heat damage than silicon devices, and it is therefore important to take due care when fitting D1 and D2 to the board. I do not find it necessary to use a heat-shunt when fitting germanium diodes, but the soldered joints must be completed without any procrastination.

There are two basic approaches to the mechanical side of construction. The unit can be built as a self-contained effects unit complete with a built-in footswitch (S2), or S2 can be an external footswitch. A built-in switch is a neater and cheaper solution, but an external type with a proper foot pedal is easier to use. If S2 is built into the main unit it must be a heavy duty type mounted on the top panel of the case. The case must be reasonably crush-proof type, and a diecast aluminium box is ideal. However, this type of case tends to be quite expensive, and a box of folded aluminium construction represents a good low cost alternative. I would not recommend the use of a plastic case, even for people with small feet, for obvious reasons.

If an external footswitch is used, the strength of the case is not a major consideration. It is still advisable to use a metal case though, as this will shield the circuit from sources of mains "hum" and other electrical noise. A small metal instrument case is used as the housing for the prototype. The connection to SW2 is made via a standard jack socket mounted on the front panel of the case. The footswitch should be supplied complete with a standard jack plug and lead. Whether SW2 is an external switch or built-in, it must be a push-to-make, nonlocking switch (also known as a "momentary action" switch).

On/off switch SW1 can be a normal switch, or a pair of make contacts on JK1. With this second method the unit is switched on when the guitar lead is plugged into JK1, and switched off again when it is removed. This method is favoured by many people who find that it reduces the risk of the unit being left switched on. It might not be impossible to obtain a standard jack socket having a single set of make contacts, but a type having twin changeover contacts can be used. Connections are then made to only two of the six switch tags.

Figure 6 provides details of the hard wiring, and this diagram should be used in conjunction with figure 4. Two versions of the wiring are shown in Figure 6. The upper section shows the wiring if SW1 is a separate switch, and SW2 is built into the main unit. The lower section shows the correct wiring if SW1 is part of JK1, and SW2 is an external foot switch.

In use

The guitar is connected to JK1, and JK2 is connected to the amplifier, in both cases using standard screened guitar leads. A little experimentation will be needed in order to find the optimum setting for VR1. Results seem to be best if VR1 is set for the highest gain (set as far in a clockwise direction as possible) without the signal becoming clipped at the output of IC1. With the distortion switched off, give VR1 the most clockwise setting that gives distortion free results. It is possible that very high output guitars will cause IC1 to become overloaded even with VR1 fully backed off. The volume control off the guitar must then be used to reduce the instrument's output to an acceptable level.

If the unit is functioning correctly, operating S2 should "fade" the distortion in and out very smoothly and obviously with VR2 set for a medium to long delay time. If VR2 is set for a very short delay the effect will simply be switched in and out by S2, but it should provide "clean" switching with no "clicks" or other glitches.

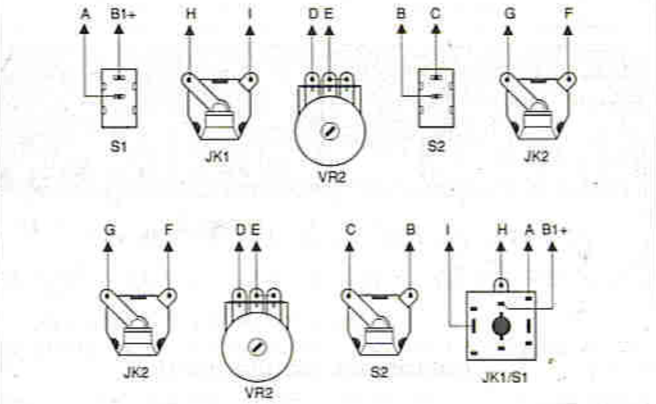


Figure 6: two versions of the hard wiring (see text)

PARTS LIST

Resistors (all 0.25 watt 5% carbon film)

R1,2	100k (2 off)
R3,5,6,7	10k (4 off)
R4,9,11	2k2 (3 off)
R8	56k
R10	22k

Potentiometers

VR1	220k min hor preset
VR2	1Mlin carbon rotary

Capacitors

C1	100u 10V axial elect
C2,7	1u 50V radial elect (2 off)
C3	4u7 50V radial elect
C4	2u2 50V radial elect
C5,6	10u 25V radial elect (2 off)

Semiconductors

IC1,2	TL071CP (2 off)
IC3	4007UBE
D1,2	OA91 (2 off)

Miscellaneous

B1	9 volt (PP3 size)
S1	SPST min toggle switch (see text)
S2	Heavy duty push-to-make switch (see text)
JK1	Standard 6.35mm jack socket (see text)
JK2	Standard 6.35mm jack socket

Medium size metal case, 0.1 inch pitch stripboard measuring 41 holes by 21 copper strips, 8-pin dil holder (2 off), 14-pin dil holder, battery connector, control knob, wire, solder, etc.

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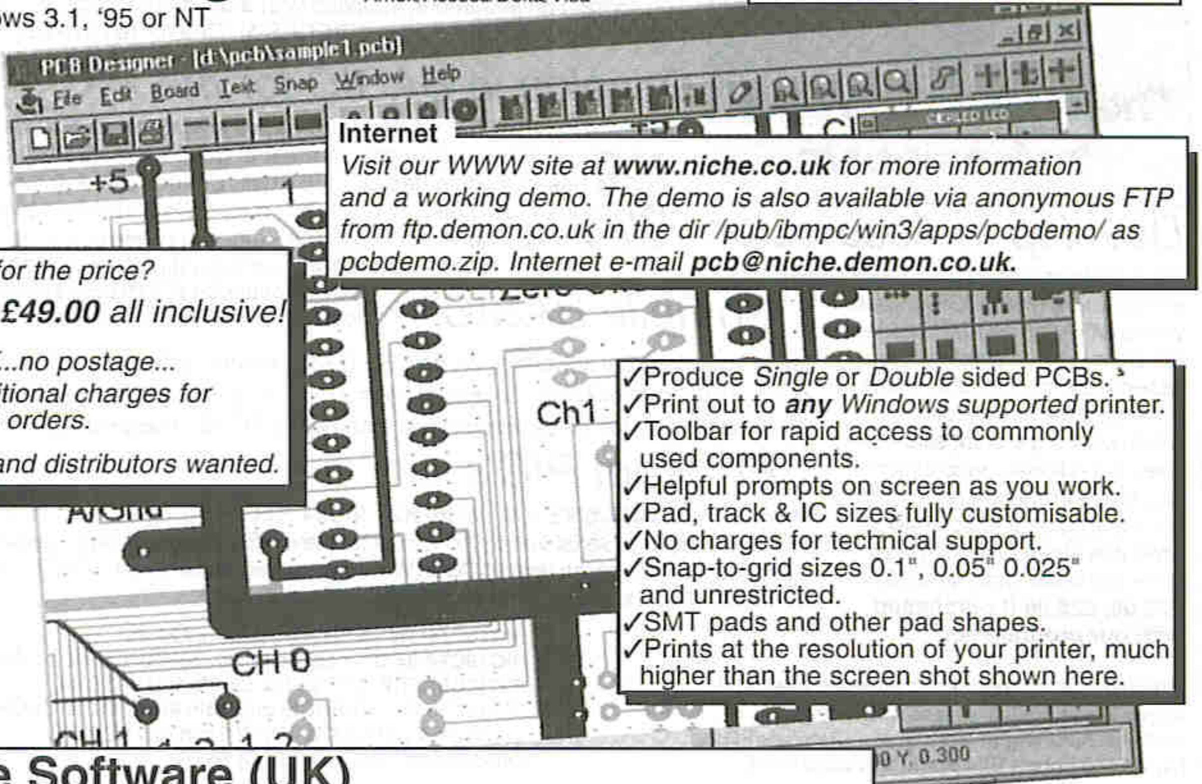

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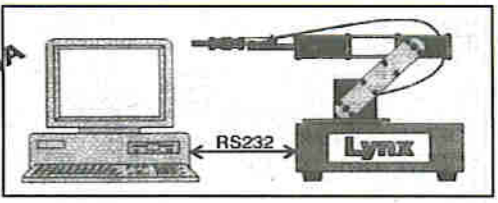

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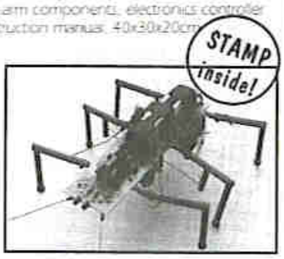

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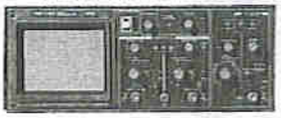

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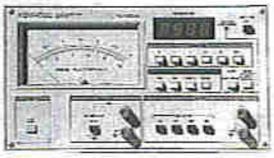

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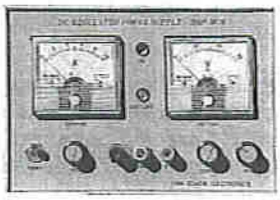

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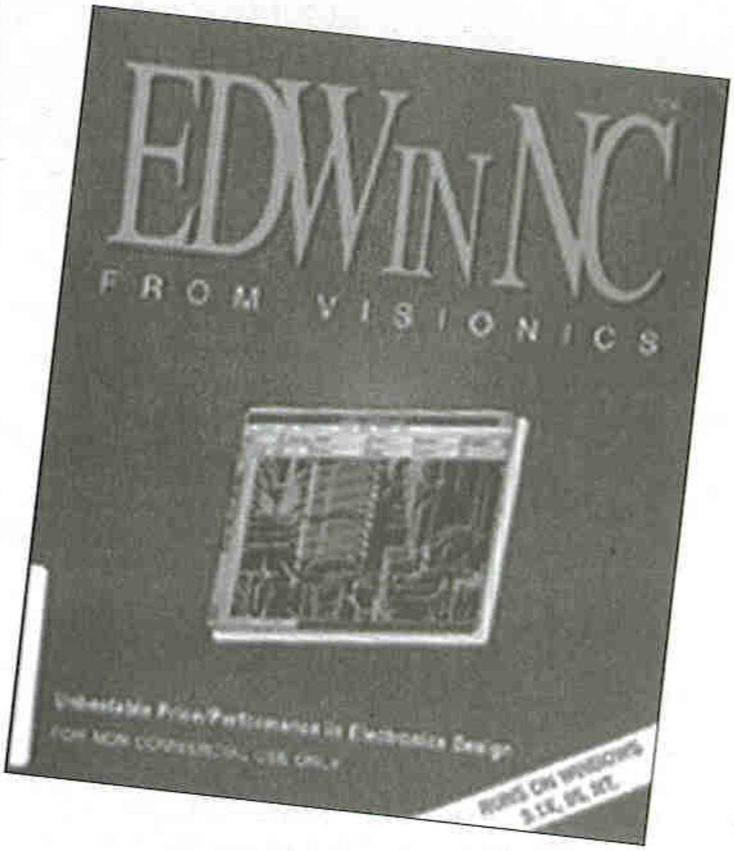
Review

EDWinNC - V. DeLuxe3
PCB CAD software - new low-cost package without commercial licence
£114.00 Swift Designs Ltd.



Recently (see News, ETI February 1997) a PCB CAD (computer aided design) program with a professional pedigree has been made available for amateur use at a very competitive price. You would expect a pcb cad system intended for industrial use to compare favourably in terms of facilities and functionality with lower-cost ones purely for amateur use, in which case it would be expected to be popular. Sceptics may wonder whether the cad system is really a professional program, or if it is just being marketed cleverly.

This is where I declare my bias: I have long been a user of the predecessor to EDWin (Visionics' EE Designer, a DOS-based program), and have used EDWin for the past two years for industrial designs. EDWin has, until now, been sold in the lower cost industrial market (in the £1000 to £5000 range rather than around £25,000) which is the area in which very many cad systems in regular industrial use are positioned.

CAD software is generally more complicated in its functions than, for example, a word-processing program, so that to evaluate a specific program, the first thing is to understand the functions which a pcb cad system must have, and those which it may include to make it more useful. The background information I am drawing on for this is a good working knowledge of EDWin and of two other widely used industrial cad systems in approximately the £3000 price range, a passing familiarity with one of the lower cost systems, and a brief evaluation of four others.

The basics

The basic requirement for pcb cad is to be able to place pads and tracks on to a layout. All the systems I have seen use component shapes, for example, 16-pin dil, and attach the tracks to the component so that if the component shape is moved the track end follows it. Some systems try to keep orthogonal tracks orthogonal as a component is moved, but most systems rubber-band the tracks and leave the user to move the bend points to make everything line up.

In all but the simplest cad systems, a component will include pads on both sides of the pcb, and very likely on inner multi-layers as well. It will also include drilling information for the pads, a solder resist mask for top and bottom of the pads, and a component outline for the silk screen layer. The silk screen normally includes a user-definable default position for component number, and maybe value as well.

More advanced cad systems, and all the ones I have made significant use of, incorporate what is often called "schematic capture", which is a means to generate connection information (usually called a "netlist") from a circuit diagram. This connection information is then used to define the connections on the pcb. This has long been, for me, the most important aspect of CAD. When this works properly, there is no longer that risk of connecting to pin 32 instead of 33 on a large expensive IC.

To make this possible there is usually a library of schematic symbols which contain information about the layout shape to be used, and about which schematic pin goes to which pin on the pcb. Often power supply pins are not shown explicitly, but are assumed to go to ground and 5V unless otherwise specified.

This is where, in most pcb cad packages, you generate a netlist and then load it into the layout program. EDWin, however, integrates the process. Instead of having schematic symbols with a link to layout shapes, there are devices with links to layout and schematic symbols. Placing a device on the schematic page (or on the layout) places both the layout symbol on the layout and the schematic symbol on the schematic page. Connecting a pin on either layout or schematic stores the connection information, so that the corresponding connection can be made on the other view. All the information is stored as one file, and in effect the layout window and the schematic capture window are different views of the same set of information.

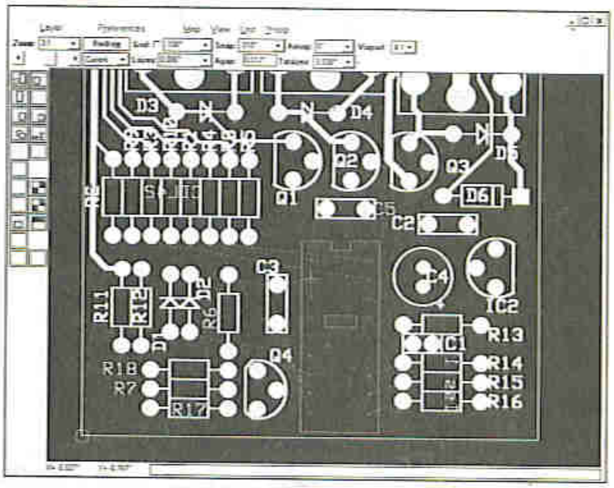


Figure 1: Ratsnest lines connecting to an integrated circuit being moved in the layout window

Normally one would start by drawing the circuit diagram, which with EDWin's devices means that all the layout shapes are ready to be viewed in the layout window. When you have done this, the next step is to display the layout window and draw the pcb outline.

Layout

So far so good. When you have a pcb shape and a set of components shown on the layout screen, you have to position the components on the pcb and connect the tracks. Different programs give you different aids to do this, up to auto positioning and auto routing of tracks. In practice, few boards seem to benefit much from the automatic placement and routing tools of the lower-cost industrial software. Still, auto positioning is available in EDWin, and this can at least start the process of positioning components ready for the tracks to be connected.

Much of the task of positioning the components must be done manually, and one should ideally position components in a logical order according to the connections that need to be made between them. What most packages do is to show you dotted lines connecting the components together (often still referred to as "ratsnest"), to illustrate how tracks will have to cross each other. EDWin provides this function via an option to show the nearest connections of the component currently being moved. This is illustrated by figure 1, showing a component being moved on a partly routed pcb.

The most important aspect of this sort of cad is a guarantee that the connections on the layout match the schematic. Different software packages show what connects to what in different ways, from displaying each unrouted connection as a thin or dotted line to highlighting the next-nearest connection. Edwin will highlight pins on the same net, and show dotted lines connecting to the nearest relevant pad. To route a track, it is necessary to click the cursor in the centre of a pad. Net name, layer, and width information is then displayed in the status line at the bottom of the window.

Many cad programs insist that you connect only to pads, so that a connection structure like that shown in figure 2 has one track laid on top of another connecting to the IC pin. In some cases this can necessitate moving two sets of bends if a track is to be moved. EDWin has a particularly powerful connection system that can allow T-junctions. If this function is selected, connections can be made to any track on the correct net, rather than to an actual pad. A bending point, which can be moved, is created at the joining point.

Indeed, if the track to be joined to is on another layer, EDWin will automatically create a via hole and connect to the track. These track-joining functions only seem like a special feature when you have to fight with a cad system that does not include something similar.

Track routing

On the subject of track routing, the layer of a whole track or just a segment of it can be changed, with via holes being automatically added or removed as necessary. Equally, track or segment widths can be changed with a click of the cursor.

A particularly useful function is the ability to swap gates or pins at the layout stage in order to uncross connections. Many cad systems require you to return to the schematic, make the change, generate a new netlist, load the netlist into the layout, and proceed. In EDWin you select, for instance, GATE SWAP, click on the two gates whose connections are visibly crossing on the layout window, and the gates are exchanged on both layout and schematic.

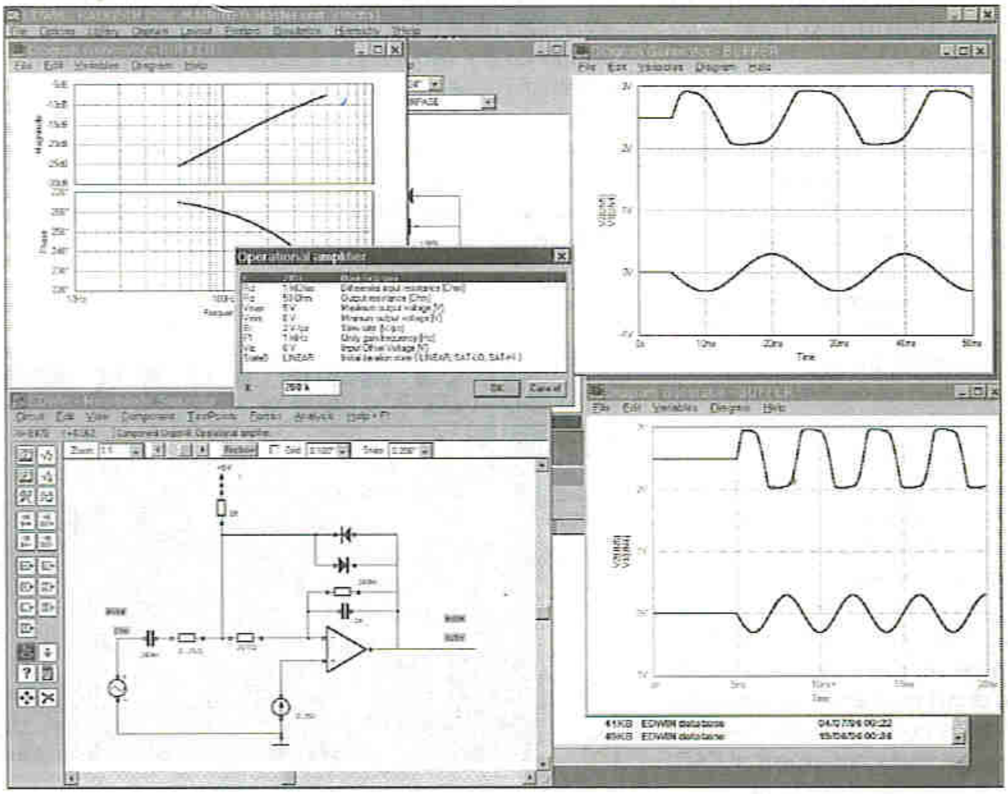


Figure 3: Simulator window with time domain and frequency domain output graphs

Figure 4: Tool bar for component editing in the layout window

Figure 2: T-junction track connection

Individual pins can be changed equally easily. There is a logical pin swap function which will allow you to exchange, for example, two identical input pins, but not to swap one of them with an output. There is also an absolute swap function to allow you to make any alteration you need.

If, for example, you uncross the tracks to a connector, the connections on the schematic will immediately reflect this change, but they will be shown at odd diagonal angles until you move the bending points to tidy up. This is so much quicker and easier than the possible alternative that it does not seem like a problem.

A corollary of the way that the schematic immediately reflects the layout is that you can draw the layout from scratch, and then use similar techniques to pcb layout to create a comprehensible schematic. This has been useful in situations where an old design has to be updated, and the drawings have been lost, or the revisions do not match. Or, if you need to repair something and a circuit diagram is not available, a section of the layout can be copied and used to create the relevant circuit diagram section to find the fault.

An important aspect of cad layout is design rule checking. EDWin has a clearance check function which will pinpoint short circuits, or pads and tracks etc too close together, with the required spacing being user configurable. There are also tools to check that all necessary connections are made, and to help you to pinpoint missing connections. A simple connection check function will tell you which nets contain missing connections, and then the nets mapping will show you which component pins are connected in each separate group (a group can consist of as little as one unconnected pad).

Simulation

EDWin contains a very effective circuit simulator. The simulation information is contained in a set of schematic symbols, and various parameters of the models can be set. For example, figures for a real mosfet can be applied to the general mosfet symbol once it has been placed on the schematic, just as different values can be assigned to resistors. Various signal generator and measurement symbols (without corresponding layout shapes) can also be placed, and the simulation can be run. Typically, the part of the circuit to be simulated would be drawn first, then when optimised the rest of the schematic would be drawn prior to layout. Figure 3 shows the simulation of a simple signal conditioning circuit, with a window illustrating how component parameters, in this case an op-amp, can be altered.

The drawback of the simulator is that it does not use Spice models, so I cannot download the Spice model for a new chip from the Internet and use it. On the plus side, the simulator models can be configured in many ways, so that a reasonably accurate simulation of a particular op-amp or whatever can be created. It is also much easier to use than many Spice implementations. It runs quickly, and normally produces helpful results. I check parts of many of my designs on the EDWin simulator before building the first prototype, and reach the final design stage noticeably quicker as a result. A Spice add-on is available in any case for those who need it.

Overall, EDWin has a different type of user interface compared to other cad systems I have seen, with toolbars for editing different items. Figure 4 shows the toolbar for components, as an example. When tools on the left are selected, different tool options appear on the right. Buttons on the right in this illustration are, from the top: rotate component 90 degrees, rotate component any angle, change component placement side (useful to put surface mount devices on the back of the board), relocate named component, swap component positions, display component ratsnest while moving, display component tracks while moving, and display component outline while moving. This last can speed up the procedure on slow PCs.

There are keyboard shortcuts, but they are not so short or memorable as some I have encountered. The controls look complicated and, to some extent, they are. CAD programs perform a more complex and precise function than ordinary wordprocessing programs, and all take some effort to learn at first. My experience is that the first layout in a new cad system takes longer than the manual artwork equivalent, but after that speed improves dramatically.

Several aspects are not as you might expect on a Windows cad system, but these are largely items that do not impact on the real use of the software. For example, you cannot use TrueType fonts even on the schematic - you merely have a choice of various sizes of plain lettering.

Multiple designs cannot be open at once - but for the most part you can only work on one design at a time any way.

Also, instead of having a large window in which child windows are created, like most other Windows programs, it has a separate title bar at the top of the screen with menus for File, Options etc, and separate movable windows for schematic capture, layout, postprocessing, simulation, and library part editing.

There is only one omission that causes me any concern, and that is in the creation of ground planes. EDWin cannot fill an area with a plane, automatically connecting to the relevant net and giving clearance around other connections, by drawing the ground plane on screen. Instead it generates a separate Gerber plot layer with a negative plot - all the tracks that the plane must not connect to are drawn wider to give a suitable gap. This plot has to be negatived photographically or in software and added to the plot of the layer for the plane. This makes it difficult to see the immediate effect of the earth plane. The facility to remove little odd bits of plane that cannot connect to anything also does not currently exist. However I believe this is to be addressed the next time that the program is upgraded.

Other cad systems also have errors and omissions, and overall I find that the balance between the good features and the items I wish were better favours EDWin over the other similarly industrially priced cad systems I have encountered. Now that the fully functional program has been made available without a licence for commercial use, I believe that those home constructors who use it will find it exceptionally good value.

Swift Designs issue non-commercial EDWin NC in a series of versions from the basic level at £49 with a 100-component database limitation, to DeLuxe 3, reviewed here, which includes the Arizona Autorouter. Swift also have a bolt-on extra for Spice3F5 (£49 including VAT) that will accept manufacturers' code models and netlist import to allow the reconstruction of schematic drawings. Contact Swift Designs Ltd. have a web page at www.Swiftdesigns.Co.UK or Tel 01438 310133.

ETI with Swift Designs have arranged a 10% discount card for ETI readers next month and a free copy of EDWin NC to be offered the following month in an ETI reader competition.

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Experimenting with Video

PART 3

A digitally controlled mixer/fader

Robin Abbott - second half of the video mixer/fader begun last month.

Last month we looked at the circuit diagram and the software operation of the video mixer/fader. This month we will look at the operation of the signals in the circuit in a little more detail, the construction, testing and setup of the mixer/fader, and the control of the fader over the serial link.

Detailed pattern generation

We will look in a little more detail at the setting of the signals around the circuit for the various wipe patterns. This information is of use for experimenters who would like to extend the operation of the circuit.

The majority of the slide patterns are controlled using the four signals SWINVERT, SWDIRECT, SWFALL and SWRISE as labelled on figure 3 (the circuit diagram) shown in the first half of this project last month. These signals are set as follows:

SWDIRECT: This signal is used by the PIC to swtich the video signal directly on or off. It is used in the vertical wipe patterns. When the SWINVERT signal is low, then the SWDIRECT signal is low to turn the video signal on, and high to turn it off. The SWDIRECT signal is wire OR'd with the outputs of the horizontal comparators, and therefore should be controlled with the TRIS registers of the PIC, effectively operating the output of the PIC as an open drain signal. The SWDIRECT signal is driven from port B of the PIC, which has its internal pullups enabled.

SWINVERT: This signal inverts the outputs of the horizontal comparators and the SWDIRECT signal when set high. This is used in some effects to reverse the direction of the fade or wipe.

SWRISE and SWFALL: These signals control the horizontal comparator outputs. The horizontal comparators have open collector outputs, and are connected to the video switch output by analogue switches. For simple horizontal wipes (pattern numbers 4 and 5) only the SWRISE signal is enabled. For wipes with horizontal bars (such as pattern 10), both the SWRISE and SWFALL signals are enabled.

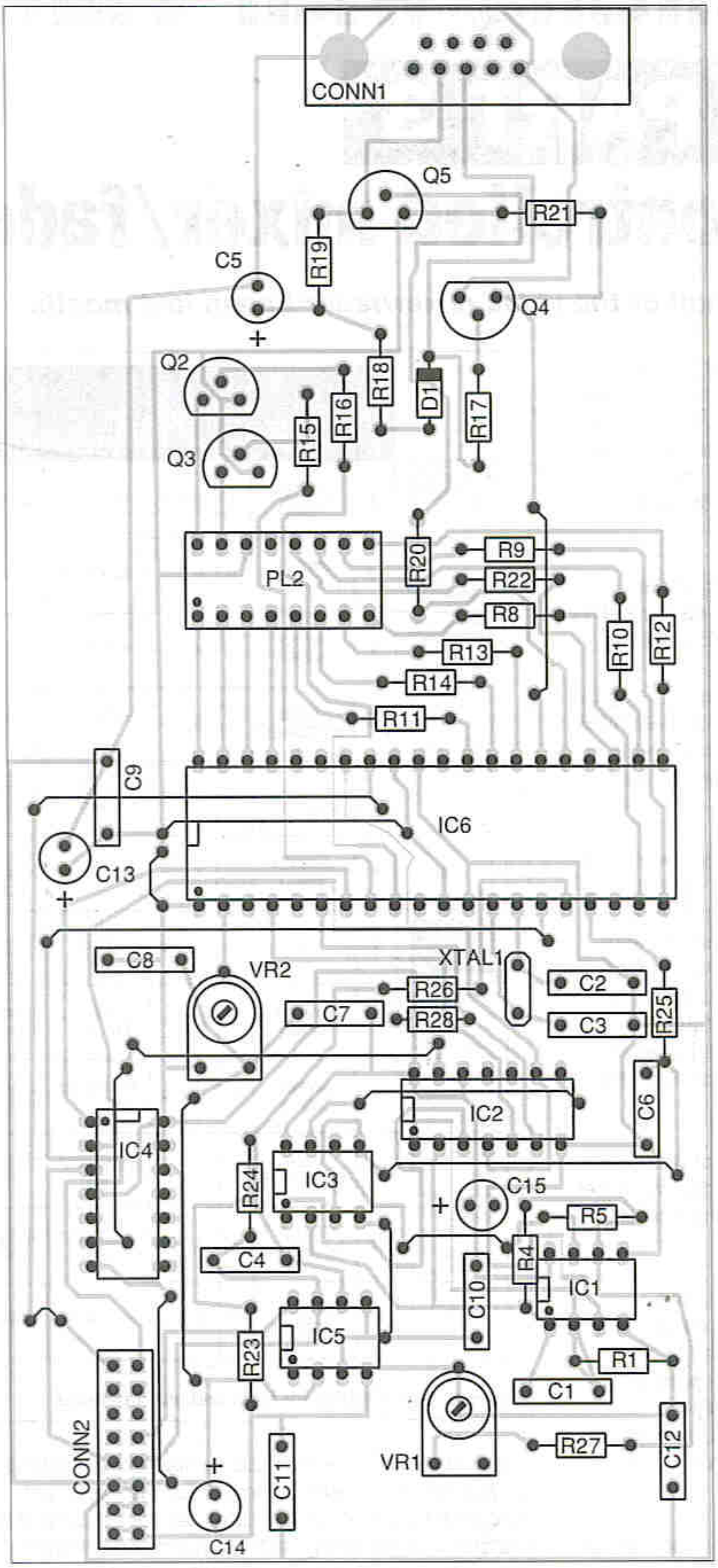
	PATTERN	SWDIRECT	SWRISE	SWFALL	SWINVERT	START FADE	END FADE
	1	SWITCH VIDEO	0	0	0	DOWN: 0	DOWN: 312
	2	SWITCH VIDEO	0	0	0	DOWN: 312	DOWN: 0
	3	SWITCH VIDEO	1	1	1	SEE 7 & 9	SEE 7 & 9
	4	HIGH IMPEDANCE	1	0	1	SLIDEVOLT +5V	SLIDEVOLT 0V
	5	HIGH IMPEDANCE	1	0	0	SLIDEVOLT 0V	SLIDEVOLT +5V
	6	SWITCH VIDEO	1	1	0	SEE 7 & 9	SEE 7 & 9
	7	0	0	0	0	VGAIN +5V	VGAIN 0V
	8	SWITCH VIDEO	0	0	0	DOWN: 0 GAP: 312	DOWN: 156 GAP: 0
	9	SWITCH VIDEO	0	0	0	DOWN: 156 GAP: 0	DOWN: 0 GAP: 312
	10	HIGH IMPEDANCE	1	1	1	SLIDEVOLT +5V	SLIDEVOLT +2.5V
	11	HIGH IMPEDANCE	1	1	0	SLIDEVOLT +2.5V	SLIDEVOLT +5V
DIRECT SWITCH	12	SWITCH VIDEO	0	0	0	SWITCH: 0	SWITCH: 1

Figure 1: Signal setting for fader and mixer patterns

For horizontal wipes the PWM output (PWM1 on Port C2) must vary to change the position across the line at which the comparators switch. This signal (SLIDEVOLT) is on pin 17 of the Pic on last month's circuit diagram. For simple wipes where only the SWRISE comparator is enabled, the voltage varies between 0 and 5V. For the wipes with horizontal bars the voltage varies between 2.5V and 5V - this can be seen on figure 5 last month. The PWM registers are set to 0 for 0V output, and 255 for 5V output.

For video fades the signal is enabled using SWDIRECT, however, the second PWM output on PIC port RC1 (pin 16)

Figure 2: the component layout and links on the main PCB



is used to generate a fade voltage between 0 and 5V. This is shown as VGAIN on the circuit diagram. When the PWM output is at 5V then the fade voltage is set to -0.5V and the video signal is set to full on. When the PWM output is at 0V, the fade voltage is set to +0.5V and the video signal is full off.

Figure 1 this month shows the setting of the various signals in the circuit for each pattern. The columns labelled Start Fade and End Fade show the state of the voltages in the circuit at the start and end of the fade or wipe. For the horizontal effects these columns show the state of internal variables in the program which control the horizontal fade. The source code for the program (which is available in magnetic form - see the end of this article) uses these variables, and should be consulted to see how they are used.

Construction

The sync separator board featured in the first article in this series in ETI Vol. 26 No. 1 (February 1997) should be constructed as shown in that article. However, one important change must be made: the 78L05 device must be changed to a 7805 device, as the total current consumption on the +5V rail rises to about 200mA. The tab of the 7805 should be towards the input of the board. A heatsink should be fitted.

There are two boards to build for the mixer/fader: the first is the main video mixer/fader, the second is the keypad and display board. The board component overlay for the main board is shown in figure 2. The board is single sided, and there are 14 wire links. If no serial control from a PC is required, then the components connected to pins 25 and 26 of the PIC may be left out.

Construction is straightforward. Use sockets for all the ics on the board. Start with the wire links, then insert all the ic sockets, resistors, capacitors, and finally the remaining components. Finish with the connectors.

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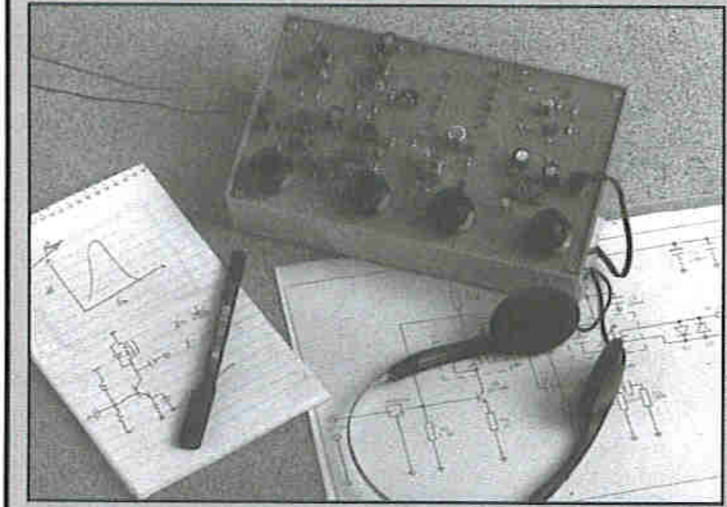

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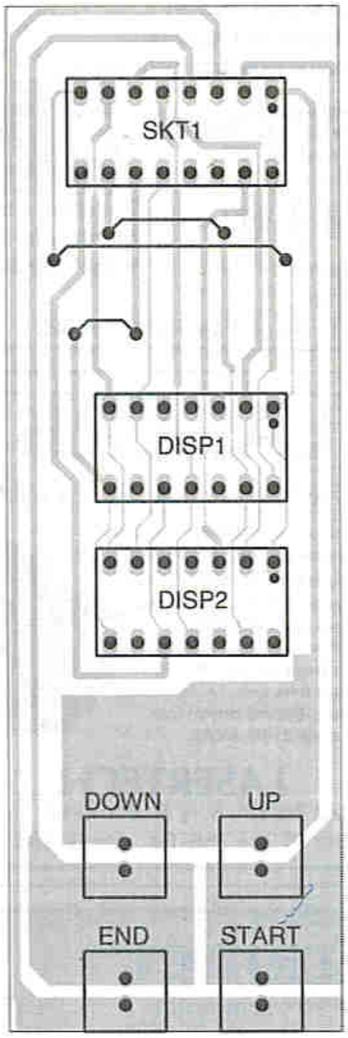
Figure 3: display board component layout with links

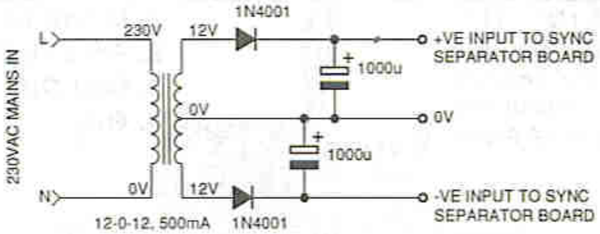


For testing purposes the variable resistor VR2 can be wired up directly, or can be temporarily replaced with a preset. Do not be tempted to increase the value of this resistor, as it drives a relatively low impedance input on the PIC. Initially set VR1 to the centre position.

The keypad and display board, shown in figure 3, is also straightforward. There are three wire links on this board. The push buttons are miniature types on a 0.1in pitch. The displays are 0.3in devices which should also be socketed to raise them from the board.

The connections between the boards use IDC connectors and 16-way ribbon cables. The connection to the sync separator board uses 16-way IDC connectors on a 0.1in pitch, and the connection between the main board and the display board uses 16-pin DIL connectors. Keep the cable between the main board and the sync separator board as short as possible. The 16- way IDC connectors on a 0.1in pitch may be attached to the cable by assembling the connector around the cable, and then gently squeezing the connector on to the cable using a vice. The DIL connector may be assembled on to the cable, and plugged in to a scrap socket soldered to a small piece of veroboard, the whole then being squeezed together using a vice and then removed from the scrap socket.

Figure 4: the video mixer/fader power supply



The mechanical construction of the project depends on the power supply to be used. The layout is not critical and the case does not need screening. The only external cutouts required are for connectors, and for the push buttons and display. The display should be mounted behind a red filter, and the display board can be mounted using the fixing nuts and washers for the push buttons.

The power supply

The power supply should be greater than +/- 9V and capable of driving at least +250mA and -100mA. A simple 500mA, +/- 12V transformer in the circuit shown in figure 4 is adequate for this project.

Testing

Connect the three boards together, and connect a power supply to the sync separator board, which should have been set up as described two months ago. Check that the power supply to the ics on the main board is correct, then power down and insert the ics and displays into the two boards. Power up again. If all is well, the displays should be showing 01. Connect a video signal and a monitor to the sync separator board and the two decimal points should come on, showing the presence of a video signal with synchronisation signals being detected successfully.

Check that the mixer/fader operates successfully as shown in last month's article (under "Operation of mixer"). The only adjustment which needs to be made is VR1. Select pattern 9, and set VR2 to slowest fade speed. Start the fade, and press either of the UP/DOWN buttons again to stop the fade; adjust VR1 until the fade bars are symmetrical on the video monitor.

PC control of the mixer/fader

The mixer/fader is connected to a PC (or any suitable computer with a three-wire serial port capability). The serial port operates at 9600bps. The cable requires three wires. Connections between the fader/mixer and the computer are shown in figure 5.

The control of the mixer/fader is straightforward, and may be accomplished from a terminal emulator, or from a Basic control program. When the fader/mixer powers up it

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SERIAL SKT	9-WAY FEMALE	9-WAY MALE	25-WAY FEMALE	25-WAY MALE
2	3	2	3	2
3	2	3	2	3
5	5	5	7	7

Figure 5: the serial interface wiring

PARTS LIST

Resistors

All 1 percent tolerance

R1	680k
R2,3	(omitted)
R4,5	100k
R6, R7	(omitted)
R8 to R14,18,22	300R
R15,16,21,24	4k7
R17,25	22k
R19	2k7
R20,28	10k
R23	47k
R26	33k
R27	68k
VR1	100k
VR2	5k pot

Capacitors

C1	100pF ceramic
C2,3	22pF ceramic
C4,6	0nF68
C5,13,14,15	100uF 16V electro
C7 to C12	100n
XTAL1	4MHz crystal or ceramic resonator

Semiconductors

IC1,5	TL082
IC2	74HC4066
IC3	LM393
IC4	74HC85
IC6	PIC 16C74 (see text)
Q1	(omitted)
Q2,3,5	BC559
Q4	BC548
D1	1N4148

Miscellaneous

Conn1	9-pin D connector
Conn2	16-way IDC socket
Disp1,2,3,4	7-segment 0.3in displays, common anode
SW1 to SW4	Pushbutton switches, 0.1in pinout
PL2	16-pin dil socket

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sends a 'K' character on to the serial interface. The 'K' character is also sent when a fade or wipe is complete, and this may be used by a controlling program to determine the sequence of a programmed fade or wipe.

Ascii codes 65 to 76 (Letters 'A' to 'L') start fade patterns 1 to 12. To start a fade or wipe, simply send the Ascii code to the fader/mixer. For example, to start pattern 2 send a 'B' character to the fader/mixer. When the fade/wipe is complete the fader/mixer will return a 'K' character. Ascii codes 97 to 109 (Letters 'a' to 'l') start an unfade of patterns 1 to 12. Therefore to fade the video picture back in using pattern 2, send character 'b' to the fader/mixer.

To set the speed of the fade, Ascii codes 48 to 57 (characters '0' to '9') are used. Code '0' is the fastest speed and '9' is the slowest. The speed sent to the fader/mixer is used for all future fades which are started from the serial interface. As soon as the keypad is used to start or end a fade, the speed set on VR2 is used again.

Finally, the '+' character will pause a fade in progress when it is received by the fader/mixer, or restart it if it is already paused.

Figure 6 is a summary of the control codes used by the fader/mixer. Figure 7 shows the QBasic commands required to drive a serial port on a PC to drive the fader/mixer. QBasic is a DOS program supplied with the MS-DOS and Windows 95 operating systems.

Obtaining parts

A disk containing the source code and Intel hex format file for the compiled code, which is too extensive to publish here, is available for the project from Forest Electronic Developments (FED) at 10 Holmhurst Avenue, Christchurch, Dorset, BH23 5PQ (01425-270191 for credit card sales). The cost of the disk is £5.00 inclusive of post and packing. The source file disk includes a text file describing how to assemble the files on the disk using Microchips assembler or FED's PICDE assembler.

Alternatively, a PIC16C74-04 preprogrammed with the code for the project is available from FED for £15.00.

All the other parts used in the project are available from Maplin or Farnell.

NUMERIC CODES	ASCII CHARACTER	EFFECT ON MIXER/FADER
43	'+'	PAUSE CURRENT FADE/WIPE
48 - 57	'0' - '9'	SET FADE SPEED FOR FOLLOWING FADES DRIVEN FROM SERIAL INTERFACE. O IS FASTER. 9 IS SLOWEST
65 - 76	'A' - 'L'	START FADE - PATTERNS 1 TO 12
97 - 108	'a' - 'l'	START UNFADE - PATTERNS 1 TO 12

Figure 6: summary of the control codes used by the mixer/fader

QBASIC COMMAND	EFFECT
OPEN "com1:9600,n,8,1,bin,cd0,cs0,ds0,op0,rs" FOR RANDOM AS #1	OPEN COM PORT 1. (REPLACE COM 1 WITH COM 2 TO USE COM PORT 2). ALSO DISABLES ALL HARDWARE PORT OPERATION
PRINT #1;"A";	PRINT CHARACTER 'A' TO THE SERIAL PORT (MUST HAVE BEEN OPENED AS SHOWN IN OPEN COMMAND ABOVE. REPLACE 'A' WITH ANY CHARACTER REQUIRED
INPUT #1;A$	READS A CHARACTER FROM THE SERIAL PPORT. THIS COMMAND WILL WAIT UNTIL A CHARACTER IS RECEIVED, AND CAN BE USED TO WAIT UNTIL THE MIXER/FADER SENDS A 'K' CHARACTER AT THE END OF A FADE OR WIPE

Figure 7: QBasic commands of use with the serial port

The Little Mule
Electric fence controller

Guard your goldfish - but mind you don't get a kick out of this project!

by Bob Noyes

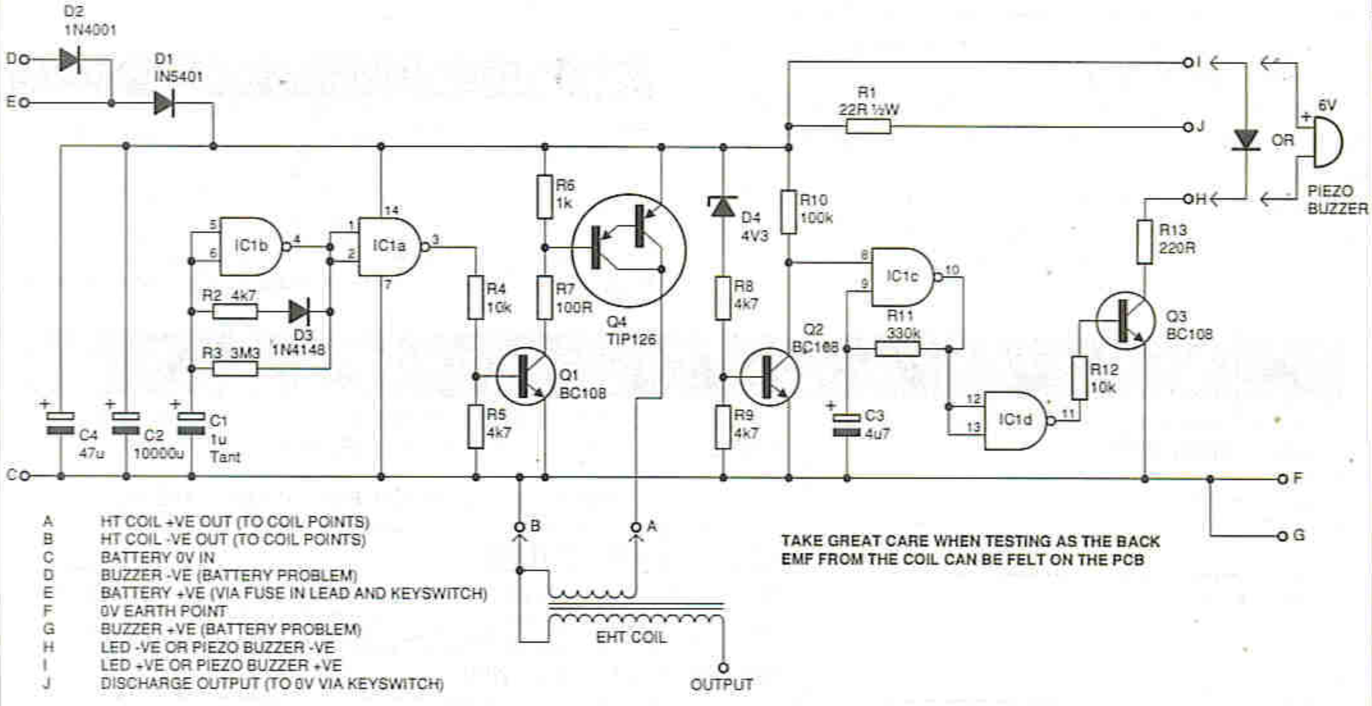
Over the past few years our garden pond has become the local 24-hour take away for all sorts of wild animals as well as the neighbourhood moggies. Cats in particular seem to think they have a divine right to help themselves to a nice juicy goldfish, and no amount of shoes slung in their general direction has any effect. We've tried covering the pond with netting, but this prevented the local frog population from migrating between nearby ponds; it was also extremely awkward to maintain the pond and pumps, etc. String with tin foil that spun in the wind was another method we tried but after a couple of weeks the novelty had worn off and it had no effect at all.

In the end, more drastic action was needed so the solution was to build and install an electric fence, the idea being to repel unwanted animals with a short, sharp shock, not to harm or kill them, "man traps" being illegal, quite apart from humanitarian (?) considerations. The name given to this project is The Little Mule: a rather apt name after your author received several such short, sharp shocks during the design, building and testing of it. (A full-size "Mule", like the sort some farms use for livestock in fields, would no doubt have been somewhat sharper without being any shorter.)

As well as protecting the pond, our fence has been designed for general purpose use to protect such things as strawberry patches, kitchen gardens and could even be used by farmers for livestock control such as fencing off small areas.

The principle

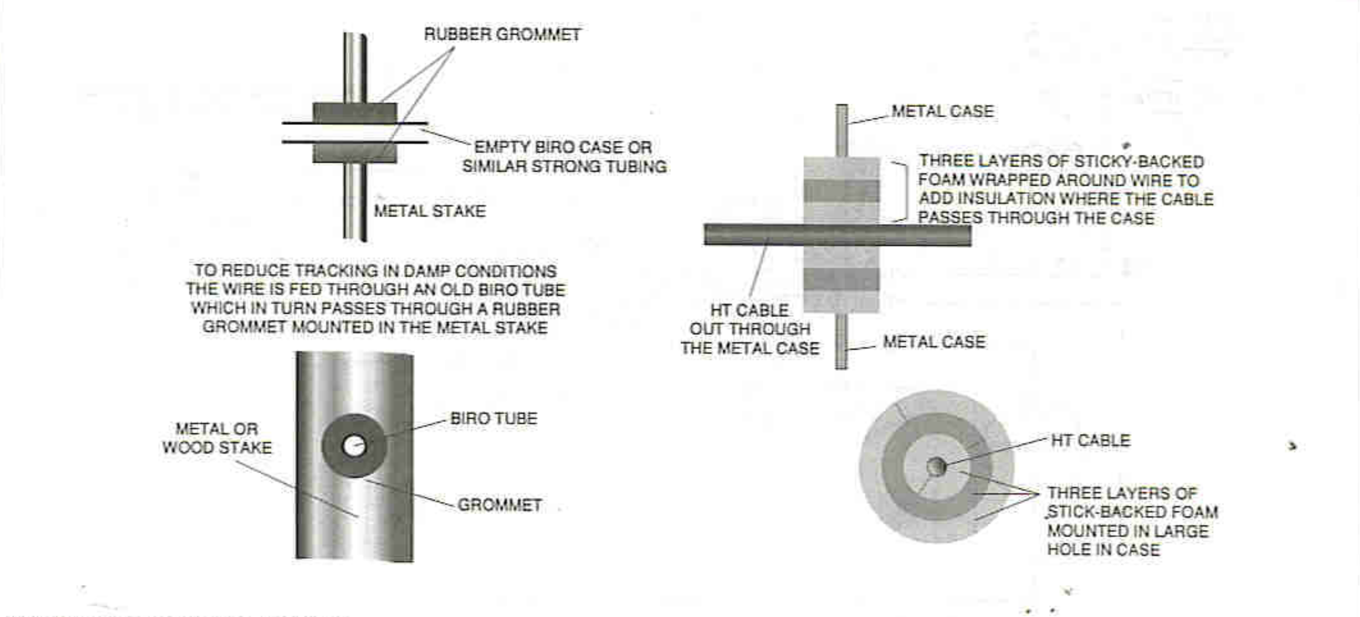
To generate a high voltage is quite easy with modern electronics; an oscillator feeding a step-up transformer produces a constant high voltage, but the power consumption is too high for battery power. In order to get any reasonable life, such as a month or so, from one battery charge a car battery or a larger type would be required - hardly practical for the small area being protected. But



A	HT COIL +VE OUT (TO COIL POINTS)
B	HT COIL -VE OUT (TO COIL POINTS)
C	BATTERY 0V IN
D	BUZZER -VE (BATTERY PROBLEM)
E	BATTERY +VE (VIA FUSE IN LEAD AND KEYSWITCH)
F	0V EARTH POINT
G	BUZZER +VE (BATTERY PROBLEM)
H	LED -VE OR PIEZO BUZZER -VE
I	LED +VE OR PIEZO BUZZER +VE
J	DISCHARGE OUTPUT (TO 0V VIA KEYSWITCH)

TAKE GREAT CARE WHEN TESTING AS THE BACK EMF FROM THE COIL CAN BE FELT ON THE PCB

Figure 1: the circuit of the Little Mule



TO REDUCE TRACKING IN DAMP CONDITIONS THE WIRE IS FED THROUGH AN OLD BIRO TUBE WHICH IN TURN PASSES THROUGH A RUBBER GROMMET MOUNTED IN THE METAL STAKE

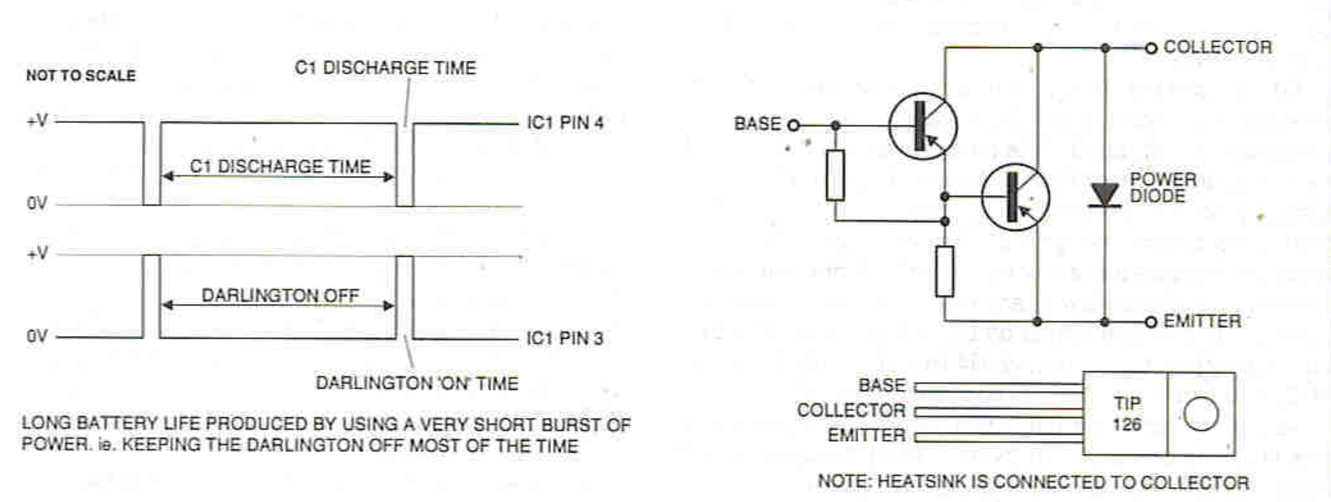
Figure 2: fence and case insulation

when looking at the problem logically, a constant high voltage is not required because an animal, once touching the wire, will soon move after the first feeling of discomfort. So a fence with short pulses of high voltage spaced one every one to two seconds or so would be quite satisfactory. A step-up transformer such as a car's High Tension coil only requires a fast pulse in the primary to produce a high voltage peak in the secondary. When the primary has a voltage across it, current flows, and quite heavy currents at that. So, to minimise the power required to run the fence for any length of time from one charge, very short pulses of primary current are used. With there being no current flowing (in the coil) for most of the time, the average current is reduced considerably to the point where a small 6 volt 1.2 amp-hour rechargeable battery will last over a month between charges.

How the circuit works

IC1b, a two-input Schmitt NAND gate, is wired as an oscillator with a very uneven mark:space ratio. R2 and D3 reduce the time for which the output is at logic 0. These two components in the resistor timing section have no effect in the charging of C1 because D3 is reversed biased, so the charging rate is set by R3. When C1 has charged to approximately 60 percent of the power supply voltage it is seen as a "1" and the output of the NAND pin 4 goes to logic 0.

D3 now becomes forward biased, so that C1 discharges much more rapidly due to the extra current flowing in R2 in series with D3. This long charge time and short discharge time is at the heart of the low power consumption. It must be remembered that this type of oscillator does not fully charge or discharge C1 because of the Schmitt action of the gate. The voltage across C1 oscillates between 40 and 60 percent. This means that when switched on there is a longer initial delay before the first pulse, because C1 must charge up from 0 to 60 percent before pin 4 goes low, whereas under normal operating conditions it only varies from 40 to 60 percent. The output of the gate pin 4 is normally high (6 volts) with very short low pulses. This is now inverted by IC1a, because when the inputs of a NAND are tied together an inverter is formed. Now the output of IC1 pin 3 is low most of the time, but pulsing high.



LONG BATTERY LIFE PRODUCED BY USING A VERY SHORT BURST OF POWER. ie. KEEPING THE DARLINGTON OFF MOST OF THE TIME

NOTE: HEATSINK IS CONNECTED TO COLLECTOR

Figure 3: the oscillator charge/discharge cycle, with a typical pnp Darlington circuit

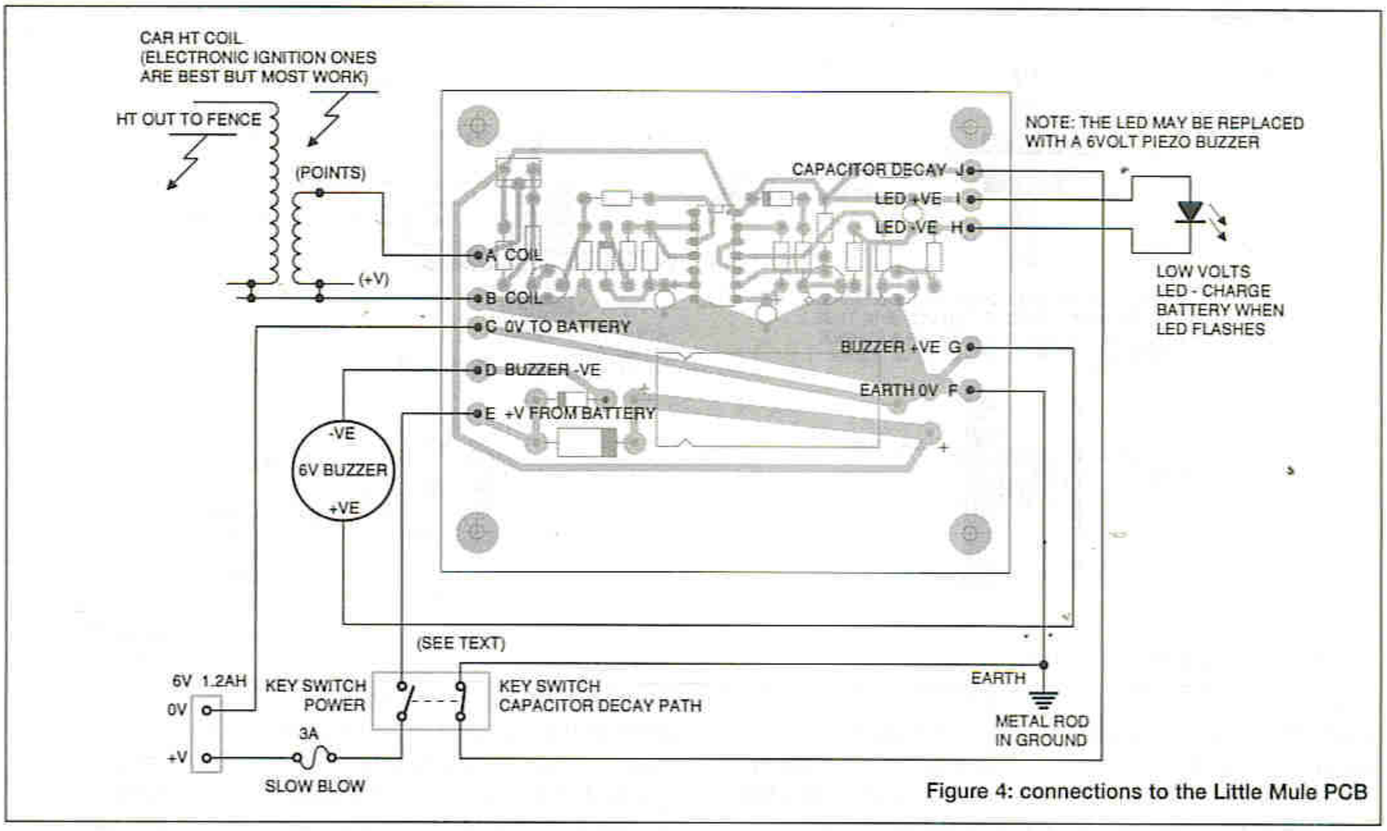


Figure 4: connections to the Little Mule PCB

The step-up transformer used here is a car's HT coil. Although normally run at 12 volts in a car electrical system, it works equally well at 6 volts, albeit with a lower output voltage. As an alternative, a small 6 volt mains transformer was tried, having had several turns removed from the secondary: this was then wired back to front with the secondary used as the primary and the primary used as the output. This was very time-consuming and not as effective as using a car's HT coil - a component designed for the job. One can be obtained from a breaker's yard more cheaply than buying it new.

The resistance of the primary of the HT coil is only a couple of ohms, so a power Darlington, Q4, is used to switch it on and off. There is a power diode built into the Darlington to help protect if from high voltages induced back into it from the primary of the step-up transformer (see figure 3). R6 is used to switch off the Darlington and to prevent leakage currents from switching it on. R7 is only rated at half a watt as a precaution because, if it were switched on all the time, the dissipation would reach one third of a watt.

Q1 provides the drive current for the Darlington. In order to reduce the heating in the Darlington Q4, it must be turned on and off quickly. The principle is that when it is ON there is a large current flowing through it but next to no voltage across it (only junction voltages), and when it is OFF there is no current through it but 6 volts across it. Heating or power dissipated is a function of ***volts X current***, so keeping one of them low at any one time ensures safe, cool running. Q1 is in turn turned on by IC1a pin 3, but this can only supply less than 1 mA, so R4 limits the output current of IC1a to below 0.5 mA, but enough to drive Q1.

As can be seen from the timing diagram, heavy currents flow in very short bursts. To try to average these out, a very large capacitor, C2, at 10,000 uF, is used as a kind of reservoir which charges up and acts like another battery to supply these heavy current spikes caused when the Darlington turns on. The one used is a 10,000 uF 10-volt axial type, but the PCB has been laid out to give the option of using a radial type instead.

To increase battery life there is no "ON" LED, as this would draw a steady current well above that of the Little Mule circuit itself, so the effective battery life would be halved. Even a flashing LED would draw a significant amount of power over the life of one charge of the battery.

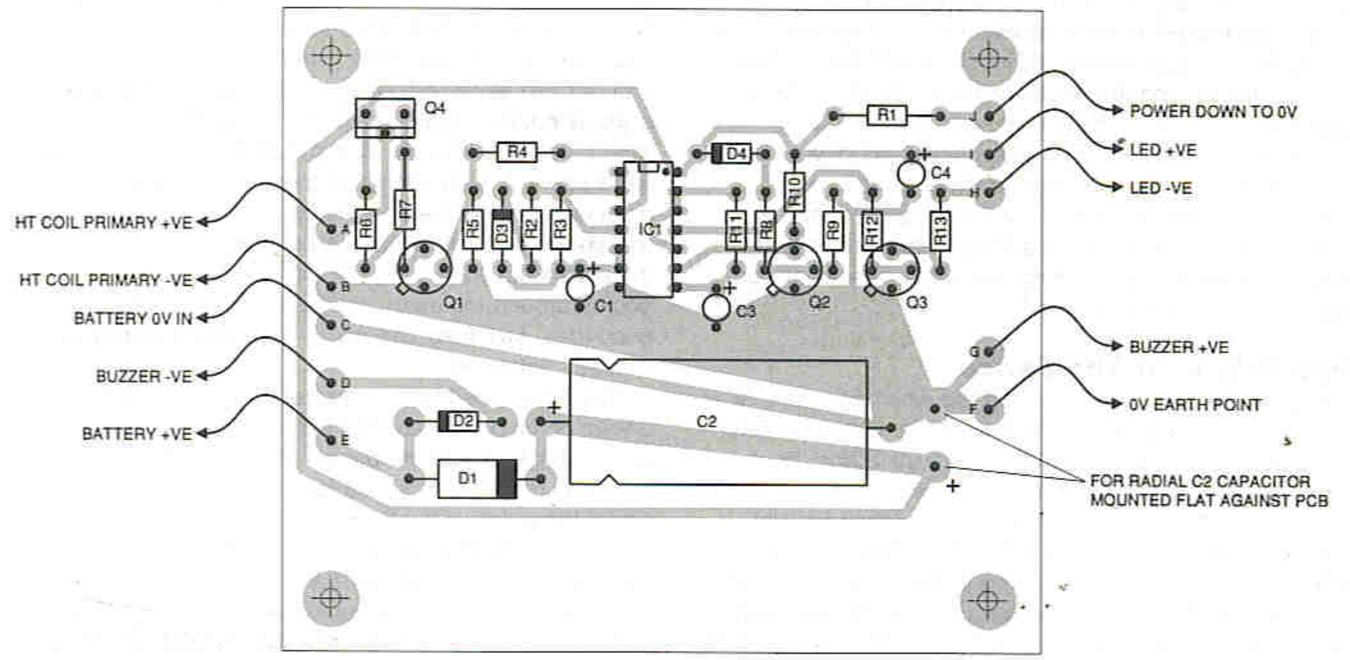
A low battery indication is needed, and a moving coil meter is unsuitable due to environmental considerations, while a digital voltmeter is expensive, and would draw some current. The answer was to build a low volts detector. Special chips are available, but these are costly and more accurate than is needed here, so I decided to build one myself using the two remaining gates in IC1.

Low volt detector

The heart of a low-volt detector, or over-volt detector for that matter, is some kind of voltage reference. The cheapest type is the zener diode, a device that will, if not over stressed, maintain a fairly constant voltage across itself by conducting to retain this voltage, but when the voltage falls below its rated value then the current through it will fall close to zero.

D4, R8, R9, R10 and Q2 form a simple low voltage detector. When the battery is fully charged, approximately 6.5 volts appears on the anode of D1 (whose function is reverse battery protection). The voltage drop in D1 is perhaps 0.6V, so that approximately 5.9V appears on the top of D4. This causes D4 to conduct, and switches on Q2 via R8. This sets IC1c pin 9 to logic 0, which keeps the pulsed alarm switched off.

R9 guarantees that, when the battery volts fall, the residual conduction of D4 is not sufficient to switch on Q2.



TAKE GREAT CARE SINCE THE BACK EMF OF THE COIL CAN BE FELT ON THE BOARD

NEVER USE A MAINS SUPPLY FOR THIS PROJECT

Figure 5: the Little Mule component layout on the PCB

When the battery volts drop, Q2 turns off and R10 pulls up pin 9 of IC1c enabling the oscillator to pulse slowly. The speed of flash is set by C3 and R11. This pulsing has two functions:

a) to indicate via the "low volts" LED that the battery is low and needs recharging. A pulsing LED is more distinctive in bright daylight. The LED can be replaced by a 6 volt piezo sounder if an audible output is required.

b) The pulsing reduces the overall current flow on an already low battery.

When the battery is in good condition, IC1 pin 10 is high. This is inverted by IC1d. The output of this inverter is connected to Q3 via R12 to switch the "low volts" LED on when relevant (that is, in low battery conditions).When this "low battery voltage" LED flashes the battery should be charged or replaced with a charged one.

For constant use, that is, 24 hours, seven days a week, it is advised that two batteries are used: while one is powering the Little Mule the other one can be slowly charged. Charging rechargables slowly increases their life expectancy over constant rapid charges.

In no circumstances should this project be mains-powered, as this device has been designed to work out of doors and the risk of electrocution is too high. For this reason there should be no mains charger built into the Little Mule as again this would require a mains supply, which is not safe.

To make charging the battery a safe operation the Mule must be turned off. I strongly advise that a key switch is used, so that it can be turned off and the key removed for safety reasons, for example when children are around, as the combined effect of an electric shock and, possibly, the presence of deep water could be lethal. (Little children, of course, should not be allowed to run unattended around even quite small ponds, because of the risk of drowning.)

Turning the Little Mule off breaks the +6 volt supply from the battery, but the l0,000uF capacitor, like all big capacitors, holds the 6 volts long enough to power the Little Mule for several seconds after switching off - so another pair of contacts that close when the power contacts on the key switch open are used to discharge this 10,000uF. A current limiting resistor R1 is used, because no electrolytic capacitor should ever be shorted out directly - let alone one of this size. The current could damage both the switch and the capacitor. When the key switch is turned off, the "low volts" LED briefly flashes as the volts across C2 die away. Wait another few seconds before touching the battery to charge or change it. Never touch the battery connections when the Mule is in operation, as a jolt can be felt on the terminals, caused by the back EMF from the coil.

Safety first

Before installing the Mule several safety aspects must be considered:

1) As already stated, there must not be any mains supply taken to the Mule for any reason.

2) The electric fence must not be set up on or near the boundary of your property such that anyone not on your property can get a shock.

3) Children must be kept well clear and if in any doubt the fence should be switched off and the key removed. Most children will frighten away any animal short of a rogue elephant, anyway - not too common in places like Reading.

To sum it up, good technical safety and common sense must prevail, and the safety of other people must be considered an absolute priority - although the energy of each jolt is small, it does hurt and could possibly be dangerous to someone not in good health, for instance, with a dicky heart. Although the jolt from the shock might not be lethal, falling back and hitting one's head could have devastating consequences. (And be sure to warn members of your family and visitors that there is an electric fence around your precious fishpond - or they may get a "surprise" that they won't thank you for as well as a shock. Most people know what an electric fence is, but some city types may not - or they may think it means Colditz!)

Installation Of The Fence

The term "fence" is a little over the top when all it really is, is a strand of wire mounted at an appropriate height (to deter next door's Tom and his mates) and insulated from its support posts. On my pond, the "live" wire is mounted about 15cm above the ground. (This is to deter small animals. Farmers would perhaps mount an electric fence wire at about 60cm or so from the ground to deter cattle, pigs etc from straying.) The part of the post carrying the live cable should be made of an insulating material and have a tracking distance of at least 10cm. This is to allow operation in wet weather, when the rain could easily cause the current to track over shorter distances (see diagram for a practical post top). As well as the live wire mounted at the desired height, ***a good earth*** is always required to give the high voltage wire a ground reference. This should be in the form of a metal spike at least 40cms long banged into the ground, and a couple of cans of water poured around it to make as good an earth as possible. A lead is connected to the spike from the Little Mule. In very dry conditions a watering can of water poured around the earth stake every so often is always a good idea, ***but turn the Mule off before doing so***, just in case - safety first.

PARTS LIST for the Little Mule

Resistors

R1	22n half watt
R2	4k7
R3	3M3
R4	10k
R5	4k7
R6	1k
R7	l00n half watt
R8	4k7
R9	4K7
R10	l00k
R11	330k
R12	10k
R13	220n D4

Transistors

Q1 - Q3	BC108
Q4	T1P126

Capacitors

C1	luF 16 volt tantalum
C2	10,000uF 10 volt radial or axial
C3	4u7 16 volt radial
C4	47uF 16 volt radial

Diodes

D1	IN5401
D2	1N4001
D3	1N4148
D4	4.3 volt Zener 300mA

Miscellaneous

Car HT coil: electronic ignition ones are best but most types will do. All good car component stockists will have a suitable one. A breaker's yard would be another source.
6 volt buzzer (for battery reverse indication).
6 volt Piezo buzzer (option in place of LED).
1 key switch (2 pole changeover contacts).
Box: any metal one that is *large enough for components not to track or arc in wet conditions.*
Battery: 6 volt 1.2 amp hour re-chargeable.

The case I used was a metal one, very well earthed to the 0 volts of the battery and the earth stake. The case should be large enough to hold the project with enough room for the HT coil to be mounted in such a fashion that it cannot track to any of the wiring or the PCB; either may possibly cause permanent damage. As well as being large enough, it must be weatherproof, as being installed outside it will be subjected to all sorts of adverse weather conditions. Although a plastic box could be used, ***the key switch should be earthed***, as a charge could build up in it with respect to earth if it is not. Screws, washers etc should be brass or at the very least chromed to prevent them from rusting.

The battery is mounted under the Little Mule on a shelf but completely protected from the elements. This means the Little Mule does not have to be opened up to charge the battery - an important consideration in the rain. The HT lead from the coil to the fence should be a car's HT lead with a crocodile clip on it to be attached to the fence. These have very good insulation, but a large hole packed with sticky backed foam increases the insulation where the HT lead emerges from the metal case of the Mule (see figure 2 again).

This circuit should never be used in any other context apart from the fence. It is not a toy and must not be used to shock people as a prank or used in public places.

A buzzer and D2 have been included; this is to show the battery has been connected round the wrong way. This is very easily done if the battery is changed in the dark. DI will prevent any damage to the circuit, so if the battery is changed and the Little Mule switched on and the buzzer sounds, turn the Little Mule off immediately and reverse the battery connections. No waiting is required as long as the circuit is switched off right away, because C2 will not have charged up due to D1 being reverse biased.

A fuse has also been included in the positive battery lead rather than in the main body of the Little Mule; this is to fully protect the battery from damage to the leads going into the device. Always, when a rechargeable battery is used, it should be fused, because extremely high currents are available due to the low internal resistance of rechargeables.

To indicate that the fence is working without the "ultimate test", a neon can be connected to the fence by just one wire. The other lead is left to float pointing away from the wire. The pulse will cause a slight flicker in the neon - easily seen at night.

Do not touch the neon or use a neon screw driver to test the fence because a kick can still be felt even through the 270k or so in the screwdriver.

Computer Radio Control for Home Automation Part 1

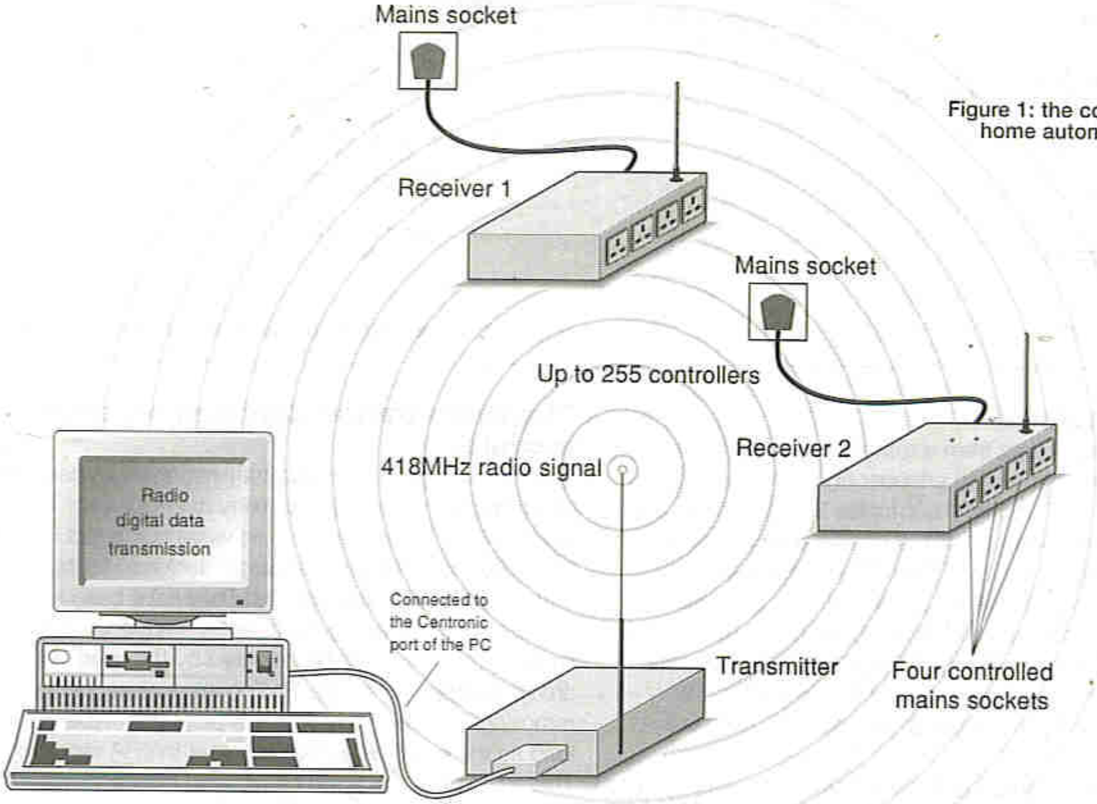


Figure 1: the computer/radio home automation system

Digital radio building blocks

Using 418 MHz licenced SAW radio modules, Dr. Pei An's digital data control system can talk to up to 255 receivers

The subject of this article is a radio digital data control system for home automation applications. The complete system consists of one radio transmitter with up to 255 receiver units with different addresses. Each receiver can control up to four mains sockets. The transmitter is connected to the Centronics port of a computer. Four bits of data issued by the port can be transmitted to any one of the receivers. These four bits control the four mains sockets of that receiver. The transmitting distance is about 50 metres in buildings and 200 metres in the open. This system is illustrated in figure 1.

In Part 1, we will see how to construct the radio transmitter and receiver modules which are the building blocks of the system. The radio transmitter and receiver modules use low power FM radio transmitter and receiver modules TMX-418-A and SILRX-418. The transmitter is type-approved to the Radiocommunications Agency specification MPT 1340 in the UK. This avoids the need to submit the final project for approval.

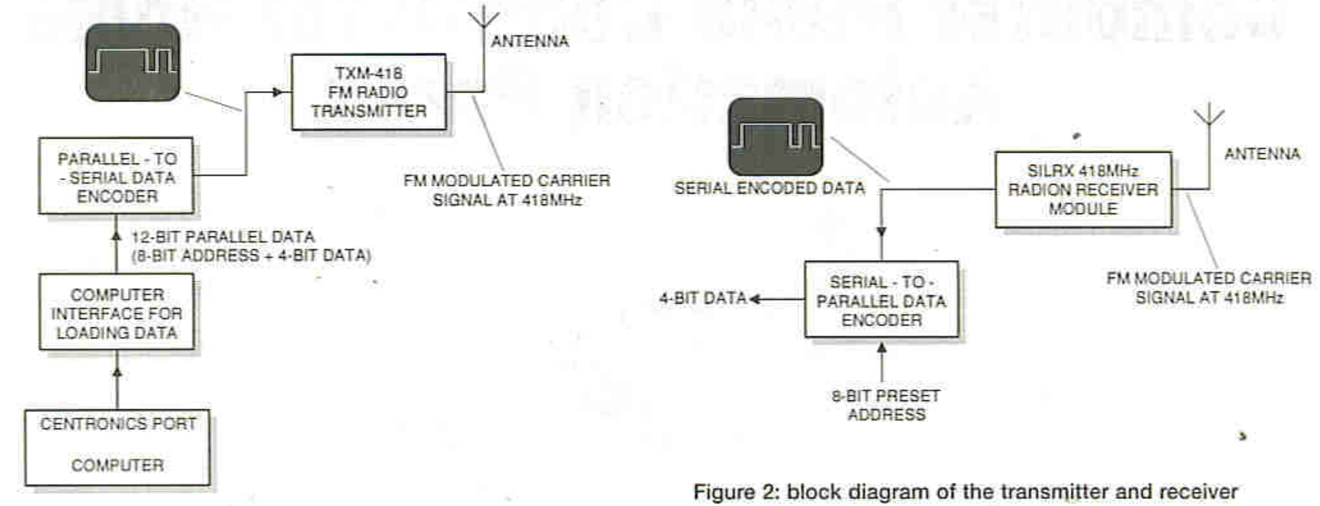
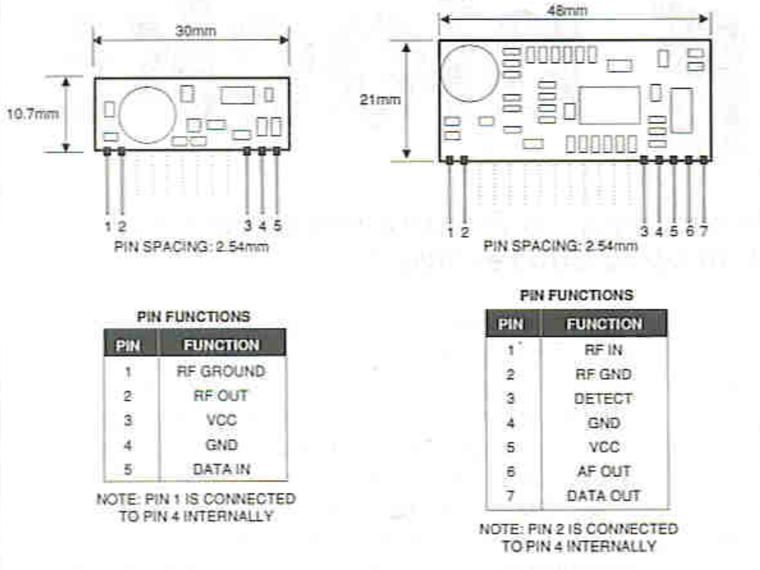


Figure 2: block diagram of the transmitter and receiver

Working principles

Transmission of digital data from a transmitter to a receiver is achieved using parallel-to-serial encoder and serial-to-parallel decoder pairs, HT-12E and HT-12D. Inside the transmitter, the encoder (HT-12E) converts 12 bits of parallel data into serial encoded data. The first 8 bits of the data represent an address, and the other 4 bits are the actual data to be sent. The encoded serial data is used to modulate a 418 MHz radio frequency signal using the FM modulation scheme. After this, the modulated radio frequency signal is transmitted to the surroundings by the FM radio transmitter module TMX-418-A (figure 2a).

At the receiver, the radio signal picked up by the antenna is demodulated by the FM radio receiver module SILRX-418-A. The demodulated serial data is fed into the serial-to-parallel decoder (HT-12D), which converts the serial data back to parallel data (figure 2b). The address bits are compared with the pre-set address of the decoder. If they match, the 4-bit data is latched to the output. If the address does not match, the decoder ignores the data. As 8-bit binary data has 255 possible combinations, the maximum number of receiver addresses is 255.



PIN FUNCTIONS

PIN	FUNCTION
1	RF GROUND
2	RF OUT
3	VCC
4	GND
5	DATA IN

NOTE: PIN 1 IS CONNECTED TO PIN 4 INTERNALLY

PIN FUNCTIONS

PIN	FUNCTION
1	RF IN
2	RF GND
3	DETECT
4	GND
5	VCC
6	AF OUT
7	DATA OUT

NOTE: PIN 2 IS CONNECTED TO PIN 4 INTERNALLY

Figure 3: the TXM-418-A radio transmitter module and the SILRX-418 receiver module

The radio transmitter and receiver modules

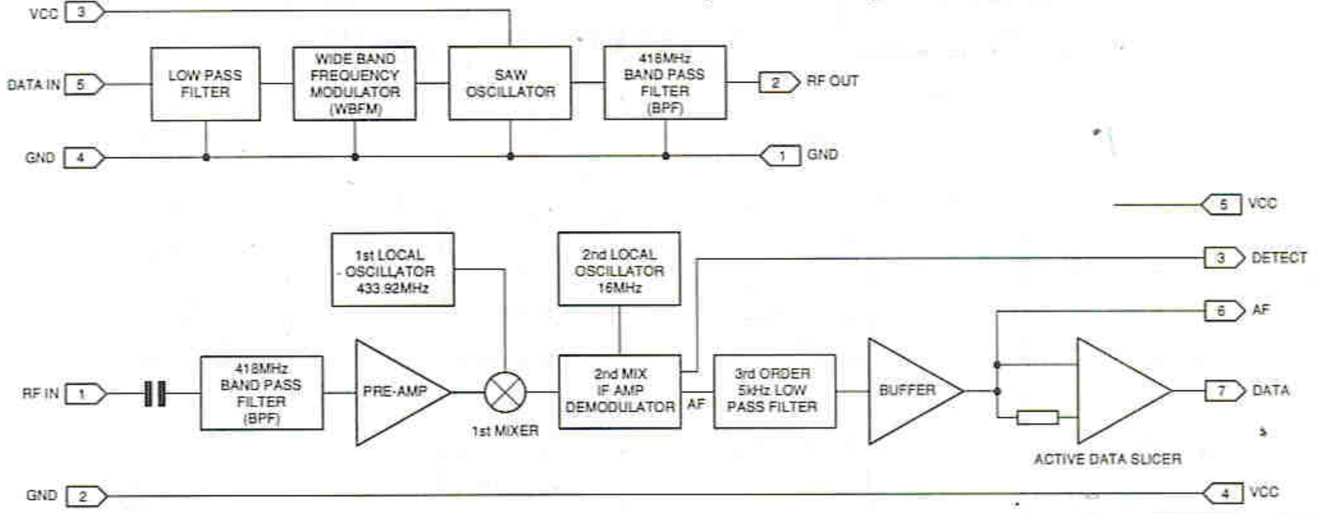
Thanks must go to the radio transmitter and receiver modules which make the radio link so easy to implement. The modules are a 418 MHz surface acoustic wave controlled FM radio transmitter and receiver, specially designed for radio telemetry and telecommand applications. They have been aligned by the manufacturer, removing the need for frequency alignment (indeed, they must not be adjusted by the user). As such they are type-approved by the Radiocommunications Agency, removing the need to submit the project for type-approval, so long as the customised circuits meet the RA requirements. These modules use state-of-art radio frequency electronic and surface mounting devices, which makes them both small in size and reliable in operation.

The transmitter TMX-418-A

The physical dimensions and pin functions of the TMX-418-A transmitter are given in figure 3a. The transmitter requires a power supply at pin 3. Pins 1 and 4 are connected together internally and form the ground. The transmitter operates over a wide voltage range from 6 VDC to 12 VDC with a typical current sink of about 6mA at 6V and 14mA at 12V. The data modulation input (which requires a cmos logic level at the same power supply voltage) is supplied to pin 5. An antenna is connected to pin 2.

The block diagram of the module is given in figure 4. The digital data at cmos logic levels is supplied to DATA IN (Pin 5). The data first passes through a R/C low-pass filter, which restricts the bandwidth of the modulation signal to 10kHz at the -3dB point (10kHz is the upper limit of the input data frequency). The filtered data is then fed into a wideband frequency modulator which accepts signals of frequencies from DC to 10 kHz. The modulator drives a varicap diode, the changing capacitance of which is used to modify the frequency of the next stage, a radio frequency oscillator. The central frequency of the oscillator is accurately set by a surface acoustic wave (SAW) resonator in the 418 MHz band (417.90 to 418 MHz). The oscillator has a 418 MHz band pass filter to ensure that any spurious emission out of the band is within the limits as specified by the MPT1340 specification. The final filtered RF output appears on pin 2.

Figure 4: block diagram of the transmitter and receiver modules

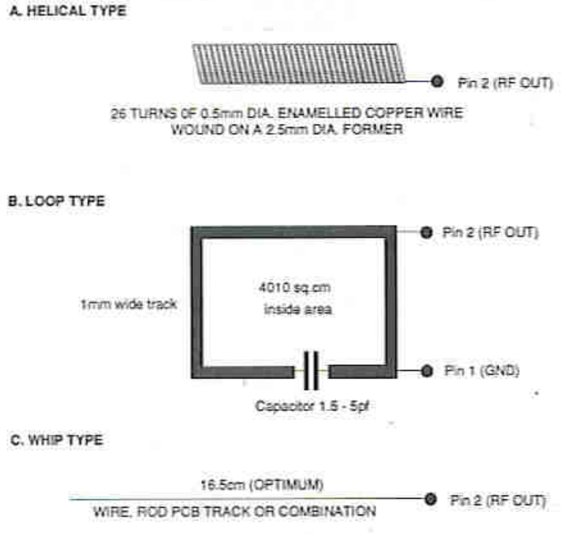


The antenna for the transmitter has three versions, the helical type, the loop type and the whip type (see figure 5). The helical antenna has a small size (17 mm length and 2.5 mm diameter). It has a high 'Q' factor and therefore needs to be optimised for the exact wavelength in use. The loop antenna consists of a loop of PCB track, which is tuned by a variable capacitor. The whip-type antenna is a wire, rod, PCB track or combinations of these. The optimum total length should be 16.5cm. Figure 5 compares the performances of these antenna.

Radiocommunication Authority MPT1340

The radio transmitter module is type-approved to the RA MPT1340 for licence exempt use within the UK for telemetry, telecommand and in-building security, provided the following requirements are met:

1. The transmitting antenna must be one of the three variants given above (see figure 5).



ANTENNA PERFORMANCE CHART

	HELICAL	LOOP	WHIP
ULTIMATE PERFORMANCE	✓✓	✓	✓✓✓
EASE OF SET-UP	✓✓	✓	✓✓✓
SIZE	✓✓✓	✓✓	✓
IMMUNITY TO PROXIMITY DE-TUNING	✓✓	✓✓✓	✓

Figure 5: types of antenna for the TXM-418 radio transmitter

2. The transmitter module must be directly and permanently connected to the transmitting antenna without the use of an external feed. Increasing the rf power level by any means is not permitted

3. The module must not be modified nor used outside its specification limits

4. The module may only be used to send digital data. Speech or music is not permitted

5. The equipment in which the module is used must carry an inspection mark located on the outside of the equipment and clearly visible; the minimum dimensions of the inspection mark shall be 10 by 15 mm and the letter and figure height must be not less than 2 mm. The wording shall read: "MPT 1340 W.T. LICENCE EXEMPT"

6. The trimmer control on the module must not be easily accessible to the end user. This control is factory set and must never be adjusted.

Failure to meet the above conditions invalidates the modules' Type Approval. Further information on MPT1340 specification issued by the RA (DTI) may be obtained from the RA's library service on +44-(0)171-215-2072 if required.

The receiver

The physical dimensions and pin functions of the SILRX-418-A receiver is shown in figure 3. The receiver requires a power supply at pin 5 and the radio signal input at pin 1. Pins 2 and 4 are the ground. The module operates over a voltage range from 4.5V to 9VDC with a typical current sink of about 13mA.

The block diagram of the module is given in figure 4. The incoming radio frequency signal, picked up by the antenna, goes to a 418MHz band pass filter via a capacitor. A radio frequency preamplifier boosts the signal before it enters the first mixer stage. The first local oscillator runs at a frequency of 433.92 MHz, which is produced again by a surface acoustic wave resonator. This signal is mixed with the received 418 MHz signal to produce the first intermediate frequency signal at 15.92 MHz. This is then fed to the second mixer, where a second local oscillator running at 16MHz produces the final intermediate frequency at 80kHz. This is then amplified and demodulated to produce an audio frequency signal. A carrier detect signal is also produced. To improve the signal-to-noise performance, the audio signal is processed by a third order lower pass filter. This signal is fed to an audio buffer with its output (pin 6) centred around the half of the power supply. It also passes through a data slicer, where the

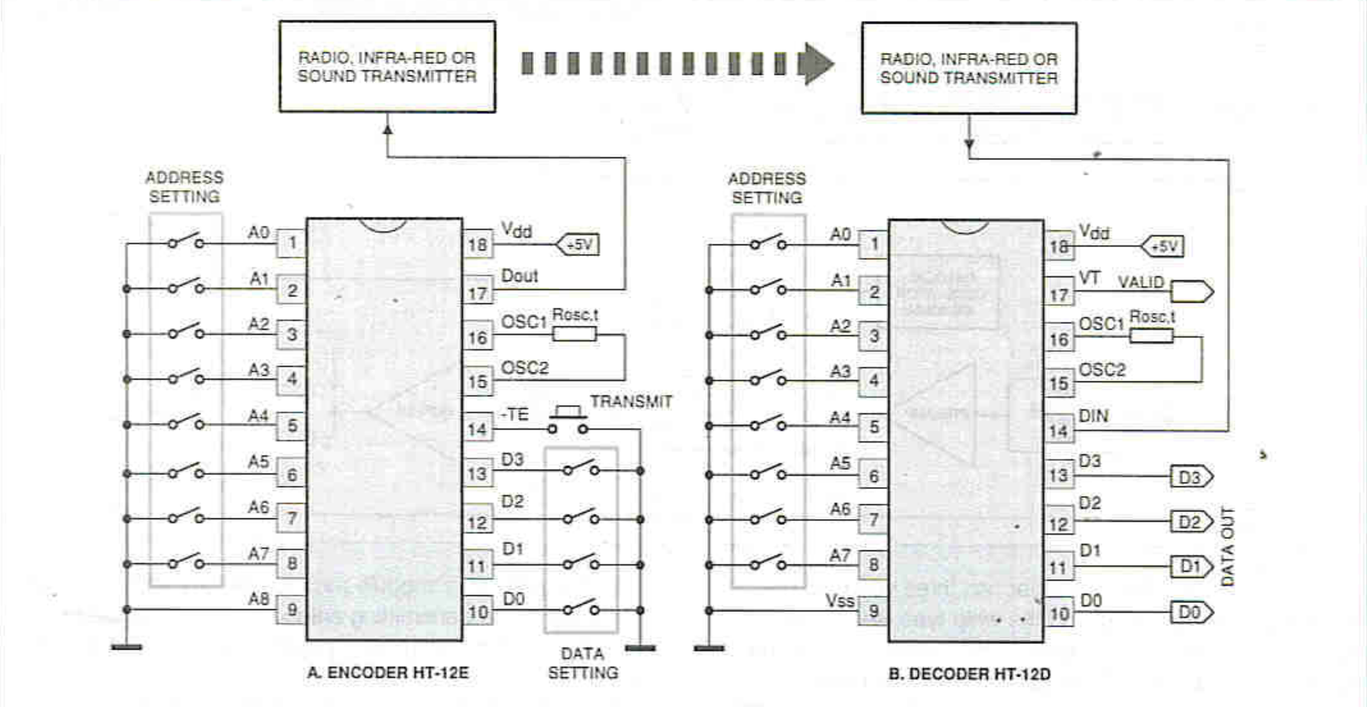


Figure 6: data encoder (HT-12E) and decoder (HT-12D) pairs showing a typical application

analogue audio signal is converted into a digital signal and is output from pin 7. The output signal has a COMS logic level.

Any of the types of antenna previously described in the transmitter section should be used with the module. However, the criteria for the receiver antenna under MPT 1340 are not as restrictive as those that apply to the transmitter. As an alternative to the integral antenna as used for the transmitter, it is permitted to use an external arrangement connected by a coax feeder. If the range of the system is to be optimised, other types of antenna may be used.

The data encoder and decoder

Encoder, HT-12E

The HT-12E and HT-12D are cmos LSI encoder and decoder ics designed for digital code transmitting and receiving. They have a wide operating voltage from 2.4V up to 12V with a typical stand-by current typically 1uA, and on-board oscillators which only require one external 5 percent resistor. The pin-out and pin functions are shown in figure 6. Typical applications of the devices are given in figure 7.

The HT-12E encodes 12 bits of parallel data into serial data. It transmits this data upon the receipt of a low-going signal at the TRANSMIT ENABLE pin (-TE, pin 14). The 12 bits of data consist of 8 bits of address (A0 to A7 connected to pins 1 to 8) and 4 bits of data (D0 to D3 connected to pins 10 to 13). Therefore the total address combination is 28. The external oscillator resistor is connected between pins 15 and 16. The choice of the resistance value will be given later (details of this can be found in the component data sheet). The serial data output is from pin 17. Pins 9 and 19 are connected to the negative and the positive rails of the power supply.

The operation of the HT-12E encoder is initially in stand-by mode. Upon the receipt of a -TE signal (low active), it begins a 4-word transmission cycle and repeats the cycle until the -TE signal becomes high. Each word contains two periods: the pilot code period and the code period, as shown in figure 9. The pilot code period has a 12-bit length period and is at logic low. The code period also has a 12-bit length period and

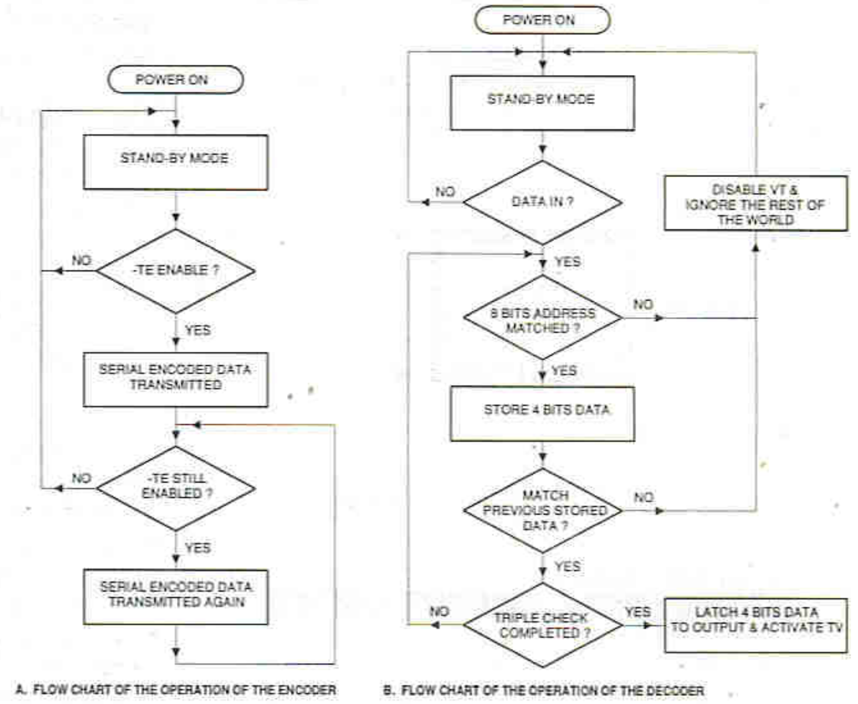
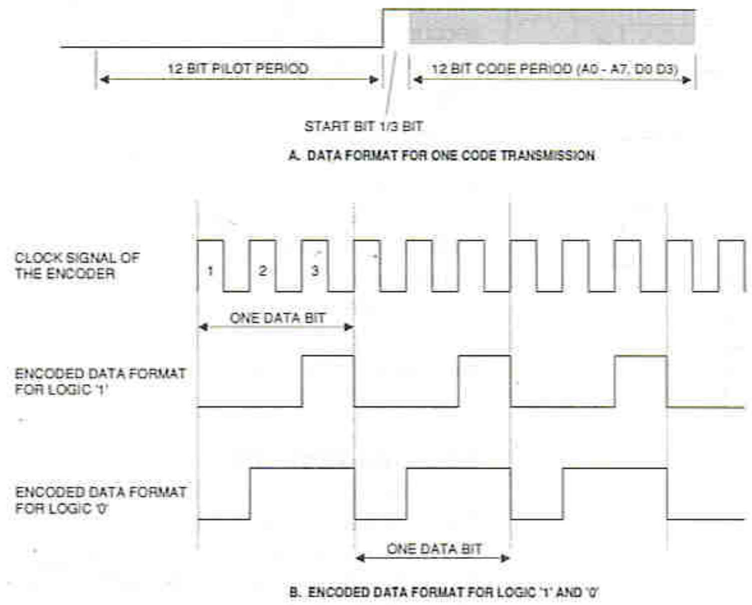


Figure 7: flow chart of the operation of the encoder and decoder



A. DATA FORMAT FOR ONE CODE TRANSMISSION

B. ENCODED DATA FORMAT FOR LOGIC '1' AND '0'

Figure 8: encoded serial data format

contains the serial encoded data. The encoder detects the logic state of the 12 bit inputs (A0-A7 and D0-D3) and transmits this information during the code period. The logic levels '0' and '1' are encoded as shown in figure 9. The order of data bit transmission is from A0 to A7, then from D0 to D3.

The decoder

The HT-12D decoder receives the 12-bit word and interprets the first 8 bits as the address and the last 4 bits as data. When the received address matches the decoder's preset address, the VALID TRANSMISSION (VT) output goes high and the 4 bits are latched to the data output pins. The preset address for the encoder is determined by the logic states at pins 1 to 8 for 0 to A7. The latched data is output from pins 10 to 13. The serial data is input at pin 14. The external oscillator resistor is connected between pins 15 and 16. Pin 17 is the valid transmission indicator output. Pins 9 and 18 are connected to the negative and positive rails of the power supply.

The external oscillation resistor

The resistors required by the devices are 5 percent resistors. The frequencies of the HT-12E and HT-12D should follow the relationship:

Fosc, HT-12D = 50 x Fosc, HT-12E

The following table gives the resistance values for 3kHz and 4.3kHz oscillation frequencies of the encoder (the present circuit uses the 3kHz oscillation frequency). For other frequencies, please refer to the manufacturer's data sheet.

HT-12E (encoder)		HT-12D (decoder)	
R	Fosc	R	Fosc
1.1M	3kHz	62k	150kHz
750k	4.3kHz	33k	240kHz

The works

The transmitter

Figure 2 gives the block diagram of the transmitter; figure 10 gives the circuit diagram. The transmitter consists of four units: the computer interfacing unit, the encoder unit, the radio transmitter unit and the power supply unit. The first one manages the interfacing between the encoder ic and the

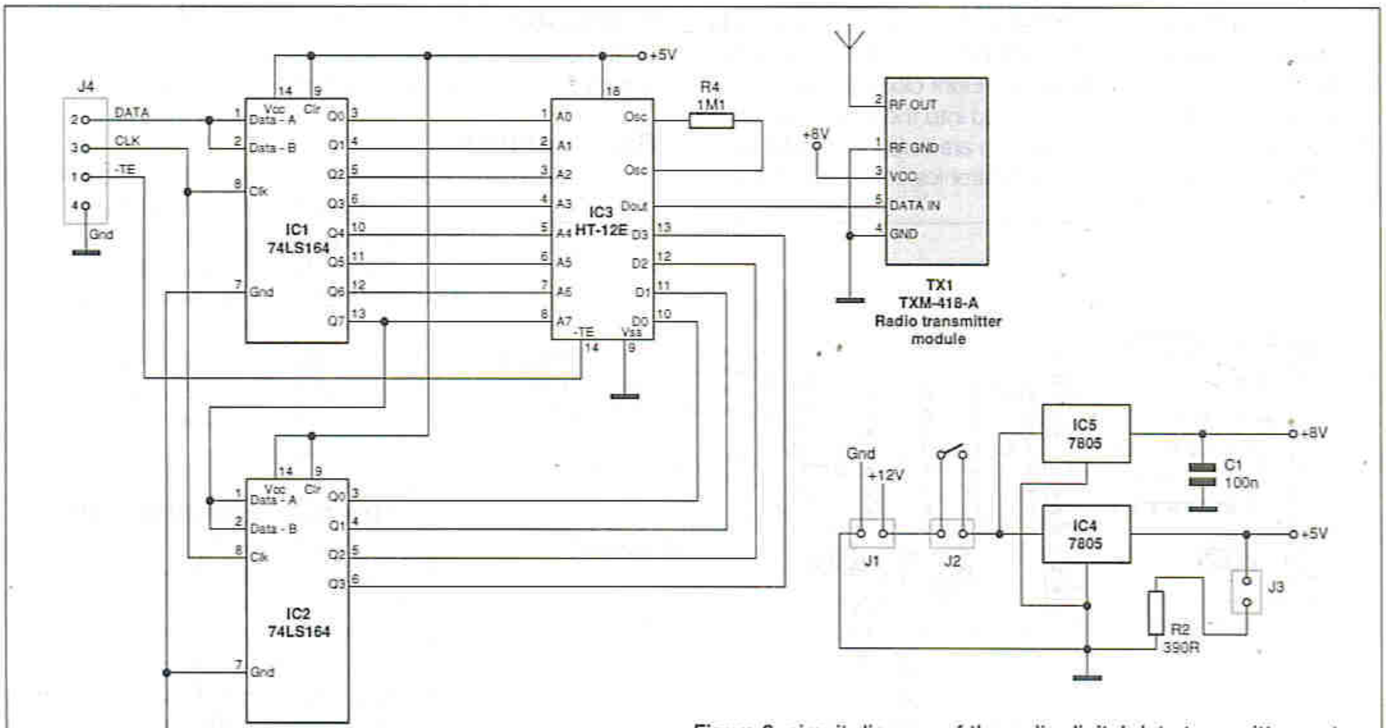


Figure 9: circuit diagram of the radio digital data transmitter system

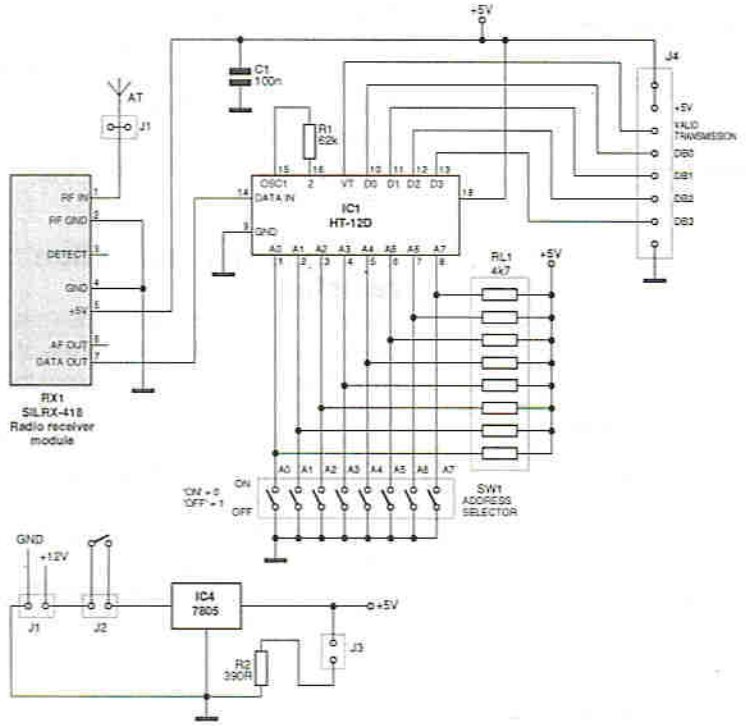


Figure 10: the circuit diagram of the radio digital data receiver

Centronics port of the computer and provides a 12-bit parallel data for the encoder ic. The encoder unit converts the 12-bit parallel data into the serial data. This serial data is used as the modulating signal in the radio transmitter unit. The modulated radio signal is sent out from the antenna. The works of each unit is explained in detail as follows:

The computer interfacing unit

This circuit is based on two 74LS164 8-bit serial-to-parallel shift registers, IC1 and IC2 (see figure 10). For IC1, when the CLOCK input (Pin 8) goes from low to high, the logic level on the DATA-a and -b (pins 1 and 2) is transferred to Q1. The next clock pulse also transfers it to Q1, and the logic level previously present on Q1 is shifted to Q2. The third clock pulse transfers the data to Q1, and in the same time shifts the data on Q1 to Q2, and that on Q2 to Q3. Eight clock pulses will enable an 8-bit data to be fully loaded into the register serially. In the present circuit, DATA -a and -b are both connected to the DB0 of the DATA port of the Centronics port (pin 2 of the Centronics port). The CLOCK is connected to the DB1 of the DATA port (pins 3 of the port). The second shift register is used for loading the data bits from 9 to12. As can be seen from the circuit diagram, the DATA-a and -b (pins 1 and 2) of IC2 are connected to Q8 of IC1. The CLOCK input (pin 8) of IC2 is connected to that of IC1. This scheme of cascading allows 12 bits of data to be loaded serially into the register. Software controlling the data loading will be discussed later in the article.

The first 8 bits of the shift register outputs (Q1 to Q8) supply the address (A0 to A7) to the encoder and the other four bits (Q9 to Q12) supply the data (D0 to D3).

The encoder unit

This circuit is built around an HT-12E encoder ic. The ic converts an 8-bit address and 4 bits of data into a serial data form. The serial data is output from DATA OUT (pin 15), provided that the -TE input (TRANSMIT ENABLE, pin 14) is set low. In the present circuit, it is connected to the DB2 of the DATA port of the Centronics port (pin 4 of the Centronics connector). While loading the data into the 74LS164 shift register, DB2 is set to '1' to inhibit the encoder from outputting data. After the data has been loaded successfully into the shift register, DB2 becomes '0', and enables the encoder to transmit data again. The data is fed into the radio transmitter unit to modulate the radio-frequency carrier signal.

The radio transmitter unit

The serial data generated by the HT-12E encoder is fed into pin 5 of the TXM-418-A radio transmitter module. A radio-frequency modulated signal emerges from pin 2 of the module. In this design, a helical type of antenna is used.

Power supply unit

The power supply unit requires a 12 to 15VDC power supply. It has 7808 +8VDC and 7805 +5VDC voltage stabilisers. The +8VDC powers the radio transmitter module and the +5VDC powers the computer interfacing and the encoder circuit.

The Receiver

The block diagram of the receiver is given in figures 2a. Figure 11 gives the circuit diagram of the receiver. The receiver is composed of three units: the radio receiver unit, the decoder unit and power supply unit. The radio receiver unit receives the transmitted radio signal, detects it and amplifies it. Then the signal is fed into the decoder unit where it is decoded into parallel data.

The radio receiver unit

In this unit, a SILRX-418 radio receiver module is used. The radio frequency signal is picked up by a whip antenna and the signal is fed into pin 1 of the module. The demodulated signal is output from pin 7. This signal is then fed into the decoder unit.

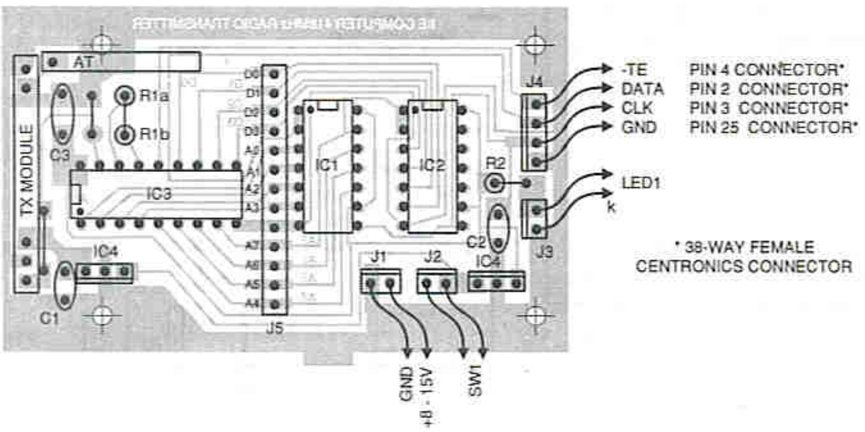


Figure 11: the component layout of the radio transmitter

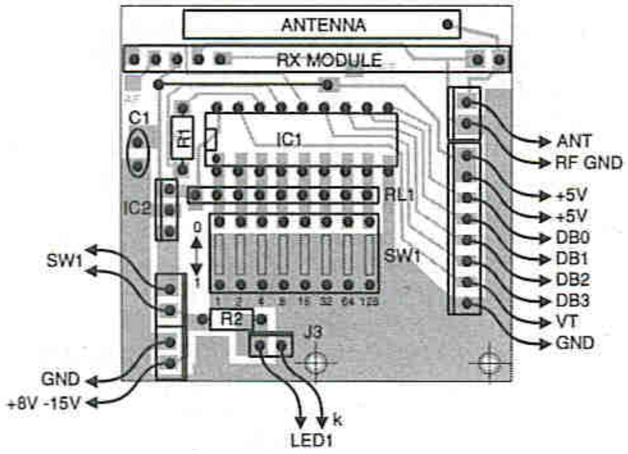


Figure 11: the component layout of the radio receiver

The Decoder unit

The decoder unit is based on the HT-12D decoder ic which is paired with the HT-12E encoder. The decoder receives the serial data at pin 14, checks it for errors and outputs the received data if it is valid. The first 8 bits are treated as address bits and must match the pre-set address of the decoder (set by SW1 dip switches connected to pins 1 to 8). If the two addresses match, the next four data bits are compared to the last data stored. If the data matches three times, the VALID TRANSMISSION output (pin17) will go high. If not, the VT output remains low.

The Power Unit

The power unit requires a 8-15VDC power supply. It incorporates a 7805 +5V voltage regulator which supplies +5VDC to the circuit.

Programming

B0, DB1 and DB2 of the DATA port of the Centronics port control the whole operation of the transmitter. However, to program the transmitter, readers should know a little bit about the works of the Centronics port.

When loading the address and data into the shift register, first DB2 (which is connected the -TE input of the encoder) is set to high to stop the ic from outputting data. Then the first MSB (most significant bit) of the parallel data is put on DB0 while DB1 is low. A low-to-high transition on DB1 (which is connected to the CLOCK input of the shift register IC) will enable the data to be shifted to the 1st register output. The second MSB, third MSB and so on are then put to DB0 in sequence. The clocks will shift the 8-bit serial data into the register outputs.

After the data is successfully loaded to the register. DB1 is brought low which enables the encoder ic to send out the encoded serial data.

A demonstration program written in Turbo Pascal 6 is listed at the end of this article.

Construction and testing

The transmitter and receiver are constructed on single-sided PCBs (figure 12). The antenna of the receiver is constructed using a piece of copper wire, 16 cm long. It is connected to the antenna connector on the PCB. The component layouts are shown in figure 13. The construction is quite simple: after soldering all the components on the PCB properly, the system should work straight away. There is no adjustment needed for the transmitter and the receivers.

Oscilloscopes are not essential for testing. A multimeter and a couple of LEDs are sufficient. The transmitter is connected to the computer and the power is supplied to the transmitter. The demonstration program is loaded into the computer. This program simply loads an 8-bit address and 4 bits of data to the shift register. The value of the address varies from 1 to 255 and the value of data varies from 0 to 15. For testing purposes, the program continuously loads the data which is input into the PC at the beginning of the program and '0' to the shift registers in turns. The program also requires the time periods for the data and for '0'. As a result, a voltage oscillation is generated at the receiver end.

This system, however, only allows a computer to operate as a controller. It would be very useful if the computer could also gather information. This is known as the remote sensing. The present system can be modified for such a purpose, and the details will be discussed in future articles.

Technical support

Please direct your enquiry to Dr. Pei An, 11 Sandpiper drive, Stockport, Manchester SK3 8UL, Tel/Fax/Answer: 0161-477-9583. E-mail: PAN@FS1.ENG.MAN.AC.UK.

PARTS LIST for the Home Radio PC Control

Transmitter

R1	1M1 (1M + 100k resistors together, metal film, 1%)
R2	390R, metal film, 1%
C1	100 nF ceramic disk
IC1,2	74LS164
IC3	HT-12E
IC4	7805
IC5	7808
J1,J2,J3	2-pin PCB connector
J4	4-pin PCB connector
TX1	TXM-418-A radio transmitter module

Receiver

R1	62K
R2	390R
RL1	4K7 8-way SIL resistor network
C1	100 nF ceramic disk
IC1	HT-12D
IC2	7805
J1,J2,J3,J5	2-way PCB connector
J4	8-way PCB connector
S1	8-way PCB mounting dil switch
RX1	SILRX-418 radio receiver module

The radio transmitter and receiver pairs can be purchased from Radio-Tech Ltd. Overbridge House, Weald Hall Lane, Thornwood Common, Epping, CM16 6NB, Tel: +44 (0)1992-576107. Other components can be obtained from Maplin or Electromail.

Update! In figure 9, for R4 please read R1. In figure 10, for J1 please read J5. In figure 10, for IC4, please read IC2 to correspond with Parts List.

The demonstration program

The program will ask for an address first (0-15), then the first time delay (T1) and the second time delay (T2). After this the program will send '1' for all the data lines. It will delay a time period T1 and then send '0' for all the data lines. After another time delay T2, the transmitter will send '1' again. This will continue until RETURN is pressed.

```
[Program radio_controller;
{Pascal demonstration program for
driving the radio data communication
system written by Dr. Pei An, 30/10/96}
{74LS164 latches the data sent serially
by the computer's Printer port.
   DB0,DB1,DB2 and DB3 are loaded with
address A0,A1,A2 and A3
   DB4,DB5,DB6 and DB7 are loaded with
data D0,D1,D2 and D3}

uses
   dos,crt,graph;
var
   address,i,j,swaddress,sdata:integer;
   weight:array[1..12] of integer;
   delaytime,lighttime:real;
   P_address:integer;

Procedure Input_printer_address;
{Universal auto detection of printer
base address}
 {$000:$0408 holds the printer base
      address for LPT1
  $000:$040A holds the printer base
      address for LPT2
  $000:$040C holds the printer base
      address for LPT3
  $000:$040e holds the printer base
      address for LPT4
  $000:$0411 number of parallel
      interfaces in binary format}
var
  lpt:array[1..4] of integer;
  number_of_lpt,LPT_number,code:integer;
  kbchar:char;
begin
  clrscr;
  LPT_number:=1; {defaut printer}
  number_of_lpt:=mem[$0000:$0411];
      {read number of parallel ports}
  number_of_lpt:=(number_of_lpt and
      (128+64)) shr 6;
  lpt[1]:=memw[$0000:$0408];
      {Memory read procedure}
  lpt[2]:=memw[$0000:$040A];
  lpt[3]:=memw[$0000:$040C];
  lpt[4]:=memw[$0000:$040E];
  textbackground(blue); clrscr;
  textcolor(yellow);
      textbackground(red);
      window(10,22,70,24); clrscr;
  writeln('Number of LPT installed    :
      ',number_of_lpt:2);
  writeln('Addresses for LPT1 to LPT 4:
      ',lpt[1]:3,'   ', lpt[2]:3,'   ',
      lpt[3]:3,'   ', lpt[4]:3);
  write('Select LPT to be used (1,2,3,4)
      :  ');
  delay(500);
  if number_of_lpt>1 then begin
      {select LPT1 through LPT4 if more
than 1 LPT installed}
  repeat
    kbchar:=readkey;     {read input key}
    val(kbchar, LPT_number, code);
      {change character to value}
    until (LPT_number>=1) and
      (LPT_number        <=4) and
      (lpt[LPT_number] <>0);
                 end;
      clrscr;P_address:=lpt[LPT_number];
      writeln('Your selected printer
      interface:LPT',LPT_number:1
      );write('LPT  Address:
      ',P_address:3);
      delay(1000);
      textbackground(black);window(
      1,1,80,25); clrscr;
end;

Procedure bit_weight;
{Find the weight of the binary bits}
begin
      weight[1]:=1;
      for i:=2 to 12 do weight[i]:=weigh
      t[i-1]*2;
end;

Procedure send_data(address,data:integer);
{Send the address to the 74LS164 shift
      register}
{When sending address, the Transmit
      Enable (-TE) must be high to stop
      transmit}
{During loading, (1) DB0 is loaded with
      the data sw[i],
      (2) DB1 (CLOCK) is made from low-
      to-high-then-low
      (3) DB2 (-transmit enable) is kept
      high all the time}
var
   sw:array[1..12] of byte;
begin
   for i:=8 downto 1 do
     begin
       sw[i]:=0;
       if address>=weight[i] then begin
          address:=address-weight[i];
          sw[i]:=1;
         end;
     end;

    for i:=4 downto 1 do begin
         sw[8+i]:=0;
         if data>=weight[i] then begin
            data:=data-weight[i];
            sw[8+i]:=1;
            end;
     end;
    {loading address and data into the
     74LS164 registers}
    for i:=12 downto 1 do
   begin
     port[P_address]:=sw[i]+4;
      {DB0=sw[i], DB1=0, DB2=-TE=1}
```

```
    delay(1); {a delay}
    port[P_address]:=sw[i]+2+4;
    {DB0=sw[i], DB1=1(loading into
    register), DB2=-TE=1}
    delay(1); {a delay for loading the
    bit}
    port[P_address]:=sw[i]+4;
    {DB0=sw[i], DB1=0; DB2=-TE=1}
        end;
end;

Procedure transmit(flag:boolean);
{Start or quit the encoded data
transmitting depending on FLAG}
begin
  if flag then port[P_address]:=0 else
     port[P_address]:=4;
end;

Procedure intialization;
begin
  textbackground(blue);
  textcolor(yellow);
  clrscr;
  writeln('   Radio Digital Data
     Communication System');
  writeln;
  writeln('   This program demonstrates
     that 255 digital data receivers
     are controlled by');
  writeln('   a PC controlled
     transmitter  via the printer
     port');
  writeln;
  textcolor(lightred);
  writeln;
  write('      Input the address of the
     receiver (1 through to 255)        :
     '); readln(swaddress);
  write('      Input the data to be sent
     to the receiver (1 - 15 )
     : '); readln(sdata);
  write('      Input the light OFF period
     (in second, minimum: 0.1 s): ');
     readln(delaytime);
  write('      Input the light ON
     period (in second, minimum: 0.1
     s): '); readln(lighttime);
  if delaytime <0.1 then delaytime:=0.1;
  if lighttime <0.1 then delaytime:=0.1;
end;

Procedure screenshow;
{show general information about the
     project}
var
  Gd, Gm ,x1,x2,y1,y2: Integer;
begin
  Gd := Detect; InitGraph(Gd, Gm, '');
  if GraphResult  <> grOk then Halt(1);
  setcolor(yellow); setbkcolor(blue);
  settextstyle(1,horizdir,6);
  { Center text on screen: }
  SetTextJustify(CenterText,
     CenterText);
  OutTextXY(Succ(GetMaxX) div 2,
     50,'Innovative Interfacing');
```

```
  setcolor(cyan);
  x1 := 10;   y1 := 20; x2 := 620;  y2
     := 100;
  SetLineStyle(0,1,3);
  Rectangle(x1, y1, x2, y2);
  settextstyle(0,horizdir,3);
  OutTextXY(Succ(GetMaxX) div 2,
     140,'presents');
  settextstyle(1,horizdir,4);
  OutTextXY(Succ(GetMaxX) div 2,
     220,'418MHz Digital Data
     Communication');

  setcolor(lightred);settextjustify
  (lefttext,centertext);
  settextstyle(1,horizdir,3);
  OutTextXY(40, 330,'*   Connected to PC
  Centronic port');
  OutTextXY(40, 330+40,'*   DTI approved
  418MHz FM radio link');
  OutTextXY(40, 330+80,'*   4-bit data
  transfer from PC to receivers');
  OutTextXY(40, 330+120,'*   Up to 255
  receiver addresses');
  readln;
  CloseGraph;
end;

{*************Main Program************}

begin
  screenshow;
  clrscr;
  input_printer_address;
  intialization;
  bit_weight;
repeat
  transmit(false);
     {stop transmission}
  send_data(swaddress,sdata);
     {loading address and data (light
     on) to the shift register}
  transmit(true);
     {start transmission}
  delay(30);
     {transmission lasts 20 ms}
  transmit(false);
     {stop transmission}
  gotoxy(35,23); writeln('Light On ');
  delay(round(lighttime*1000-30));
     {delay a specified time period-1}
  send_data(swaddress,0);
     {loading address and data (light
     off) to the shift register}
  transmit(true);
     {start transmission}
  delay(30);
     {transmission lasts 20 ms}
  transmit(false);
     {stop transmission}
  gotoxy(35,23); writeln('Light off');
  delay(round(delaytime*1000-30));
     {delay a specified time period-2}
until keypressed;
    readln;
end.
```

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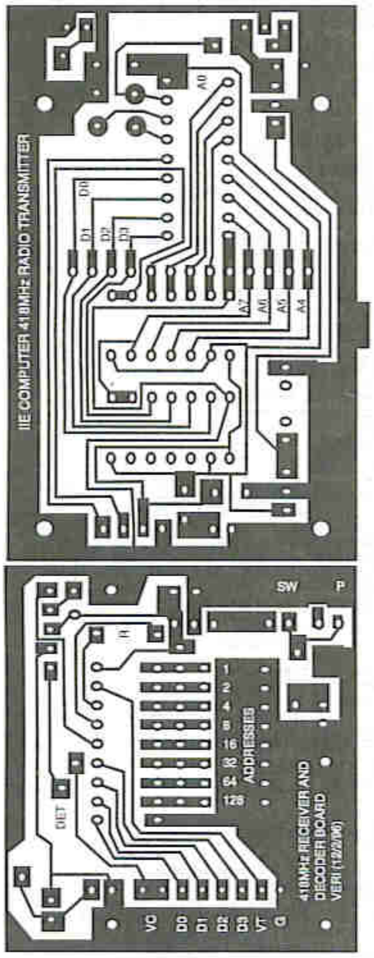
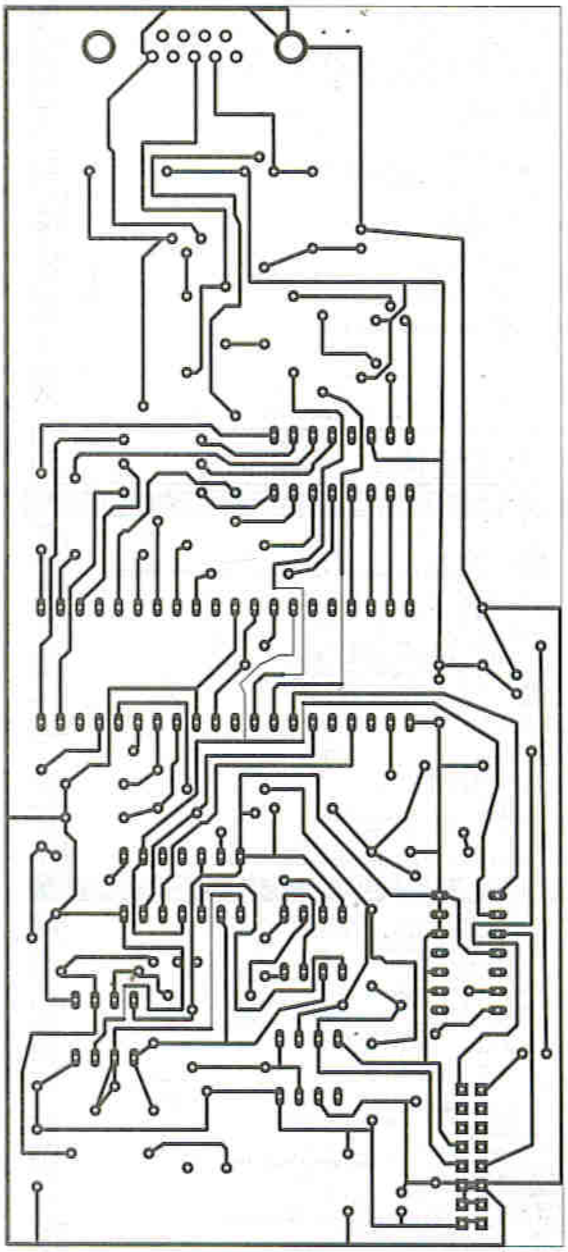


RADIO COMPUTER CONTROL: Tx and Rx



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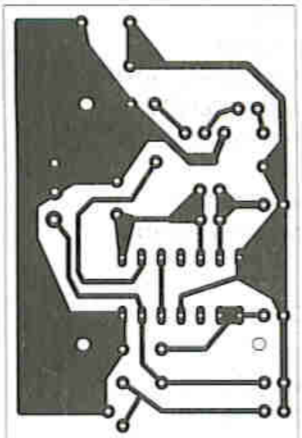

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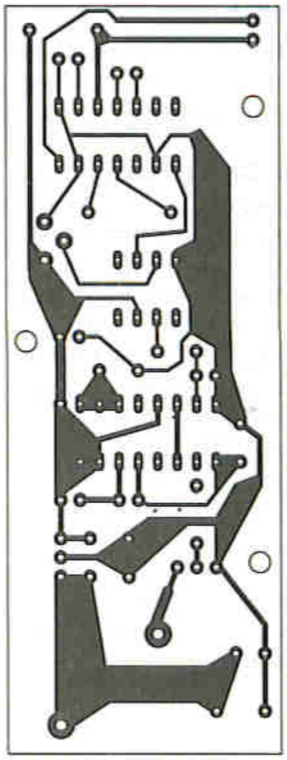

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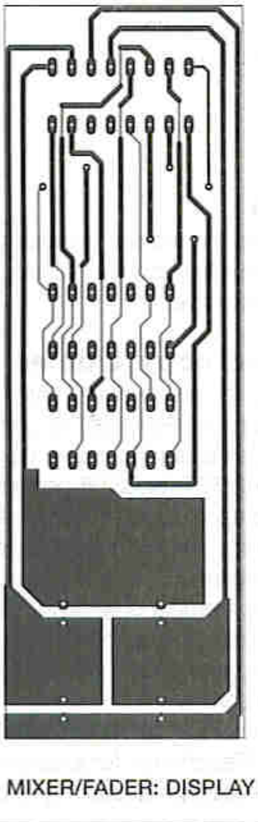

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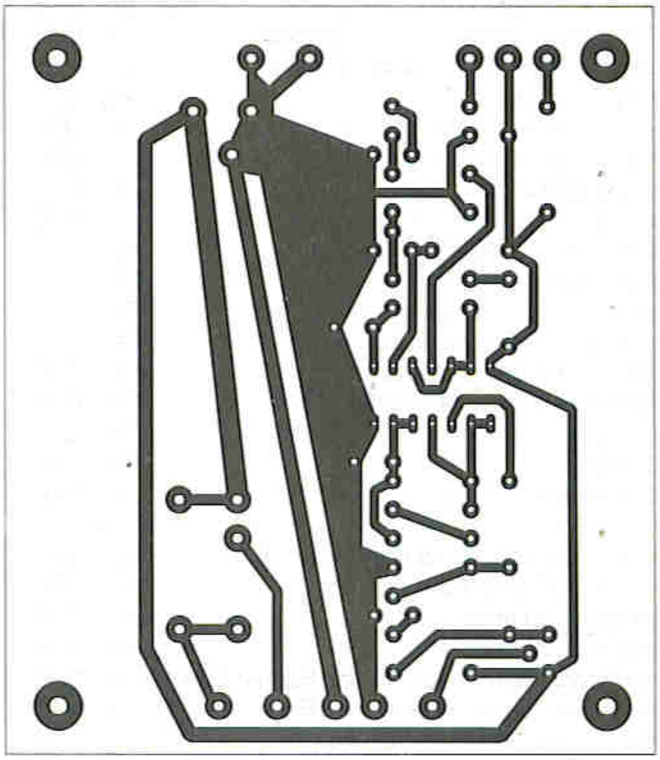

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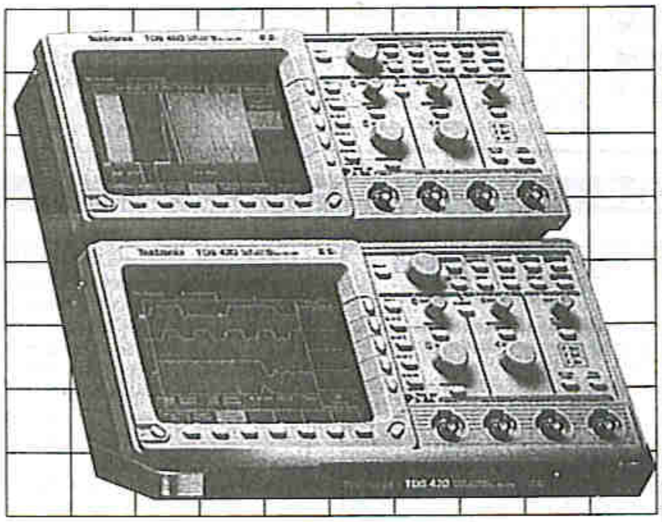

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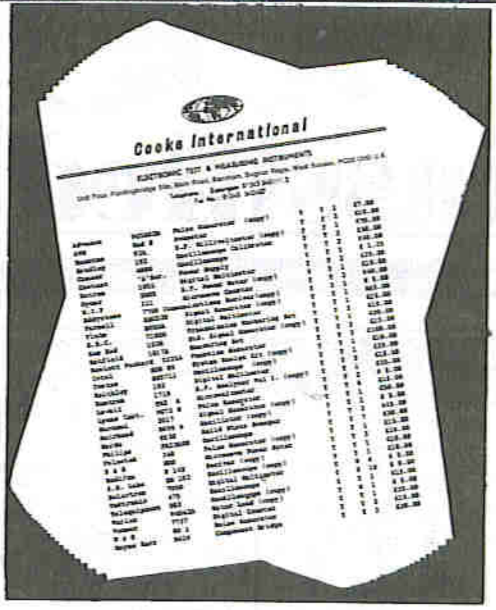

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Around the Corner

Two ETIs ago, a report from the Federation of the Electronics Industry led me once more to the subject of whether it is the job of schools and colleges to bridge the gap between technical expertise and understanding management.

It is not a new subject, of course. Apart from the output of the coffee machine, it quickly becomes the most important complaint of technical trainees embarking on their first employment, and frequently keeps running up until they retire.

This is not just an idle concern or the excuse of the less-than-motivated. The bottom-line requirements of getting the product developed and running the business/workshop/nation (without which, no development at all) as a going concern often seem to fight with each other.

The business is driven by competition and the need to survive towards "faster, cheaper products and bigger promises", while the designers, if they have any respect for their profession at all, are driven by "does is work, does it do the job", and they must achieve this aim without a bottomless expenditure of lifeblood-draining and irreplaceable resources (time and money, to the rest of us).

Of course it is daft that these two aims should conflict when we all know that both the public and industry want reliable, versatile and efficient technology - don't they? The trouble is that all customers have limitations on their resources - not just commercial ones. (Well, I do, and I bet you do, too.) The lure of the lower-cost has a hypnotic effect that can only be unlearned by bitter experience. And then there is that other old favourite, "it-must-be-better-because-it-costs-more". That is a game that managements enjoy, when they can get away with it, for obvious reasons.

Colleges and Universities in particular have been blamed for not raising the awareness of their technical undergraduates to management needs - costing, overheads, regulations, documentation, designing to a price, negotiation of contracts, record-keeping, working in teams. More colleges are involved in industrial placement now, which is a valuable start. Of course, many technical graduates go into management at an early stage, but they often achieve their management skills at the expense of their practical engineering skills, and it is easy to get out of touch with the dilemmas of the people on the design desks.

In theory, schools should be the ideal place to instil some basic understanding by teaching technology students to consider the demands of development in terms of material resources (How much will it cost? How is project time costed in?) as well as human resources (How do you keep on terms with your supervisors/customers/ colleagues even when they annoy you?).

But schools and colleges can hardly be expected to turn out ready-formed mini-managers when they must also concentrate on teaching the complexities of maths, science and electronics - disciplines that need concentration as much as experience.

The only answer is for industry itself to give employees more training - and that, in turn, needs everyone in the team to understand the importance of quality control and supervision on the job, and - just as important - how to be supervise and be supervised. Experience is good - 'bitter' experience is not so desirable.

The Challenge - *Things that electronics hasn't fixed yet*

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Next Month...

Volume 26 no. 4 of Electronics Today International should find its way to your newagent faster than usual, thanks to our leader article on a developing GPS system for automobiles ...Terry Balbirnie will be back to quick-checking his batteries after his sudden diversion into hedgehog-seeking last month ... Robert Penfold has designed us a freezer-meltdown alarm (no mean feat in the middle of winter) ... Ever wanted to sing with yourself? For most of us it's the only option! Tom Scarfe has thought of a voice harmoniser to make one voice sound like two ... Dr. Pei An is working on applications for his Home Computer Radio Control project ... We have a Fast Fiver from Owen Bishop, who also continued his series on Spice ... and more.

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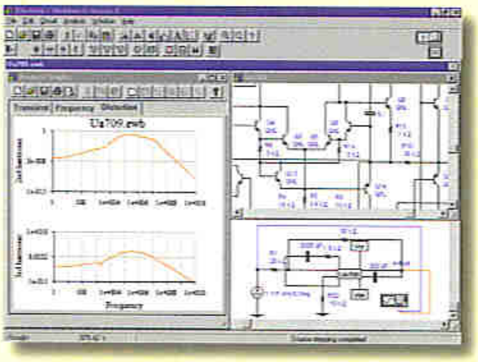

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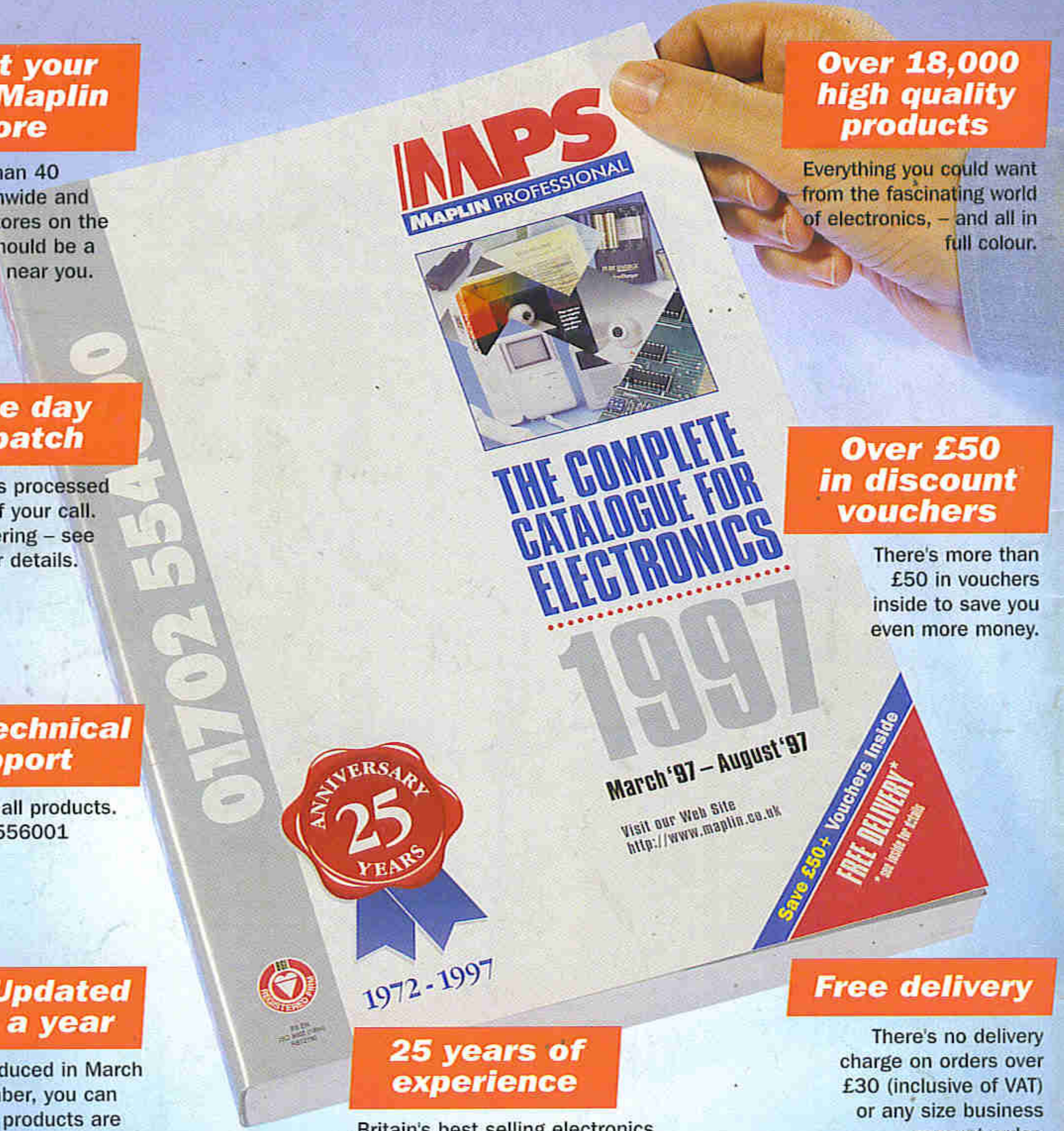
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