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No. 102

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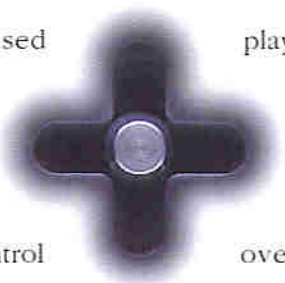

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JUNE 1996
VOL 15. No. 102

IN THIS ISSUE...

PROJECTS *FOR YOU TO BUILD!*

FEATURES *ESSENTIAL READING!*

REGULARS *NOT TO BE MISSED!*

FROM THE EDITOR . . .

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

Magazine Publications Manager

We extend a warm welcome to Paul Freeman-Sear who joins the team as Magazine Publications Manager with a wealth of experience from *ETI* and *Electronics in Action*.

The Traffic*master* Competition

Traffic*master* has teamed up with *Electronics* this month to offer readers the chance to win three *YQ* units and seven Traffic*mate* units inclusive of 12 month information keys. See page 28 for further competition details.

'Get the Beep' Competition Winners

We are pleased to announce the result of our 'Get the Beep Competition'. We have one BT Echo, one B/T Benetton, one Swatch Beep, and one Mercury MiniCall to give away.

Left to right: Robin Hall, editor of *Electronics*, pictured with Paul Freeman-Sear, Magazine Publications Manager.

The winners are: A. Deeley of Sheffield, I. Hogarth-Jones of Paignton Devon, J.W.H Simon of Leuchars Fife and M. Wallis of Wellingborough.

So until next month, from Paul, the rest of the team and myself, enjoy this issue.

ABC CONSUMER PRESS

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Project Ratings

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

1. Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering iron, side cutters, pliers, wire strippers and screwdriver). Test gear not required and no setting-up needed.
2. Easy to build, but not suitable for absolute beginners. Some test gear (e.g., multimeter) may be required, and may also need setting-up or testing.
3. Average. Some skill in construction or more extensive setting-up required.
4. Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.
5. Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

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Kits, components and products stocked by Maplin can be easily obtained in a number of ways:

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Prices of products and services available from Maplin, shown in this issue, include VAT at 17.5% (except items marked NV which are rated at 0%) and are valid between 10th April and 31st August 1996 errors and omissions excluded. Prices shown do not include mail order postage and handling charges, which are levied at the current rates indicated on the Order Coupon in this issue.

Technical Enquiries

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics*, the Technical Sales Department may be able to help. You can obtain help in several ways; over the phone, Tel: (01702) 556001 between 9.00am and 5.30pm Monday to Friday, except public holidays; by sending a facsimile, Fax: (01702) 553935; or by writing to: Technical Sales, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Don't forget to include a stamped self-addressed envelope if you want a written reply! Technical Sales are unable to answer enquiries relating to third-party products or components which are not stocked by Maplin.

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If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service, return the complete kit to: Returns Department, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Enclose a cheque or Postal Order based on the price of the kit as shown in the table below (minimum £17). If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost plus parts.

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Over £150.00	£60.00 minimum

Readers Letters

We very much regret that the editorial team are unable to answer technical queries of any kind, however, we are very pleased to receive your comments about *Electronics* and suggestions for projects, features, series, etc. Due to the sheer volume of letters received, we are unfortunately unable to reply to every letter, however, every letter is read – your time and opinion is greatly appreciated. Letters of particular interest and significance may be published at the Editors discretion. Any correspondence not intended for publication must be clearly marked as such.

Write to: The Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex, SS6 8LR, or send an e-mail to AYVI@maplin.demon.co.uk

TECHNOLOGY WATCH!

with Keith Brindley

Apple Newton PDA

If I was honest, which, of course, I always am (as regular readers will know), I've been positively itching to get my hands on one of these. I last looked at Apple's Newton way back when it was first developed. While it was good then, it did suffer from a few inadequacies. However, in the personal digital assistant field, it was the cream of the crop.

Nonetheless, if the original Newton (the MessagePad 100) was good, and the MesagePad 120 got better, you should now take a look at the recent arrival, the MessagePad 130. A new operating system (Newton 2.0), brings a whole new dimension of operability to both these devices.

Where handwriting recognition in the earlier operating system was merely OK if you spent time letting it learn your scribbles (as well as *you* having to relearn how to write, so it could translate your scribbles), Newton 2.0 picks up handwriting from the moment you take it out of the box. It represents a change from the Newton operating system's word-based handwriting recognition to character-based recognition, and the difference is quite remarkable.

There's an optional accessory in the form of a keyboard, too. However, we shouldn't get carried away here. If we're going to buy a personal digital assistant for its portability and ease of use, then buy a keyboard, why should we stop there? What about a disk drive? What about a monitor? Get my drift? No, the MessagePad is great for doing what it's good at. Don't try to turn it into a multi-piece computer. The MessagePad is complete with backup utilities and a connection kit to link it to both Mac and Windows personal computers, and that's all the computing ability it should ever have.

Apart from improved handwriting recognition, the operating system is faster – much faster. Things move altogether more speedily in all aspects, particularly when doing searches for information. This bodes extremely well for the future, because Apple is working on further MessagePads which will use faster microprocessors. The MessagePad 120 and 130 use an ARM device (the ARM610), developed by Advanced Risc Machines, a division of our very own Acorn Computers, running at 20MHz. A MessagePad slated for later this year will use the ARM710, running at around 60MHz, with a later model using the StrongArm microprocessor running at well over 100MHz.

It's an exciting phase for personal digital assistants. Where computers merely double in power every couple of years, personal digital assistants are set to increase their power by a complete order of magnitude over the same time. If they can maintain this rate, by the turn of the century, personal digital assistants will actually have the same sort of computing power as advanced desktop computers.

Calling Long Distance

There's an upcoming fight in the telecommunications arena, which only now, the traditional telephone companies world-wide are beginning to realise they're in. Rapid growth of Internet services due to many millions of users gaining access, has created a market for software which can allow computer users to communicate by voice while connected. Traditionally, let's say in the old-fashioned way, long-distance voice communication has only been by telephone. Of course, telephone companies (also traditionally) make pots of money for providing the service. However, Internet access is over a local line, and so at local charges. Apparently, some 20,000 people already use Internet telephone software.

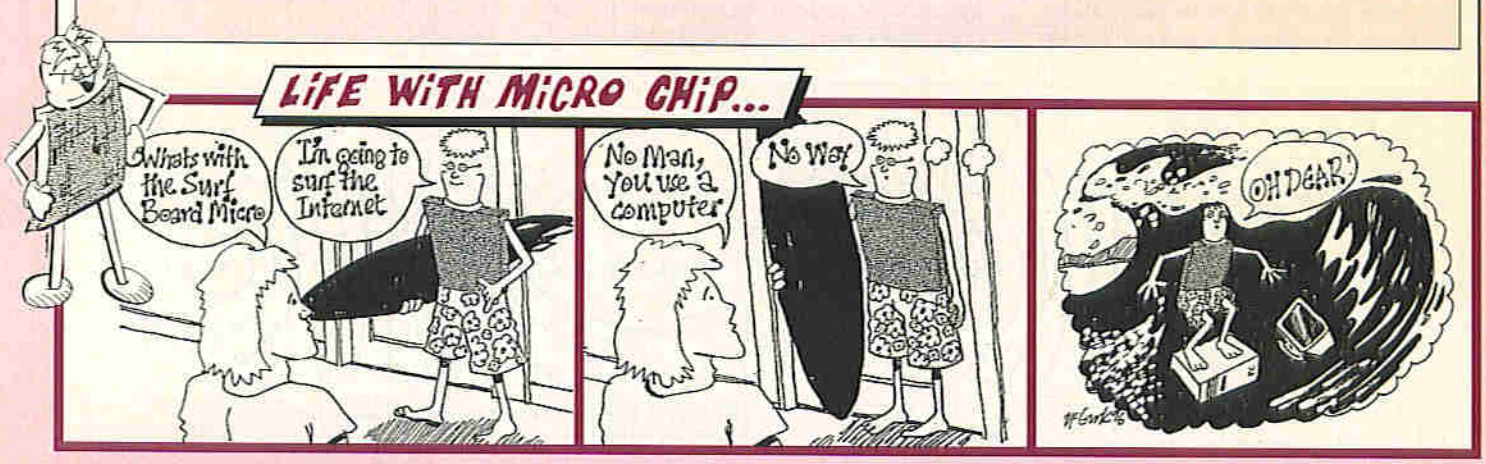
It's not yet a feasible concern on a large scale, however, because the bandwidth available on the Internet isn't big enough by any stretch of the imagination for millions of regular telephone calls. Voice communications over the relatively low bandwidth Internet as it stands are, as a result, scratchy and frequently broken to say the least, and certainly not yet of the quality that you'd want to call mum long distance with, but they will be within a few years. Once the proverbial information superhighway network is in place, there will be bandwidth a-plenty for vocal (and, indeed, visual) communications over the Internet.

If the Internet continues in the same vein it has done over the last few years, there's a good chance that the old-fashioned telephone companies will have to drastically re-evaluate their positions as service providers. Long-distance calls will have to get cheaper and to pay for that, local calls will probably have to be more expensive.

One2watch

Finally, Mercury's one2one digital phone network is to be expanded outside of its now-traditional south of England and West Midlands base to the rest of the country. By the end of the year, Mercury expects to cover up to 80% of the country, and by the end of next year, will be in place for 95% of us.

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



HOLOGRAPHY
Theory and Practice

by Laura Haston Ryden

A hologram is a photographic record of the interference pattern of two superimposed beams of coherent light, one directly from the source and the other reflected or scattered from a physical object.

In 1948, Dr. Dennis Gabor initiated the science of holography when trying to improve the performance of transmission electron microscopes. In his acceptance speech when awarded the Nobel prize for his invention, he said "I have the advantage in this lecture . . . that I need not write down a single equation or show an abstract graph. One can, of course, introduce any amount of mathematics into holography, but the essentials can be explained and understood from physical arguments."

In the past decade, holographic images have become familiar to everybody and holography has become an art form in its own right. Anyone who has seen the bright, three dimensional images produced by holography cannot fail to be fascinated by the experience. They are widely distributed as the tiny silver images on credit cards. Many people have seen holograms at exhibitions, and they can be purchased as 'executive toys'. They have even been given away free with packets of breakfast cereal. In addition, holography has various other applications, such as double exposure holographic interferometry, which enables very small displacements or distortions of an object to be measured. Another example is the holographic optical components used to produce diffraction gratings in the bar code scanners at supermarket check-outs.

There are two major classes or types of hologram. The first is the transmission hologram, which is viewed by passing a beam of coherent laser light through it. The other type is the reflection hologram, which can be viewed under incoherent white light that is reflected from it. Whilst both types of hologram rely on the interference effects of light waves for their operation, the theoretical explanation of each type is substantially different.

There are two major theoretical models of the operation of holography: the Geometric model and the Gabor Zone Plate model. The Geometric model can be used to explain both reflection and transmission holograms, where the photographic emulsion used is thick enough to record a three-dimensional interference pattern. By comparison, the Zone Plate model is only useful in describing the transmission hologram produced by a two-dimensional interference pattern recorded in a thin photographic emulsion.

It was decided to create a reflection hologram for this project, as this can be viewed in white light. Consequently, the theory presented here will be limited to an explanation of the geometric model as applied to the reflection hologram.

Theory

The Geometric Model

Consider the two points, A and B, shown in Figure 1. Let us imagine that both A and B are mutually coherent sources of light, and that the light from each of them is in phase. The light will spread out from each point, producing ever expanding spherical wave fronts.

The interference of these two light sources will produce regions in space where the light intensity is high, as the waves arrive in the same phase. These regions are shown as the curves on the diagram. Conversely, there will be regions of low intensity where the waves from each source are out of phase. These are

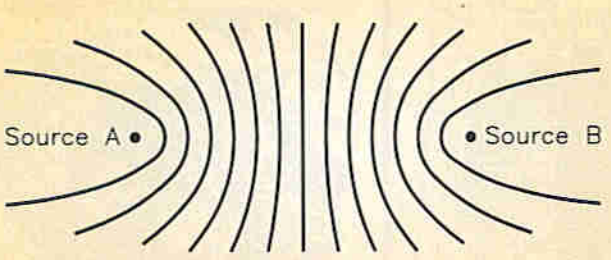


Figure 1. The appearance of the interference pattern.

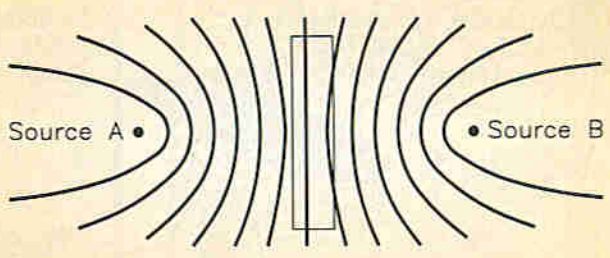


Figure 2. The interference fringes lie essentially along the length of the plate.

the regions in-between the curves on the diagram. These regions are actually three-dimensional, and can be visualised as the surfaces that are traced out by rotating the curved lines of the diagram about an axis passing through points A and B. It can be seen that the curve drawn half way between the two points (the central interference fringe) is, in fact, a straight line, as it must be *equidistant* from the two points. This line represents a plane perpendicular to the paper. Less obvious, is the fact that the curved lines in the diagram are actually hyperbolic in nature, representing hyperboloids in three-dimensional space.

Now assume that it is possible to record the position and shape of these curves and reproduce them as partially reflecting surfaces. The mechanism by which this is done will be described shortly. In Figure 2, the rectangle represents a cross-section through a sheet of some form of recording media that achieves this; the media being 'thick' enough to contain a few tens of thousands of wave lengths of the light used. The surfaces of high intensity passing through the media are recorded and transformed into partially reflecting regions.

The source of light at point B can now be removed and the light emanating from point A is allowed to fall on the recorded interference pattern, which is placed in the position of the original interference pattern. This is shown in Figure 3. The interference pattern in the media is shown as the curved lines within the rectangle, but now the light emanating from A is drawn as rays.

As the original interference pattern has been recorded as partially reflecting surfaces, the light rays from A are reflected at these surfaces. It can be seen that the reflected light must form a virtual image of point B on the reflecting surface that results from the central interference fringe. This reflecting surface is, after all, a plane mirror, albeit partially reflective.

It must be accepted that the hyperbolic, partially reflecting surfaces also produce a virtual image of the point B (although the geometry of this is somewhat harder to work out). In general, the recording media need not be centrally positioned, as all the reflecting surfaces would be hyperboloids.

This is all very well, but what is required is a virtual image of a three-dimensional object, not just a point of light.

As a first step to understanding how this might be achieved, imagine that instead of just the point B on one side of the recording media, we have two points B and C, as in Figure 4. Clearly, the light from point C will create an interference pattern with the light from point A (as described above). The two interference patterns will be superimposed on each other. They will result in partially reflecting surfaces being recorded in the media. These reflecting surfaces will also be superimposed on each other. Some of them will result in creating a virtual image of B, while the others will create a virtual image of C. This is also shown in Figure 4.

The final step in visualising how an extended three-dimensional image is formed from an object, is to consider the object as a very large number of point sources of light. These point sources each contribute an interference pattern that is superimposed on all the others, as described for points B and C.

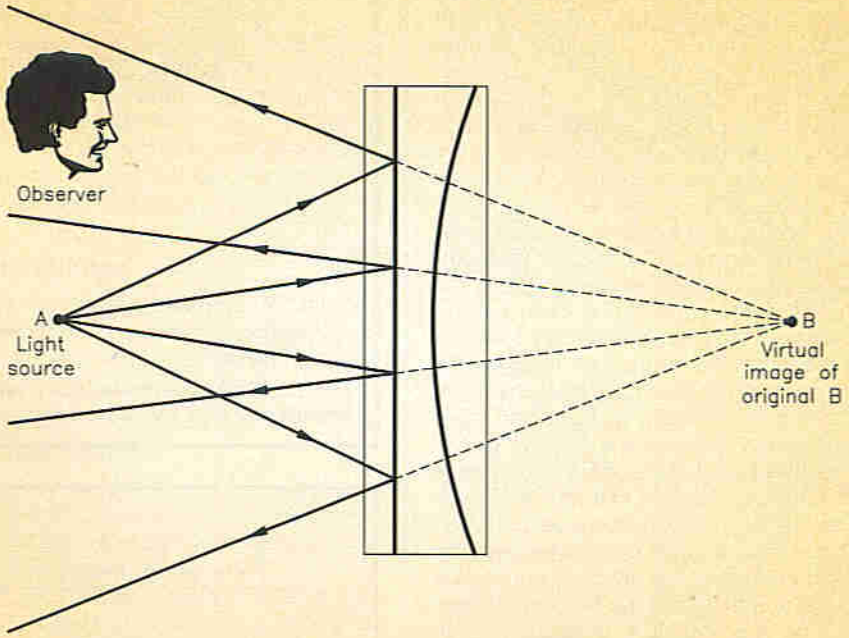


Figure 3. Formation of a virtual image by the recorded interference pattern of source B.

Each one of this huge number of interference patterns creates a set of partially reflecting surfaces in the media that are themselves superimposed, and each set of partially reflecting surfaces contributes one point to the virtual image of the object.

Practical Realisation

Before continuing with the theoretical explanation of the reflection hologram, we shall look at how it is possible to record interference patterns and convert them into partially reflecting regions.

The first requirement is to produce the two mutually coherent beams of light. The light from the object is called the 'object beam' and the light with which it interferes is called the 'reference beam'. These beams can only be produced by splitting the light from a single source. Part of the beam is directed onto the object, from which it is reflected onto the recording media. The other part of the beam is directed straight onto the recording media. This is commonly done by splitting the beam with a semi-silvered mirror and then using further mirrors and lenses to direct the beams as required. Alternatively, it is possible to illuminate both the object and the media with a single wide beam of light as shown in Figure 5. However, an ingeniously simple way of providing a reference and object beam without the use of mirrors is shown in Figure 6. Here, the reference beam travels through the media and is reflected back on itself by the object.

Clearly, in order to produce interference fringes in the media, it is necessary to have a source of light whose coherence length is greater than the difference in pathlengths of

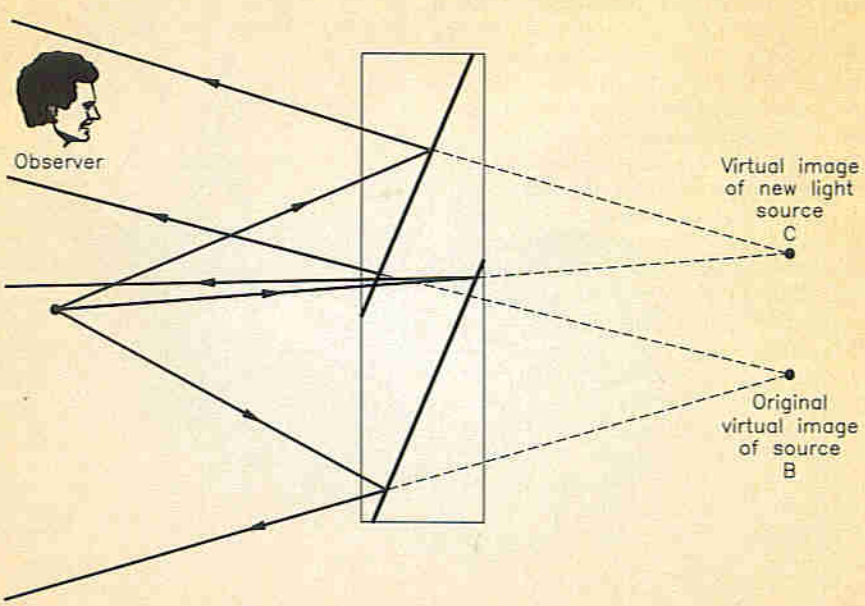


Figure 4. Interference patterns from sources B and C, when recorded in the media are superimposed, giving rise to two virtual images.

the reference and object beams. Such a source is readily provided by a laser. Even the cheapest and most common helium-neon laser can produce a beam with a coherence length of 20 to 30cm. The beams from these lasers are in the region of 1 to 2mm in diameter. This can easily be expanded to the size required to illuminate an object of larger dimensions by means of a lens.

The second major requirement is for a suitable recording media. In this case, we used a special photographic emulsion. When the photographic emulsion is exposed and developed, the areas that receive sufficient light energy (the product of intensity and exposure time) will become blackened. This is normal in conventional black and white photography, producing a negative image. These blackened areas will absorb a large percentage of the light that travels through them, transmit a small percentage and reflect the rest. This situation is not very useful for creating reflection holograms, as not enough light is reflected from the blackened areas. However, it is possible to process the emulsion after development, in a suitable bleach that will convert the blackened areas into transparent areas. These converted areas have a different refractive index to the surrounding transparent areas that were not blackened. This gives rise to a greater percentage of reflected light, giving a brighter image.

The final major requirement is to keep the light source, object, recording media and other apparatus mechanically stable during the exposure. A movement of half a wavelength in any of these would completely destroy the interference pattern. Stability of about one tenth of a wavelength is required for high contrast fringes. This corresponds to a movement of about 60nm! This requirement for stability dictates using a heavy optical bench with good vibration dampening properties. The bench should also be isolated from external vibrations (e.g., from floors, etc.).

Bragg Reflection

From the discussion so far, it is now apparent that the recording of the interference patterns that are formed between two coherent light sources can create curved, mirrored (partially reflecting) surfaces. When illuminated by a point source of light, similar to the original reference beam, these surfaces reflect light in such a way as to create an image of the original object. The next stage is to consider the fact that there is actually a large number of closely spaced reflecting surfaces within the thickness of the recording media. This gives rise to some striking colour effects in the resulting image.

We will now consider what happens when these layers of partially reflecting surfaces are illuminated when viewing the hologram. Figure 7 shows such a situation. Clearly, at each partially reflecting surface, some of the light will be reflected and some will be transmitted. The transmitted light is, in turn, partially reflected from the next surface and so on. It can be seen that the reflected beam is, in fact, composed of the sum of all the partial reflections throughout the thickness of the recording media. It is this combination of these multiple surface reflections and the resulting interference that is called Bragg reflection.

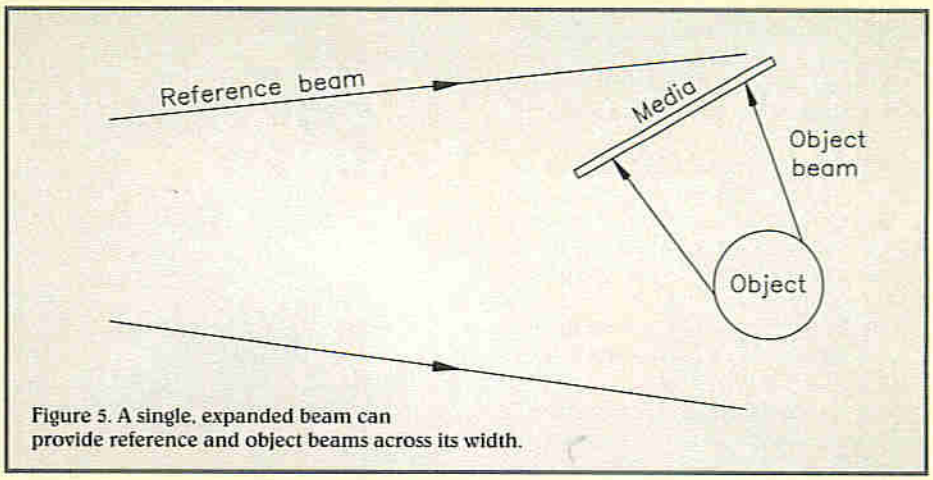


Figure 5. A single, expanded beam can provide reference and object beams across its width.

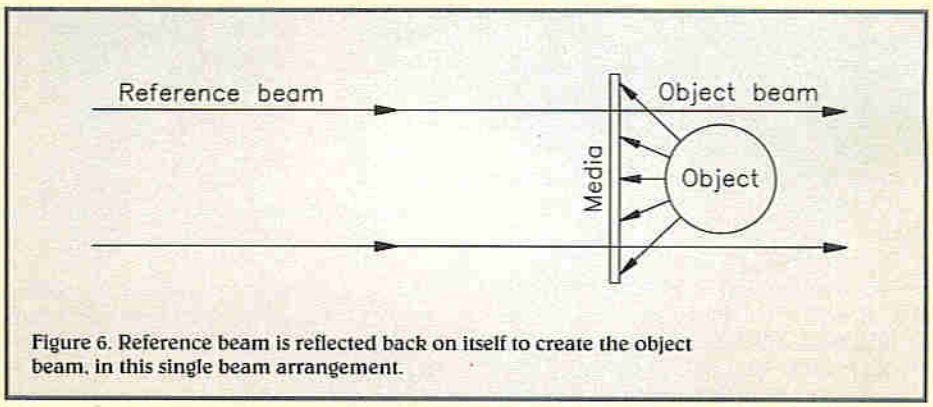


Figure 6. Reference beam is reflected back on itself to create the object beam, in this single beam arrangement.

It can be seen that if the various lengths of the light paths through the multiple planes are always different by a whole number of wavelengths, all the emerging wave fronts will be in phase. In this case, *constructive interference* takes place and a bright reflection results. For pathlengths that differ by an extra half wavelength, the emerging wave fronts will be out of phase and *destructive interference* takes place, resulting in no reflection. Also, the pathlengths taken by the light travelling through the planes are dependent on the distance between the planes and the angle at which the light is travelling through them. From the geometric model, it can be deduced that the Bragg effect gives rise to constructive interference for the reflected rays that form the virtual image.

When the hologram is viewed under white light, all the wavelengths will be reflected from the partially reflecting surfaces. However, only those wavelengths that satisfy the Bragg condition for constructive interference will be reflected strongly. The other wavelengths will suffer destructive interference and their reflections greatly attenuated. It is this mechanism that causes reflection holograms viewed under white light to

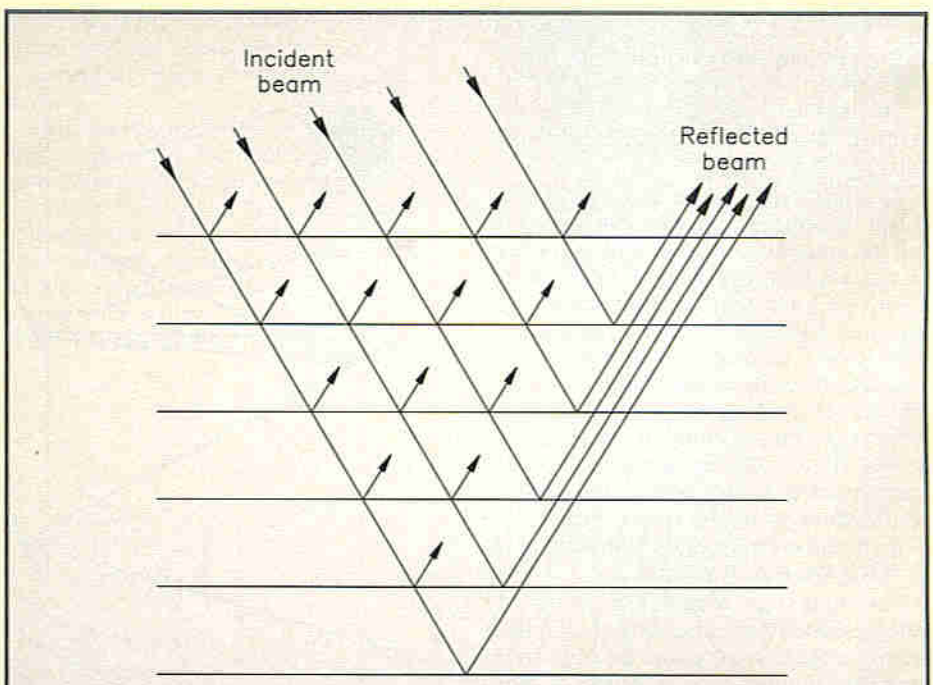


Figure 7. The reflected beam from the stacked surfaces is the result of light reflected from the various surfaces and interfering with each other as they emerge from the stack.

appear in a single colour. This effect also explains how a hologram may appear in a different colour than that of the light used to record it. This can happen if the recording medium shrinks or expands during processing, thus changing the spacing between the partially reflecting planes and allowing a different wavelength to satisfy the Bragg condition. It is common practice to treat holograms chemically, to achieve these colour effects.

It may seem strange to speak of viewing a hologram under a source of white light when our discussion of Bragg reflection assumes illumination by a coherent light source. It is a great advantage of the reflection hologram that it is easily viewed under a white light source, whereas the transmission hologram requires a coherent playback light source. To understand how this is possible, it is only necessary to realise that even a white light source has some temporal coherence. It also has a coherence length, albeit very short compared with that of a laser. When considering Bragg reflection in the recording media, we see that the coherence length required is only of the order of the thickness of the media. Given that the media is approximately 15μm thick, we can see that if the coherence length of white light is 0·1mm, then Bragg reflection can take place.

Equipment and Apparatus

Laser

There are many inexpensive low power helium-neon lasers on the market. The one used in this project was the cheapest available at the time (1990). It is still supplied in kit form (LM72P) by Maplin Electronics.

The kit contains a laser tube and all the components required to construct the accompanying power supply.

Construction was very straightforward. It was only necessary to solder the power supply components onto a printed circuit board. The laser tube was then mounted onto the board (using the plastic brackets supplied) and the completed board was then placed into the aluminium case provided.

Care had to be taken with the construction and operation of the laser, as the power supply was capable of delivering 8,000V.

This laser produces a red light of 632·8nm wavelength, at a power of 2mW. The output beam is approximately 1mm in diameter. The distribution density of light intensity across the width of the beam consists of a single gaussian peak, and the laser is said to operate in TEM 00 mode.

Photographic Media

The photographic media used was in the form of glass plates supplied by Agfa-Gevert, under the name 'Holotest 8E75HD'.

The photographic emulsion on these plates is specifically designed for the production of holograms. It has a spectral sensitivity that is maximum at the 632·8nm wavelength of the helium-neon laser. Its sensitivity to green light is low, thus allowing a green safe light to be used in the dark room.

Emulsions used for holography have a very fine grain size, in order to accurately record interference fringes. The emulsion is also quite thick, so as to record the interference pattern in the three dimensions that are required for reflection holograms.

Whilst it is possible to obtain this emulsion on a flexible polyester or triacetate film base at greatly reduced cost, the glass plates were selected for reasons of stability. It was not felt to be worth the risk of flexible film moving during the long exposures required when using a low power laser.

Plate Holder

Each photographic plate was held vertically, by clipping it to the vertical legs of two heavy-duty shelving brackets that were screwed down to the chipboard worktop.

Optical Bench

Due to the stringent stability requirements, optical benches are conventionally constructed from steel and are extremely heavy and expensive.

The optical bench used in this project was far less costly, consisting of a chipboard kitchen worktop. This material is ideal as an optical bench, due to its high density and high vibration dampening properties (i.e. the use of chipboard in loudspeaker construction). What it does lack compared to the professional optical bench is long term stability, as wood will tend to warp over a period of time, but this is not important here. The dimensions were approximately 61 × 122cm (L). The worktop was painted matt black to minimise stray reflections.

Car Tyre Inner Tubes

The tubes were inflated to approximately 75% of their capacity. There had to be enough tubes to support the work surface. In this case, only two were needed.

Lens

The lens used in this experiment was a microscope objective type.

Lens Holder

The lens holder was constructed from a piece of copper piping which was supported by slotting it into a hole in the centre of a heavy piece of metal (in this case, the flywheel from a model steam engine!) The microscope objective lens was attached to the vertical copper pipe by means of two jubilee clips glued together at right angles (one of the clips being tightened around the objective, which is held horizontally). This setup gives the ability to raise, lower and rotate the lens easily.

Shutter

The film exposure is controlled by means of a shutter. This was simply a piece of black cardboard folded into a V shape, so that it could be stood in the path of the laser beam.

Aperture

The laser tube emits a cone of blue light in addition to the red laser beam. It was necessary to prevent this blue light from reaching the film and fogging it. This was achieved by passing the beam through a piece of black card that had been pierced with a small hole for the beam to pass through.

Dark Room

The apparatus was set up on a kitchen floor. The doors and windows were totally covered and sealed with black card and black tape.

In addition to the requirement for darkness, a holographic darkroom must be as vibration-free as possible. Fortunately, the kitchen used had a solid concrete floor and the house was situated away from excessive traffic.

Safe Light

A dim green safe light was made in order to have some visibility in the dark room. This was a simple plywood box with an open front

Photo 1. Experimental setup for reflection holograms.

and a piece of green filter material taped over the opening. The box contained a 15W bulb.

The green filter material is very sensitive to heat and therefore, the box had ventilation holes in the sides and the top and bottom to enable air to convect through the box. These openings were baffled to prevent white light escaping from the box.

Object

The object used was a small toy car made of metal. This was chosen as it is relatively stable and highly reflective. The car was elevated into a central position with respect to the photographic plate. This was achieved by placing the car on the top of a small but heavy piece of matt black painted metal.

Chemicals

The chemicals used for developing and bleaching the plates were supplied by Laser Holograms Ltd. (Reading), under the name 'RLD1'.

Miscellaneous Items

These were a stop-watch, thermometer and three plastic trays for processing chemicals.

Method

Setting Up

Refer to Photo 1. The optical bench was isolated from the floor by the two car tyre inner tubes. They were inflated sufficiently to hold the bench approximately 75mm. from the floor. Inflating the tubes any further, to 'round them out' would have produced too much 'bounce' in the bench. The laser, aperture, lens, plate and object were positioned on the bench as in the photographs.

The laser was raised by approximately 25mm. from the bench, by placing it on top of a piece of cast iron. This eliminated the need for the laser to stand on its rubber feet, which would have introduced instability. This also positioned the beam centrally with respect to the photographic plate. The expanded beam could then be observed on a piece of white card held in the plate position. The position of the lens was then adjusted so as to provide a diverging beam that fell centrally onto the plate. The aperture was placed approximately 52mm. from the laser, so as to block out most of the blue light cone.

The white card showed that the expanded beam was not of even intensity, but consisted of stripes and swirls of intensity. These patterns were due to interference effects caused by imperfections in the lens and dust on its surfaces. By carefully adjusting the lens position vertically and horizontally, it was possible to avoid the worst of these fringe patterns falling onto the plate.

The object was placed within 5mm of the plate position. This ensured that the largest possible amount of light reflected from the object reached the plate. For high contrast interference fringes, the ratio of intensities of the reference beam and object beam should be 1:1. The shutter was placed in the unexpanded beam, between the laser and the lens.

The processing chemicals were mixed according to the manufacturer's instructions. The developer solutions were maintained at close to 20°C by standing their containers in a water bath.

Exposure

The laser was switched on and the photographic plate clipped to its holder. The apparatus was then allowed to settle for ten minutes. This delay allowed time for the thermal expansion of the laser and for any relaxation in the clips holding the plate.

The shutter was then lifted from the bench and held in the path of the beam for one minute. This time allowed for any vibration caused by lifting the shutter to subside. The shutter was removed from the beam and the plate exposed.

Processing

Following exposure, the plate was removed from the holder and processed as follows:

(a) 100ml each of parts A and B of the developers were mixed into the developer dish. This was done immediately prior to use, as the mix will deteriorate within five to ten minutes.

(b) The plate was immersed in the developer and continuously agitated for the development time. During this time, the plate was observed to blacken completely.

(c) The plate was then removed from the developer and immediately rinsed under cold running water for four minutes.

(d) The tap water was then removed from the plate by immersion for 15 seconds in deionized water. This is necessary as the bleach can produce a cloudy precipitate if it comes into contact with tap water, which could form a scum film on the hologram.

(e) The plate was then immersed in 200ml of bleach in the bleach tray. The plate was observed to become transparent again, and the time taken for this to occur was recorded.

(f) The plate was again rinsed in running tap water for 10 minutes to remove the bleach completely.

(g) A windscreen wiper blade was then used to remove the excess water from the plate and a hair dryer was used to complete the drying process. During drying, the holographic image was observed to appear slowly.

Results

The major variables in creating a hologram are: the exposure time, the intensity of light used during the exposure, the ratio of the intensities of the reference and object beams, the immersion time of the plate in the developer, the temperature of the developer and the immersion time of the plate in the bleach solution.

Of these variables, some were fixed by the apparatus used. The intensity of the light was fixed by the power of the laser, and by the amount by which the beam is spread (which is fixed by the position of the lens in order to cover the plate and the object). In our single beam setup, the ratio of the reference and object beam intensities was fixed by the reflectivity of the object and the distance between the object and the plate.

The processing times and temperatures are specified in the instructions supplied with the chemicals. The processing times are, however, specified over a large range, that is, between 1·5 and 2·5 minutes for the developing time. The bleaching time was specified as being 1·5 times the time taken for the developed plate to change from black to clear.

In order to find a satisfactory combination of exposure time and processing times, it was decided to select a development time of 90 seconds and to vary the exposure time until the brightest image was found. Then we would create further holograms using the best exposure time whilst varying the development time. Table 1 shows the various parameters used in creating the 8 plates that were exposed.

Plates 1 to 6 are the results of trying to 'home in' on the correct exposure and development times as described.

Having completed the first six attempts, it was decided that none of the images were sufficiently bright, and advice was sought from Laza Holograms Ltd. They suggested that the development time should be fixed at 120 seconds at 20°C. In addition, the bleaching time should be 15 seconds; that is, the plate should have cleared after 10 seconds.

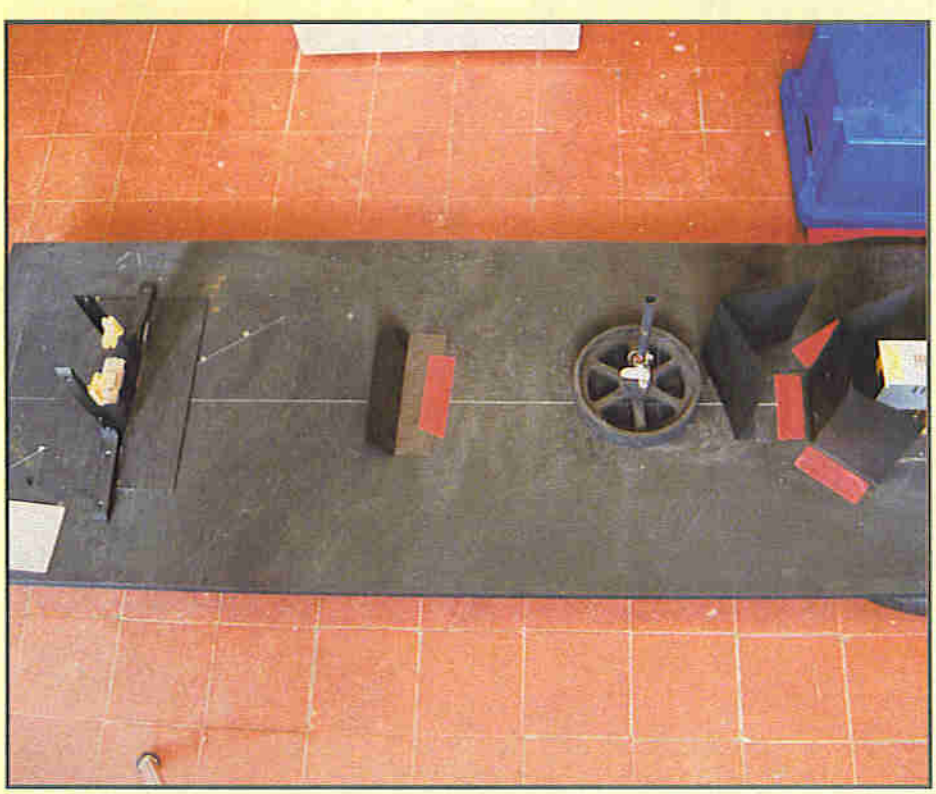


Plate No.	Exposure Time (s)	Developing Time (s)	Developing Temperature (°C)	Bleaching Time (s)
1	30	90	17	60
2	60	90	17	60
3	60	90	20	60
4	90	90	18	60
5	60	100	20	60
6	70	90	20	60
7	10	120	20	20
8	5	120	20	15

Table 1. The various parameters used in creating the eight exposed plates.

One could then ascertain that if the plate had not cleared in this time, then the exposure time must be too long. Also, it was suggested that as the bleaching times attained so far were about 4 times too long, then the exposure time should be reduced by a similar factor.

Heeding this advice, plate 7 was exposed for 10 seconds. The result was a much brighter image, but the time required for the plate to clear in the bleach was still too long, indicating that the exposure time was also too long. The final plate, number 8, was, therefore, exposed for only 5 seconds. This plate cleared in the bleach in the recommended time and gave a reasonably bright image.

In conclusion, it has been shown that it is possible to create holograms using very simple and relatively inexpensive apparatus. This was despite doubts about achieving the required degree of mechanical stability and about having sufficient output from a small laser. In order to improve on these results, it would probably be necessary to use a split beam set up (so that the object and reference beam intensities can be adjusted to be more equal), in order to achieve greater contrast in the interference pattern produced.

Glossary

Coherence

Coherence refers to the degree of order in waves emitted from a light source. Temporal coherence refers to the time variation in the waves of the source. A source with high temporal coherence will emit light at a single wavelength that does not change over time, e.g., a laser.

Spatial coherence refers to the variations in the waves of a light source in space. For example, the waves at different points across the width of a laser beam will be in phase. The beam is said to be spatially coherent.

White light emitted from a bulb has low temporal coherence, as it contains many wavelengths. It also has low spatial coherence, as there is no phase relationship between the light waves travelling out in different directions.

Coherence Length

If a coherent beam of light is split into two beams (with, say, a semi-silvered mirror) and the beams are then recombined to create interference effects, the results will depend on the difference in the pathlengths travelled by the two beams. If the difference in pathlengths is greater than a certain maximum, the interference effects will not be observed. This maximum difference in lengths is called the coherence length and is dependent on the temporal coherence of the light source.

This occurs because of the changes in wavelength of the source over time. The beam that travels furthest takes longer and is, therefore, older than the part of the beam that it is recombined with. Due to the change in wavelength over time, the recombined beams can lose their phase relationship.

Interference

When two mutually coherent sources of light meet at a point (for example, on a screen), the resultant intensity depends on the phase relationship between them at that point. If they are in phase, the intensity is high as the waves reinforce each other. If they are out of phase, the intensity is reduced as the waves cancel each other out. This is known as constructive and destructive interference, respectively.

Phase

Phase is a measure of the relative position of two sinusoidal wave forms. Phase differences can be expressed as a fraction of the wavelength or as an angle. In other words, a phase displacement of $^1/_4$-wavelength is equivalent to 90°. 'In phase' refers to a phase difference of 0°. 'Out of phase' refers to a phase difference of 180°. A phase difference of 360° is equivalent to zero phase difference.

Transverse Electric and Magnetic (TEM)

Within a laser tube, light is reflected back and forth between two mirrors. One of the mirrors is not 100% reflective, such that a small fraction of light is transmitted as the output beam. Various patterns of light paths are possible between these mirrors, depending on their geometry. These various configurations are known as TEM modes and are identified by a pair of numbers. Most of the modes give rise to multiple peaks of intensity across the width of the output beam. Only one mode gives a single intensity peak, as is required for holography. This is the TEM 00 mode.

Wavefront

A point source of light emits electromagnetic waves in all directions. The peaks and troughs of these waves will spread out as spheres of increasing radius. Each one of these spheres constitutes a wavefront. Wavefronts can be considered as contours of equal phase. Wavefronts need not be spherical, depending on the light source and the way in which the light is modified as it passes through lenses, etc.

References

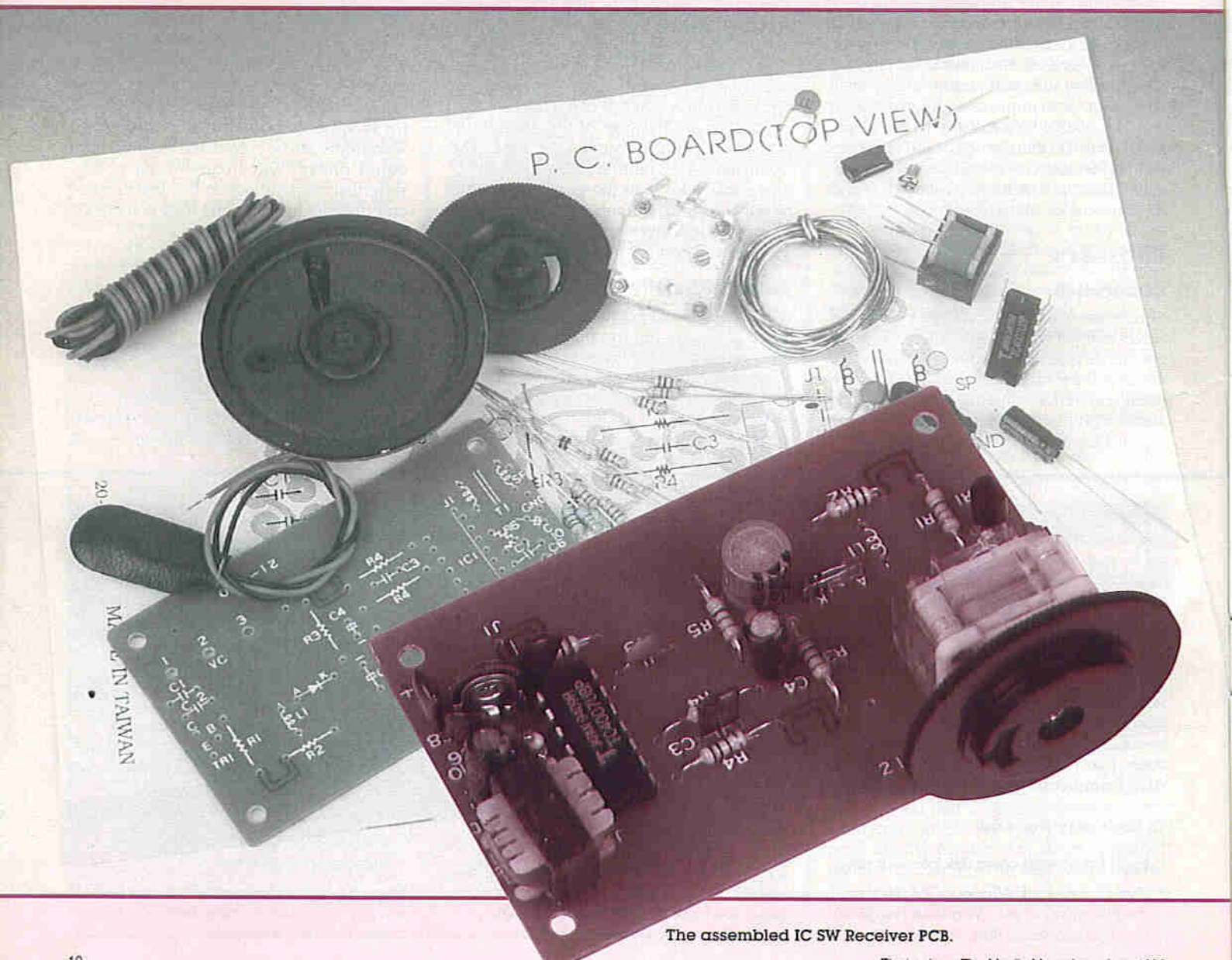
The Complete Book of Holograms, J. E. Kasper and S. A. Feller.
Laser Principles and Applications, J. Wilson and J. F. B. Hawkes.
Optics, F. G. Smith and J. H. Thomson.
Electronics – The Maplin Magazine, February 1990 issue. An article by S. Wiseman.

KIT AVAILABLE (95092) PRICE £9.99

IC SHORTWAVE RECEIVER

1 PROJECT RATING

Text by David Powell



The assembled IC SW Receiver PCB.

Circuit Description

The block diagram is shown in Figure 1, with the circuit diagram shown in Figure 2. Studying these should assist in following the circuit description, or with fault-finding.

Radio signals from a wide selection of frequencies are picked up by the antenna and fed via C1 to the first stage TR1 which forms part of a simple wide-band RF preamplifier.

These amplified signals are fed to the parallel tuned circuit consisting of L1 and CV1. Tuning the receiver to the desired frequency is accomplished by L1 and CV1. The radio signals are detected (demodulated) by diode D1, and the audio signals of the received station are passed to the audio preamplifier stage IC1a.

The audio signals are fed via C5 to the preset volume control VR1 and then onto IC1b and IC1c for further amplification raising the audio signal level to drive the loudspeaker via the impedance matching transformer T1.

PCB Construction

It is easiest to begin with the smallest components first, working up in size to the largest. Refer to Figure 3 and the Parts List when orientating components.

If you are new to project building, refer to the Constructors' Guide (order separately as XH79L) for helpful practical advice on how to solder, component identification and the like.

Begin by identifying resistors R1 to R7 according to their resistance values. Insert and solder these in position on the PCB using Figure 3 as a guide. Note that both components R4 and R6 are made up from two 10Mohm resistors in series (see Figure 2).

Specification

DC Power Source:	9V PP3 battery
Frequency range:	25 to 60Mhz (see text)
Reception mode:	AM
Sensitivity:	1mV
Rated Audio impedance:	8Ω
Audio output power:	90mW into 8ohms
PCB size:	79 × 50mm

FEATURES

- ★ Simple construction
- ★ Compact single-sided PCB
- ★ Operates from 9V PP3 battery
- ★ Speaker included

The component VR1 as supplied is a skelleton 500K (470K) preset. It may be necessary to adjust the position on the board if another size of preset is supplied. Alternatively fit three leads into the presets position on the board and solder to an external 500K (470K) volume control.

Identify, insert and solder the ceramic disc capacitors C1, C2, C7 and C9. Insert and solder the remaining non-electrolitic polyester capacitors C3, C5, C6 and C8.

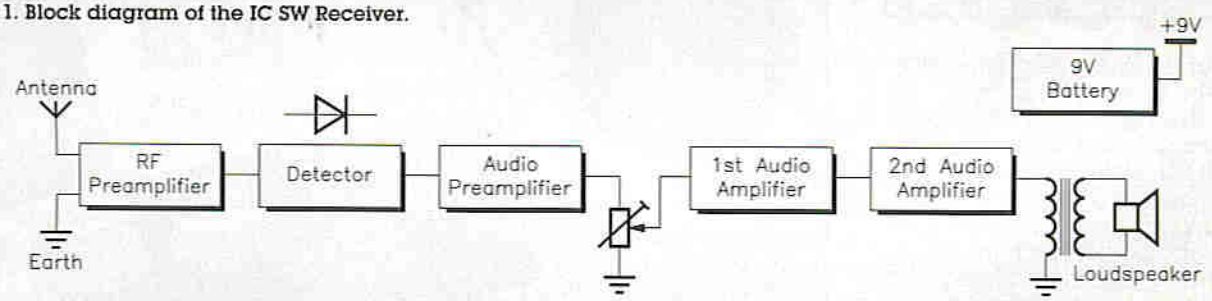
Identify, insert and solder the electrolytic capacitors C4, C10 and C11. Be careful to correctly orientate these polarized devices. Insert the lead identified by a stripe and the (–) symbol on the body of the capacitor into the PCB holes as indicated by (–) on the PCB legend. Another method of identifying the negative lead is that it is the shorter of the two leads.

For correct orientation of diode D1, identify a band around one end of the body which indicates the cathode and is marked by a (K) on the PCB legend. Insert the diode into the PCB aligning the end with the band towards C11, and solder into position.

For transistor TR1, simply align the shape of the plastic body to the shape as shown in Figure 2, and insert all three leads in the holes marked as C B E and solder into position.

Next mount the miniature transformer T1. Identify the 'primary side' as having three connecting wires, the secondary has only two. Carefully bend the central primary wire at right angles to clear the PCB, and insert all of the remaining four wires into the PCB such that the centre wire points towards the IC1 position. Ensure that T1 remains flat on the board while soldering then trim off the spare centre wire.

Figure 1. Block diagram of the IC SW Receiver.



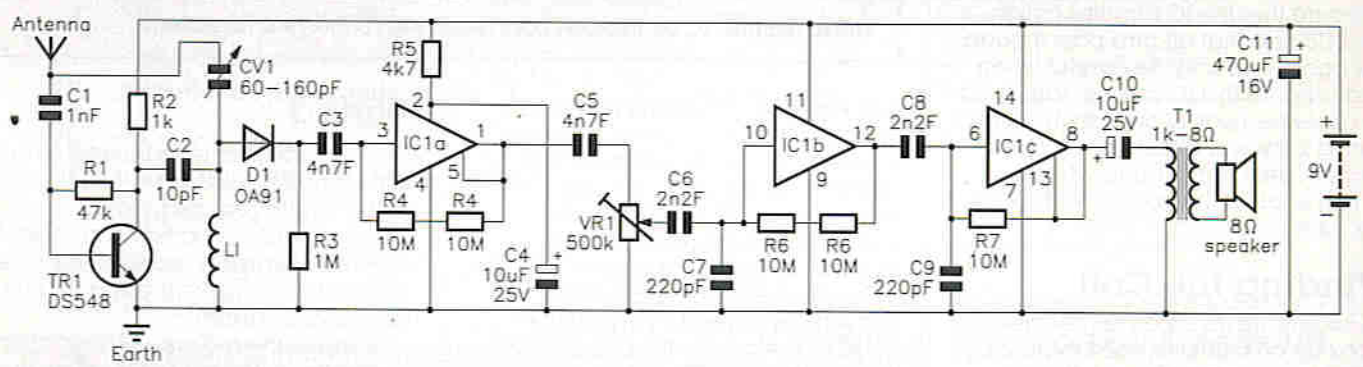


Figure 2. Circuit diagram of the IC SW Receiver.

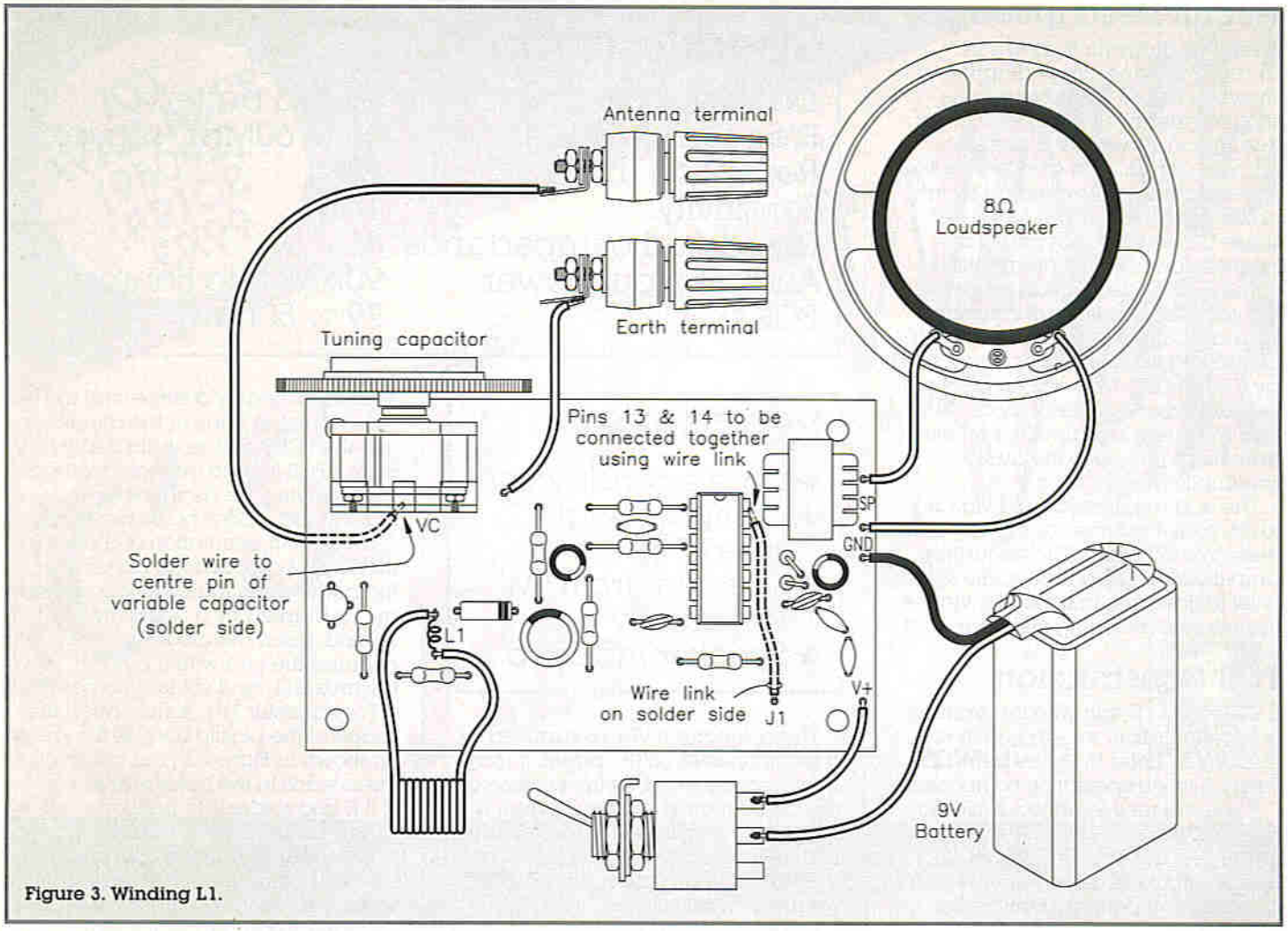


Figure 3. Winding L1.

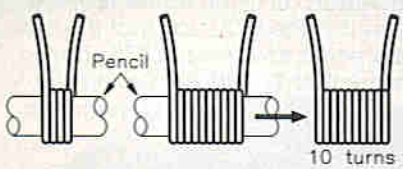
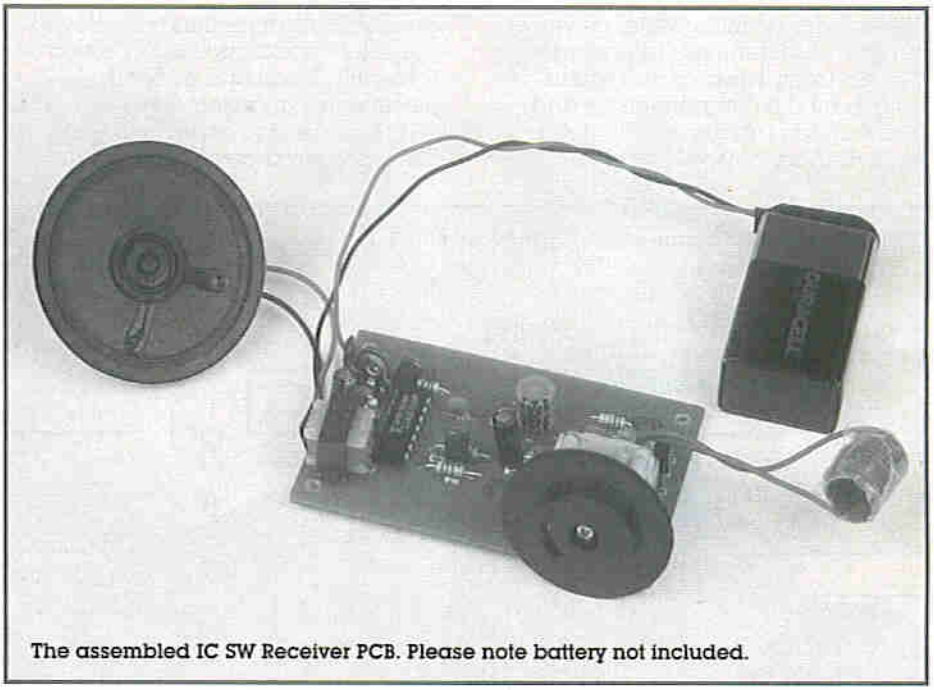


Figure 4. Winding Diagram.



The assembled IC SW Receiver PCB. Please note battery not included.

Locate and fit the tuning capacitor VC1 with the short shaft facing outwards. Trim off any excess leads from the track side of the board.

Lastly, fit IC1. Note that this is a CMOS device and is susceptible to damage by static electricity, so handle with care and do not touch the pin-out leads more than is absolutely necessary. Note also that the IC must be orientated as shown in Figure 3, with the notch in the plastic package towards the top edge of the PCB.

Ensure that the IC remains flat on the PCB and that all pins pass though the board correctly. Be careful when soldering, as this IC can be damaged by excessive heat. Allow a short cooling period between soldering each pin.

Lastly, attach the thumbwheel tuning knob to the shaft of VC1 using the screw provided.

Winding the Coil

Preferably use insulated single-core wire (hook-up or 'bell' wire, see the Optional Parts List), construct L1 as follows:

Wind 10 to 12 turns of wire onto a temporary former of 4mm diameter (see Figure 4). When the former is removed, the wire should retain its shape. The coils can be mounted as shown in Figure 3, or it can stand-on-end on the PCB with a longer lead from the top reaching the second hole, which is neater.

To alter the tuning range you can experiment with varying the number of turns on the coil. By increasing these turns it is possible to receive signals at lower frequencies.

Wiring

The loudspeaker is connected to the pair of holes adjacent to T1 with wires of the length required. Connect the black wire of the battery connector to the antenna earth terminal, and then connect this point to the PCB 0V point as shown in Figure 3.

Connect the red wire of the battery connector to the supply point on the PCB via a suitable optional on/off switch. The aerial input connection

at the top left of the PCB is simply connected by a length of wire to an optional antenna terminal. If an antenna terminal is not used, a length of wire connected directly to the PCB will suffice.

The finished PCB may be installed into a suitable optional plastic case with space for the battery, on/off switch and antenna terminals.

Use

With the receiver PCB built and checked, it is now time to connect the external aerial and earth and fit a 9V battery.

The frequency and tuning range of the receiver will depend on how L1 has been constructed. Once signals are received it is possible to check these frequencies out against another shortwave receiver preferably with a digital display.

IC SW RECEIVER PARTS LIST

RESISTORS: All 1/4W 5% Metal Film (Unless stated)

RESISTORS		
R1	47K	1
R2	1K	1
R3	1M	1
R4a,b, R6a,b,7 R5	10M	5
4k7	1	
RV1	500k Vertical Preset	1

CAPACITORS		
C1	1nF Ceramic	1
C2	10pf Ceramic	1
C3,5	4n7f Polyester	2
C4,10	10µF 25V Electrolytic	2
C6,8	2n2F Polyester	2
C7,9	220pF Ceramic	2
C11	470µF 16V Electrolytic	1
CV1	60-160pF Tuning Capacitor	1

SEMICONDUCTORS		
D1	1N60/OA91 Germanium Diode	1
TR1	DS548	1
IC1	4007 CMOS IC	1

MISCELLANEOUS		
L1	Hook-up Wire (see text)	1
T1	1kΩ/8Ω Output Transformer	1
	8Ω 8W Loudspeaker	1
	Thumbwheel Tuning Knob	1
	PP3 Battery Clip	1
	PCB	1
	Connecting Wire	As Supplied
	Solder	As Supplied

OPTIONAL (Not in Kit)			
	Black Bell Wire (10M)	1 Pkt	(BL85G)
	PP3 9V Battery	1	(JY60Q)
	Miniature SPCO Toggle Switch	1	(FH00A)
	Earth Terminal Post	1	(FD69A)
	Aerial Terminal Post	1	(FD72P)

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

The above items (excluding Optional) are available in kit form only.

Order As 95092 (IC SW Receiver) Price £9.99

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

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1
PROJECT RATING

Earth Lift Box

KIT AVAILABLE (95093) PRICE £19.99

Earth loops are caused when two (or more) pieces of equipment connect a signal 0V to earth. Differing potentials on the 'Earth' connection at each mains outlet give rise to small currents that pass along the interconnecting cables – generally worsening as the distance between earth points increases. These currents manifest themselves as an annoying '50/100Hz hum' heard from the amplifier that just won't go away until you break the two earth connections (see typical example shown in Figure 1).

Designed by Tony Bricknell

Text by Tony Bricknell and Maurice Hunt

Specification

Case dimensions: 120 × 65 × 40mm

THE almost standard way of avoiding earth loop 'hums' is to disconnect the earth from the offending item (usually a power amplifier). This is a very dangerous practice to adopt as it leaves the equipment user with little or no protection against electric shock or 'fault' hazards!

Many pieces of rack equipment are designed for use without an earth conductor and many of those that do have an earth lead have a built-in ground lift, but there will always be one that gives you a problem. The solution is to break the DC path through the signal 0V lead, by either a 'ground lift' resistor of about 180° or, in more extreme cases, total disconnection of the signal 0V (as the signal 0V connection is being made by both the signal lead and the mains earth, disconnection of one leaves only one signal path and so eliminates the earth loop 'hum'). In extreme cases, you may have to isolate the chassis of the offending effects unit from the metal frame of the rack.

The Earth Lift Box is fitted with a three-position switch: the position marked 'Direct' hardwires the earth of the input to the earth of the output. With the switch in the position marked 'Float', the earth of the input is totally disconnected from the earth of the output. This is a common method of avoiding buzzes and hums caused by earthing problems. The third position of the switch is marked 'Lift' and, in fact, connects the earth of the input to the earth of the output through a low value resistor and AC 'bypass' capacitor.

Circuit Description

Figure 2 shows the circuit diagram of the Earth Lift Box. As can be seen, it is extremely simple, consisting only of half a dozen passive components.

The assembled PCB.

APPLICATIONS

- ★ Electronic musical instrument and amplifier setups
- ★ Stage PA and recording
- ★ Safe eradication of earth hum loops

FEATURES

- ★ Removes annoying 'hum' from PA set-ups
- ★ Enables two 'Earthed' audio products to be connected
- ★ Compact, rugged casing
- ★ Easy to build and use
- ★ Configurable for stereo/ multi-channel systems

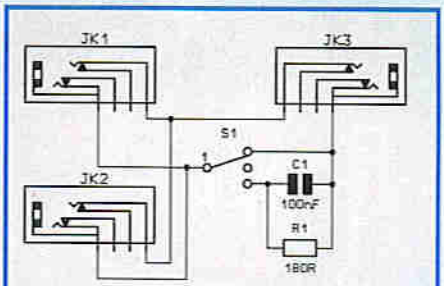
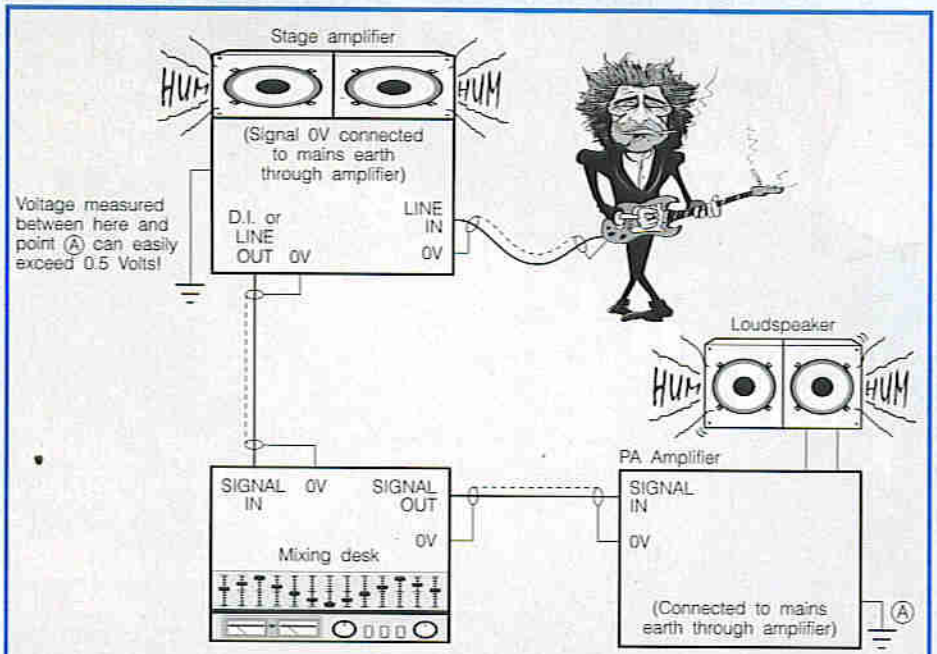


Figure 2. Circuit diagram of the Earth Lift Box.

JK1 is the audio signal 'input' to the Earth Lift Box. A 'link' output is provided at JK2 – this is simply wired directly across JK1. The signal input at JK1 is directly connected to the signal output at JK3. However, the 'screen' of JK1 is connected to JK3 through switch S1, as follows:

S1 Position	JK1/2 to JK3 Screen connection
Direct	Directly linked
Float	100% isolated
Lift	Connected through a 180Ω resistor in parallel with a 100nF capacitor

In the 'Direct' position, the 0V audio connection is made from input to output. This position is only provided for testing purposes, as it would not break an earth loop. In the 'Float' position, the 0V connection of the input and output are totally disconnected – this is the 'last ditch attempt' position and should only be selected if the 'Lift' position does not work. In the 'Lift' position, the 0V *audio* connection from input to output is made through the 100nF capacitor (providing an AC bypass to the 180Ω resistor). However, the DC path is blocked by the resistor, providing just enough resistance to 'uncouple' the input and output at DC.



Due to resistance of the earth wiring between each mains socket, the two ⏚ earth connections are not at *exactly* the same potential, resulting in current flowing down the 'screen' of the audio connections.

Figure 1. How earth loops are formed.

PCB Construction

Refer to Figure 3, showing the PCB legend and track. First, fit the resistor and capacitor – either way around will do, as they are not polarised. Next, fit the toggle switch, followed by the three jack sockets – install them as close to the board as possible. And that's it as far as PCB assembly is concerned – waiting for the soldering iron to heat up will probably be the longest part of the assembly process! Check for solder bridges, whiskers or dry joints. Finally, clean excess flux off the board using a suitable solvent.

Case Construction

A pre-drilled die-cast box is supplied in the kit, and is also available separately – see Parts List. However, if you wish to drill your own box (undrilled box available as Stock Code LH71N), refer to the drilling diagram shown in Figure 4.

Fit the assembled board into the box as shown in Figure 5, remembering to place the washers between each jack socket and the inside wall of the casing. Don't overtighten the plastic nuts, else they will crack. Fit the lid on using the four screws supplied, wipe the box clean, then apply the label depicted in Figure 6, or a photocopy of it, covered in Fablon or similar.

Note that there is room for two assembled boards, fitted to opposite sides of the specified casing, if you wish to build a twin-channel Earth Lift Box for a stereo system. In this case, another assembled board is required (see Optional parts list), and both sides of the box will need to be drilled in accordance with Figure 4 (or only one side if you are using the pre-drilled box). Additionally, an extra label will be required.

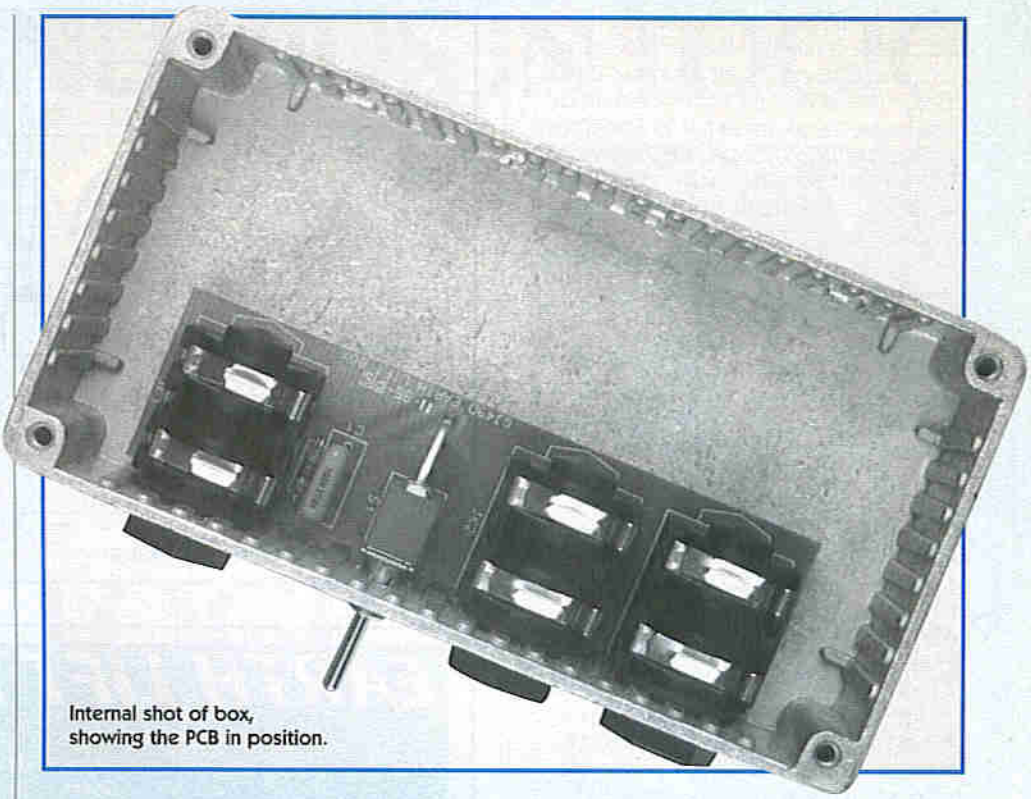
Testing and Use

Due to the simplicity of the project, the only testing necessary is to plug the unit into a problematical amplifier setup, as described below, and see if it successfully eradicates the earth loop hum.

Once you have set up and turned on all the equipment for your performance/rehearsal, etc., if you are suffering from the 'Earth Loop Hum' blues, then there are two ways of determining what is causing the problem:

i. One by one, unplug each item of equipment from the mains. If the hum is still present when an item is unplugged, plug it back in and continue on your quest. Once you have determined which item is providing the unwanted 'earth' connection, you can proceed to step ii, knowing that the Earth Lift Box requires insertion in the audio output from this piece of equipment.

ii. One by one, disconnect each audio connecting cable until the hum stops. The last cable disconnected is the one that requires the Earth Lift Box inserted in line.



Internal shot of box, showing the PCB in position.

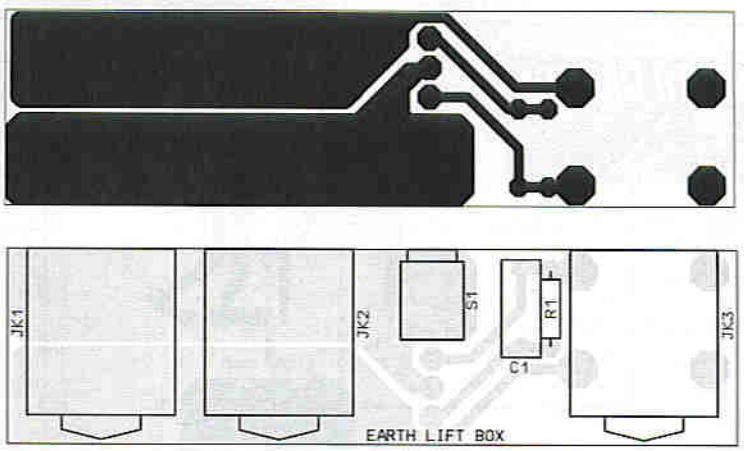
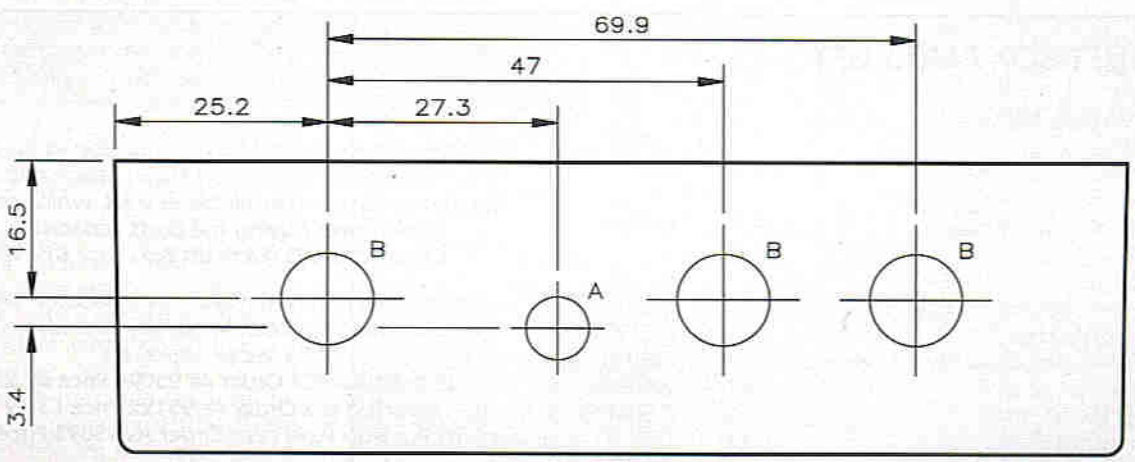


Figure 3. PCB legend and track.

Figure 4. Box drilling details.

HOLE DATA		
A	ø7.5	1
B	ø11	3

ALL DIMENSIONS IN MILLIMETRES



Insert the Earth Lift Box in series with the audio cable connecting the two offending items, and ensure the switch is in the 'Direct' position. If all is well, the hum should still be there. Move the switch to the 'Lift' position (this is the preferred position as it still gives a 0V signal path along the audio cable). If the hum does not disappear with the switch in this position, try the 'Float' position. If this position does not work, then it is not this cable causing the problem. Go directly back to step ii. Do not pass go, do not collect £200.

In practice, your signal source would be plugged in to JK1, with a local connection made from JK2 to your amplifier. JK3 would then be connected to the mixing desk (or whatever piece of equipment is causing the problem), see Figure 7 for two typical but *slightly* different wiring arrangements.

In *exceptional* circumstances, improved results may be obtained by increasing the value of R1 to around 220-270Ω, but for most applications, the 180Ω resistor should be ideal; if the resistance value is reduced from 180Ω, there will be an increased likelihood of problems with hum reaching the amplifier.

Note that for complex earthed set-ups, several Earth Lift Boxes may be required to break the earth connections; if you have a setup with multiple amplifiers, use an Earth Lift Box on the input connection to each amplifier.

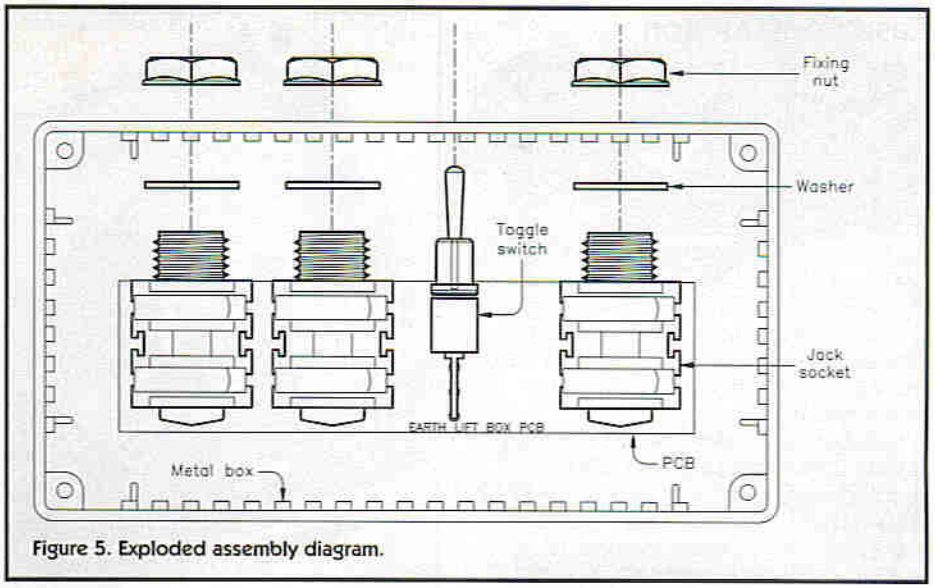


Figure 5. Exploded assembly diagram.

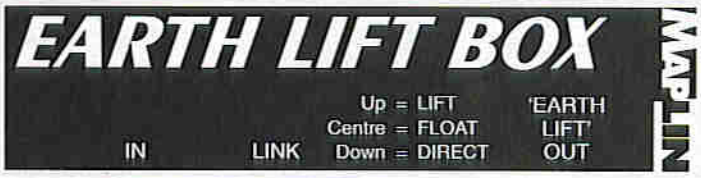


Figure 6. Front Panel Label.

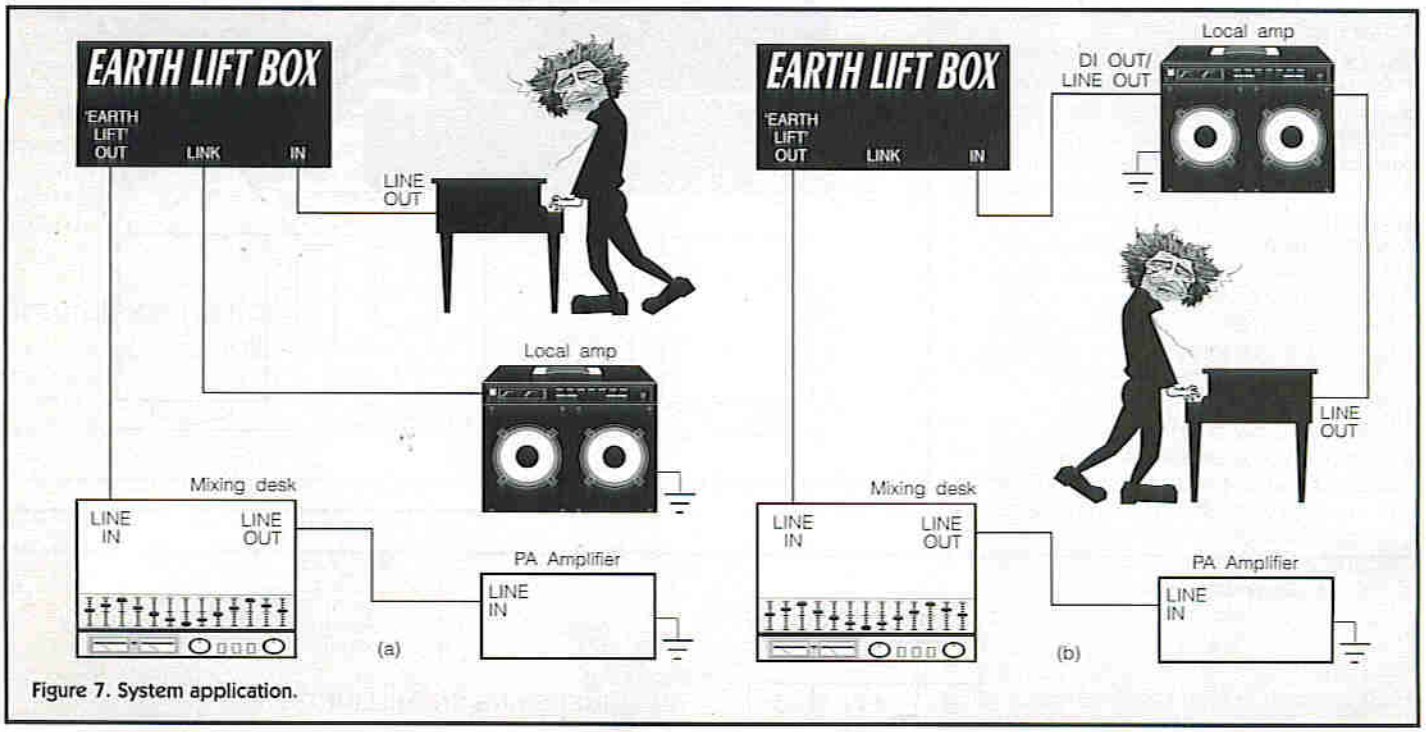


Figure 7. System application.

EARTH LIFT BOX PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1	180Ω	1	(M180R)
CAPACITORS			
C1	100nF Polyester Layer	1	(BX76H)
MISCELLANEOUS			
JK1-3	PCB-mounting ¼in. Mono Jack Socket	3	(FJ00A)
	Pre-drilled Box	1	(95122)
S1	Right-angled Toggle Switch Centre Off	1	(KE93B)
	PCB	1	(95094)
	Front Panel Label	1	(95095)
	Instruction Leaflet	1	(XZ17T)
	Constructors' Guide	1	(XH79L)

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

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

Order As 95093 (Earth Lift Box) Price £19.99

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

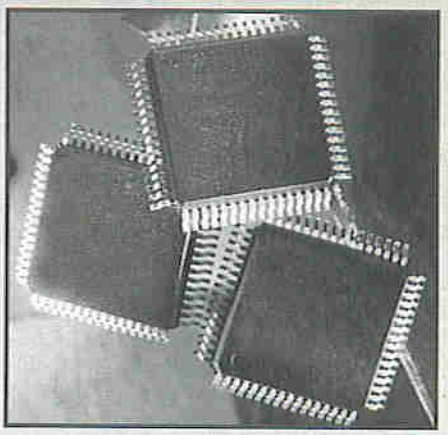
Earth Lift Box PCB **Order As 95094 Price £2.29**

Pre-drilled Box **Order As 95122 Price £3.99**

Earth Lift Box Front Panel Label **Order As 95095 Price £3.99**

NEW STANDARDS IN LOGIC

3·3 VOLT LOGIC ARRIVES



It may not be long before 5V is no longer the main standard supply for logic devices. Since the 1960s, when the first TTL logic family was introduced, the standard supply voltage has been 5V. This was chosen because the breakdown voltage for multi-emitter inputs like those used on multi-input gates was 5·5V. As a result, virtually all logic families since then have adopted the 5V rail as standard.

by Ian Davidson

Now, a number of new developments are taking place, which have a major bearing on logic design and these are bringing about a total change in the choice of voltage rail is required.

In recent years, there has been an growing trend to increase the levels of integration for each chip. The latest processors are far more complicated than their predecessors, and they run much faster as well. To achieve this, it has been necessary to reduce the size of the structures and components within the integrated circuits. A few years ago, two and three micron processes represented the latest in technology. Now, most manufacturers are using 0·5 or 0·6μm processes and looking towards introducing 0·3 or 0·4μm in the next year or so.

This reduction in size has meant that the field strengths within the semiconductors are reaching levels where the gate oxide is nearing breakdown if the 5V standard is retained. This would lead to a short circuit of the transistor, and device failure. To overcome this, a reduction in supply voltage is needed.

A further demand is being placed upon device manufacturers as a result of the increased use of battery powered equipment. Cellular phones, laptop computers and a host of other pieces of electrical equipment are now commonplace. With the vast markets that are opening up, competition is fierce, and manufacturers have to ensure that their products can meet the customers' expectations. One major requirement is a long battery life, and accordingly, any actions which can be made to improve this have to be taken on board.

A further advantage is that a reduction in voltage reduces the amount of heat which is generated. One of the main problems which manufacturers encounter is that heat removal from within a chip becomes more of a problem as the size of the chip increases. As more circuits are piled onto a single chip, so the power consumption rises. In view of the very small size of the actual chip, heat removal can be very difficult, and it is one of the factors limiting further levels of integration. By reducing the supply voltage, large savings in heat consumption can be made because the power generated is proportional to the square of the voltage. Reducing the supply from 5 to 3·3V reduces the power consumption by more than half.

Even now, many existing dynamic RAMs use 3·3V for their internal circuitry, only converting to a 5V standard at the output. If a low internal voltage was not used, the heat generated would be too large to allow the current levels of integration. Similarly, most of the static RAMs of 16M-bit and larger are being designed to operate on the 3·3V standard, and in the near future, lower standards may be used.

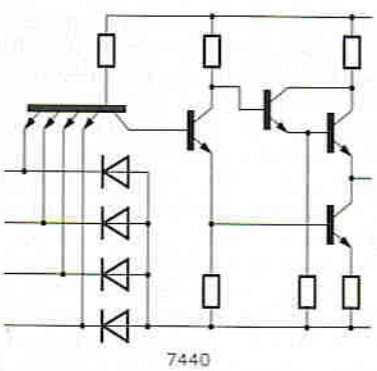


Figure 1. Multi-emitter input stage used in a logic IC.

Progress

Migration to 3·3V logic will take place over a number of years because of the limited number of devices available. DRAMs were the first devices to use the new low voltage standard, followed shortly by SRAMs. Most of the standard low voltage logic devices are available, as are some processors.

Not all the very popular microprocessors are available yet, although most manufacturers have plans to convert the modern families to the standard. Other devices, including liquid crystal displays, A-to-D and D-to-A converters, and disk drives still need to be made available in the new standard. Until then, it will still be necessary to covert between standards.

Why 3·3V?

There are a number of reasons for the choice of the 3·3V standard. Many of them are associated with the battery voltages which are likely to be encountered in portable equipment.

Family	Manufacturer(s)	Supply Voltage (V)	Output Current Capability (mA)	5V Equivalent family	Comments
LV-HCMOS	Philips	1·2 to 3·6	±6	74HC	Inputs cannot be driven by 5V logic.
LV	Texas	2·7 to 3·6	±8	74HC	5V tolerant inputs?
LVX	Motorola, Nat. Semi., Toshiba	2·7 to 3·6	±4	74HC	LVX is faster than LV, 5V tolerant inputs.
LVQ	Nat. Semi., Toshiba	2·7 to 3·6	±12	74HC	Not advised to drive inputs from 5V logic.
LVC	Philips, Texas	2·7 to 3·6	±24	74AC	–
LCX	Motorola, Nat. Semi., Toshiba	2·7 to 3·6	±24	74AC	5V tolerant inputs
ALVC	Philips, Texas	2·7 to 3·6	±24	74AC	Not tolerant to 5V input.
LVT	Philips, Texas, Motorola, Nat. Semi.	2·7 to 3·6	+64/-32	74ABT	High output, very fast. 5V tolerant inputs.

Table 1. Low voltage logic families.

A problem arises because battery voltages can vary quite considerably, according to the type of battery being used. In the first instance, two dry cells produce about 3V when they are fully charged, falling to around 2·7V after some use. This governs the lower end of the operating band, as many small palmtop computers use these cells. It is important that the ICs are characterised at these lower voltages, where performance can fall. Most important are the propagation times, which can rise significantly, and the output current capability can fall.

Secondly, the top end of the band is governed by the use of Ni-Cd cells. Three cells in series produce about 3·6V when charged, although the spread can range as high as 3·9V, especially just after the cells have been charged. However, the operating maximum is taken to be 3·6V, with the ICs being capable of withstanding 3·9V.

New Logic Families

The popular 5V logic series have been traditionally sourced by a large number of manufacturers. Unfortunately, the situation is not quite as clear cut with low voltage logic. Motorola and National Semiconductor have an agreement, as do Philips and Texas Instruments. This means that there are two main sets of families, each addressing similar fields, but both slightly different. Even then, Philips and Texas have slightly different characteristics for their 3·3V versions of the 74HCXX family. Fortunately, it is likely that in most cases, the chips from different manufacturers will be interchangeable without too much risk.

Although these are the major players, there are a few other manufacturers. Toshiba have second sourced some of the Motorola and National Semiconductor devices. A few other companies, including IDT, Pericom, Quality Semi and Cypress are making 3·3V devices, although they are not generally manufacturing the main line series. Many of them are voltage translators for interfacing to other families and voltage levels or other specialised functions.

Surprisingly, Harris, a major manufacturer of 5V logic, has not entered this market yet. However, with the acceptance of the 3·3V standard becoming more widespread, it is likely that they will start manufacture in the future.

Types Available

In the past, there has been a vast variety of functions available, from the simple NAND and NOR gates, right through to more complicated functions like bus transceivers. The new 3·3V series covers a far more limited range. Manufacturers are concentrating on the high volume products, and it is expected that many of the functions which were previously required as stand-alone chips will now be incorporated in microprocessors or within application specific ICs (ASICs). As a result, there are only about a quarter of the types available in the 74LV range that were available in the 74HC range. This means that designers will have to be more flexible in the ways they operate. It may also be necessary to use the odd 74HC device in the circuit.

Fortunately, this is possible. 74HC devices are specified to operate over the range 2·0 to 6·0V. However, there is a major penalty to be paid when operating them at the these low voltages. The propagation delay through the device increases significantly, and the output current capability falls. Both parameters depend upon the actual conditions of operation, but there can be a very significant fall in performance, so it is necessary to be careful when designing these chips to work at the lower voltages.

Faster Speeds

At the moment, many people are converting to low voltage logic and using the 74LV and 74LVX families. These are ideal because they are a low-cost option, and virtually an equivalent of the familiar 5V family.

Technology is moving on, and speeds are increasing. Many equipment manufacturers need speeds equivalent to the best being offered at 5V. Reducing the structure sizes in the chips enables speeds to be increased even though the voltages are lower.

It is likely that the faster ranges will be more popular in the future, especially with computer and other high volume manufacturers. In view of this, National Semiconductor look to the 74LCX range as being their flagship for the next few years. For anyone requiring faster speeds, families like the LVT range can be used. Even faster is the 74ALVC and 74HLL range. This is produced by Philips on a 0·6µm process and it is faster than any of their 5V families, proving the improvements which can be made by using smaller architectures.

Interfacing

In the near future, it should be possible to build a complete system using 3·3V logic. However, for the next year or so, designers will find that there is a need to interface between the two standards. This is most inconvenient, because it could require additional translator chips. These increase the amount of board space required to build a circuit, as well as the cost.

This could have been a major problem in the acceptance of the new low voltage standard. Accordingly, many of the low voltage devices can interface directly to the old 5V standard, although interfacing to CMOS is a problem in view of the input voltages which are required to ensure a logic '1' is seen on the input. Figure 1 shows a multi-emitter input stage used in a typical logic IC.

As the low voltage logic families have CMOS outputs, they are able to switch to within a small amount of the rail, and as such, they are able to reach the TTL standard 2·4V required for a logic '1'. Interfacing the other way is not so easy. It requires that the inputs of the chips can withstand 5V. In some cases, the input circuitry is protected against electrostatic discharge (ESD) and this interferes with the ability to accept the 5V input. In some cases, the circuits are designed for direct interfacing in both directions, as shown in Table 1.

Where it is not possible to interface directly between two standards, there is a range of translators which can be used to perform this function. Many of these are octal devices intended for bus operation.

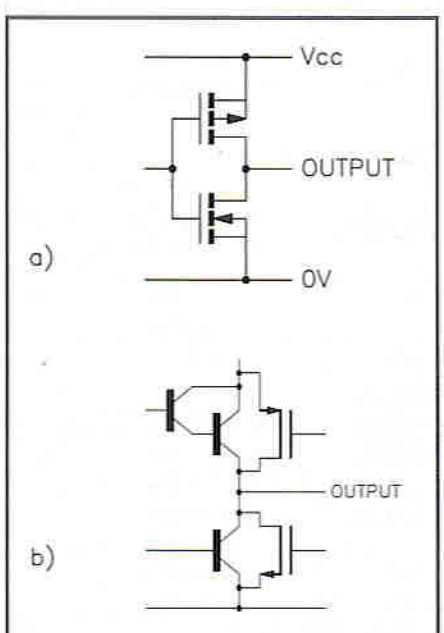


Figure 2. Output stages for low voltage logic.

Voltage Levels

The voltage levels required for the two logic levels are well-known for the 5V families. These had to be redefined for the 3·3V families. Across the families, 0·8V is accepted as the standard to guarantee a logic '0'. For a logic '1', the voltage on the input must be at least 2·0V. If voltage rails are used outside the standard 2·7 to 3·3V, then these limits will vary. This is particularly true for some variants of the 74LV series, which can be used down to 1·2V when it would clearly be impossible to achieve a logic '1'.

The output stages in the different families vary, but all include FETs to ensure that the output voltages from the chips can switch very close to the rails. Like ordinary CMOS or HCMOS, the output is normally within a few hundred millivolts of the rail at their maximum output current, and much less if the current is low.

To achieve switching close to the rails, CMOS output stages like those shown in Figure 2a are used in many of the families. Where bipolar stages are required to give the additional speed as in the LVT family, auxiliary pull up and pull down FETs are used as Figure 2b.

Usage

Like all other logic families, basic design and layout rules must be obeyed if the required performance is to be maintained. As some of these families are very fast, these rules become even more important. Problems of crosstalk and ringing may appear if they are not obeyed. Also, the rise times on the waveforms may be slowed.

The first point to remember is that adequate supply decoupling must be provided. A power rail with little decoupling will have an AC impedance of around 100Ω. This means that any changes in the current required by the chip will reflect onto the supply rail. This will cause a drop or rise in the supply voltage, causing the rise and fall times to become elongated.

To reduce the impedance of the supply to transients, it is necessary to employ sufficient decoupling. It is recommended that each board should have a large value electrolytic capacitor in the region of 50 to 100µF. On top of this, each chip must have its own local decoupling. A value of 100nF is recommended for this.

Crosstalk can be greatly reduced by employing good layout techniques. If tracks are run alongside one another, this can be a recipe for

74LV	74LVX	74LVQ	74LVC	74LCX	74LVT
74LV00	74LVX00	74LVQ00	74LVC00	74LCX00	
74LV02	74LVX02	74LVQ02	74LVC02		
74LV04	74LVX04	74LVQ04	74LVC04	74LCX04	
			74LCX05		
74LV08	74LVX08	74LVQ08	74LVC08	74LCX08	
		74LVC10	74LCX10		
			74LCX11		
74LV14	74LVX14	74LVQ14	74LVC14	74LCX14	
74LV32	74LVX32	74LVQ32	74LVC32	74LCX32	
		74LVC38			
74LV74	74LVX74	74LVQ74	74LVC74	74LCX74	
74LV86	74LVX86	74LVQ86	74LVC86	74LCX86	
		74LVC112	74LCX112		
74LV125	74LVX125	74LVQ125	74LVC125	74LCX125	74LVT125
74LV138	74LVX138	74LVQ138	74LVC138	74LCX138	
74LV139					
	74LVQ151				
74LV157	74LVX157	74LVQ157	74LVC157	74LCX157	
74LV164					
74LV174	74LVX174	74LVQ174			
74LV240	74LVX240	74LVQ240	74LVC240	74LCX240	74LVT240
	74LVQ241	74LVC241			
74LV244	74LVX244	74LVQ244	74LVC244	74LCX244	74LVT244
74LV245	74LVX245	74LVQ245	74LVC245	74LCX245	74LVT245
		74LVC257	74LCX257		
74LV259					
74LV273	74LVX273	74LVQ273			74LVT273
74LV365					
74LV368					
74LV373	74LVX373	74LVQ373	74LVC373	74LCX373	
74LV374	74LVX374	74LVQ374	74LVC374	74LCX374	
		74LVC540	74LCX540		
74LV541			74LVC541	74LCX541	
		74LVC543	74LCX543	74LVT543	
74LV573	74LVX573	74LVQ573	74LVC573	74LCX573	74LVT573
74LV574			74LVC574	74LCX574	74LVT574
		74LVC620			
		74LVC623			
		74LVC640			
		74LVC646	74LCX646	74LVT646	
		74LVC648			
		74LVC651			
		74LVC652	74LCX652	74LVT652	
				74LVT2952	
74LV4051					
74LV4052					
74LV4053					
74LV4060					
74LV4066					
74LV4799					

Table 2. Low voltage device availability.

trouble. The capacitance between the lines as well as the mutual inductance will mean that any changes in one will be reflected into the other. To overcome this, lines should obviously not be run close together. However, in real life, it is often necessary to run lines parallel to one another. In cases like these, the two lines should be separated by a ground line to act as a screen between them.

Most boards these days have several layers. If possible, lines on two adjacent layers should be organised to run at right angles to one another. This will reduce the coupling between any two lines. Alternatively, it may be possible to separate the two by a ground layer in the board. Often, the ground and supply will be included in the board as two planes covering much of the board area.

Summary

The new range of 3·3V logic is set to become more commonplace as time progresses. They now form part of the impressive selection of different families of logic, ranging from the original TTL series through low power Schottky to the high-speed CMOS. In addition to these, there are a host of other families which are aimed at more specialised use. Originally, the Schottky series were used to give speed, whereas now designers might use 74ABT.

Sales of the new devices are increasing, and many new computers are already using them. However, for the home experimenter, they are unlikely to become as widespread as the old familiar types. As they are being aimed at the high volume users, they are only available in surface mount packages. Whilst this may appear to make things more difficult for the home user, it is a trend which will increase in the years to come. Table 2 shows the current availability (at the time of writing) of low voltage logic ICs.

One may ask how long will this standard last. 5V logic has been with us for over 30 years, but with the pressure to reduce the process sizes in IC manufacture and reduce power consumption, it is likely that lower voltage rails will be introduced in years to come. Manufacturers are already talking of logic operating at voltages of a volt or so. However, it takes several years for a standard to be accepted. 3·3V has gained this status, although many new ICs still need to be introduced before it can be used universally. In the meantime, it is unlikely that any new standards have any chance of being accepted. Accordingly, 3·3V logic will be here for several years to come. How many? Ten to fifteen? Well, that's anybody's guess!

Trafficmaster

In this article, Keith Brindley investigates one of traffic technology's cleverest uses – the Trafficmaster™ traffic data network.

THERE's no doubt about it – one of the greatest benefits the motor car has given us is freedom. Freedom to go where we want, when we want. In comfort and ease. Through bad weather, through good weather. It gets us to work, it gets us home again, it takes us on holidays and it does it all under our control. However, the freedom the motor car gives us sometimes comes at a cost – the cost being that every other car owner seems to be driving along the same road *we're* driving along, resulting in the all-too-familiar scene shown in Photo 1. Wouldn't it be nice if there was a system which would tell us whether the road ahead was clear? Wouldn't it be just great if we could check the route ahead was free from roadworks or other obstructions? Then we could sidestep the road blocks and get to our destination without standing in a queue for an interminable time.

Well, there is such a system, and I've been road-testing it for a while now. It's national, covering all the motorways and major roads throughout England, Scotland and Wales. You can tap into the system in several ways. The best way is with the Trafficmaster YQ, a dashboard-mounted device which holds an LCD display, on which traffic delays are indicated – see Photo 2. The YQ lets you zoom in on a specific section of the road network to isolate where delays are happening. Another way to access the network is with the Trafficmate, shown in Photo 3.

This is dashboard-mounted device too (see Photos 4 and 5), but doesn't feature a display. Instead, it warns you verbally of any delays you should expect on the road ahead.

Why Queue When There's YQ?

When you first turn the Trafficmaster YQ on, the display shows a map of the national motorway network – as Photo 6 shows. You move a cursor to the area you're interested in, then zoom in to the level you need. Traffic delays are indicated on-screen with a flashing flag, representing about two miles of congestion, showing average speed and direction of traffic. If there's no flag, traffic is flowing freely, so you can expect a clear journey. Controls on the Trafficmaster YQ are simple and easy to use. A central four-way 'quad' push-button key steps a boxed section around the map on the display. Once you locate the boxed section on the area of the country of interest, plus and minus buttons zoom the display in and out through national, to regional and local levels. The 'M' key allows you to access menus, based on icons on the display, covering pages for news and weather as well as personal messages, and facilities to mute the tone, and adjust contrast and backlight.

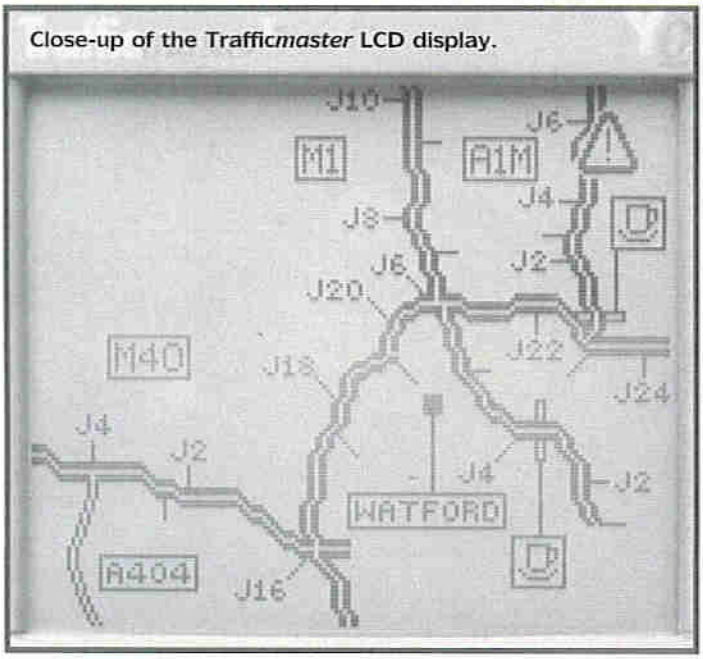
Finally, the standby button toggles the Trafficmaster YQ between on, standby, and off. In standby mode, signals about traffic nationwide are received and held in memory, but the display is turned off to conserve battery power. As a result, as soon as the Trafficmaster YQ is turned on again, the device displays up-to-date traffic information.

Personal messages are relayed to a driver's Trafficmaster YQ on the Vodapage paging network. Callers simply select an appropriate message from a choice of eight, together with 'phone numbers or other details. The Trafficmaster YQ, on receipt of the paged signal, alerts the driver that a message has been received, and with a

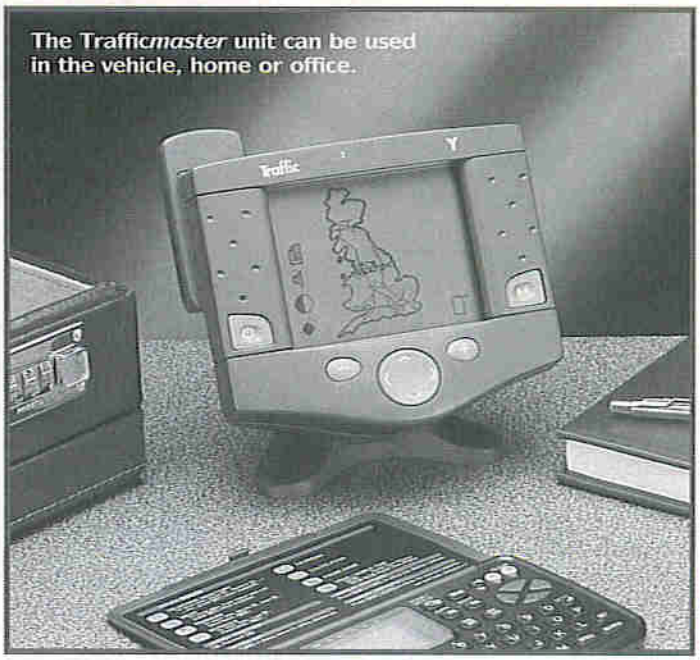
Trafficmate unit, with information key.

Trafficmate unit mounted on the vehicle dashboard.


Trafficmate in use on the motorway.



Close-up of the Traffic*master* LCD display.


The Traffic*master* unit can be used in the vehicle, home or office.

couple of button pushes, the message is displayed on-screen. This messaging service is free for the Traffic*master* YQ user, though callers pay a small charge.

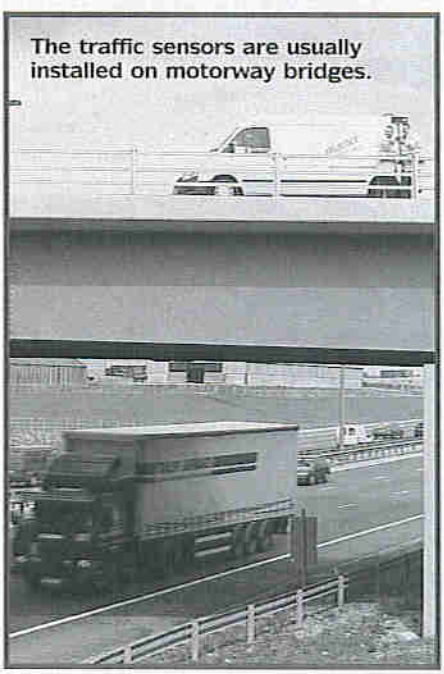
The Traffic*master* YQ is a neat device. It's elegantly styled and simple to operate, and won't look out of place on any dashboard. It is positioned in the car on a special mount, which is attached to the dashboard with strong adhesive pads. The mount can be fitted easily by a user. The Traffic*master* YQ itself clips easily in and out of the mount, so can be taken indoors at night, say, or carried into the office during the day – as Photo 7 suggests.

In-car power is obtained via a lead which plugs into the car's cigar lighter socket, but it's an easy enough job to wire it in permanently to the car's 12V circuit. Additionally, an internal Ni-Cd battery gives up to eight hours' use away from 12V power, if in standby mode, from full charge. An optional accessory is a desk-stand to hold the Traffic*master* YQ when away from the car, and this features a built-in mains-powered charger/power supply. Other accessories include an additional car mounting kit, a leather carrying case, and an additional dashboard adhesive pad kit.

How Do They Do That?

OK, we know the Traffic*master* system is clever, so now let's have a few technical details. It all starts outside on the motorways, where traffic sensors, such as that shown in Photo 8, are mounted on motorway bridges (see Photo 9), spaced approximately two miles apart. The actual distance apart depends, of course, on the availability of bridges. A network of some 2,400 bridge-mounted sensors contribute to the Traffic*master* network, and sensors are typically aimed at the central lane of traffic on the road. A pair of sensors are used to monitor traffic flow in each direction. They are connected to a microprocessor-controlled radio transmitter, which monitors signals from the sensors. Under free-flowing

Engineers with a traffic sensor.


The traffic sensors are usually installed on motorway bridges.

traffic conditions (when traffic is flowing at over 30mph), the system doesn't respond, but when traffic flow drops to below 30mph, things start to happen.

Traffic speed below the 30mph limit is transmitted by the receiver over the PAKNET radio network, and picked up at two locations countrywide (see Photo 10). From there, data is gathered and relayed to Traffic*master*'s central control over British Telecom's KiloStream data service. Central control, based at Traffic*master*'s National Traffic Data Centre in Milton Keynes (shown in Photo 11) monitors all incoming signals from around the country, and relays them via Vodapage to all Traffic*master* YQ devices.

Within the National Traffic Data Centre, monitoring of all signals is done on an automatic computer controlled basis, and turn around of data leaving the sensors when traffic speed falls below 30 mph, to being received by Traffic*master* YQ is no longer than three minutes. This means that information displayed by a Traffic*master* is always up-to-date.

Traffic*mate* Speaks for Itself

Like the Traffic*master* YQ, Traffic*mate* is a nationally operated system. Coverage isn't quite as wide as Trafficmaster currently, as indicated on the coverage map, but is being upgraded constantly.

Traffic*mate* operates in a slightly different, though not unconnected, way to Traffic*master*. While all traffic data is collected via the main Traffic*master* network of 2,400 sensors, and gathered at the Milton Keynes National Traffic Data Centre, using the same system, each Traffic*mate* gets its information directly from a radio transmitter located at each motorway junction, and ultimately, at bridges spaced at approximately two miles distance along each motorway. Currently, some 1,500 transmitters are in place, and more are being added in a rolling process.

Information from the National Traffic Data Centre is forwarded to the transmitters, which in turn, transmits the information. So far, the system is identical in principle to the Traffic*master* system, but here's the clever part. As a result of this localised transmitter approach, each Traffic*mate* device is able to 'speak' digitally processed information about traffic flow locally on a motorway, initially as the car approaches the motorway junction. At this time, Traffic*mate* doesn't know which direction the car will travel once on the motorway, so it only relays which motorway and junction is being approached, and whether delays can be expected in either direction. Of course, if there are severe delays in the direction the driver wants to go, the driver has the option not to join the motorway at all, instead taking a different route to the destination.

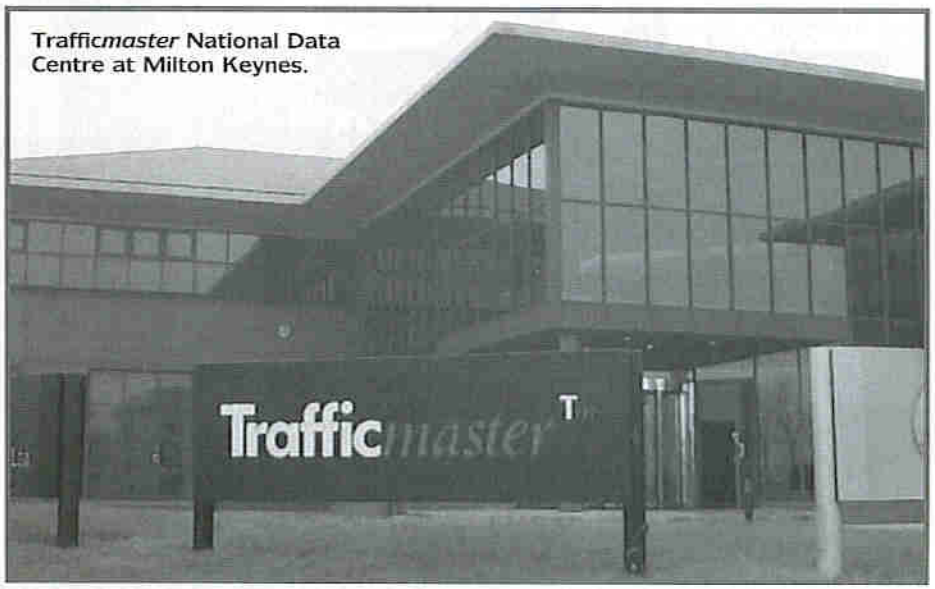
Once the car is on the motorway and is within the vicinity of a second transmitter, Traffic*mate* is able to calculate vehicle direction, so only gives information relating to traffic conditions in that direction, and covering the road ahead for approximately ten miles or two motorway junctions – whichever is the greater. Assuming that a driver wants to avoid a delay, this distance ensures sufficient warning to turn off a motorway before the delay is expected. An estimate of time the delay will add to the journey is also announced by Traffic*mate*, so drivers may choose to stay on the motorway if the expected delay is small in comparison with the likely time added if the car has to detour around the delay.

Unlike the Traffic*master* YQ, the Trafficmate is powered totally with an internal battery of four ordinary AA-sized cells. Good quality alkaline cells should give around three months of general use. A single control (operated by pushing the front lens) performs main functions – there is, however, a volume control on the side. Pressing the lens once turns Traffic*mate* on, whereupon it speaks (in a female, digitised, voice) to give any available traffic information. After this, Traffic*mate* speaks any further received traffic information automatically. You can toggle Traffic*mate* between this automatic mode and manual mode, by pushing the front lens twice within a period of two seconds. In manual mode, Traffic*mate* only speaks available traffic information when you push the lens. When left for more than thirty minutes and no traffic information is received, Traffic*mate* turns off automatically.

Both Traffic*master* YQ and Traffic*mate* use an information key – a smart-card type of arrangement – to enable them to receive information broadcast by Traffic*master*'s National Traffic Data Centre. Information keys can not be transferred between units and without a current information key, the devices are effectively rendered useless – a good theft deterrent. Traffic*master* YQ comes complete with an information key lasting one month. Traffic*mate* is supplied with a year's information key. Further keys can be bought from any Traffic*master* stockist, such as Maplin.

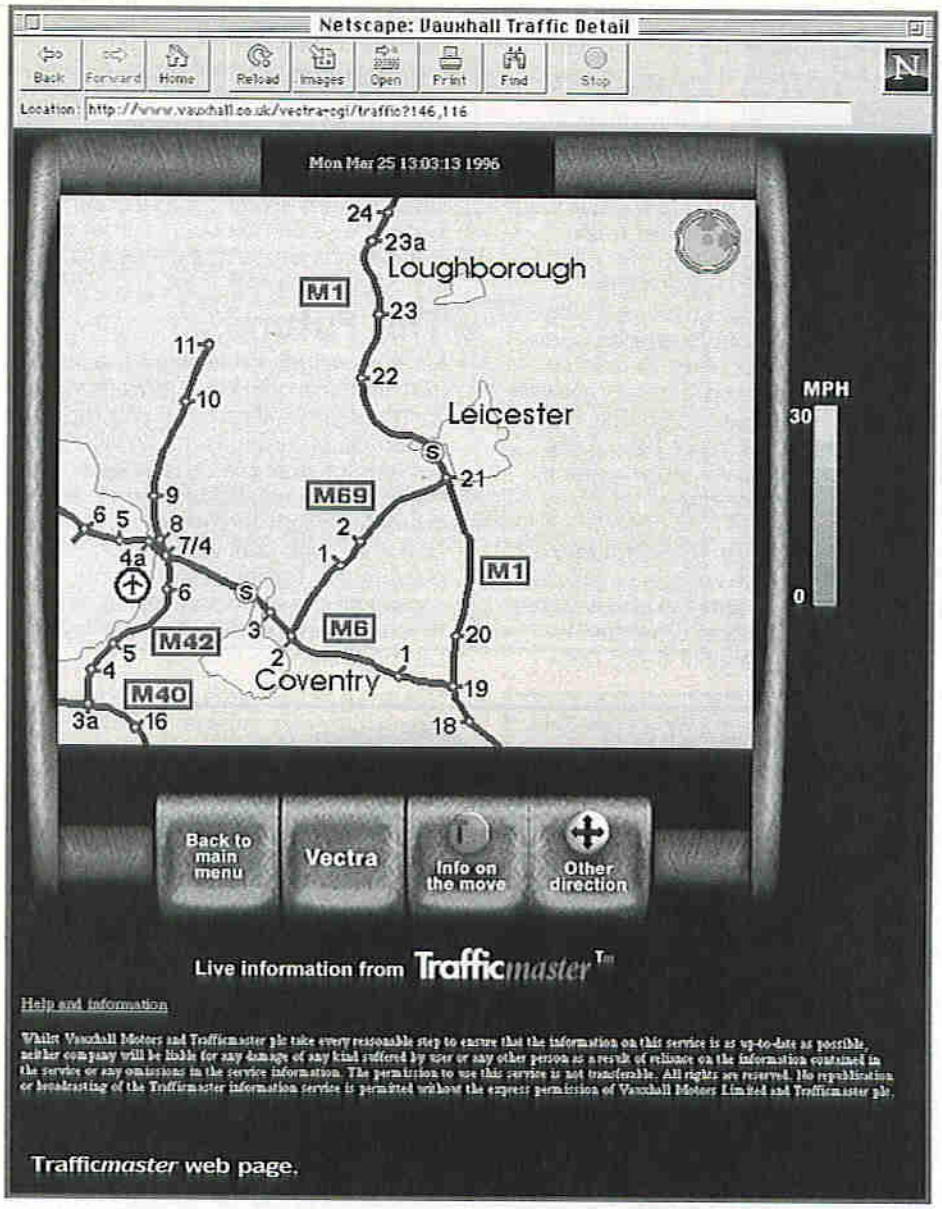
The Future

Far from resting on its laurels, apart from Traffic*master* YQ and Traffic*mate*, Traffic*master* is keen to extend the system to other areas. Its Monitor system, for example, is television-based and is intended for hotels and businesses, with the aim of providing customers and staff with an access point to the Traffic*master* network. By consulting the television display prior to journeying, possible traffic delays can be seen.



Traffic*master* National Data Centre at Milton Keynes.

Control room.



Trafficmaster web page.

Also, in a venture with the RAC and ITN, the Trafficmaster network is now available as an up-to-the-minute traffic information service to listeners of local and national radio stations. By tuning into stations using the service, listeners are able to hear the information about traffic delays as soon as it occurs.

Trafficmaster network information is available on the Internet now, too. In collaboration with Vauxhall Motors, a Traffic Information Service is on the Internet for anyone with Internet access to obtain. If you've got access, point your World Wide Web browser to **http://www.vauxhall.co.uk** and select the Trafficmaster information pages (see Photo 12).

If you use our major trunk roads and motorway network regularly, you will find the Trafficmaster network an advantage to tap into. Doing it with Trafficmate or Trafficmaster YQ ensures you get the information you need, when you need it – in your car, as you are driving. While you might consider the units (and their information keys) expensive, you have to bear in mind the savings you'll make in time, simply because you have the information at your fingertips. When time is money, the outlay of either of the devices (Trafficmate is £49.99 including a twelve month information key; Trafficmaster YQ is £149.99 including a one month information key) together with their running costs (a twelve month information key for Trafficmate costs £23.99; a six month information key for Trafficmaster YQ costs £59.99; a twelve month Trafficmaster YQ information key is £109.99), seems eminently worth it. This, apart from the savings in sheer frustration if you get stuck in a traffic jam without Trafficmaster!

WIN A TALKING SOLUTION TO TRAFFIC CONGESTION!

The average frequent driver spends five full days a year stuck in traffic jams on work-related journeys alone. Overall in the UK, 1·2 billion man hours are lost through traffic congestion. Trafficmaster plc, providers of continuous live traffic information, launched their latest in-car product in October last year. Trafficmate uses state-of-the-art speech technology to deliver audible messages on motoway congestion. Both Trafficmate and YQ give live traffic information, which is updated every three minutes from Trafficmaster's network of 2,400 sensors.

Trafficmate is priced at £49.99 and YQ is priced at £149.99, and can be bought from Maplin and Mondo stores. However, you have a chance to obtain one of these units free of charge!

How to enter

All you have to do to enter, is complete the coupon (right), correctly answering the four questions, or send your answers on a postcard or back of a sealed-down envelope. Entries must be received by 31st May 1996.

Please note that employees of Maplin Electronics, associated companies and family members are not eligible to enter. In addition, multiple entries will be disqualified. The prizes will be awarded to the first all-correct entries drawn. The Editor's decision will be final.

Trafficmaster has teamed up with *Electronics – The Maplin Magazine* to offer readers the chance to win 3 YQ units inclusive of 12 month information keys, and 7 Trafficmates. No purchase necessary.

Send your entry to: **Trafficmaster Competition, The Editor, *Electronics – The Maplin Magazine* P.O. Box 3, Rayleigh, Essex SS6 8LR.**

Trafficmaster Competition

ELECTRONICS The Maplin Magazine

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

1. How many man hours are lost annually in the UK due to traffic congestion?
- ☐ 24·5.
- ☐ 1·2 billion.
- ☐ 3·5 million.
- ☐ 5 days worth.

2. Trafficmate delivers information to the driver by means of:
- ☐ Audible messages.
- ☐ An LCD display.
- ☐ A printout.
- ☐ Interrupting the radio programme.

3. Who is the manufacturer of Trafficmate and YQ units?
- ☐ Birds Eye.
- ☐ Halfords.
- ☐ Trafficmaster.
- ☐ Maplin Electronics.

4. The Trafficmaster units provide information on:
- ☐ The price of a pint of milk.
- ☐ Your vehicle's fuel economy.
- ☐ Where to get the cheapest petrol.
- ☐ Traffic congestion.

Name _____ Daytime Tel. _____

Address _____

_____ Postcode _____

SOUND REINFORCEMENT SYSTEMS

The aim of this two-part article is not so much a comprehensive discussion of sound reinforcement systems but more a practical guide to setting up a sound system for your band, to enable you to get out gigging.

for Gigging Bands

Part 1

by Andrew Rimell MSc BEng AMIEE

In this article, we will only discuss enough technical content as is necessary to connect a system together; for a detailed technical description of professional audio systems, see the series 'A Guide to Professional Audio' by T. A. Wilkinson (Electronics, Issues 64 to 74).

The systems discussed here would be suitable for a venue holding up to about 250 people, whether it be a town/village hall, church or your local pub. The emphasis will be on getting practical systems working, and how to do this whilst spending as little as possible.

The aim of any sound reinforcement system is to enable the audience to hear parts of a performance they could not otherwise hear due to, say, voices being lost in a large room. It is also possible to adjust the relative volume levels during a performance, for example, to make a guitar the loudest instrument during a lead break, but then later blending it with the other instruments so that the vocals may be heard during the remainder of the song. The art of mixing is a skill to be developed, just like playing a musical instrument, but with correctly selected and set up equipment, it can be mastered. At best, the audiences' attention is completely taken up with the band and the sound engineer is unnoticed, at worst, the performance of the band is let down by poor equipment and bad mixing, and the audience are aware that things are not going well. In this article, we will pass on some of the tricks of the trade necessary to pass from the latter to the former.

First of all, we will describe the various pieces of equipment necessary and how to connect them together, then we will discuss the actual art of mixing sound itself.

Cables

The first area of equipment we will look at is cables. Good quality cables are essential to any sound system, since the cables are to the sound system what arteries and veins are to the body, and if one is faulty, the whole system will suffer. A look in any music shop will show that good quality leads are expensive, however, by using components found in the Maplin Catalogue, it is possible to make your own for a fraction of the price.

There are basically three types of wire used in audio systems:

- Unbalanced wire (single core and screen)
- Mains wire (2- and 3-core)
- Balanced wire (2-core and screen)

Mains Wiring

For mains wiring, three core must be used as it is essential that all equipment is earthed (there have been tragic cases of band members being killed because their equipment was not properly earthed); this applies to all mains cables, including extension leads. It also important to ensure that all mains cables have a suitable current rating for the equipment used, and the safe solution is to make all of your extension leads 13A rated. The total load connected to any 13A socket must not exceed 13A (about 3,600W), if it does, then spread the load evenly over a number of socket outlets.

Unbalanced Cables

An unbalanced signal cable would normally have a mono jack plug on each end, such as that used to connect a guitar to an amplifier.

Because any piece of wire can act as an aerial, it is necessary to use screened cable (otherwise the wire may pick up the signal from a nearby radio transmitter). Screened cable has a central core surrounded by a twisted wire braid (screen); the screen is the earth and the core carries the signal.

Balanced Cables

Balanced wire consists of two cores and a screen. This type of cable is usually terminated with a 3-pin XLR plug, as shown in Figure 1. A problem with long lengths of single core cable is that they pick up noise which is amplified as the signal is amplified. A common type of noise is 50Hz AC hum which is induced into the cable from nearby mains wiring. With a balanced line, both in-phase (hot) and out of phase (cold) signals are transmitted down the wire. As both hot and cold cores travel together, they both pick up the same noise. At the amplifier end, the out of phase signal (cold) is inverted and the two signals are added together. As the cold signal is transmitted out of phase, it is now in phase, and the noise is now out of phase. When the hot and cold signal are added together, the noise cancels out, as shown in Figure 2, which depicts signal balancing.

Balanced lines are used for microphones, since because of their low voltage, the signal needs to be amplified a lot and thus, it is important to have a minimum of noise. Balanced line microphones have a male XLR socket on the back, which accepts a female XLR plug. Amplifiers and mixers have a female XLR socket which accepts a male XLR plug and thus, an XLR to XLR balanced cable has a male plug on one end and a female on the other. It is important to keep noise to a minimum, by using balanced equipment wherever possible, and to keep unbalanced cables as short as possible.

Sometimes, it is necessary to connect a piece of balanced line equipment to an unbalanced input (although this should be avoided wherever possible), such as a microphone connected to an unbalanced microphone input on a mixer-amplifier. For this connection, a special cable needs to be made which has a 3-pin XLR connector on one end and a mono jack plug on the other. The standard wiring convention is shown in Table 1.

DI Boxes

As it is better to use unbalanced cables than balanced ones, all signal cables should ideally be balanced from the stage to the mixing desk. If the equipment on stage is a microphone, this is easy, as the output from the microphone is balanced, but what if the equipment is a keyboard which only has unbalanced jack outputs? The answer is to use a DI box. DI stands for Direct Injection, and it converts an unbalanced output from an instrument to a signal equivalent to that from a balanced microphone. DI boxes usually have an additional unbalanced output for running a backline combo-amp (so that keyboard players can hear themselves).

DI boxes cost from around £40 each, which can be a great expense for many people. One solution is to build your own, such as the Maplin kit (LU23A), or to hire them for a large concert, and to use line level signals for smaller concerts (as with most things quality has a price, but the difference in not using balanced lines may be small for small venues).

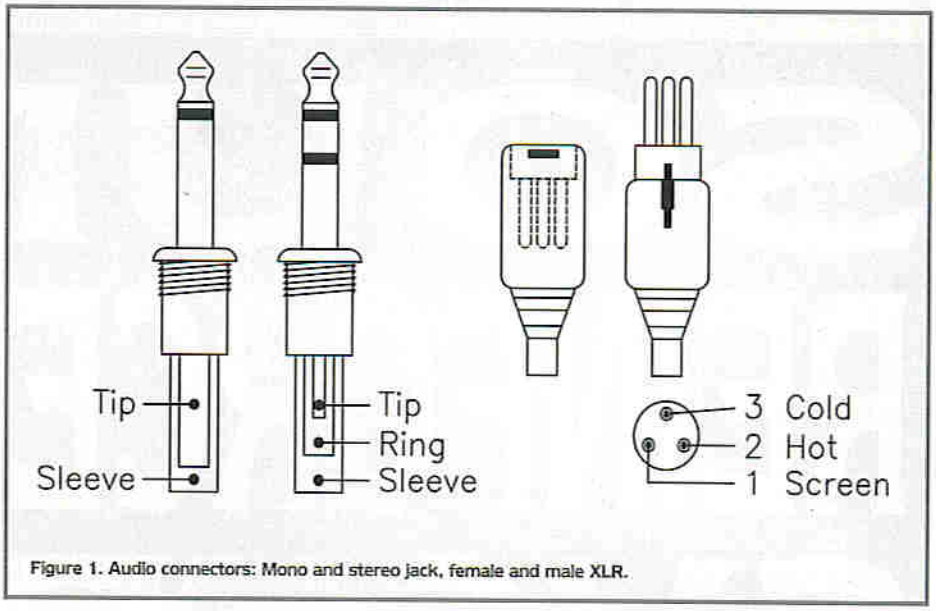


Figure 1. Audio connectors: Mono and stereo jack, female and male XLR.

Another common type of connector is the RCA/phono, as found on the back of Hi-Fi equipment. This connector is not at all robust, and should be avoided wherever possible, however, where it is used (such as with a tape deck/CD player), make some good quality phono-jack/XLR leads. Never use cheap phono connectors on your cables, as they are difficult to solder and are likely to break easily.

Speaker Leads

Speaker leads are of a different construction to signal cables, as they carry a higher current and as the signal will not be further amplified, noise induced is not a problem. Mains flex is ideal for speaker leads, but for long leads, a large cross-sectional area is recommended (e.g., 2·5mm^2), to keep the cable resistance low. The most common connectors used are the jack and the XLR, and it is important not to get the speaker leads mixed up with the signal leads, i.e. don't use speaker leads for signals or signal leads for speakers. A simple method of avoiding confusion is to use cable markers or use a distinct colour for the speaker cable or speaker connector. There are other speaker connectors in use, one of the newer ones is the Neutrik Speakon (Stock Codes CC72P and CC73Q) connector, which is a large plastic item not unlike a hosepipe

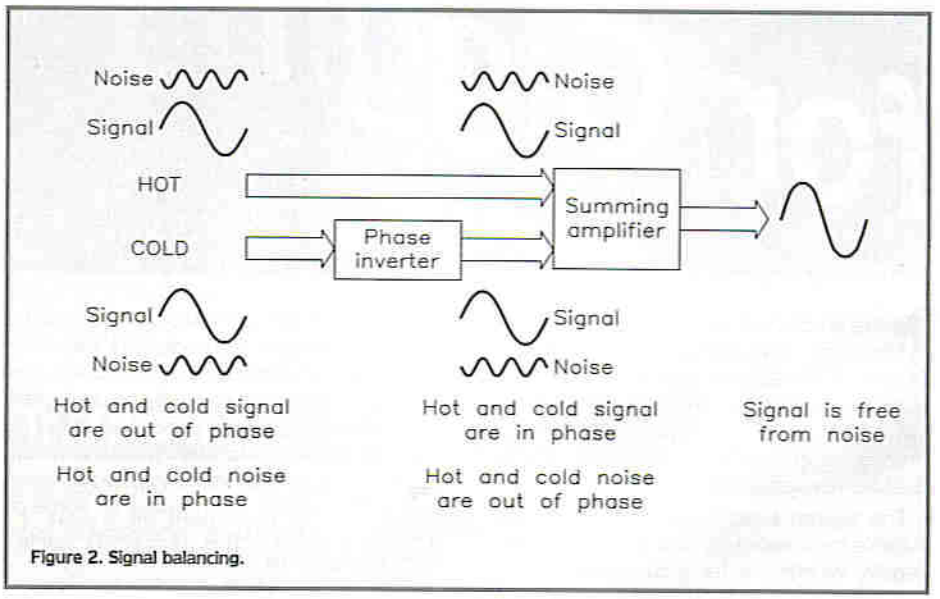


Figure 2. Signal balancing.

	XLR	2-pole jack	3-pole jack	Speaker XLR	Speaker jack
Hot	2		Tip		
Cold	3		Ring		
Screen/Earth	1	Sleeve	Sleeve	1	Sleeve
Signal		Tip		3	Tip
Not used				2	
Insert					
Send			Tip		
Return			Ring		
Screen			Sleeve		

Table 1. Standard wiring convention for different connectors.

connector. The speaker output of power amplifiers is usually a jack or an XLR. XLR connectors are better than jack, because they lock into position, avoiding being accidentally pulled out during a concert. In the future, power amplifiers will only have Speakon connectors on and so if you are about to invest in some speaker cables, it may be worthwhile planning ahead.

Multicore Cables

It is preferable to have the mixing desk towards the back of the audience and thus, it is necessary to take all of the microphone and instrument signals from the stage to the mixing desk. It is possible to have one cable for each item, but this is untidy and bulky for a large number of items, so a multicore cable is used. A multicore cable is basically a long extension lead for many signal cables, but each of the cores is inside one big cable with connectors on each end. Thus, there is only one cable from the stage to the back, which carries all of the signals to the mixing desk, and often carries the outputs from the mixing desk back to the amplifiers which are situated at the side of the stage.

Cable Management

As the cables are the lifeblood of any sound system, it is important to look after them properly. After each concert, coil them neatly and tape them up; this will stop them unwinding in storage and save you hours of untangling. Large plastic storage boxes are ideal for keeping your cables in.

When connecting up equipment, keep mains cables away from signal cables (at least 1m if possible) and where they do need to cross, do so at right angles; this simple precaution will help to reduce mains hum to a minimum. It pays to be neat when laying signal cables out on the stage floor. Put the coil of unused cable at the instrument end, not at the stagebox end (otherwise all of the spare cable will be by the stagebox and it will become tangled up). Being neat makes it easier to trace cables if problems occur later on.

On stage, use gaffer tape to tape down any cables that may get tripped over. Off stage, tape down all cables where the audience is free to walk. Avoid crossing main walkways and doorways, but if this cannot be avoided, then tape the cables down well, since an extra roll of gaffer tape is better than a member of the audience tripping over and breaking their leg! Car floor mats and pieces of carpet are also useful for placing over cables where they cross walkways.

Microphones

All microphones used should have low impedance balanced outputs (with a male XLR socket on the end), for the reasons discussed in the section on cables. Microphones come in many shapes and sizes, costing from a few pounds to a few thousand pounds. The important thing to bear in mind when selecting microphones, is that it is more flexible to have a selection of general-purpose microphones than specialist microphones.

Vocal Microphones

The main workhorse of the live vocal work is the Shure SM58 (Stock Code CY82D). This microphone is a high quality, rugged device that is used by bands and top performers from all over the world, and can often be seen in use on televised concerts. The SM58 is designed for vocal use and although not ideal, it can be used for miking up guitar amps (the Shure SM57 is designed for this purpose). By professional standards, the SM58 is a low-cost microphone, but for many bands, it may be too expensive to buy a set of, say, six in one go. There are many lower cost, similar-looking microphones around, but remember that you get what you pay for. A sensible compromise is to buy a SM58 for the lead vocals and cheaper microphones for other functions.

On/off Switch

A look in the microphone section of the Maplin Catalogue will show that the more expensive microphones do not have a built in on/off switch; this is to prevent the embarrassing situation when a performer is trying to sing into a microphone which is not turned on (it is the job of the sound engineer to switch off unwanted microphones, at the mixing desk). If you buy a dynamic microphone with a built-in on/off switch, it is a good idea to either solder a short circuit on to the switch or to glue the switch into the on position. If the microphone is not a dynamic type (e.g., a condenser microphone), then don't tamper with the switch, as you will continually drain the batteries.

It is quite common for a singer to be using a microphone, and for the XLR plug to fall out of the back of it, which is embarrassing for both the singer and the sound engineer. The simple method of preventing the plug falling out is to tape it to the microphone, being careful to avoid taping down the button, which releases the plug.

When a performer is moving or adjusting a microphone stand, the vibration causes the microphone to transmit a great amount of noise through the system. This is unprofessional and annoying for the audience. The solution is to turn off the microphone whenever the stand is being adjusted.

Guitars

As mentioned before, guitar combos can be miked up with a general-purpose microphone. Even though combos have a line output, it is better to use a microphone because the guitarist will have chosen a combo with a particular sound that they like and generally this characteristic will not be present in the line output signal.

Drums

To mike up a drum kit properly can at first appear more difficult than it really is. Whilst in theory, you should have special microphones for each drum, in practice, it is possible to do a good job with a few SM57s.

With four microphones, it is possible to cover a whole drum kit, and the recommended positions are:

1. Bass drum;
2. Snare drum;
3. Overhead microphone (hi-hat and Cymbals);
4. Overhead microphone (cymbals).

Naturally, more microphones means more mixer channels, so multicore channels are required and thus, the whole system expense escalates, so you may decide that for the size of venue you play, the drums are loud enough on their own. However, there comes a time where the venue is too large to have the drums unmicrophoned. For medium sized venues, it may only be necessary to microphone up certain drums (e.g., the snare), that would otherwise be lost.

Radio Microphones

A type of microphone which is now becoming affordable is the radio microphone. There is a wide variety available, ranging from cheap and nasty to very high end (and high price) professional.

There are basically two types of radio transmitters, single frequency and diversity. The single frequency types transmit the signal on a single frequency in the range 173·800 to 175·000MHz in FM format. The spacial diversity types have two receivers physically located at different positions on the stage and the unit switches between the two, selecting the strongest signal. The non-diversity format is cheaper and quite satisfactory for semi-pro use. As the transmitters are low power (100m range), no licence is necessary, however, transmitters should be DTI approved. The best bet is to stay with familiar brand names such as HW (which uses a Shure SM58 microphone transducer) or Shure (Stock Code MK52G).

It is also possible to have radio guitar pickups which give guitarists the freedom to roam around the stage, however, for most of the stages that you are likely to encounter, this facility may be a luxury rather than a necessity.

If the radio receiver is placed next to the mixing desk, then another channel on the multicore is freed for use elsewhere. With most radio microphone systems, it is possible to have five different frequencies operating simultaneously, and the actual frequencies are standardized as follows:

1. 173·800MHz
2. 174·100MHz
3. 174·500MHz
4. 174·800MHz
5. 175·000MHz

Other frequency ranges have also been reserved for radio microphones, but these require licences and are not practical for amateur bands.

Accessories

Each microphone will require a stand. A stand with a boom arm is the most adaptable, as it may be used for any application. Stands should be looked after if they are to have a long life, and should be transported in strong boxes or canvas bags. Microphone clips normally come with the microphone, but it is often necessary to buy thread adaptors to enable the clip to be connected to the stand. It is advisable to remove the clip when storing and transporting the stands as clips are easily broken and it is frustrating having good stands that cannot be used because of broken clips; keeping a supply of spare clips also helps.

Foam pop-shields help to remove the pop sound in vocals (when the letter 'P' is pronounced) and reduce the noise of wind when outside. As they only cost a few pence, it is worth having a few ready.

As microphones cost a lot of money, it is worth looking after them properly. One place that a microphone might get damaged is

Continued on page 38.

PASSIVE DIRECT INJECT BOX

Original design and text by Joe Fuller

Design update by Nigel Skeels

Revised text by Maurice Hunt

1 PROJECT RATING

FEATURES

- ★ Does not require a power source
- ★ Allows line-level signals to be fed into microphone-level inputs
- ★ Earth lift facility
- ★ Link output for easy connection
- ★ ¼in. jack input and XLR output
- ★ Rugged construction

APPLICATIONS

- ★ Stage PA and recording
- ★ Eliminating hum loops safely
- ★ Direct injecting keyboards and other electro-music equipment

This updated version of the Passive Direct Injection (DI) Box, which first appeared *Electronics*, Issue 67, now incorporates the addition of a 'phantom power' switch, which enables high output instruments to be connected into the microphone input of a mixer equipped with phantom power facilities, by dropping the voltage down to create a balanced line. Also new to this version is a PCB instead of 'bird nest' internal wiring (which helps reduce noise transmission), and detail improvements, including a rearranged layout of the sockets and a prepunched die-cast metal box.

Completed Passive DI Box in use.

KIT AVAILABLE (95099) PRICE £29.99

THE Passive DI Box unit is designed to withstand the rigours of on-stage use, and also to be convenient and simple to operate. The 'phantom power' switch is recessed into the casing, so as to prevent inadvertent switching while the unit is being used.

To the uninitiated, a direct inject box is simply an impedance/level matching unit that is designed to allow unbalanced line level signals to be fed into a low level balanced microphone input on a mixing desk. Wish to know more? Well, first of all, let's look at why someone would *want* to feed a line level signal into a microphone input.

Miking Up

The traditional way of picking up sound from an instrument, both for recording purposes (live on stage or in a studio) and providing PA at a concert, is to use a microphone. This technique can be applied to a diverse range of instruments, ranging from acoustic instruments (drums, guitar, saxophone, piano, etc.; to electro-music instruments) electric guitar, electronic keyboard and the like. In the case of the latter, where amplification is required, it is the amplified output from the *speaker cabinet* that is 'miked-up' instead of the actual instrument. Miking-up instruments, principally a simple technique, is in reality, quite an art.

Different instruments produce sounds of different loudness, timbre and frequency range; consequently, choosing the correct microphone for the job is a prerequisite in ensuring that the sound of the instrument is faithfully reproduced. It is not intended to discuss microphone techniques here; the reader is referred to Tim Wilkinson's excellent 'A Guide to Professional Audio' series, where such matters are discussed in greater depth.

Direct Inject (DI)

However, there is another technique for picking up sound from an instrument; if an instrument is of the electric/electronic variety, a direct connection can be made between the instrument and the mixing desk or recording equipment. This technique is known as Direct Inject (DI). Where cable lengths are short, the set up is simple (i.e. home recording) and the appropriate impedance/level input is available, all that is required is a screened cable with suitable connectors. Signals are usually unbalanced (signal and screen connection) and most of the time, everything is fine. However, where cable lengths are long, the set up complex or suitable inputs are not available, then a slightly different approach is required.

Hum Loops and Level Mismatch

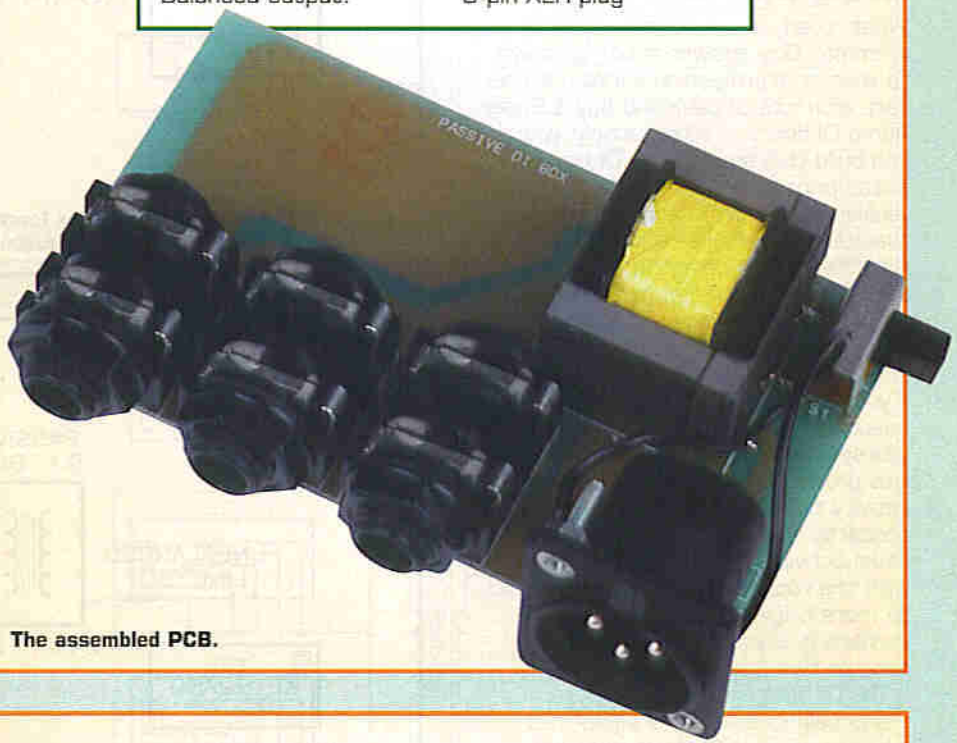
Any one, or all of the unfavourable combinations mentioned is more than just a little likely to introduce hum and noise. This is the scenario faced by musicians, roadies and PA crews involved in concerts (amateur and professional alike). Figures 1 and 2 show how hum can be introduced.

Long cables, *will* pick up hum and noise, especially when run anywhere in the vicinity of mains power cables.

Earth loops are another problem; at the risk of turning live performers into dead performers, earth wires on Class 1 mains powered equipment are all to frequently disconnected, in an attempt to solve the problem. This highly dangerous practice may solve the problem, but also exposes all concerned to the risk of electrocution should a fault develop. The way to stop hum loops is to break the loop in the signal path, and leave the mains earth wire firmly in place.

Specification

Maximum input signal:	+18dBu
Distortion:	<0·05% @ 1kHz
Frequency response:	10Hz to 20kHz ±0·5dB
Input impedance:	20kΩ
Output impedance:	600Ω
Case dimensions:	120 × 65 × 40mm
Input connectors:	¼in. mono jack socket
Link output:	¼in. mono jack socket
Balanced output:	3-pin XLR plug



The assembled PCB.

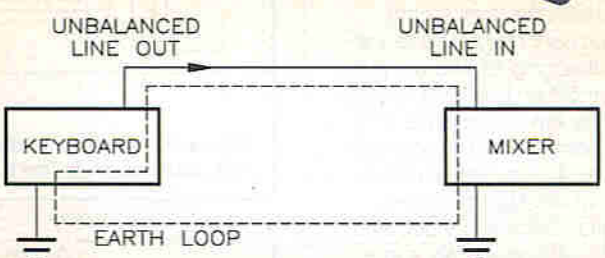


Figure 1. How an earth loop can be formed between two pieces of earthed equipment.

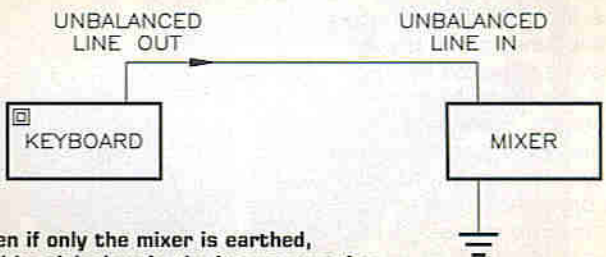


Figure 2. Even if only the mixer is earthed, hum may still be picked up in the interconnecting cable, especially if the cable is very long.

Many mixers intended for 'on the road' PA use are provided with microphone inputs only, often this is because more microphone inputs are required than line inputs and it is easier to convert a microphone input to a line input than vice versa. Microphone inputs are highly unsuitable for anything other than microphone level signals and feeding an electronic keyboard into such is likely to result in severe distortion.

Using a DI Box

What, then, is the solution to this dilemma? One answer is to pop down to your local professional music store, part with lots of cash and buy a Super Acme DI box. . . . Alternatively, you can build this smart little DI box for a less princely sum. A ready-made version of this project will also be available – details to be announced. Admittedly, this design is not state-of-the-art and you can get better performance from top-notch ready made units, but it works well, and is suited to most applications. After all, if you are a famous fabulously wealthy musician, you wouldn't be building it yourself would you? There again, building this project would provide a wholesome activity to help fill the time between concerts if one was tiring of the more usual activities commonly associated with the rock'n'roll lifestyle, and would be more original into the bargain – perhaps it would even inspire a song or two, you never know.

The DI box serves to translate the unbalanced line level signal into a balanced microphone level signal. The input is relatively high impedance – suitable for connecting to the output of a keyboard or other line level output, and the output is low impedance and suitable for connecting to a microphone input. The conversion is performed by a transformer, which also provides complete isolation between input and output (earth lift). However, in some situations, it is preferable to carry through the earth.

Figure 3 shows how the DI box is used to connect an earthed keyboard to a mixer – in this case, the earth lift is used to prevent a hum loop being formed. In Figure 4, where the keyboard is double-insulated (unearthed) better performance may be achieved by carrying through the earth from the mixer to the keyboard. There are no hard and fast rules here; the easiest way to find out is to try both ways, the one that works best is the one to use.

Sometimes it may be necessary to provide local on-stage amplification, some keyboard players prefer using their own 'combo', to hearing themselves through the foldback system only. I certainly do – on more than one occasion, an inexperienced operator adjusted the foldback mix during a song so I couldn't hear what I was playing, and it taught me to be self-sufficient. Some will disagree, but do whatever suits you best. The method of providing a split feed (link output) to both the mixer and an on-stage amplifier is shown in Figure 5.

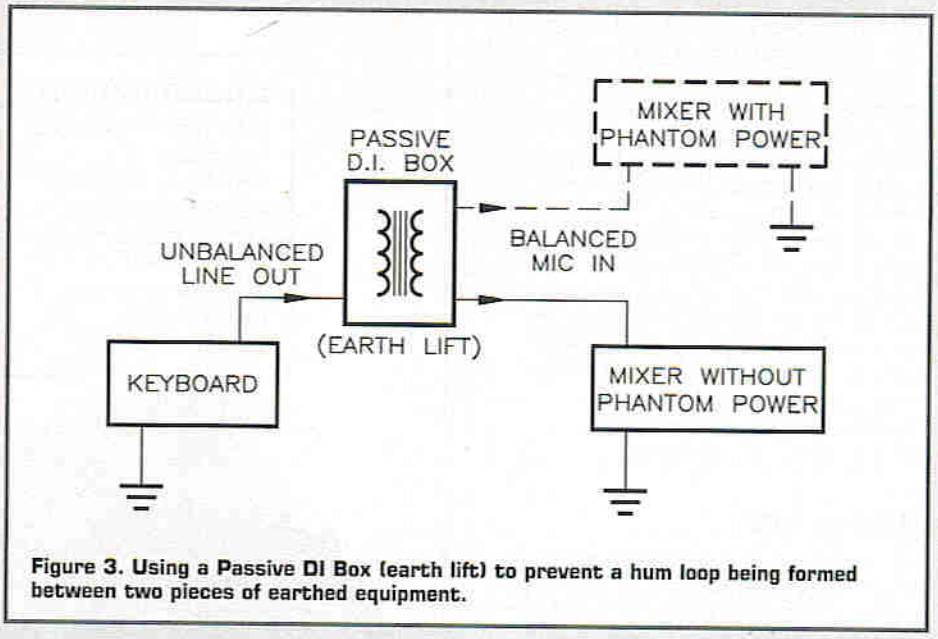


Figure 3. Using a Passive DI Box (earth lift) to prevent a hum loop being formed between two pieces of earthed equipment.

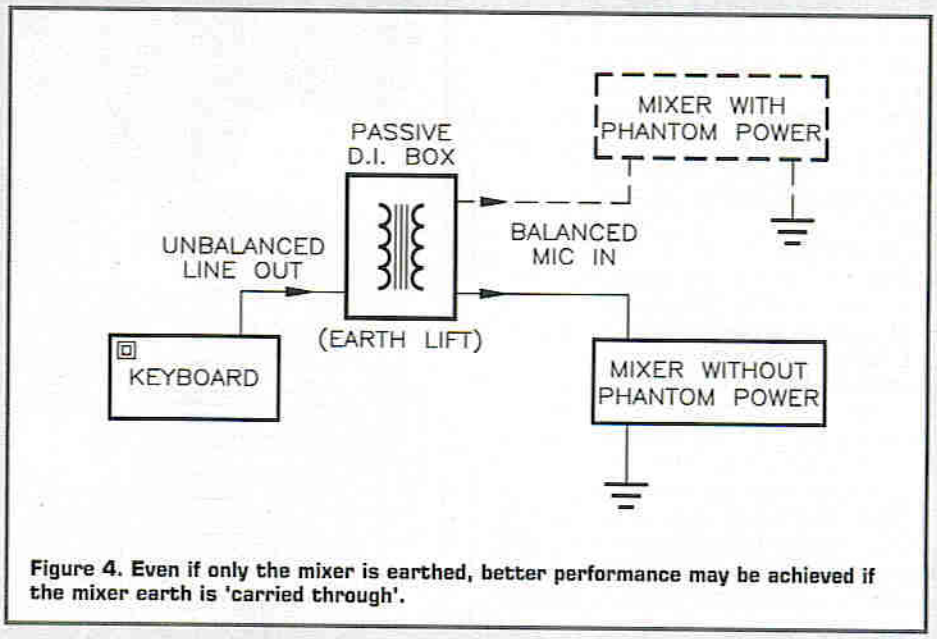
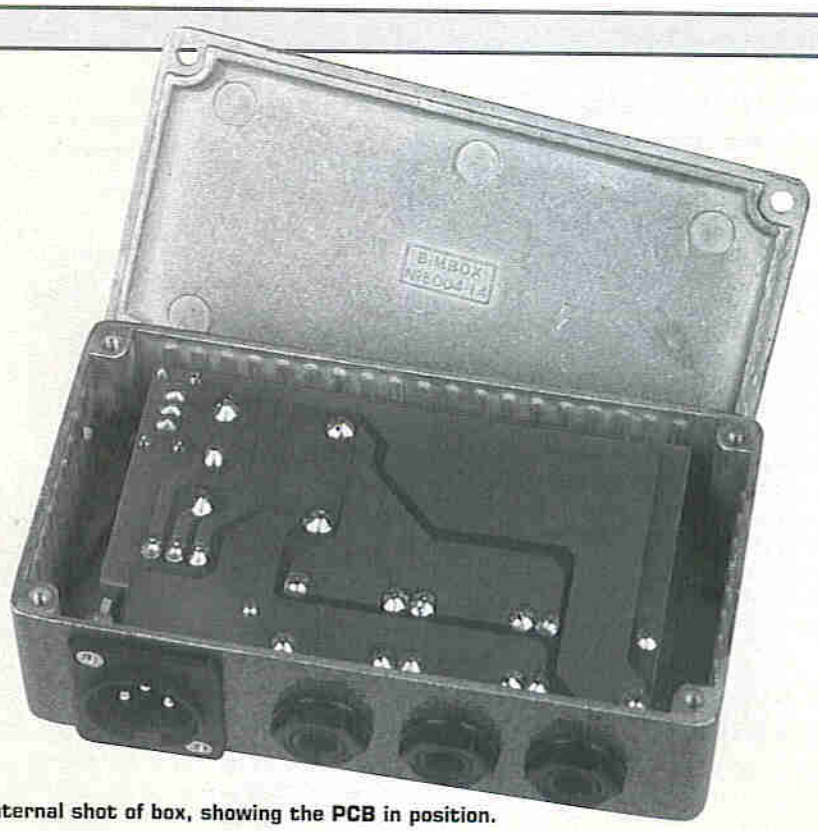


Figure 4. Even if only the mixer is earthed, better performance may be achieved if the mixer earth is 'carried through'.



Internal shot of box, showing the PCB in position.

Circuit Description

As can be seen from the circuit diagram shown in Figure 6, the design is straightforward with a minimal component count.

SK3 is the 'normal' input which provides earth carry through from input to output, as well as providing the signal path. SK1 is the 'earth lift' input; inserting a jack plug breaks the earth connection whilst still maintaining the signal path. SK2, the 'link output' is simply wired in parallel with the input sockets. The metal box, used for screening purposes and strength, is connected to the 'sleeve' contact of the jack sockets. Transformer T1 provides impedance and level matching; the centre tap of the transformer is connected to the screen pin of PL1 (pin 1) with the 'phantom power' switch in the ON position, and the ends of the secondary are connected to the in-phase and out-of-phase pins of PL1 (pins 2 & 3, respectively).

Construction Details

Refer to Figure 7, showing the PCB legend and track. The only parts to be fitted to the board at this stage are the three 1/4in. jack sockets, slide switch and the transformer – fit them as close to the board as possible.

A prepunched die-cast metal box is supplied in the kit, which does not require further drilling, therefore simplifying the assembly process. However, drilling details are provided in Figure 8 if you wish to produce your own casing – an undrilled die-cast box is available separately, Stock Code (LH71N).

Figure 9 shows the assembly and wiring of the DI box, which will be of assistance with the construction of the project.

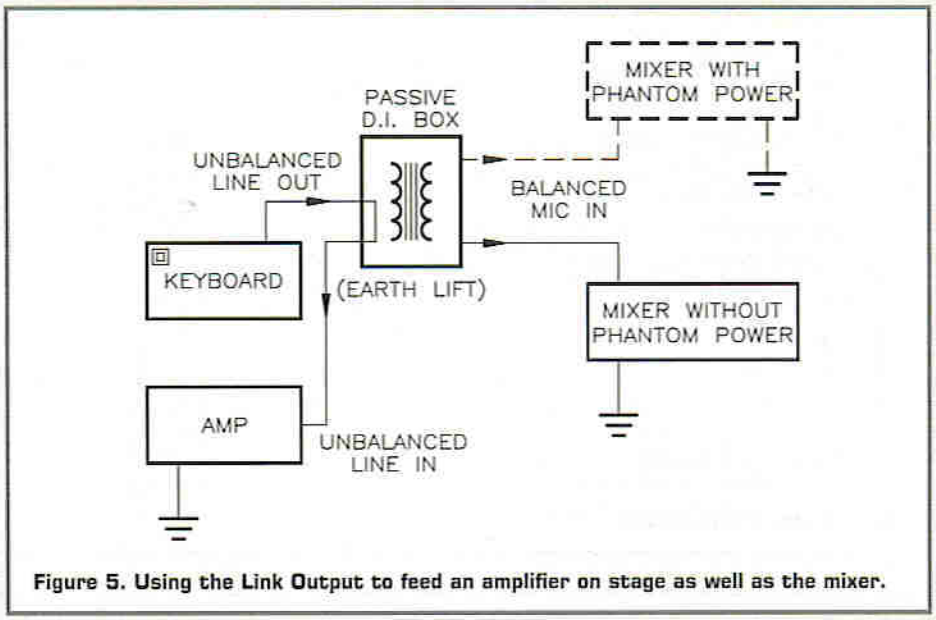
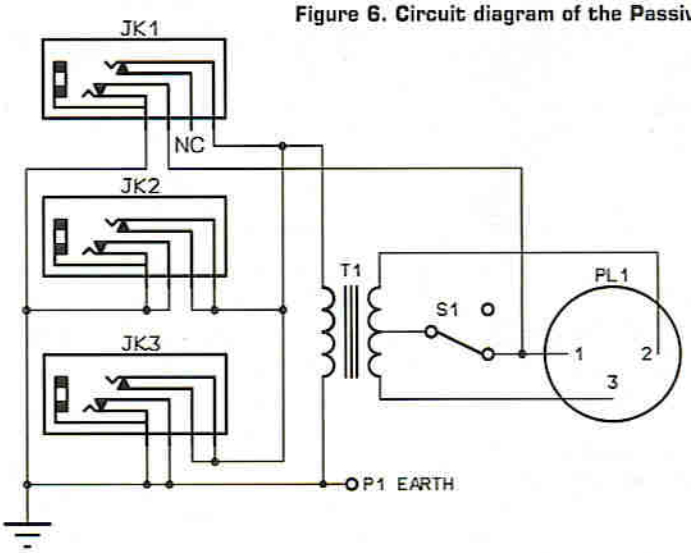


Figure 5. Using the Link Output to feed an amplifier on stage as well as the mixer.

Figure 6. Circuit diagram of the Passive DI Box.



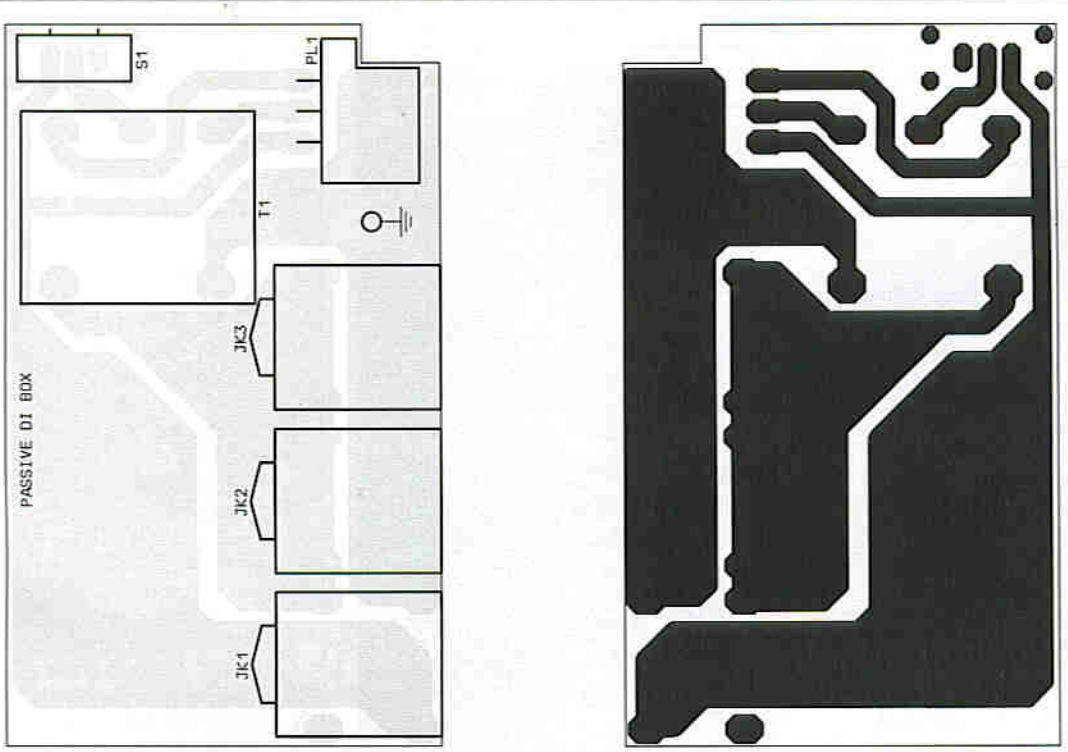


Figure 7. PCB legend and track.

Hole Data		
Ref	Size	No. Off
A	ø3.5	2
B	ø12	3
C	ø21.5	1

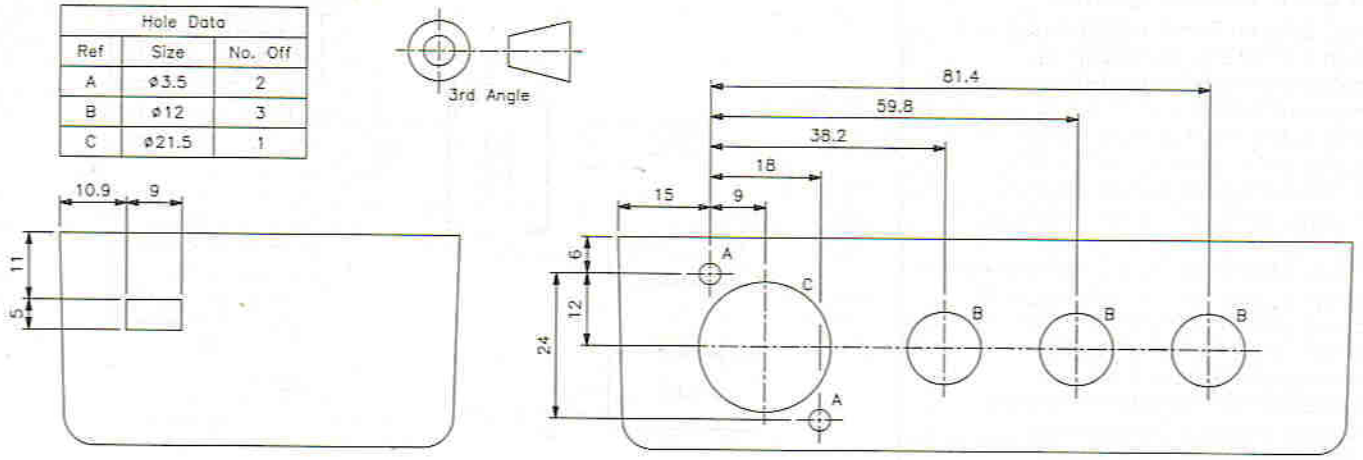


Figure 8. Box drilling details.

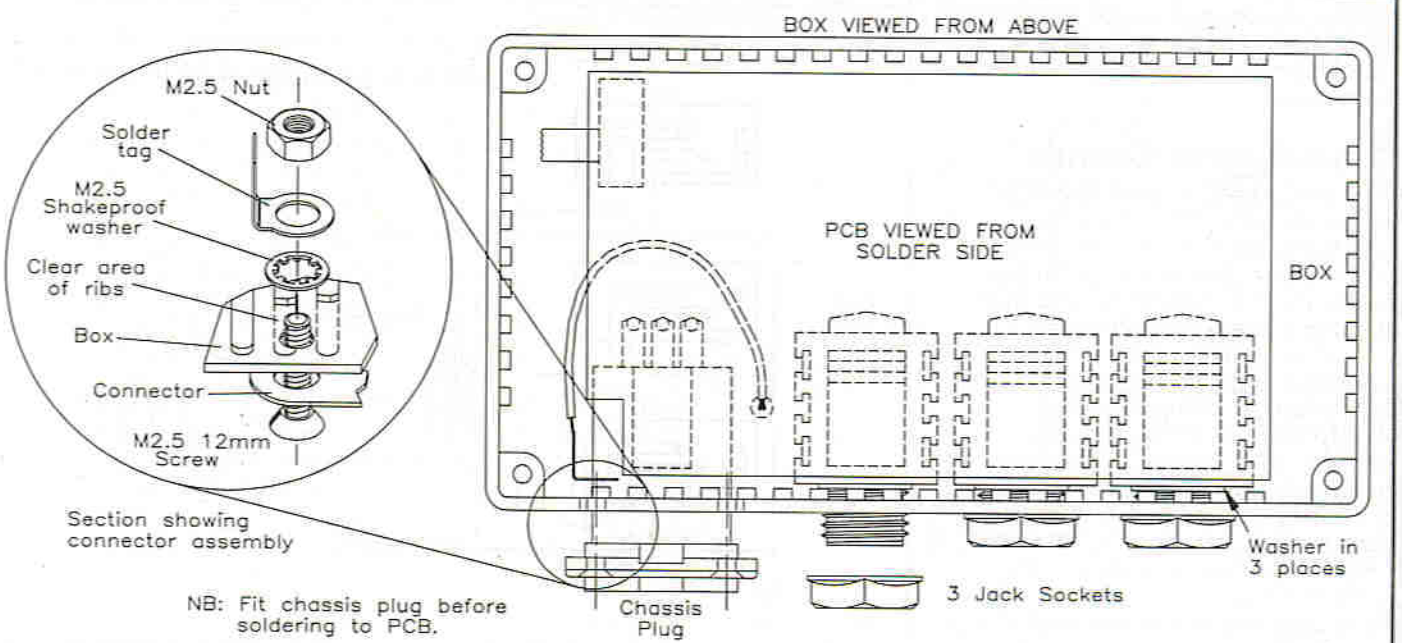


Figure 9. Assembly and wiring diagram.

It is necessary to fit the XLR socket into the casing and secure it in place using the two M2·5 bolts, nuts, and shakeproof washers, with the M2·5 solder tag on the uppermost screw, making sure that the terminals point upwards. Next, solder the earth lead between the PCB pin on the board and the solder tag. Now fit the PCB, track side facing upwards, into the box and onto the XLR socket terminals, ensuring that the slide switch is in alignment with its cut-out in the box. Fasten the nuts onto the jack socket threads (with a washer between each socket and the casing), and solder the terminals to the board. Take care to ensure this stage is done correctly, as the only way to get the PCB out again is to desolder the XLR socket. Check for solder bridges, whiskers and dry joints, then clean excess flux off the board using a suitable solvent. Finally, fit the lid onto the box with the four bolts provided.

Once all assembly and wiring is complete, wipe the box clean and apply the front panel label, as shown in Figure 10. The label, supplied in the kit, is available separately. Alternatively, the label can be photocopied (or even cut straight out of the magazine if you really must!), stuck onto the bottom of the DI Box and protected with clear self-adhesive plastic film, such as 'Fablon' (available from most DIY or good general stores).

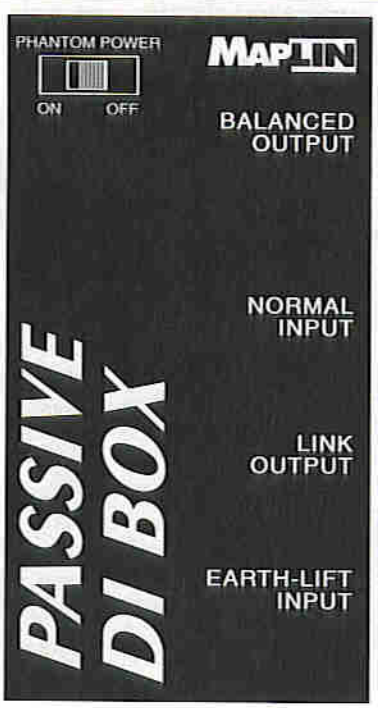


Figure 10. Label for the Passive DI Box.

Testing and Use

Simply connect the DI Box as shown in Figures 3 to 5, switch on the equipment and (hopefully), after a little experimentation for the best input to use, everything should work fine. It is unlikely that problems will be encountered, but if they are, a mistake in the assembly is the probable cause.

If the unit is being used in conjunction with a mixer that has the phantom power facility, the 'phantom power' switch should be moved to the ON position with the aid of a small flat-bladed screwdriver or similar, applied through the cut-out in the box. Otherwise, use the unit with the switch in the OFF position.

PASSIVE DIRECT INJECT BOX PARTS LIST

T1	Microphone Transformer 600Ω/20kΩ	1	(FD23A)
JK1,2,3	Mono PCB-mounting ¼in. Jack Socket	3	(FJ00A)
PL1	Low-cost XLR ACM-PC Socket	1	(KC56L)
S1	Right-angled SPDT Slide Switch	1	(FV01B)
	M2·5 × 12mm Pozi-drive Screw	1 Pkt	(BF40T)
	M2·5 Shakeproof Washer	1 Pkt	(BF45Y)
	M2·5 Solder Tag	1 Pkt	(LR65V)
	M2·5 Steel Nut	1 Pkt	(JD62S)
	1mm Single-ended PCB Pins	1 Pkt	(FL24B)
	16/0·2 10m Hook-up Wire, Black	10m	(FA26D)
	Predrilled Passive DI Metal Box	1	(DT22Y)
	PCB	1	(95100)
	Front Panel Label	1	(95101)
	Instruction Leaflet	1	(XZ13P)
	Constructors' Guide	1	(XH79L)

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

The above items are available in kit form only.

Order As 95099 (Passive DI Box) Price £29.99

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

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

Passive DI Box PCB **Order As 95100 Price £2.99**

Passive DI Box Front Panel Label **Order As 95101 Price £3.99**

when it is being transported. It is a good idea to keep your microphones in a hard carrying case, such as an ABS plastic or aluminium photographers' case.

Amplification

There are two main routes that may be taken with amplification:

- Mixer-amplifier system
- Power amplifier system

Refer to Figure 3, showing ways of linking amplifiers together.

Mixer-amplifier

A mixer-amplifier combines the functions of mixer and amplifier. It will generally have six inputs, each of which can be balanced low impedance or unbalanced high impedance. For each input, there will be a volume, treble, bass and reverb control (most units have a simple spring reverb unit built in). There will also be an overall volume, overall reverb and overall brightness control. The unit will have a speaker output (usually two in parallel), a line output and connectors for an effects loop. The control potentiometers are rotary, which makes live mixing rather difficult compared to the linear faders of a mixing desk/amplifier combination.

Mixer-amplifiers are often the first purchase for bands starting out, as a mixer-amp is considerably cheaper than a mixing desk and amplifier. The price paid is loss of controllability during the performance, and most mixer-amplifiers are mono. Having said that, the money saved could be used to buy other necessary pieces of equipment such as microphones, which would still be used later on when the upgrade was made. In fact, the mixer-amplifier would not become redundant either, as it makes an excellent foldback amplifier.

Power Amplifier

A power amplifier is used to amplify the mixed output from the mixing desk for powering the speakers. Power amplifiers for sound reinforcement applications differ from Hi-Fi amplifiers in a number of ways; they are rated at a higher power rating (typically 300 to 400W per channel into a 4Ω load), they are built into sturdy 19in. rack-mounted steel cases, the input connectors are XLR or jack and the output connectors are XLR or Speakon. As discussed earlier, in the future, most power amplifiers will have Speakon connectors. There are often two connectors

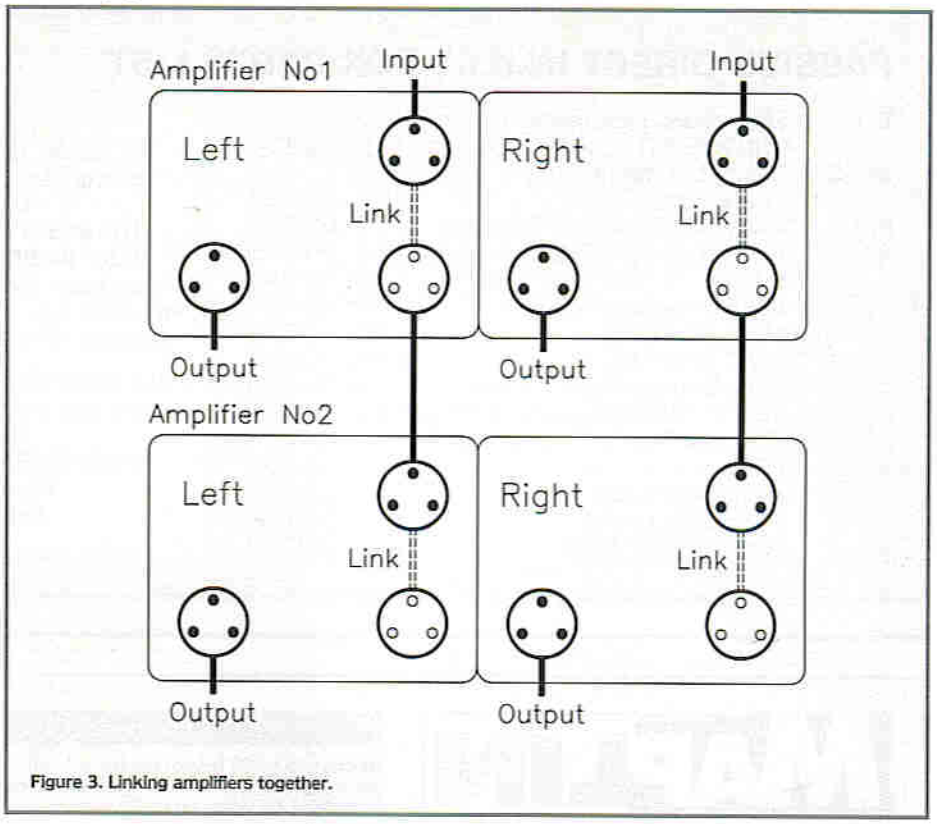


Figure 3. Linking amplifiers together.

on the input, enabling you to 'chain' together amplifiers for more power output (NEVER connect the output of one amplifier to the input of another).

As described in the section on loudspeakers, an active system is sometimes employed which separates the signal into two parts: high and low frequencies, each being fed into separate power amplifiers and then separate loudspeakers, thus using four power amplifier channels and four speakers for a two-way system: Left low, right low, left high and right high.

A power amplifier will often have VU meters on the front showing the gain in dB, where 0dB is the maximum calibrated gain. Driving the amplifier over the 0dB point will cause distortion, therefore, it is better to have a high power amplifier running below its full rated power than a lower power amplifier running flat out. Having too small an amplifier will cause the signal to clip, causing annoying high frequency distortion.

Selection

When selecting a power amplifier, look for the following characteristics:

- Power rating: Look for a suitable power rating for your application. A good starting point may be a 2-channel (stereo) 400W per channel into 4Ω. Two standard 8Ω speakers connected together in parallel give a 4Ω load.
- Bandwidth: Look for a bandwidth in excess of that of the human hearing (20Hz to 20kHz). In practice, all good quality amplifiers meet this requirement.
- Slew rate: Slew rate is a measure of how quickly the output of the amplifier responds to a change in the input. A typical value is 60V/s.
- Signal-to-noise ratio (SNR): Look for a high signal-to-noise ratio. The signal-to-noise ratio of a CD recording is 96dB, so any value in this region will be fine.
- Construction: The amplifier should be well made, with a sturdy steel enclosure and good carrying handles. The connectors should be protected so that they cannot get broken off if the amplifier is stood on them.

Amplifiers are expensive pieces of equipment, and so it pays to buy one that will last for years. Next month, Part 2 will cover mixing desks and mixing, loudspeakers, effects units, and hints on typical setups, touring and hiring of equipment for gigging.

12 Twelve great reasons to get ELECTRONICS under cover

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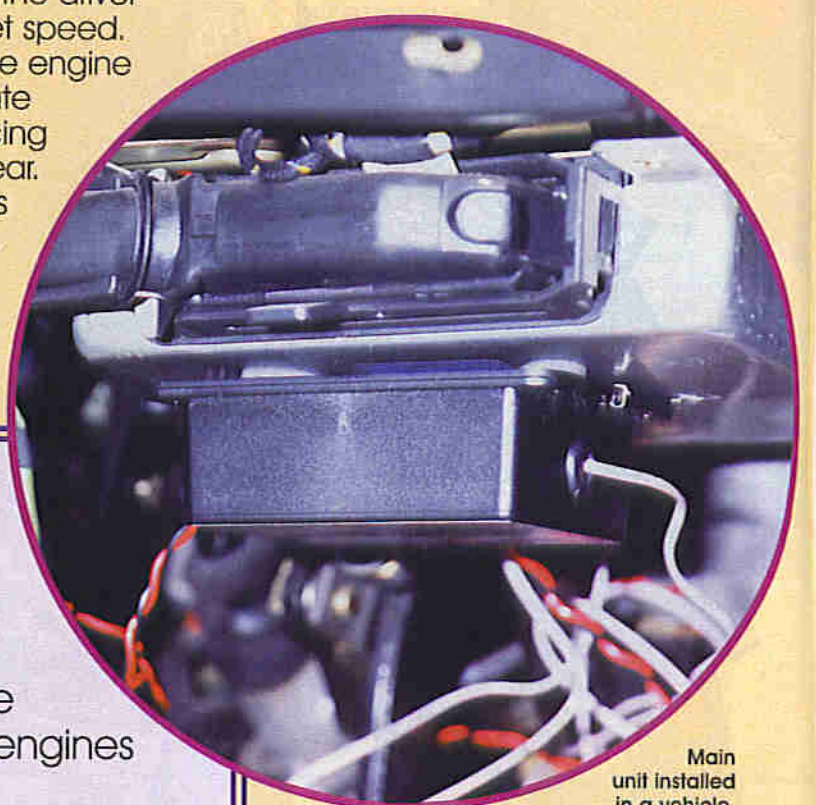
Design by Alan Williamson

Text by Alan Williamson
and Maurice Hunt

Inductive Sensorhead fitted to an ignition HT lead.

OVER REV INDICATOR

A great accessory for any petrol-engined vehicle, this unit gives a clear audible and visual indication to the driver when the engine reaches or exceeds a preset speed. It can, therefore, be used to indicate when the engine is in danger of being over-revved, or to indicate when it is turning at a speed when it is producing its maximum power or torque in a particular gear. This helps the driver to carry out gear changes at favourable points in the engine's rev range, for achieving higher levels of acceleration, pulling power or economy from the vehicle being driven, depending on the setting of the preset rev indication point.



Main unit installed in a vehicle.

FEATURES

- ★ Wide operating voltage
- ★ Low current consumption
- ★ LED and buzzer indication
- ★ Easy to build, install and calibrate
- ★ Configurable for 2- and 4-stroke engines

APPLICATIONS

★ Petrol-engined road cars and vans ★ Race/rally cars ★ Motorcycles ★ Powered Go-karts

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

2 PROJECT RATING

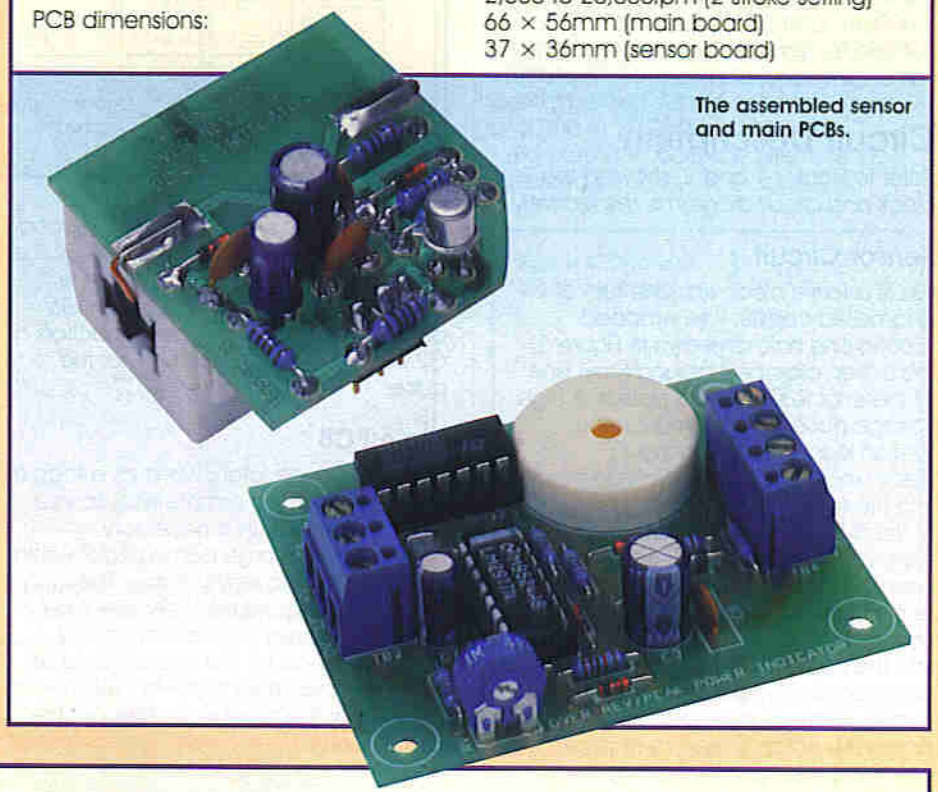
KIT AVAILABLE (95096) PRICE £29.99

THE majority of racing/rally cars and motorcycles feature an Over-Rev Indicator to allow the driver to get the best possible performance out of the vehicle, and to reduce the risk of the engine being stretched beyond its rev limit, particularly since there is not often time in the heat of competition to keep an eye on the rev counter (tachometer) – whereas an LED lighting and buzzer sounding provides an unmistakable prompt to the driver that it is time to change gear, all the time while he/she is concentrating on the road ahead! Such a device is also a useful feature to have on a road-going vehicle, and can increase the efficiency of your driving.

However, commercially available over-rev indicator systems tend to be rather expensive, and can be tricky to install. This rev indicator is different from most, in that it monitors engine speed by inductively coupling from one of the engine's spark plug leads, rather than the usual direct connection to the ignition coil. Only two other connections are required to install the unit, for the positive supply and earth, and it can be easily transferred between vehicles. The unit is also suitable for both positive and negative-earthed vehicles.

Specification

Operating voltage:	9 to 16V (12V nominal)
Quiescent current consumption:	8·5mA @ 12V
Activated current consumption:	17mA @ 12V
Overcurrent protection:	100mA 1¼in. (31·75mm) Quickblow fuse
Engine speed range:	1,000 to 10,000rpm (4-stroke setting) 2,000 to 20,000rpm (2-stroke setting)
PCB dimensions:	66 × 56mm (main board) 37 × 36mm (sensor board)



The assembled sensor and main PCBs.

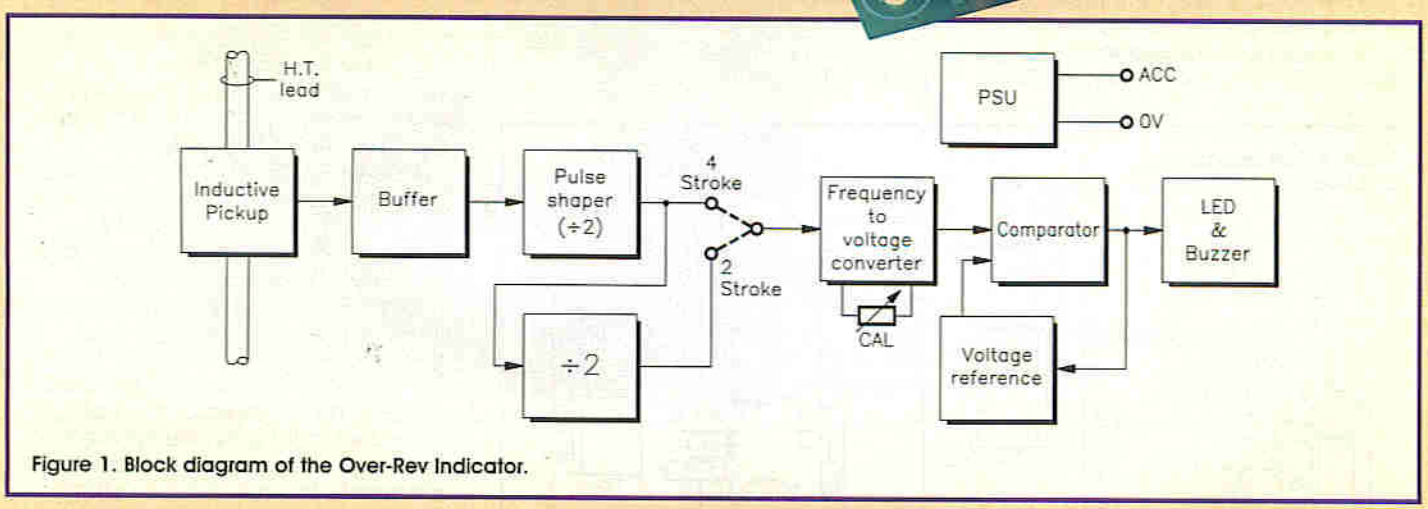


Figure 1. Block diagram of the Over-Rev Indicator.

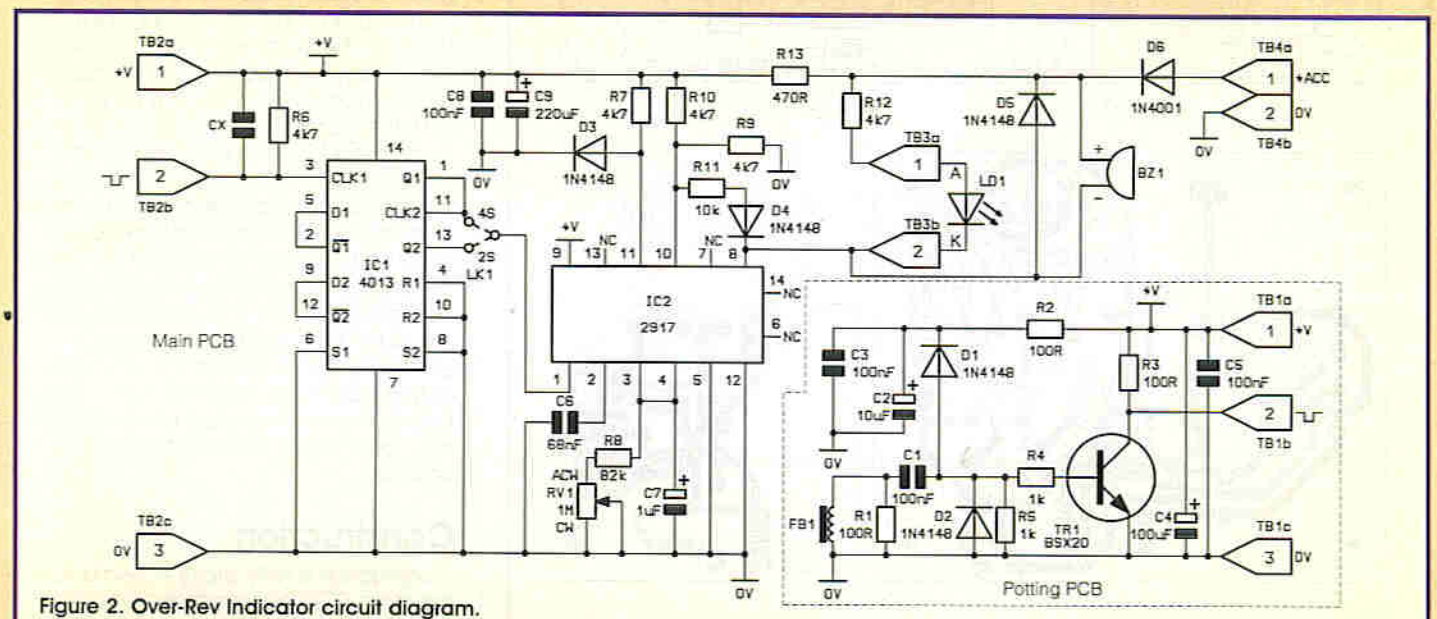


Figure 2. Over-Rev Indicator circuit diagram.

Most designs of rev indicator require a link fitted to select the number of cylinders and will work on 4-stroke engines only; this circuit only requires a link to select between 4-stroke and 2-stroke engines, irrespective of the number of cylinders. The module can be set for any engine speed between 1,000rpm and 20,000rpm (making it suitable for high-revving motorcycle/go-kart engines as well as cars).

Circuit Description

Refer to Figures 1 and 2, showing the block and circuit diagrams, respectively.

Sensor Circuit

FB1 is a ferrite block with one turn of enamelled copper wire wrapped around one half, as shown in Figure 3; this is then clamped around (any) one of the engine's spark plug leads. A high voltage pulse passing through the ignition lead radiates a large electromagnetic field, which permeates into the ferrite and induces eddy currents to flow, producing a magnetic field. When the ignition pulse has passed, the magnetic field within the ferrite block will collapse; this collapsing magnetic field will induce a current flow into the single turn of copper wire wrapped around the ferrite block. The current pulse will develop a voltage across R1, which is used to dampen the coil (the single turn of wire) and to provide a low input impedance. Capacitor C1 AC couples the pulse to the high-speed saturated switch formed from TR1, a high-frequency transistor; the diodes D1 & D2 serve to protect the transistor by clipping the pulse to ±1V outside the supply rails. The capacitors C2 & C3 serve as a 'sink well' for the pulse.

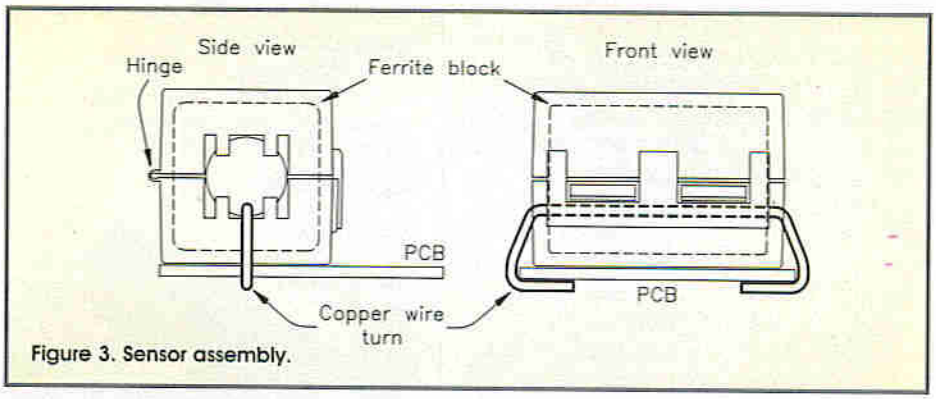


Figure 3. Sensor assembly.

Main PCB

IC1a is a D-type latch, wired as a toggle (÷2) to produce a symmetrical square wave output, which is necessary because the charge pump circuit within IC2 is sensitive to wave shape. The capacitor Cx is not normally fitted, but may be required in an exceptionally noisy environment; the value should be as small as possible (10nF to 100nF), since too large a value will filter out the ignition pulses! Any type of non-polarized capacitor with appropriate physical dimensions can be used, such as the ceramic disc variety.

IC1b is also wired as a toggle; the link LK1 selects the output of either IC1a or IC1b to be fed to the input of IC2. The output of IC1a (÷2) should be selected for use with four-stroke engines; the output of IC1b (÷4) should be selected for use with two-stroke engines, or for engines capable of speeds above 10,000rpm!

IC2 is an LM2917, a frequency-to-voltage converter. The device has two sections; the first is a tachometer, which contains a comparator with hysteresis feeding a frequency-doubling charge pump; the second half is an opamp/comparator with floating transistor. The IC also has an integrated Zener diode for supply regulation. A voltage proportional to the input frequency fed into IC2 pin 1, will be produced on pin 3.

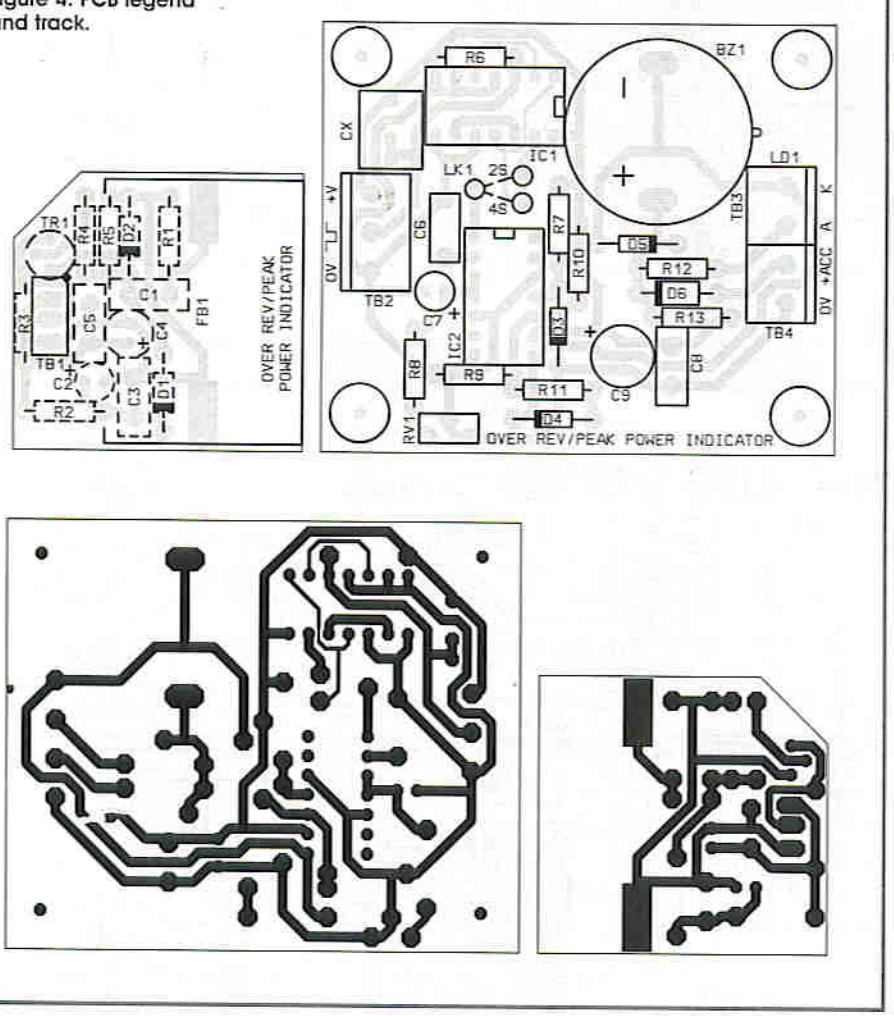
The input square wave signal switches on and off the tachometer input comparator, this in turn controls the charge pump, whose constant current (i_2) charges and discharges the capacitor C6. During the charge and discharge cycles, the constant current (i_3) output at pin 3 is 'OFF', and is switched 'ON' only when the capacitor C6 is *fully* charged or discharged.

Therefore, a Pulse Width Modulated (PWM) waveform at twice the input frequency is produced across R8 & RV1. The capacitor C7 integrates the current pulses to an averaged output voltage. The values of R8 & RV1 determine the discharge rate of the capacitor C7; C7 determines the output ripple voltage and the system response time.

The op amp non-inverting input (pin 4) monitors the voltage across C7; when the voltage rises above the voltage set at the inverting input (pin 10) by R9 & R10, the output transistor will switch on, illuminating LD1 and causing BZ1 to sound.

It is necessary to add a small amount of hysteresis (positive feedback) to the op amp to prevent the output switching on and off (toggling) due to the ripple voltage across C7. This is achieved with the aid of R11 and D4, which are effectively in parallel with R9, when the output transistor is switched 'ON'; this moves the inverting input reference to a new lower value, below the ripple voltage.

Figure 4. PCB legend and track.



Construction

Construction is fairly straightforward for the main PCB; begin with the smallest components first, working up in size to

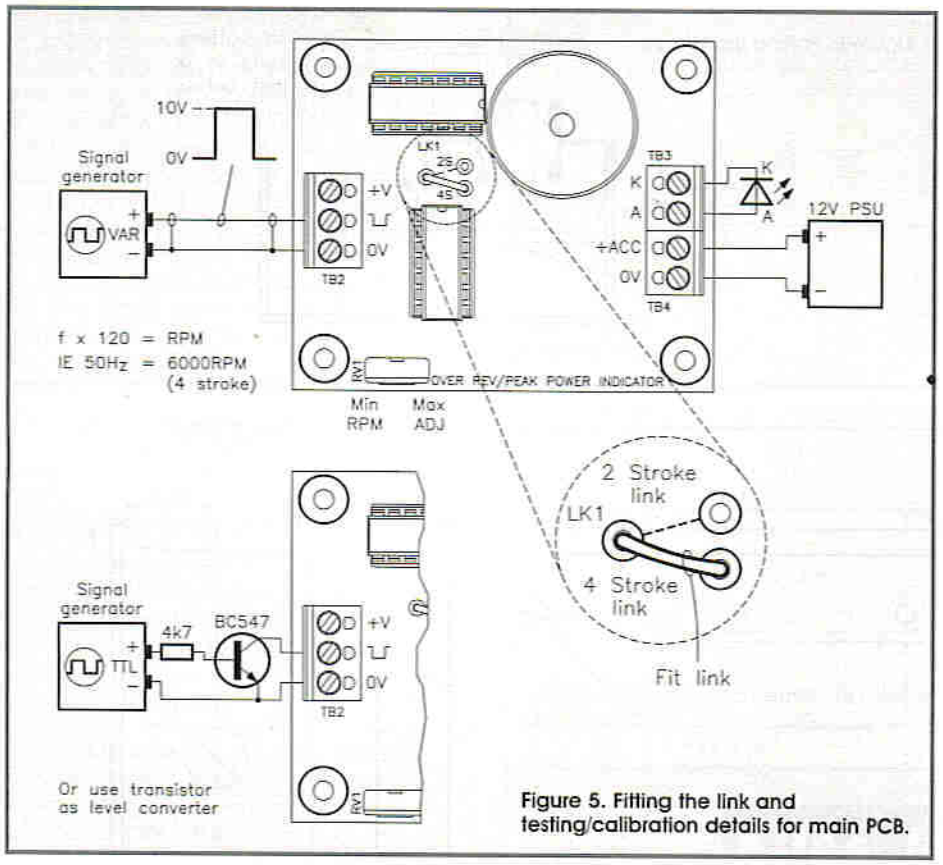
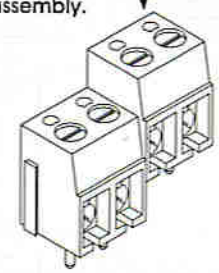


Figure 5. Fitting the link and testing/calibration details for main PCB.

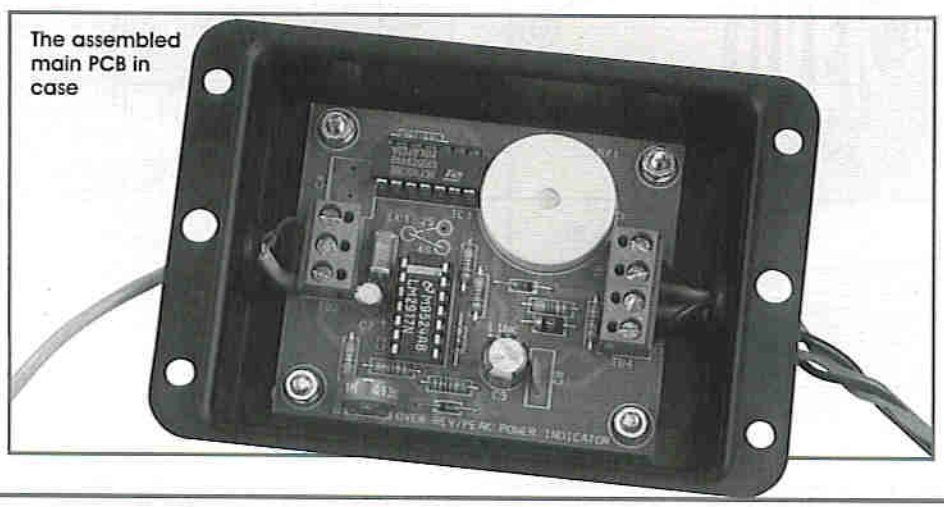
the largest. Refer to the PCB legend and track, shown in Figure 4 to assist in component placement. Note that the PCB is supplied as a one-piece item that must be separated into the main and sensor boards. Use a component lead offcut for LK1, and fit it in the position marked '4S' for 4-stroke engines or '2S' for 2-stroke – see Figure 5. However, for very high-revving 4-stroke engines, fit the link in the 2-stroke position, which will provide a rev range of 2,000 to 20,000rpm to be set.

Be careful to correctly orientate the polarized devices, i.e. electrolytics,

Figure 6. Terminal block assembly.



Slide the 2–way terminal blocks together



The assembled main PCB in case

diodes and ICs. Fit the terminal blocks together as shown in Figure 6 prior to fitting them. The ICs should be inserted into their sockets last of all, taking suitable antistatic precautions when handling them. Thoroughly check your work for misplaced components, solder whiskers, bridges and dry joints. Finally, clean all the excess flux off the PCB using a suitable solvent.

Construction of the sensor PCB is a little unusual, in that the components are mounted on the *track* side, except for the connector and ferrite block. Fit the components BEFORE fitting the ferrite block, and trim off the excess leads flush with the board.

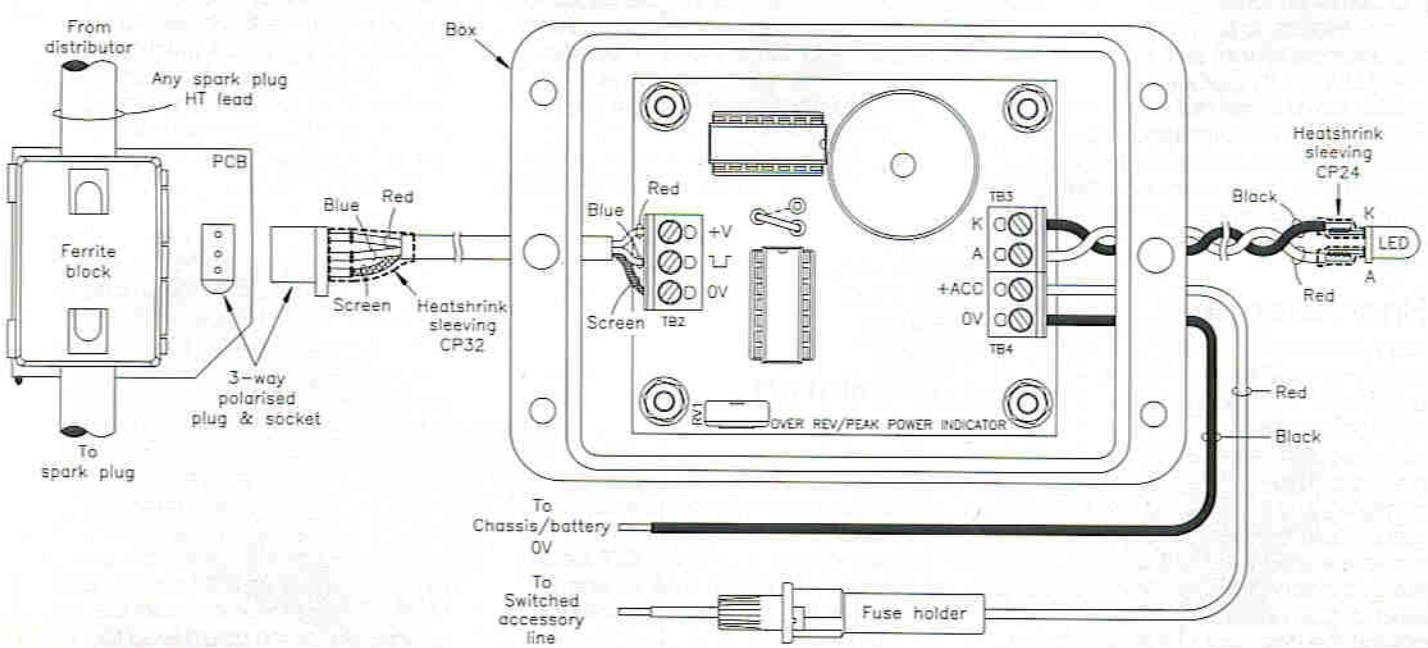


Figure 7. Wiring diagram.

If you wish to bench test the unit before potting it, do not fit R1 or the ferrite block. Make and fit the connection lead between the two PCBs as shown in the wiring diagram, Figure 7.

Testing of the Main PCB

Refer to Figure 5. Connect a 12V DC power supply to the circuit and switch on. To set the required rpm trip speed, divide the maximum rpm by 60 (for a 4-stroke engine) to find the calibration frequency, i.e. 4,500rpm ÷60 = 75Hz. Consult the handbook for your vehicle to find details on the engine's performance characteristics, to provide a guide as to the appropriate rpm setting.

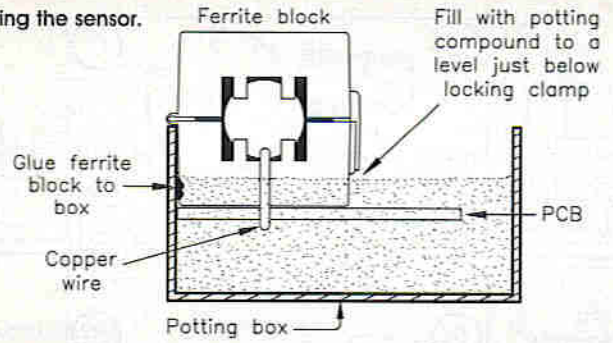
Adjust RV1 fully clockwise and apply a **square wave** signal of the appropriate frequency to the ferrite block input; then adjust RV1 *slowly* anticlockwise to find the trip point. The unit has now been tested and calibrated and the final assembly can now be completed.

Final Assembly

Fit R1 and the ferrite block; it is highly recommended that the sensor PCB is potted into the box because of the hostile environment it will live in. Silicone rubber sealant is not recommended as a replacement for the potting compound, due to the curing agent used. Figure 8 shows the way in which the sensor should be potted. Note that the cyanoacrylate adhesive (optional) is used to glue one edge of the PCB against the inner wall of the potting box. The potting compound is then applied through the cut off corner of the PCB. Follow the instructions that are supplied with the potting compound, and do not get it on your skin or clothing; besides being a messy black substance, it is carcinogenic. Allow at least 24 hours for it to set.

Drill and countersink the appropriate holes in the box for the main PCB as per Figure 9, then assemble the main unit as shown in Figure 10. Wipe the box clean and apply the label depicted in Figure 11. Finally, install the project into the vehicle.

Figure 8. Potting the sensor.



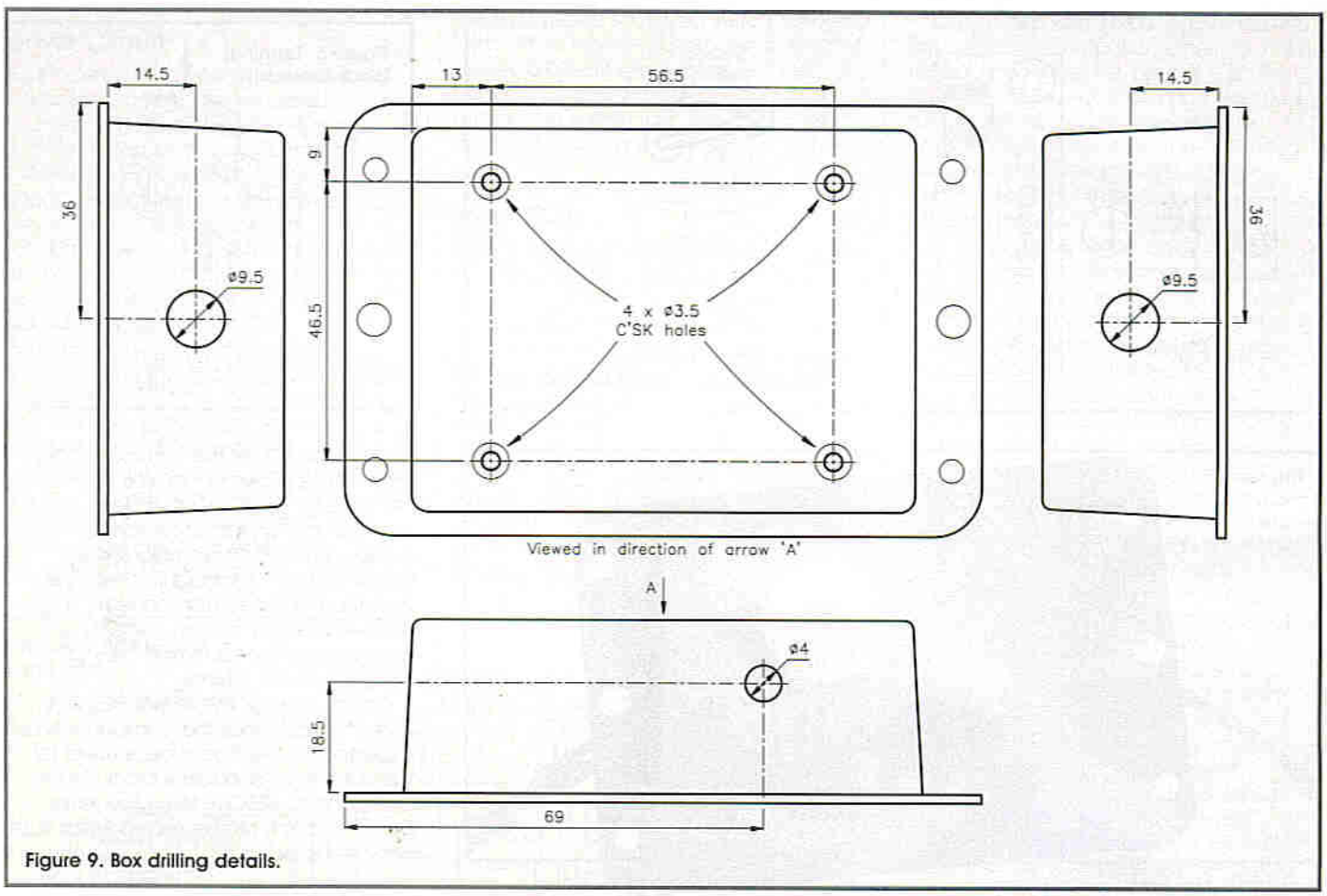


Figure 9. Box drilling details.

Installation

Refer to the safety warning regarding working on vehicle wiring before installing the project. If in any doubt, consult an automotive electrician before proceeding further. Ensure that the vehicle's ignition is switched OFF before starting the installation work, or when carrying out adjustment or maintenance on the unit.

Refer to Figure 7, showing the wiring diagram for the unit. Fit the supplied fuse into the fuseholder (see Specification table), and fit the fuseholder as close as possible to the ignition switch controlled 'ACC' (accessory) live feed. Ensure that where cables pass through panels, bulkheads, etc., grommets are used to prevent chafing of the insulation.

The sensor can be clipped onto any of the ignition leads between the distributor and the spark plugs, but should *not* be fitted to the lead between the distributor and the ignition coil. Use cable ties around the lead at each end of the sensor to prevent the assembly from sliding along the chosen ignition lead, and ensure that the sensor is fitted in such a way that it is restrained from moving about and possibly coming into contact with the fan, hot exhaust manifold, etc. A bracket could be made up to secure the sensor box to the engine bay if required, but ensure that the ignition lead still has an 'easy' routing – don't force it into severe contortions, as this could lead to premature failure.

Mount the main unit in a suitable area

in the vehicle, such as below the dashboard, so that the buzzer is clearly audible. Also, you may wish to alter the rev setting, so don't make the unit too inaccessible. The LED should be mounted in a suitable position on the dashboard, preferably in the line of sight of the driver, but not so that it will cause distraction, especially in the dark. If in doubt as to where to mount it, watch some in-car race/rally driving footage on TV, and watch out for the 'change gear' light that their vehicles invariably have! If you find the buzzer to be annoying, it could be omitted from the circuit, or muffled with some Blu-Tack, sticky tape or similar, placed over the sound exit hole.

Final Testing and Use

Having installed the unit in accordance with the instructions, you will no doubt be eager to try out the project for real! Start up your vehicle's engine, and rev it to the point that you have set the Over-Rev Indicator to operate at (a rev-counter helps here), whereupon the LED should light and the buzzer should be heard. However, warm the engine up before demanding high revs from it, else damage may result.

If the circuit worked OK on the bench but not in the vehicle, the problem may be caused by excess noise causing premature triggering of the indicator, in which case, the optional capacitor Cx may be required (see Circuit Description).

Alternatively, delayed/non-operation may be due to the design of ignition/engine management system fitted to modern vehicles, some of which cut off the ignition to one or more of the cylinders if the engine is not under load. In which case, you will need to drive the vehicle in varying conditions to further test the project. Also try fitting the sensor to a different spark plug lead.

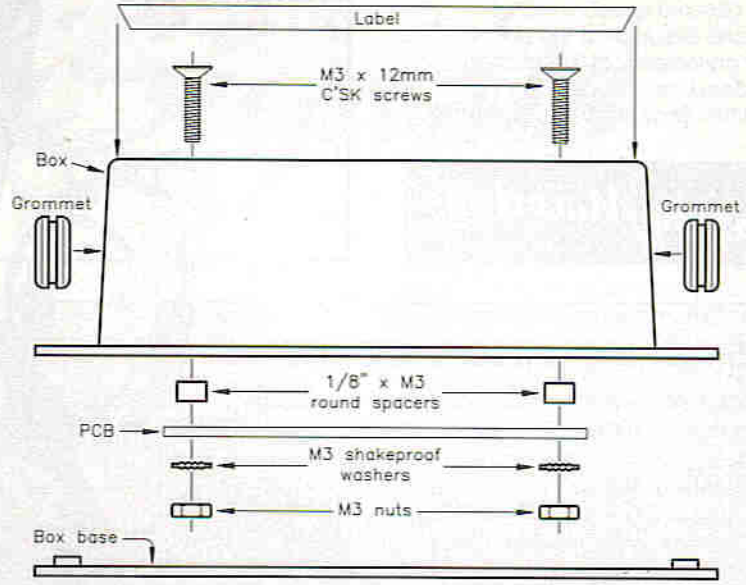


Figure 10. Exploded assembly of main unit.

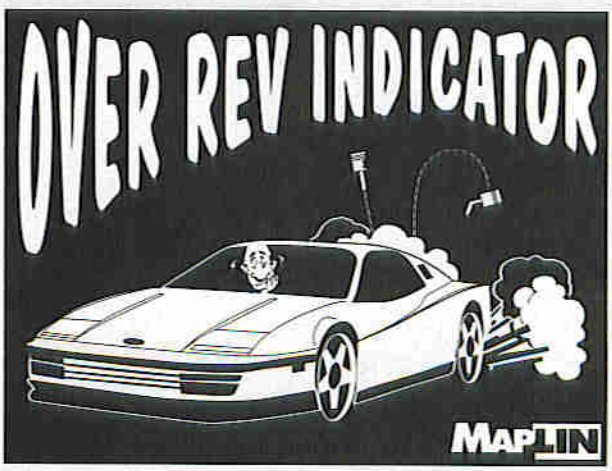
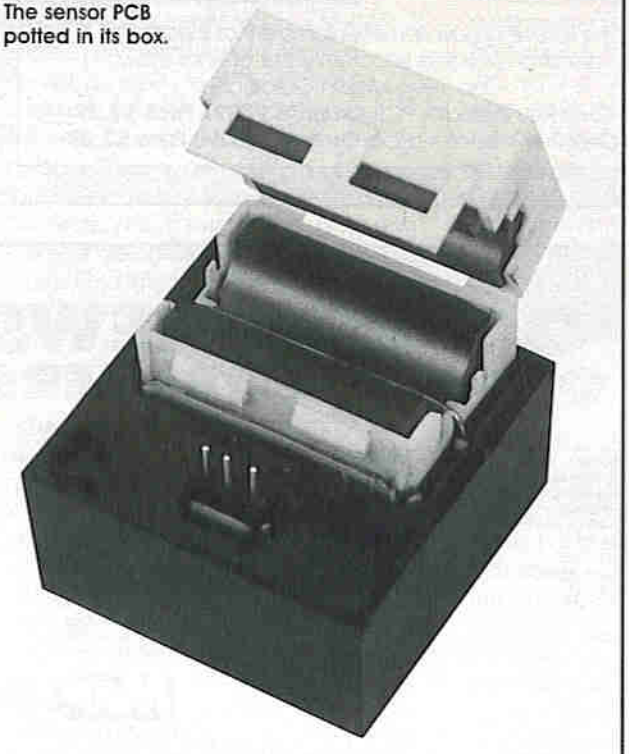


Figure 11. Front panel label.

The sensor PCB potted in its box.



The assembled sensor PCB prior to potting

All being well, take the vehicle for a spin (not forgetting to fasten your seat-belt and observe speed limits, of course), and ensure that the unit operates consistently at the desired engine speed, and stops once you have got the engine revs down again.

Happy Motoring!

The completed Over-Rev Indicator

OVER-REV INDICATOR PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless Specified)			
R1,2,3	100Ω	3	(M100R)
R4,5	1k	2	(M1K)
R6,7,9,10,12	4k7	5	(M4K7)
R8	82k	1	(M82K)
R11	10k	1	(M10K)
R13	470Ω	1	(M470R)
RV1	1MΩ Vertical Preset Potentiometer	1	(UH22Y)
CAPACITORS			
C1,3,5,8	100nF 50V Ceramic Disc	4	(BX03D)
C2	10µF 63V Radial Electrolytic	1	(AT77J)
C4	100µF 25V Radial Electrolytic	1	(AT48C)
C6	68nF Polyester Layer	1	(WW39N)
C7	1µF 63V Radial Electrolytic	1	(AT74R)
C9	220µF 25V Radial Electrolytic	1	(AT49D)
SEMICONDUCTORS			
D1,2,3,4,5	1N4148	5	(QL80B)
D6	1N4001	1	(QL73Q)
LD1	2mA Red LED	1	(CZ31J)
IC1	HCF4013BEY	1	(QX07H)
IC2	LM2917N	1	(WQ38R)
MISCELLANEOUS			
BZ1	PCB Buzzer	1	(KU58N)
FB1	10mm Noise Filter	1	(BZ33L)
TB1	3-pin Offset Plug	1	(FK99H)
TB2	3-way 5mm PCB-mounting Terminal Block Type 300	1	(JY94C)
TB3,4	2-way 5mm PCB-mounting Terminal Block Type 300	2	(JY92A)
	Box and Base Type 1	1	(JX56L)
	6·4mm Grommet	1Pkt	(JX65V)
	16/0·2 Wire 10M, Black	1Pkt	(FA26D)
	16/0·2 Wire 10M, Red	1Pkt	(FA33L)
	Heat Shrinkable Sleeving Type CP32	1	(BF88V)
	Heat Shrinkable Sleeving Type CP24	1	(BF87U)
	Small Potting Box	1	(LH57M)
	Potting Compound 50g	1	(FT17T)
	100mA 1¼in. Fuse	1	(WR08J)
	Car In-line Fuseholder	1	(DR79L)
	100mm Cable Tie	As Req.	(BF91Y)
	M3 × 12mm Pozi-drive Screw	1Pkt	(BF37S)
	M3 Shakeproof Washer	1Pkt	(BF44X)
	M3 Nut	1Pkt	(JD61R)
	M3 × ⅛in. Spacer	1Pkt	(FG32K)
	3-way Polarized Socket	1	(FK98G)
	22swg 0·71mm Enamelled Copper Wire	1m	(BL27E)
	7/0·2mm 2-core Lap-screened Cable	3m	(XS23A)
	14-pin DIL Socket	2	(BL18U)
	PCB	1	(95097)
	Front Panel Label	1	(95098)
	Instruction Leaflet	1	(XV95D)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
	Cyanoacrylate Adhesive 3g	1	(FL64A)

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

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

Order As 95096 (Over-Rev Indicator) Price £29.99

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

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

Over-Rev Indicator PCB **Order As 95097 Price £3.29**

Over-Rev Indicator Label **Order As 95098 Price £2.29**

Stray Signals

by Point Contact

More on Radio Power

When he first saw details of the famous clockwork radio for Africa, PC wondered at the energy-storage method chosen. Instead of storing mechanical energy in a spring and then releasing it to drive a generator supplying the circuitry, the obvious solution seemed to be to drive the generator directly and store the electrical energy produced in a Ni-Cd battery. Further to his comments in the last issue, PC recently acquired a clockwork radio himself. Not the one featured on television, and advertised in *Radio Times* at over £60, but one from Maplin at less than a quarter of that price. Well, it's not exactly clockwork – the handle drives the generator, which charges the internal Ni-Cd exactly as described above. Additionally, the top surface is covered with a panel of solar cells which will, over a period, charge up the batteries, or even operate the radio directly under really brilliant light.

- Alternatively, the Ni-Cds can be charged via a DC jack from external power, and for good belt-and-braces measure, a battery compartment accepts two 'AA' cells. These may be either ordinary zinc-carbon Leclanché cells, or more Ni-Cds.

The PCs took it with them on a recent winter holiday on the Costa del Sol, where it pulled in loads of stations, including the BBC Overseas programme on VHF. This is broadcast by a local relay station, presumably for the benefit of the numerous British ex-pats who, in Nerja, were said to outnumber the locals. In fact, the set's sensitivity is such that it really warrants a slow-motion drive for the tuning, rather than the usual knob directly on the tuning gang. PC found the statement in the 'User Manual' that 20 minutes playing time will be provided by cranking the generator for 1 to 3 minutes continuously to be just about correct. You will need a full three minutes if starting with the internal Ni-Cds completely flat, but certainly a minute or so's cranking will get you the news and weather summary on the hour on your local radio station. PC keeps the set in the obvious place when not in use, viz a sunny windowsill – this seems to give you a few minutes playing time whenever required even in winter; it will be interesting to see how much this improves in summer. More about the set later.

Calling 70cm Buffs!

Well, at least those of them (if there still be any such) who make their own rigs, instead of buying a Japanese black box with all the bells and whistles. After an unfortunate motoring experience some years ago, PC provided the Missus with an AA Emergency 'Phone to carry with her in the car at all times. This operated via the Vodaphone network, but would only allow calls to the AA or the 999 services. It was a car 'phone with 2·5W output rather than a hand mobile, but being contained in a neat grey nylon 'canvass' holdall about 11in. square by four deep and powered via the cigar lighter socket, it conveniently went either with Mrs PC in her car, or PC's Bedford Rascal when we went out together. Now, however, the AA have announced that they are to replace it, at no charge, with a hand-held model working on the same network, and providing full outgoing and incoming call facilities.

We await the new arrival with impatience, meanwhile, the disposal instructions for the old model, when it is no longer needed, are to take it to the local amenity tip! So if you are a 70cm experimenter, keep a look out when next at your local tip for a neat grey nylon holdall with a black and yellow AA logo. It contains an RF transistor line-up, good for over 2W output at 900MHz, not to mention a receiver line-up, IF filters and sundry other goodies worth salvaging. But don't bother to look out for PC's old set – it won't be going to the tip!

Talking Computers

PC recently mentioned to his better half that the laptop computer on which these lines are penned occasionally talks to him. Not being very technically minded, she completely refused to believe this. A musical chime when starting Windows, or a plaintive beep when one tries to do something stupid is one thing, but talking – never! In fact, it has only done so since hitching up an HP Laserjet 5MP printer to it. So, next time she came into the lab/study/office, PC pulled out the printer cable. A teeny, tiny, tinny voice said, in an unmistakable American accent "The printer does nart resparnd" – the laptop's internal speaker must be very small, possibly even just a piezo sounder. Recently, PC switched the clock rate from fast (for full computing speed) to slow (for longer battery life). Now, the computer complains about the printer in a sepulchral slow drawl, like a Democrat from the deep South of USA!

Yours sincerely,

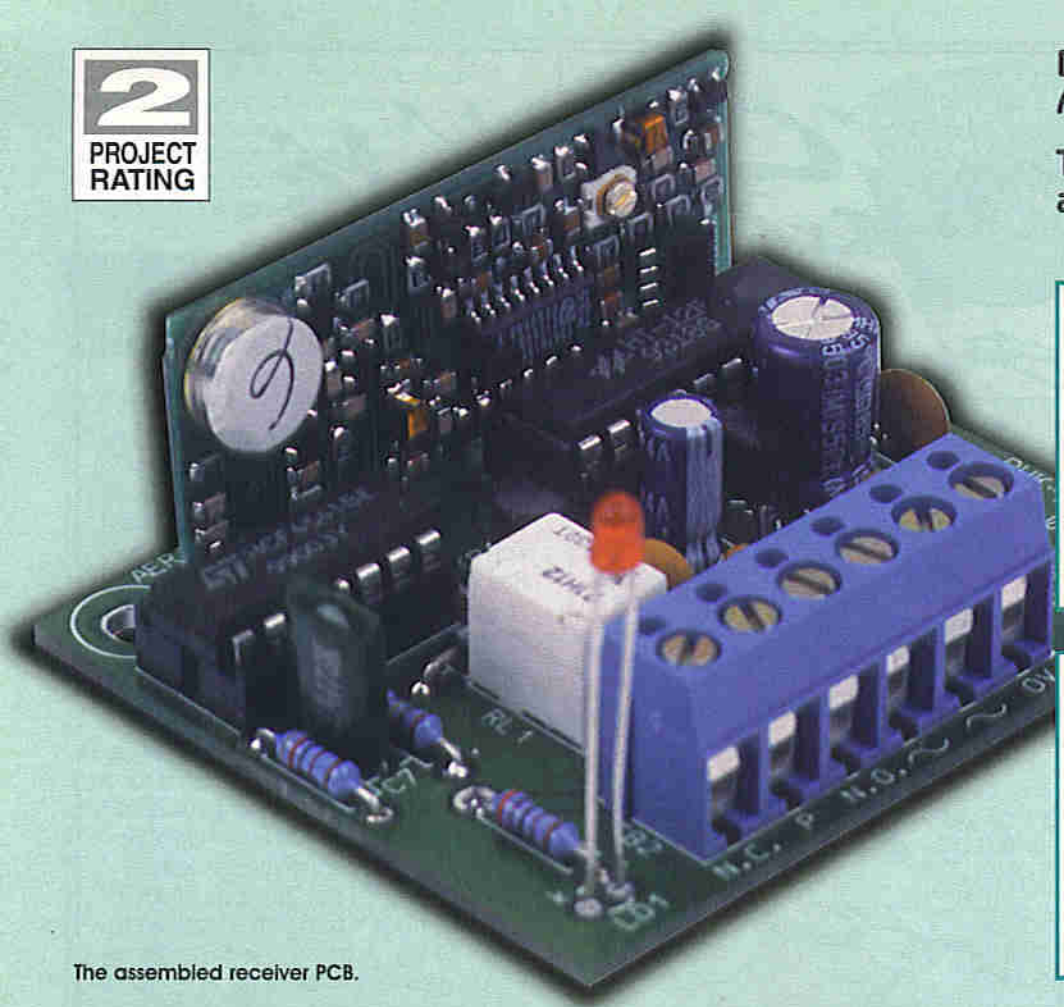
Point Contact

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

2
PROJECT RATING

Designed by
Alan Williamson

Text by Alan Williamson
and Maurice Hunt



The assembled receiver PCB.

FEATURES

- ★ Easy to build and use
- ★ Low current consumption
- ★ Ready-made and aligned RF module
- ★ 4,096 Codes
- ★ FM Operation
- ★ DTI approved to MPT 1340

APPLICATIONS

- ★ Domestic/commercial security
- ★ Guard patrol protection
- ★ Lone worker protection
- ★ Medical alert
- ★ Nurse call systems
- ★ Educational establishments

Help is on its way with the

RADI-CALL RECEIVER

The Radi-Call Receiver project presented in this article is designed to complement its companion project, the Radi-Call Transmitter (previously featured in *Electronics*, Issue 101). This 418MHz encoded FM transmitter/receiver combination are a boon for the frail, infirm, sick and elderly. Using these projects means that stand-alone or wire-interconnected equipment can now be linked to good effect by totally wireless means.

KIT AVAILABLE (95083) PRICE £44.99

This project uses a ready-built and aligned radio receiver module SILRX-418-A (AM28F), and similarly, the Radi-Call Transmitter project uses a ready-built and aligned radio transmitter module TMX-418-A (AM27E). With ideal antennae, these modules are capable of transferring data reliably up to a distance of 50m in buildings and over 200m under open field conditions. The 418MHz modules have been optimized for battery powered operation, and both are designed for reliability and performance in the field. They perform well with very small antennas and require no alignment whatsoever, making the transmitter-receiver pair straightforward to construct and set up.

Specification

Power supply voltage:	230V AC into 9-0-9V 250mA transformer
Current consumption	
Quiescent current:	35mA
Operating current:	14mA
Overload protection:	50mA Time Delay Fuse
PCB dimensions:	49 × 57mm

The Assembled Radi-Call Receiver in its optional box.

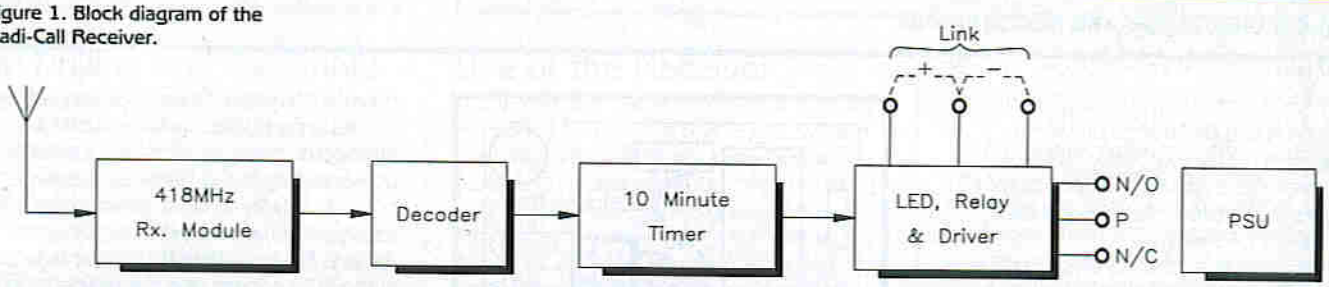
The Receiver Module

The receiver module is a double conversion FM superheterodyne (superhet) type, with a data level converter driven by the audio output buffer.

All the stages of the receiver are powered from a single +5V DC supply, which is applied to pin 5 of the module. The 0V power connection is on pin 4 with the antenna ground on pin 2.

The incoming 418MHz signal, picked up by the antenna, is connected to pin 1 of the module, where it then passes through a capacitor into the 418MHz bandpass filter (BPF). An RF preamplifier boosts the signal before it enters the first mixer stage.

Figure 1. Block diagram of the Radi-Call Receiver.



The first local oscillator runs at a frequency of 433·92MHz which is accurately set by an SAW resonator. Its output is fed to the first mixer stage where it mixes with the amplified 418MHz received signal to produce the first IF signal at 15·92MHz. This is then fed to the second mixer where a second local oscillator running at 16MHz produces the final IF signal at a frequency of 80kHz. It is then amplified and the wide-band frequency modulated signal demodulated to produce an audio signal. In addition, a fast-acting carrier detect signal is produced which is made available on pin 3 of the module, and in this application, is used to control a duty cycle power saving circuit.

To improve the signal to noise performance and reject any unwanted signals, the audio is processed by a third order low-pass filter (LPF) with a 5kHz cut off point. This signal is fed to an audio buffer and its output is centred around the half supply reference and appears on pin 6 of the module. It is also tapped off to the active data slicer, where the analogue audio signal is converted into a digital signal which appears on pin 7. This output is fed to the decoder IC.

The choice of antenna and its position directly controls the effective range of the receiver. The best position, by far, is for the antenna to stick out of the top of the finished boxed unit. This is often not desirable for practical or ergonomic reasons, so a compromise may need to be reached. If an internal antenna must be used, keep it away from other metal components, batteries, PCB tracks/earth plane, etc.

IMPORTANT! The trimmer control on the receiver module is factory set and must never be adjusted.

Circuit Description

Refer to Figure 1, which shows the block diagram of the receiver circuit, while Figure 2 shows the circuit diagram.

The connections to the 418MHz receiver module are as previously described, with the digital data output from pin 7 used to drive the data input of the remote control decode chip, IC1.

The code pattern (one out of 4,096 combinations) is set by solder bridges on the track side of the PCB next to IC1; if a matching code is received, pin 17 will become active high for the duration of the transmission.

IC2, a programmable timer, is configured as a monostable; when pin 6 is taken high, the output will become active high, the timeout period commencing when pin 6 is returned to logic 0. The output period 't' can be calculated from the formula:

$$t = 65{,}536 \times 2{\cdot}3 \times R3 \times C7$$

With the components specified, the timeout period works out at a shade under 10 minutes, or to be exact, 580·9 seconds (±10% for component tolerance), which equals 9 minutes and 40·9 seconds. This allows adequate time for an autodialler, if used in conjunction with the receiver, to phone up several numbers and convey a prerecorded message to each. The time may be altered to suit a particular application by changing R3 and C7, but note that R3 must be in the range 5kΩ to 1MΩ and C7 in the range 100pF to 100nF. Additionally, R4 must be at least twice the value of R3.

The additional transistor switching stage formed from TR1 enables the higher current devices (LD1 & RY1) to be controlled. Reverse-biased diode D3 prevents the back emf generated by switching of the relay coil from damaging the transistor. The relay has normally open (no) and normally closed (nc) outputs,

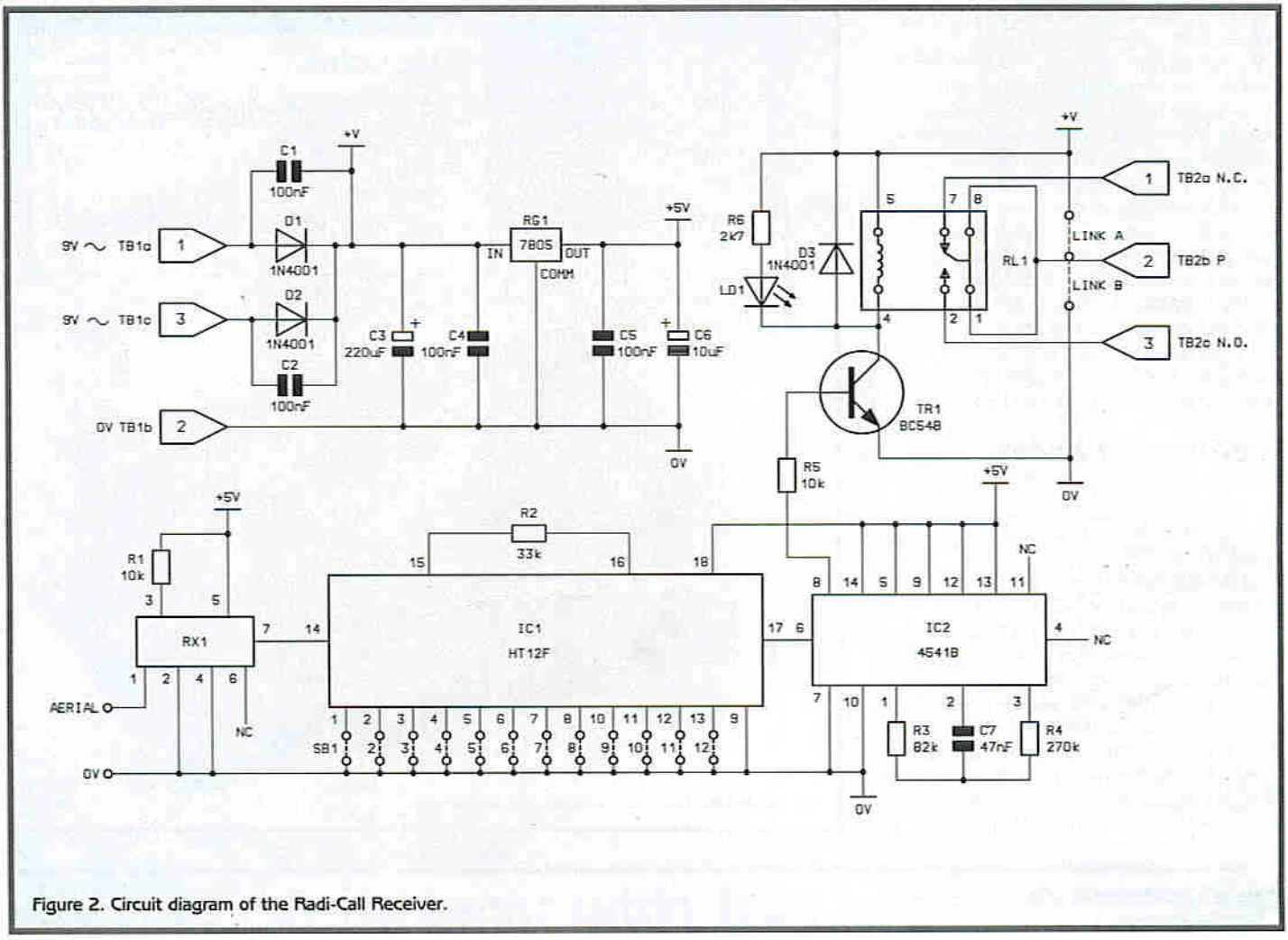


Figure 2. Circuit diagram of the Radi-Call Receiver.

which are available from terminal block TB2. Link A can be fitted to provide a supply switched output, while link B, if fitted, provides a ground switched output. If neither link is fitted, the relay contacts act as an SPDT switch.

The PSU section consists of a full-wave rectifier (D1 & D2) with suppression (C1 & C2) ideally suited to a 9-0-9V 250mA centre-tapped transformer (WB01B); the main supply decoupling is provided by C3, and high-frequency decoupling by C4. Regulation of the supply for the circuit is achieved with the aid of RG1, whose +5V DC output is decoupled by C5 & C6.

Construction

The PCB has a printed legend and ghost track that will assist you when positioning each item – see Figure 3.

Construction is fairly straightforward: begin with the smallest components first, working up in size to the largest. Be careful to correctly orientate the polarized devices, i.e. electrolytic capacitors, transistor, diodes, LEDs and ICs. Fit the IC sockets with their end notches in alignment with the printed legend, prior to mounting the taller components, as it is then easier to fit them flatly onto the board.

Ensure correct orientation of the ICs (note alignment of the end notches) and insert them into their sockets, taking suitable antistatic precautions, since CMOS devices are used; do NOT fit the 418MHz receiver module at this stage.

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

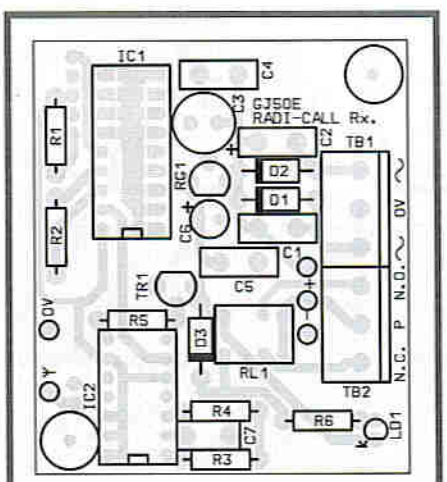


Figure 3. PCB legend and ghost track.

Code Setting

The code setting must be carried out BEFORE the 418MHz receiver module is fitted. The code pattern (one out of 4,096 possible combinations) is set by solder bridges on the track side of the PCB of IC1 (refer to Figure 4). Obviously, set the same code for the receiver as you have for the transmitter.

Intermediate Testing of the Receiver

The purpose of this intermediate testing stage is to establish that the main part of the receiver board, in particular, the supply regulation section, is operating properly before connecting the relatively expensive 418MHz receiver module to it, to avoid the risk of incorrect voltages appearing at the connections to the module caused by erroneous assembly. Connect a suitable power supply to the Radi-Call Receiver board (a 9-0-9V 250mA transformer is ideally suited) – see the wiring diagram given in Figure 5. Note that a fuse is required in the Euro socket. Use a multimeter to test voltages relative to 0V (available from the centre terminal of TB1) at a number of points around the board; ensure that the output of the voltage regulator RG1 is +5V DC, which should be seen at pin 5 of the receiver module, pin 18 of IC1, and pins 5, 9, & 12 to 14 of IC2. Disconnect the power supply on completion of the above tests.

If all is well at this stage, the 418MHz receiver module can be fitted to the board. Note that the module may be fitted on the component or track side of the board, as required. However, it is recommended that it should be fitted to the track side in accordance with the printed legend, having pre-bent the pins at 90°, using pliers – take care not to strain the leads where they attach to the module. Ensure that there is adequate clearance between the board and the horizontally oriented module pins, to avoid short circuits. Clean off all excess flux from the PCB using a suitable solvent.

Final Testing

Connect the transformer and ancillary components to the module as shown in the wiring diagram (Figure 5). Remember to fit a fuse into its compartment on the Euro socket. Fit a suitable aerial terminated with a BNC plug, and if it is a telescopic type, extend it to the appropriate length.

The optimum length for the aerial will be at around the quarter-wavelength mark, i.e. 17·94cm. Switch on the PSU and the module; the relay will energize and the LED will illuminate briefly during power up.

Press the activation pad on the transmitter, to cause continuous transmission of a valid code (continuous, that is, while the pad is being pressed); note that the module will activate on power-up – the receiver module's relay should energize and the LED should illuminate during the timeout period. Wait until the reset condition occurs following the delay period, when the LED will extinguish.

The antenna on the receiver module can now be optimized by range testing. Move the transmitter away from the receiver until the receiver stops working; 'tweak' the antenna until maximum range is obtained.

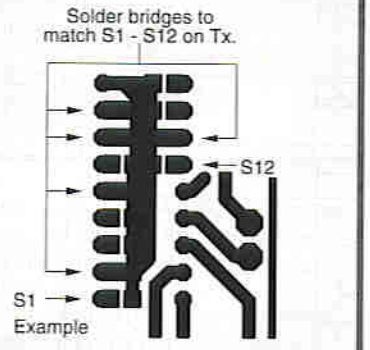
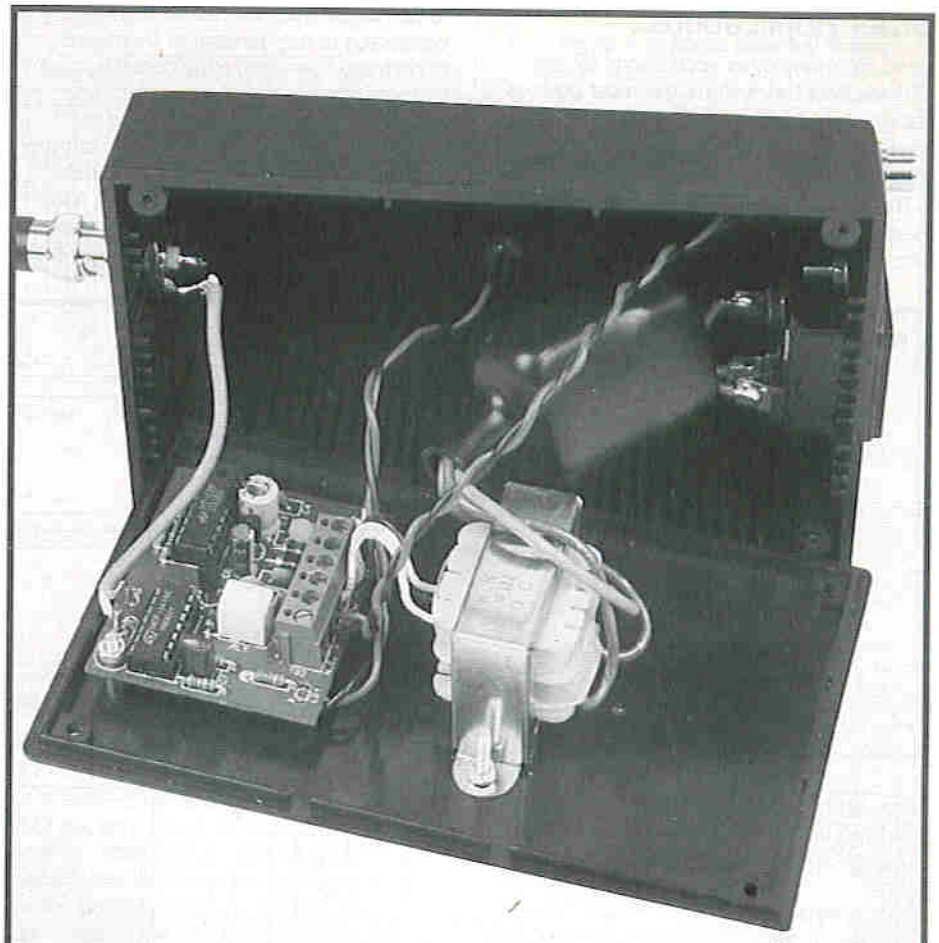


Figure 4. Decode selection by solder pads.



The assembled PCB in the optional box.

Box Drilling and Assembly

Refer to Figure 6, showing the box drilling diagram. With the box suitably prepared, install the project as shown in Figure 7, the exploded assembly drawing. Finally, wipe the box clean and apply the front panel label (refer to Figure 8 of the Radi-Call Transmitter article, in *Electronics*, Issue 101). The label is supplied with the Radi-Call Transmitter kit, but is also available separately (Stock Code 95085). Note that the MPT 1340 label for the transmitter is not required for the receiver.

Use of the Receiver

The transmitter and receiver were originally envisaged for use as a 'nurse call' system, to enable a frail/infirm or elderly person to be able to quickly summon help should they need it. The lightweight and compact transmitter is carried by the vulnerable individual, so that it can be operated in case of emergency. The receiver can be connected to a telephone auto-dialler (communicator), such as the GL03D unit stocked by Maplin (or alarm system). Activating the transmitter would cause the receiver to operate the relay, which in turn, would cause the telephone communicator to dial the preprogrammed number(s) and relay the prerecorded emergency message. The GL03D unit stores the emergency message in battery backed-up RAM and can be programmed with up to four telephone numbers. The Radi-Call Transmitter article provides further information on installation of the receiver into the communicator unit. Note that installing the receiver into the GL03D communicator unit will invalidate the unit's BABT and CE approval.

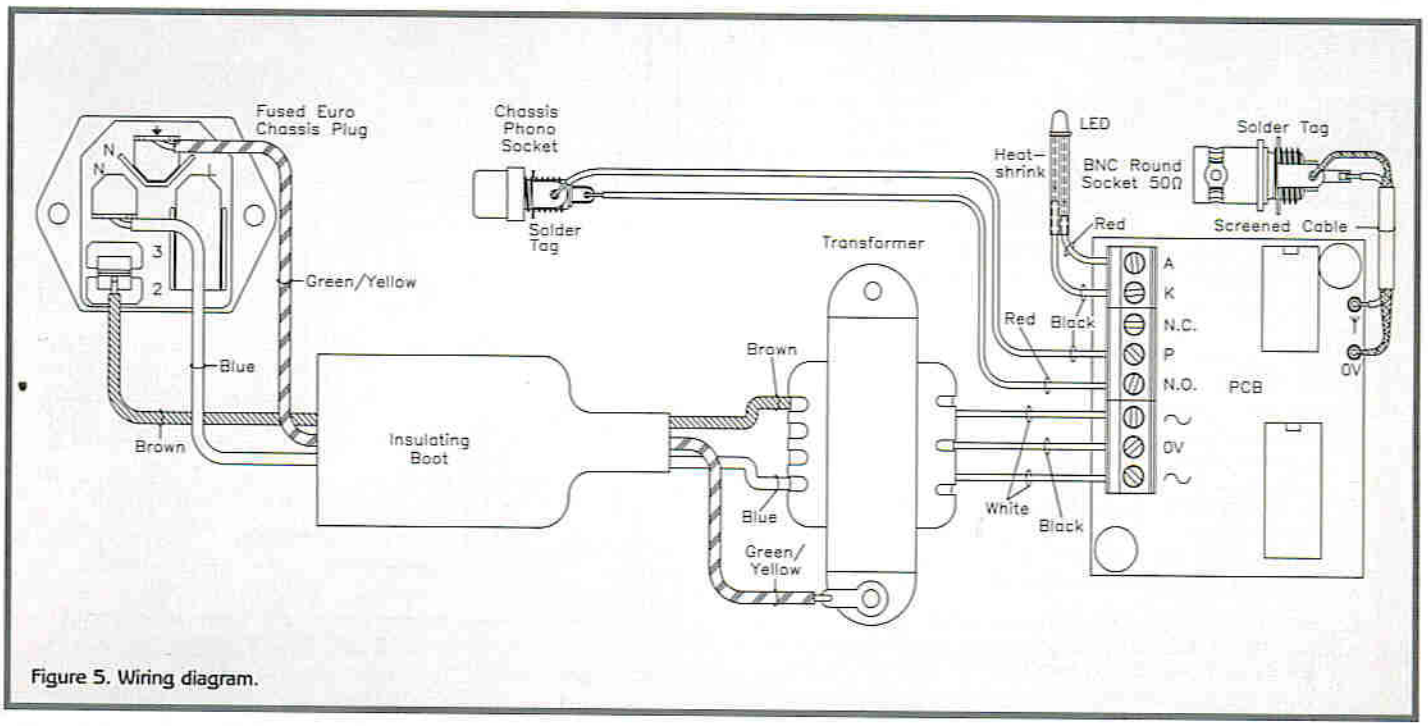


Figure 5. Wiring diagram.

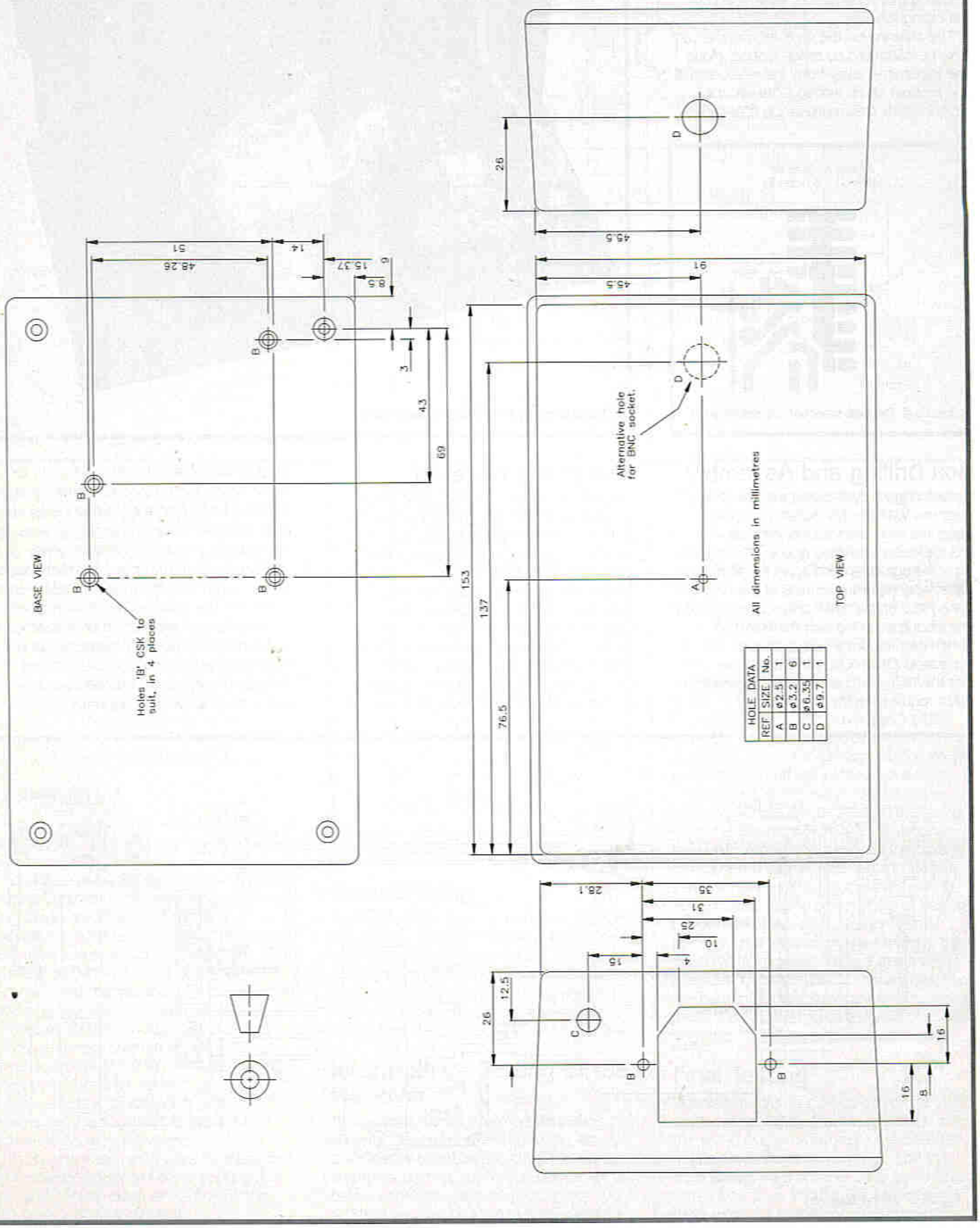
Other Applications

There are many other applications for the 418MHz Radi-Call system, the most obvious being as part of a security system, in the home, workplace or particularly in the light of recent events, in educational establishments.

The transmitter/receiver projects could be used as a means of connecting a remote sensor to an alarm system without having to run wires. A remote sensor can be connected to the transmitter by means of normally open (no) relay contacts, such that when the sensor is triggered, the transmitter is activated. Interfacing the receiver to an alarm system can be achieved by simply connecting to the appropriate contacts of the low power relay. The relay contacts would be connected to either a normally open (no) or normally closed (nc) loop (or panic loop) on the alarm system, so that when a valid code is received, the relay is operated and the alarm system triggered. Note that installation of either the transmitter or receiver into a CE-approved alarm system will invalidate this approval.

By connecting the transmitter to a vehicle, caravan, house or outbuilding alarm system, a paging alarm system would be created, such that when the alarm is triggered, the

Figure 6. Box drilling.



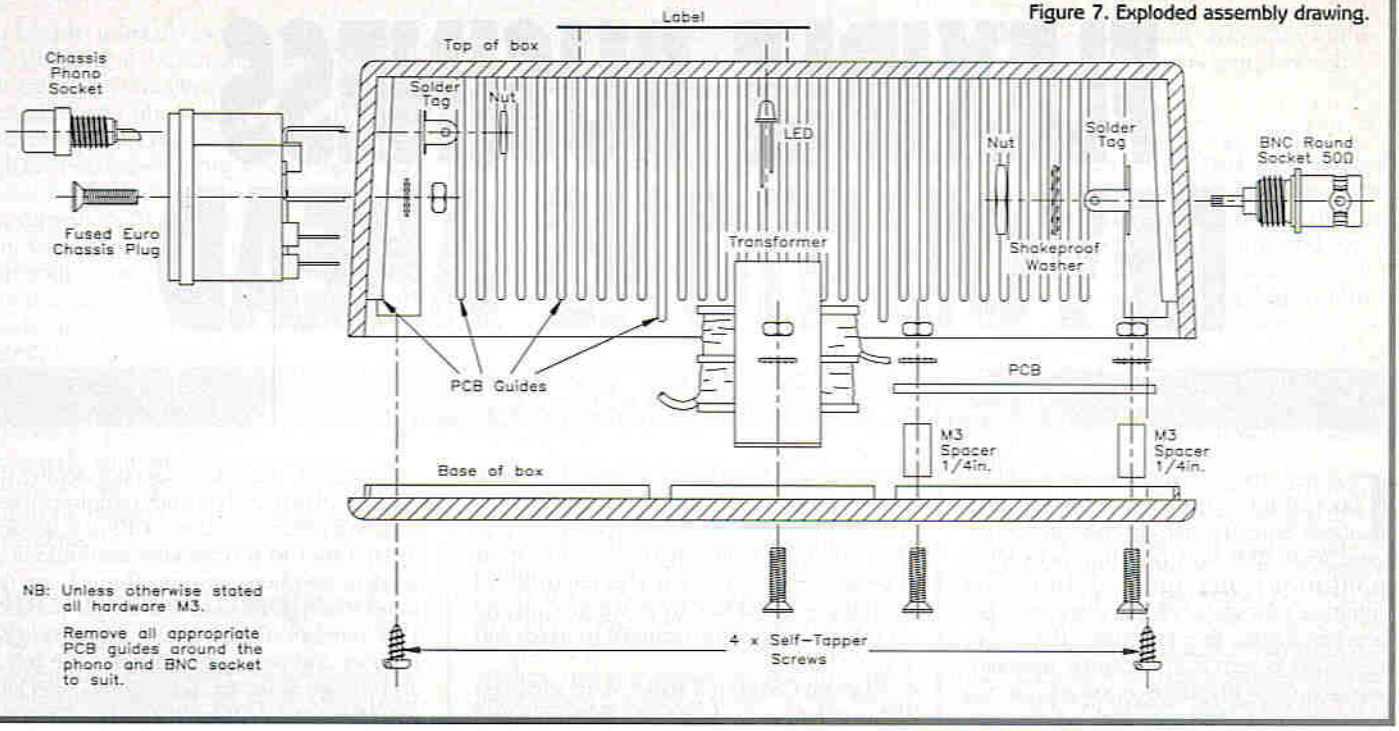


Figure 7. Exploded assembly drawing.

transmitter is activated. When a valid code is received, the relay on the receiver will be activated, triggering the alarm and alerting the owner to a theft attempt.

Another application could be a 'watchdog' for remote machinery not often checked, where unexpected down time could be expensive.

As long as the range of the Radi-Call system is not exceeded, it is possible to use it to safeguard a boat, vehicle or caravan kept near your home, or to protect the contents of the garage, garden shed or greenhouse. To extend the operating range, use the project in conjunction with the Super Scan active aerial (Stock Code LT27E) featured in *Electronics*, Issue 89.

With a total of 4,096 codes to choose from, there is a plenty of scope for using multiple units in many different applications. In all cases, it is wise to perform range tests to ensure adequate coverage is obtained. With security applications or emergency call systems, correct operation should be checked regularly and batteries replaced as a matter of course.

The 418MHz low-power receiver module used in this project was covered in a DATA FILE in *Electronics*, Issue 73.

RADI-CALL RECEIVER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1,5	10k	2	(M10K)
R2	33k	1	(M33K)
R3	82k	1	(M82K)
R4	270k	1	(M270K)
R6	2k7	1	(M2K7)
CAPACITORS			
C1,2,4,5	100nF 16V Ceramic Disc	4	(YR75S)
C3	220µF 16V Radial Electrolytic	1	(AT41U)
C6	10µF 63V Radial Electrolytic	1	(AT77J)
C7	47nF Mylar Film	1	(WW20W)
SEMICONDUCTORS			
D1-3	1N4001	3	(QL73Q)
LD1	Miniature 2mA Red LED	1	(CZ28F)
TR1	BC548	1	(QB73Q)
IC1	HT12F	1	(AE19V)
IC2	HCF4541BEY	1	(QQ47B)
RX1	418MHz Receiver Module	1	(AM28F)
RG1	LM78L05ACZ	1	(QL26D)
MISCELLANEOUS			
TB1,2	3-way PCB-mounting 5mm Terminal Block Type 300	2	(JY94C)
TB3	2-way PCB-mounting 5mm Terminal Block Type 300	1	(JY92A)
RL1	12V 1A Micro-miniature Relay	1	(DC48C)
	1mm PCB Pins	1 Pkt	(FL24B)
	0·71mm 22swg Enamelled Copper Wire	1 length	(BL27E)
	14-pin DIL Socket	1	(BL18U)
	18-pin DIL Socket	1	(HQ76H)
	PCB	1	(95084)
	Instruction Leaflet	1	(95085)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)			
	Right-angled Phono Plug	1	(FJ74R)
	ABS Plastic Box Type H2851	1	(B274R)
	Stick-on Feet Small	1 Pkt	(FE32K)
	Communicator Auto-dialler	1	(GL03D)
	Epoxy Resin 15g	1	(JL92A)
	Round 50Ω Impedance BNC Socket	1	(HH18U)
	144/430MHz Telescopic Aerial & BNC Plug	1	(JM12N)
	9-0-9V 250mA Transformer	1	(YN15R)
	Chassis-mounting Phono Socket	1	(YW06G)
	Fused Euro Chassis Plug	1	(FT37S)
	Cover For FT37/MK18	1	(JK67X)
	50mA 20mm Time-delay Glass Fuse	1 Pkt	(QZ85G)
	Miniature Coaxial Cable	1m	(XR88V)
	10m 16/0·2 Wire, Red	1 Pkt	(FA33L)
	10m 16/0·2 Wire, Black	1 Pkt	(FA26D)
	Wire, Green/Yellow	1m	(XR38R)
	Heat-shrink Sleeving CP24	1	(BF87U)
	Euro Socket to 13A Plug Lead	1	(MK41U)
	M3 × 16mm Pozi-drive Screw	1 Pkt	(JC70M)
	M3 × ¼in. (6·35mm) Spacer	1 Pkt	(FG33L)
	M3 Steel Nut	1 Pkt	(JD61R)
	M3 Shakeproof Washers	1 Pkt	(BF44X)
	M3 Solder Tag	1 Pkt	(LR64U)
	Transmitter/Reciever Label	1	(KV06G)

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

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

Order As 95083 (Radi-Call Receiver) Price £49.99 B1

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

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

Radi-Call Receiver PCB **Order As 95084 Price £5.49**

FLEXIBLE BUSINESS REVOLUTIONS AHEAD

by Frank Booty

It is easy to think that everyone will be hooked up to the Internet in the years ahead. Sure, the start-up costs are low for World Wide Web sites (the Internet's killer application) and internal Internets ('Intranets') for global corporations with far-flung employees. Few talk about the downsides, such as zero fault tolerance, reliability, and scalability – all features missing from current technology and essential for mission-critical enterprise applications.

However, it is possible that many planners could be scared away from the Web towards other emerging technologies, e.g., messaging middleware or groupware. Think instead of the Internet in a telephone service analogy. The upcoming business revolution of new applications to facilitate flexible working, for example, will actually involve universal personal communications, online services, multimedia and/or broadband services, and groupware. The Internet is there, but as a service. It is a point that is often overlooked.

Universal Personal Communications

Cellular radio is one of the success stories of the late 20th Century. In 15 years, the global subscriber base for cellular has risen from zero to over 50 million, with expectations of it doubling by 2000. Indeed, some manufacturers predict up to 400 million users of mobile communications worldwide by 2005. This would give parity with the existing level of fixed telephone installations.

The key to the success of cellular communications is its capability to liberate the user from the inflexibility of the wire in the wall, to allow him/her to make and receive calls anywhere, anytime. The major shift in the cellular market occurred when the concept of mobility was grasped by the ordinary consumer. Cellular had traditionally been seen as a productivity tool for the business community, but the benefits of mobility opened up a mass market which is now the main driving factor behind today's explosive growth.

The most exciting development in cellular technology has been the introduction of digital technology. All the original cellular networks used analogue technology, which provided good speech quality but offered only limited capability for services such as data. The move towards digital, and in particular GSM, global system for mobiles, has enabled the introduction of new and advanced services.

GSM was designed to solve the European analogue cellular scene's problems. Before GSM, it was impossible for a cellular user to travel between countries and use the same mobile 'phone. The GSM specification offers a range of features, including speech encryption, facsimile, data services, and the short message service. There is also international roaming – the ability to move around the world using the same terminal to make and receive calls.

Work on GSM is not static. More advanced data transmission functions, facsimile and general packet radio feature on the list of enhancements. Indeed, some pundits see GSM as the potential platform for the third generation communications systems – the mobile communications technology for the 21st Century.

Hitherto, the principal requirement for cellular telephony has been for speech communications. However, digital technology's capabilities are creating a new, growing market for data communications. Today, the business community is demanding mobile office type services – facsimile, e-mail, local area network and database access. As technology develops, there will be increasing demand for wireless multimedia services, including not only voice and data, but images and video as well.

The development of wireless multimedia will require major steps forward in technology. The bandwidth of today's wireless interface is but a few hundred bits compared to the megabits of bandwidth offered by fibre-optic cable. The physical qualities of the radio medium will ensure this limitation will continue (although new technologies will become available which will increase the bandwidth to 2M-bit/s over the next decade).

Today's cellular 'phones are inadequate to provide full video and image capability, presenting the mobile industry with a major challenge in developing the next generation of telephones.

Third generation systems, being developed under the auspices of the International Telecommunications Union (ITU), will provide a seamless, global communications service through small lightweight terminals, and will be designed to interface with existing fixed and mobile telecommunications networks. Key features and objectives include a high degree of commonality of design worldwide, acceptable costs, and the provision of voice and non-voice services to mobile users over a variety of different user density and geographic areas.

Services offered will range from basic wide area paging, through voice telephony to data services and audiovisual communications. Users will select the services needed for their personal/business lifestyles.

In parallel, the ITU is also developing the concept of personal mobility or universal personal telecommunications (UPT), i.e. the ability of a user to receive telecommunications services anywhere, anytime, through any terminal, through the use of a unique personal UPT number. Callers dial the unique UPT number and the system handles the call in accordance with the subscriber's specified requirements. A variable routing algorithm will indicate where the user is at any time, and on which network he/she is available.

While there are obvious technical challenges to be overcome, such service implies the capability to roam around the world sending and receiving telephone calls, facsimiles, data messages and video. Yet to be determined, for example, is who will develop and administer the payment and collection systems, and who will allocate the UPT numbers?

Online Services

Over the past four years, the online services market has changed dramatically, fuelled by the rise in popularity of consumer-oriented networks and the huge growth in business-oriented applications (such as electronic messaging and electronic document interchange (EDI)) over commercial networks.

Examples of services include CompuServe, America Online, Prodigy, Microsoft Network, and Apple Computer's eWorld, while in Europe, there's Europe Online, America Online/Bertelsmann, and a host of mass-market services, e.g., teletext and videotex. Europe today is highly competitive.

The telecommunications media are either already digital or headed to become digital. When they do, the distinction between computer networks and telecommunications networks may entirely disappear. Further, there is expected to be a blurring of the distinction between smart telecomms devices and telecom-equipped computers. Simply put, there is no distinction between a television equipped to compute and provide network services, and a computer equipped for television.

To date, online services have not enjoyed the same successes of television, telephones or even the catalogue shopping by mail (which originated in the 19th Century). So, will they succeed now? Possibly, yes.

Why? Because several things have changed. PCs have spread (decreasing in cost while increasing in power and capability), to accustom many people to interactive digital applications. Adults can use spreadsheets and online applications in the home or at work, while children can play games and do educa-

tional tasks using the same machine (though obviously not at the same time). There is also the improved usability of online services signalled by the phenomenal growth of the Internet's World Wide Web.

It has become clear that when substantially better ways are found for individuals to use the capacities of networks directly (with excellent user interfaces employing multimedia and with access to useful services and vast amounts of information) people rapidly adopt them and online service vendors equally rapidly provide them.

A converged online environment has been envisaged, in which a computing telecomms device is left permanently on like a telephone, to provide an immediate network dial tone. Over such a device, people will be able to obtain information, conduct business, and be entertained.

Multimedia/Broadband Services

Will television disappear, or will the TV set be the integrating device? Will the PC absorb television, or will new media be experienced through a completely new type of device? Will telecomms companies become major players in the programming business, or will a layer of intermediaries emerge? And that is just the business framework – what of the applications themselves?

From a technology user's perspective (whether business or individual) multimedia is a trend which allows different information, communications or entertainment media to become available through a single system or user device. The formerly separate disciplines of creating text, video and sound will then be able to be combined within a single product.

From the provider and user ends of the spectrum, multimedia seems to threaten (or promise) a revolution in the way information and communications are shared. But while business leaders and industry gurus are agreed on the process, no-one can be sure of the outcome.

After content, the first item multimedia requires is bandwidth. PC multimedia is, thus, based around the compact laser disc or CD-ROM, which has the capacity to store large amounts of graphics, plus video sequences. CDs further have the distinct advantage of being a well-understood consumer item.

Multimedia developers and users will design the applications to match existing cost structures. Given today's limitations, it is not surprising that network-based multimedia applications are limited to primitive text, graphic and animation mixes, at the World Wide Web end of the sector, or to high-value applications that can justify the hefty cost of bandwidth, at the other.

At the high end is telesurgery. Down the scale are specialised commercial business services for text and video programming. But the leading high-value sector involves systems which combine teleconferencing and groupware, where participants are able to communicate face-to-face and share files and data. Great flexible working potential indeed.

Groupware

Groupware can be defined as "technology that communicates and organises unpredictable information, allowing dynamic groups to interact across time and space". Companies now and in the future face challenges in the increased need for company-wide co-ordination running alongside newly dispersed responsibilities (the results of the moves to re-engineering). Groupware is the system touted as the panacea. However, the many offerings in the groupware sector face competition from 'intranets'.

These are simpler, cheaper private networks on the World Wide Web which combine text, photos, graphics and even video to distribute company news, answer employee questions, update personnel records, and connect far-flung workers. Sounds good. However, users can interact with groupware databases, whereas there is no interaction with a Web site. Groupware also scores on replication, design and development, and security.

The future remains uncertain, as many vendors race to produce products to improve and enhance the Web. Whatever the outcome, the opportunities and potential promised for companies worldwide have far-reaching ramifications. 'Going to work' will never be the same again. Think laterally, not just Internet.

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HEWLETT PACKARD MODULATOR 8403B £50; Marconi noise generator, TF2091, £50; Marconi noise receiver, TF2092A, £50. Tel: Peter (01582) 620578.

WANTED

EQUIPMENT FOR MAKING PCBs (multi-layer printing, front-back through-hole processing and etching equipment). Any advice greatly appreciated. Dada Wilson, 57 North Grove, London N15 5QS.

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APPLE CRACKERS. FirstClass Client BBS, mainly for AppleMac and PC users. Baud rate 2-4K-bit/s to 28·8K-bit/s, 8 data bits, no parity, 1 stop bit. Tel: (01268) 781318/780724.

SPIDER! AMIGA BBS. The lighter alternative. Mainly Amiga and some PC files. Fidonet, Mercurynet and Mufonet. Online games. Speeds up to 19200. Tel: (01568) 613520.

MACTEL METRO/ICONEX. FirstClass Client BBS, AppleMac and PC users. E-mail address on Internet for registered users. Baud rate 2-4K-bit/s to 28·8K-bit/s, 8 data bits, no parity, 1 stop bit. Tel: (0181) 543 8017 (Metro) or (0115) 9455417 (Iconex).

CLUB CORNER

AARS (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Crescent, Kincorth. For details contact: Martin, (GM0JCN), Tel (01569) 731177.

THE BRITISH AMATEUR ELECTRONICS CLUB (founded in 1966), for all interested in electronics. Four newsletters a year, help for members and more! UK subscription £8 a year (junior members £4, overseas members £13.50). For further details send S.A.E. to: The Secretary, Mr. J. F. Davies, 70 Ash Road, Cuddington, Northwich, Cheshire CW8 2PB.

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

CRYSTAL PALACE & DISTRICT RADIO CLUB. Meets on the third Saturday of each month at All Saints Church Parish Rooms, Beulah Hill, London SE19. Details from Wilf Taylor, (G3DSC), Tel: (0181) 699 5732.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY meets every Wednesday at 7.30pm, at 119 Green Lane, Derby. Further details from: Richard Buckby, (G3VGW), 20 Eden Bank, Ambergate DE56 2GG. Tel: (01773) 852475.

ELECTRONIC ORGAN CONSTRUCTORS SOCIETY. For details of meetings, Tel: (0181) 902 3390 or write to 87 Oakington Manor Drive, Wembley, Middlesex HA9 6LX.

E.U.G. User group for all 8-bit Acorn Micros, since 1991. Still going strong. Programming, news, information, sales. Contact: E.U.G., 25 Bertie Road, Southsea, Hants. PO4 8JX. Tel: (01705) 781168.

THE LINCOLN SHORT WAVE CLUB meets every Wednesday night at the City Engineers' Club, Waterside South, Lincoln at 8pm. All welcome. For further details contact Pam, (G4STO) (Secretary). Tel: (01427) 788356.

MODEL RAILWAY ENTHUSIAST? How about joining 'MERG', the Model Electronic Railway Group. For more details contact: Paul King (Honorary Secretary), 25 Fir Tree Way, Hassocks, West Sussex BN6 8BU.

PRESTON AMATEUR RADIO SOCIETY meets every Thursday evening at The Lonsdale Sports and Social Club, Fulwood Hall Lane, Fulwood, (off Watling Street Road), Preston, Lancashire PR2 4DC. Tel: (01772) 794465. Secretary: Mr Eric Eastwood, (G1WCQ), 56 The Mede, Freckleton PR4 1JB, Tel: (01772) 686708.

SCIENCE AT YOUR FINGERTIPS, for 'hands-on' science experiences and experiments, *Science at Your Fingertips Science Review*, Membership £2.50. For further details, please contact Daniel and Caroline Gee, The S.A.Y.F., 37 South Road, Watchet, Somerset TA23 0HG.

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

SOUTHEND & DISTRICT RADIO SOCIETY meets at the Druid Venture Scout Centre, Southend, Essex every Thursday at 8pm. For further details, contact: P.O. Box 88, Rayleigh, Essex SS6 8NZ.

SUDBURY AND DISTRICT RADIO AMATEURS (SanDRA) meet in Gt. Cornard, Sudbury, Suffolk at 8.00pm. Visitors and new members are very welcome. Refreshments are available. For details please contact Tony, (G8LTY), Tel: (01787) 313212 before 10.00pm.

TESUG (The European Satellite User Group) for all satellite TV enthusiasts! Totally independent. TESUG provides the most up-to-date news available (through its monthly 'Footprint' newsletter, and a teletext service on the pan-European 'Super Channel'). It also provides a wide variety of help and information. Contact: Eric N. Wiltsher, TESUG, P.O. Box 576 Orpington, Kent BR6 9WY.

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

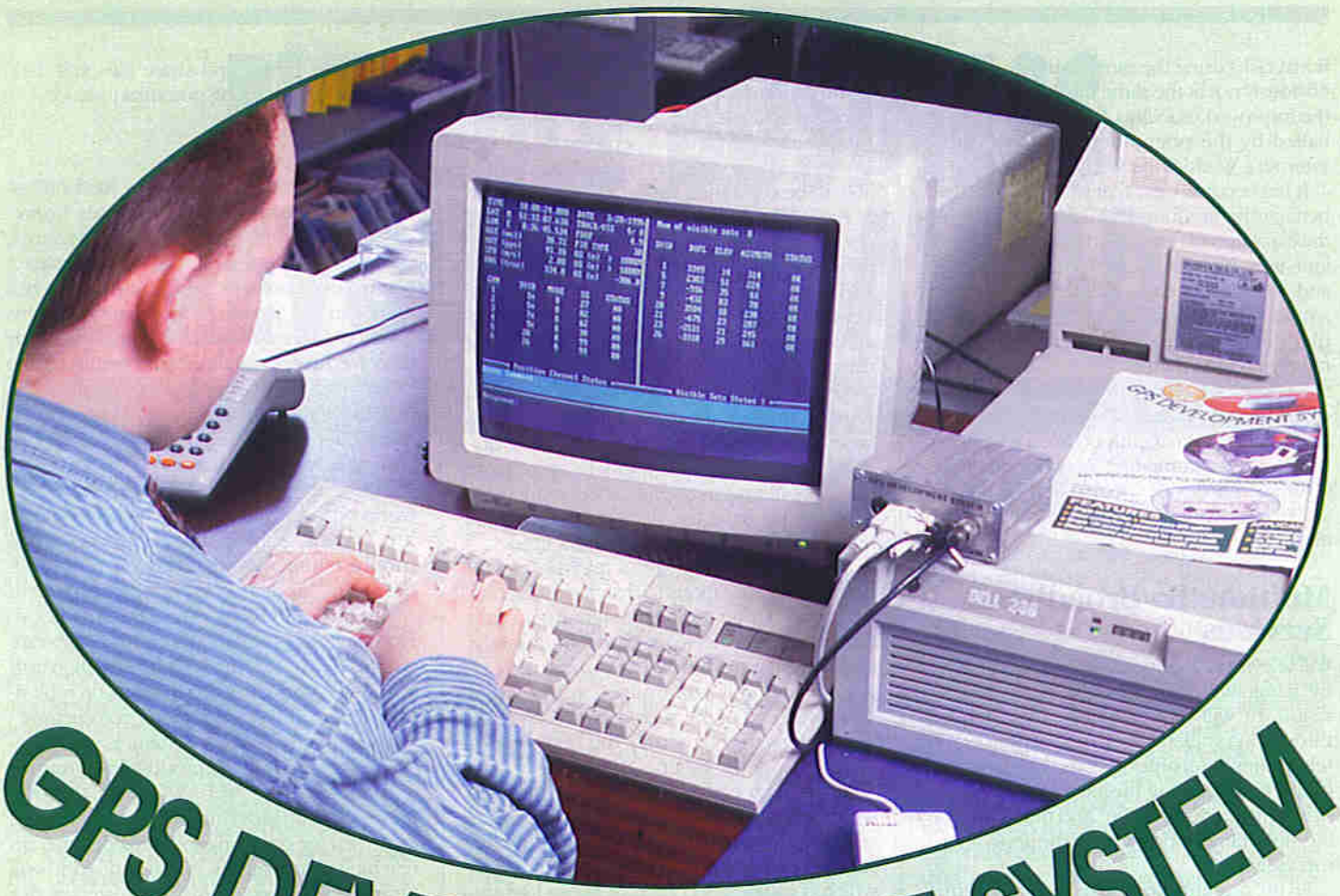
WAKEFIELD AND DISTRICT RADIO SOCIETY meet at 8.00pm on Tuesdays at the Community Centre, Prospect Road, Ossett, West Yorkshire. Contact Bob Firth, (G3WWF), (QTHR), Tel: (0113) 282 5519.

THE (WIGAN) DOUGLAS VALLEY AMATEUR RADIO SOCIETY meets on the first and third Thursdays of the month from 8.00pm at the Wigan Sea Cadet HQ, Training Ship Sceptre, Brookhouse Terrace, off Warrington Lane, Wigan. Contact: D. Snape, (G4GWG), Tel: (01942) 211397 (Wigan).

WINCHESTER AMATEUR RADIO CLUB meets on the third Friday of each month. For full programme contact: G4AXO, Tel: (01962) 860807.

WIRRAL AMATEUR RADIO SOCIETY meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the the 1st and 3rd Wednesday of every month. Details: A. Seed, (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE.

WIRRAL AND DISTRICT AMATEUR RADIO SOCIETY meets at the Irby Cricket Club, Irby, Wirral. Organises visits, DF hunts, demonstrations and junk sales. For further details, please contact: Paul Robinson, (G0JZP) on (0151) 648 5892.



GPS DEVELOPMENT SYSTEM

Part 2

Two of the programs described in this article have been developed specifically for use with the GPS Development System as featured in Electronics Issue 97 (January 1996). The third is a demonstration mapping program for use with any GPS receiver with NMEA output and a suitable RS232 interface. All three programs run on any IBM-compatible PC operating under Windows™ 3.x or Windows™ '95.

DISKETTE/ SOFTWARE MANUAL AVAILABLE (95051) PRICE £9.99

Ever since man could walk, he has relied on two-dimensional navigation to find his way around the World (see the 2-D introduction in Part 1). In the 1970's the first GPS satellites were launched for the Navstar Global Positioning System. This is a truly global network of satellites, placed in orbits so that most of the Earth's surface is adequately covered by the 'web'. Tracking with three satellites gives an accurate two-dimensional position, but when four satellites are in view, accurate user height can be determined as well, thus giving true three-dimensional (3-D) positional information.

The system is now fully in place in the 1990's and allows anyone with the right hardware to receive several of the GPS satellites simultaneously. With the right software the processed signals can be displayed on a computer in tabular form in programs such as Excel or Lotus, or with digitised maps and charts for land and marine use with the benefits of graphical information such as roads, hotels and restaurants or digitised charts with coast lines, navigation channels and buoys makes it a powerful tool for a variety of uses.

Motorola GPS Control Program

Loading

In order to correctly load the GPS Control Program software, place the program disk into the appropriate size disk drive and transfer control to the disk drive (ex: a: <CR>).

Type the following command at the prompt:
gpsload <source_drive> <target_drive> <CR>
(ex: gpsload a: c: <CR>)

The GPS Control Program and all essential utility files will be transferred into a subdirectory of the target drive's root directory. The name of the subdirectory corresponds to the current release version of the GPS Control Program (ex: c:\gps90).

If the subdirectory to be created already exists, a prompt will be provided to determine if the user wishes to over-write any files with like names or terminate the GPSLoad program.

Provided within the utility subdirectory of the newly created GPS Control Program directory are two files: MARKNET.EXE and RELNET.EXE.

These files are part of the TSR Utilities package produced by TurboPower Software and are provided free of charge.

MARKNET.EXE and RELNET.EXE require DOS version 3, 4 or 5, if you are using a later version of DOS, i.e. 6.xx or Windows '95 it is necessary to use the SETVER.EXE program to enable MARKNET.EXE and RELNET.EXE to run. Information on using the SETVER.EXE program may be found by typing HELP SETVER at the DOS command prompt.

Executing

In order to execute the GPS Control Program, the user's present working directory must be the newly created GPS Control Program directory (ex: c:\gps90). Execution will begin by typing the following at the prompt:
gps <CR>

NOTE: By placing the created GPS Control Program directory into the 'PATH=' statement of the PC's AUTOEXEC.BAT file, the GPS Control Program may be executed from within any system directory.

Receiver Initialisation

With the GPS Control Program running the user will be prompted to input some information. First which COM port for RS232 communication?

Enter **1** or **2** <CR>

This depends on which COM port the ONCORE receiver is connected to.

Next select the number of channels

Enter **8** <CR>.

The program sets the ONCORE receiver to use Motorola Binary Format, as well as updating the receiver date and time with the system date and time from the computer.

After a couple of seconds the program will indicate that the ONCORE receiver is receiving satellite data by displaying information on the computer screen.

Control Commands

The ONCORE receiver is controlled by commands, a list of the most commonly used are shown in Table 1.

The keyboard function keys F1 to F10 (see Table 2) associate with screen displays which are shown on the righthand portion of the screen.

Recording Data

It is possible to record data from the ONCORE receiver to the PC. This data can then be imported to Excel, Lotus or other spreadsheet programs for plotting.

The record command is:

record [option]

The options are:

alm, eph, cor, alt, evt, bin, ps8, rg8, et8 and **ts8**

To start the recording process type in the appropriate command for the type of data you require, i.e. **record rg8** (satellite range data).

Note: You must also request data output from the receiver

type **rg8 1 record rg8**

To stop the recording process type in the appropriate command followed by the letter c, i.e. **record rg8 c**. This closes the file to the computer.

File Formats

Data recorded by the PC Controller program has specific file format information associated with it. File names are assigned automatically by the PC Controller program based on the date and the file number yymmdd##.ext.

For example, an ephemeris data file created on the sixteenth of July 1992 would have a file name 92061604.eph.

The 04 indicates the file number i.e. the fourth .eph file.

All files recorded in the Comma Separated Variable (CSV) format can be imported to Excel, Lotus or other spreadsheet programs. In some cases such as Excel 2.0 the extension file name (which is unique to the ONCORE receiver data output) must be changed to .CSV.

Table 3 shows file extensions associated with the 8-channel receiver.

Almanac and Ephermeris Data

The ONCORE receiver stores Almanac and Ephemeris data for current operational satellites. These can be manually stored on a PC computer as files (see the previous section on how to

Controller Command	Function	Syntax
ah (*d* | *e*)	Altitude Hold Enable/Disable	*d* disable *e* enable
ahp (*hhhhh.hh*) (*gps* | *msl*)	Altitude Hold Fixed Height	*hhhhh.hh* fixed altitude height in m *gps* GPS ellipsoid height *msl* MSL – height above mean sea level
alm (*0* | *1*)	Almanac Status Message	*0* output once) *1* output upon change
almhold (*u* | *n*)	Almanac Update/No Update Mode	*u* automatic update *n* no automatic update
almout (*0* | *1*)	Output Almanac Data Message	*0* output once *1* output upon change
aptype (*a* | *h* | *l* | *m* | *s*)	Set Application Type	*a* air *h* hand held *l* land *m* marine *s* static
datum (1 to 49) (50 to 51)	Datum id Code (see Table 2)	*12* EUROPEAN_1950_WestEurope *39* ORD_SRVY_GRT_BRITAIN_1936
dtp *x*DOP (8 channel)	*x*DOP Table Status Message	*G*DOP *P*DOP *H*DOP *V*DOP *T*DOP
doptype *x*DOP	*x*DOP Satellite Selection Criteria	*G*DOP *P*DOP *H*DOP *V*DOP *T*DOP
dos	DOS Shell	
ephhold (*0* | *1*)	Ephemeris Hold Enable/Disable	*0* disable *1* enable
fix (*b* | *n*)	Position Fix Algorithm Type	*b* best 4 satellites *n* n satellites in view
hgt *hhhhh.hh* (*gps* | *msl*)	Sets the Initial Height Coordinate	*hhhhh.hh gps msl*
id	Outputs ID message from ONCORE receiver containing copyright version/revision information	
ioformat (*0* | *1* | *2*)	Selects I/O Format	*0* Motorola Binary Format *1* NMEA-0183 Format 2 LORAN Emulation Format
lat ((-)*dd mm ss.sss*)	Sets the initial latitude coordinate	((-)*dd mm ss.sss*)
lon ((-)*dd mm ss.sss*)	Sets the initial longitude coordinate	((-)*dd mm ss.sss*)
mode (*i* | *f*)	Forces the ONCORE receiver to the i Idle or Position *f* Fix mode	
ph (*d* | *e*)	Manually turns the position-hold function on and off	*d* disable *e* enable
quit	Exit to DOS	
record (alm | eph | cor | evt | bin | ps8 | rg8 | et8 | ext | alt | ts8 | C	Record GPS Data	
rng8 (*0*(*1 to 255*))	Outputs basic satellite range and range rate information for each of the satellites tracked	*0* one time only *1* to *255* rate of message repetition
run (*filename*)	Computer specific command	(*filename*) i.e. nmea.dta
selftest	Causes the receiver to perform a self-test	
sm (*a* | *m* | *h*)	Satellite Select Modes Automatic/Manual	(*a* | *m* | *h*)
time (*h m s*)	Changes the current time of day in the receiver	*h* hours *m* minutes *s* seconds
vis (*0* | *1*)	Outputs the results of the most current satellite alert computations	*0* displays out one time only *1* outputs when visibility changes

Table 1.

Function Key	Screen Display
F1	Visible Satellite Status
F2	Dilution of Precision Table Status
F3	Almanac Status
F4	Almanac Data
F5	Ephemeris Data
F6	Satellite Range Data
F7	Pseudorange Correction Data
F8	Self Test
F9	Alert Planning Data
F10	Event Message record
Shift-F1	Extension Data
Shift-F3	Navigation Data – Optional Feature
Shift-F4	Time RAIM Setup & Status – Optional Feature

Table 2.

File Type	File Format	File Extensions
Alert Table Data *	Text	.alt
All Data	Motorola Binary Format	.bin
Almanac Data	Motorola Binary Format	.alm
Ephemeris Data	Motorola Binary Format	.eph
Event Data	Text	.evt
Position/Channel Extension Data *	CSV Format	.et8
Position/Channel Status *	CSV Format	.ps8
Pseudorange Correction Data	CSV Format	.cor
ange Data *	CSV Format	.rg8
Time RAIM Setup and Status	CSV Format	.ts8

* (8-channel receiver)

Table 3.

record data). It is important to do this from time to time in case the GPS receiver is reset.

NMEA-0183 Format

The GPS Control Program will automatically switch the ONCORE receiver into Motorola Binary Format, regardless of previous data format selected.

Some applications will require the ONCORE receiver to be placed into NMEA Format data output mode. In many cases it will be necessary to manually select this mode by using GPS Control Program since the application may be unable to perform this task. An example of this is the GPSS program from Sunninghill Systems supplied free on the additional disks included.

NMEA Format data output may be quickly and easily selected by executing the GPS Control Program and then running the pre-defined macro NMEA.DTA within the GPS Control Program. This is achieved by entering the following command at the GPS Control Program command prompt:

run nmea.dta <CR>

NMEA messages are enabled/disabled using ASCII command strings as detailed on pages 6.150 to 6.165 Oncore Software Command Manual (Order Code: DT12N).

To facilitate ease of NMEA message selection two files NMEA1.TRM and NMEA2.TRM are provided for use with Microsoft Windows Terminal Program TERMINAL.EXE – this program is supplied with Windows 3.1, 3.11 and '95 and resides in the windows directory.

The two *.TRM files will be found in the NMEACFG directory on the GPS Utilities Installation Disk and should be copied from the installation disk into the Windows directory. To use the files, run the Windows Terminal Program (normally found in the Accessories Program Group), then select 'Open' from the 'File' pull-down menu then select either NMEA1.TRM (ONCORE module connected to COM1) or NMEA2.TRM (ONCORE module connected to COM2).

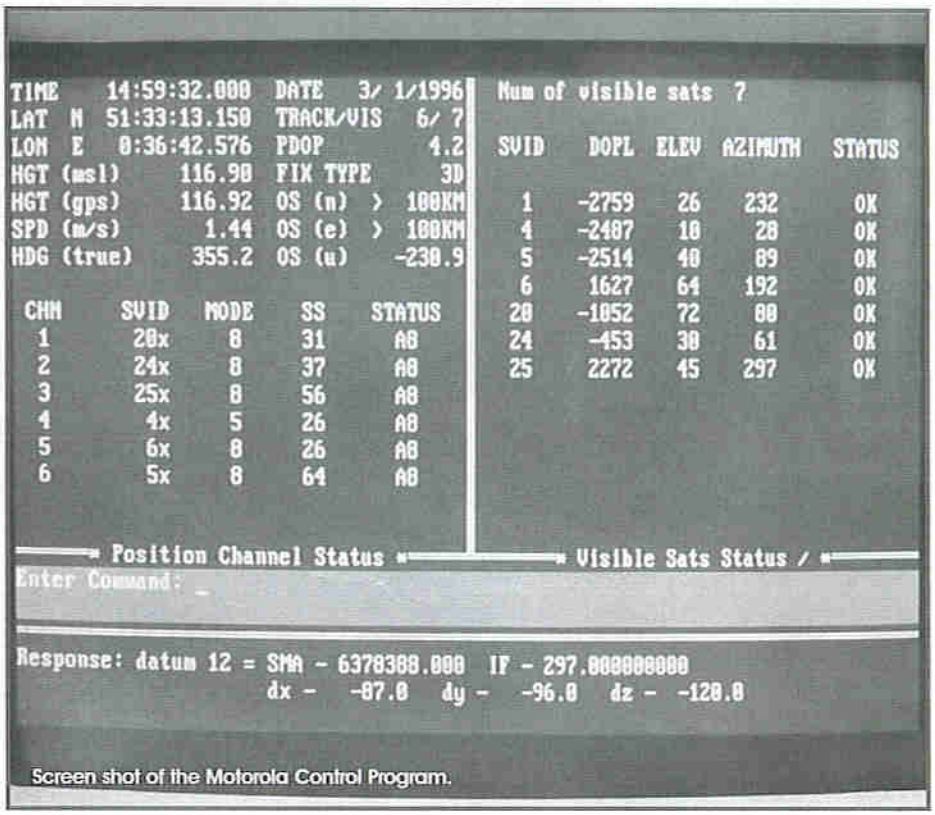
Each file configures the Windows Terminal Program to communicate with the ONCORE module on the appropriate COM port at 4800 BAUD. With either NMEA1.TRM or NMEA2.TRM opened, seven buttons each bearing a NMEA message name will be displayed at the bottom of the window. Another button bearing 'Level: n' (where 'n' is 1 or 2) will also be displayed. 'Clicking' on the 'Level: n' button will toggle between 'Level: 1' and 'Level: 2'.

'Level: 1' displays seven NMEA message 'ON' buttons and 'Level: 2' displays seven NMEA message 'OFF' buttons. 'Clicking' on a NMEA message 'ON' button will enable the corresponding NMEA message with an update rate of once per second. Similarly 'Clicking' on a NMEA message 'OFF' button will disable the corresponding NMEA message.

If a NMEA message is currently disabled 'Clicking' on a NMEA message 'OFF' button will 'one-shot' the corresponding NMEA message – i.e. the ONCORE module will send the corresponding NMEA message once then stop, other currently enabled or disabled messages will remain unaffected. NMEA messages will appear on screen as they are sent by the ONCORE module – such is a useful diagnostic facility should problems be experienced.

Once the ONCORE module is configured in this way to send the appropriate NMEA messages, Windows Terminal may be closed-down – the ONCORE receiver NMEA message configuration will remain set until changed by the user, even if the receiver is powered-down (configuration is stored in battery backed-up on-board RAM).

Please note that executing the GPS Control Program will switch the ONCORE receiver back into Motorola Binary Format, if subsequent operation in NMEA Format is required, re-run the NMEA.DTA macro and re-configure NMEA messages using the Windows Terminal Program as described above.



Screen shot of the Motorola Control Program.

NGR.BAS QBASIC Program

This program requires Microsoft QBASIC (as supplied with recent versions of DOS). It demonstrates how programs may be written in QBASIC to utilise the data from the ONCORE receiver. Before running the NGR.BAS program, initialise the ONCORE receiver by executing the GPS Control Program – this will also ensure

```
SUB interpret (nodenchars$) STATIC

    nodeshuffer$ = nodeshuffer$ + nodenchars$

    posmsg = INSTR(1, nodeshuffer$, "$$Ba")
    messagelen = LEN(nodeshuffer$)
    IF posmsg = 0 THEN EXIT SUB
    IF messagelen - posmsg < 68 THEN EXIT SUB

    nodeinput$ = MID$(nodeshuffer$, posmsg)
    nodeshuffer$ = MID$(nodeinput$, 44)
    ea$ = INSTR(nodeinput$, 4)
    IF ea$ <> "$$Ba" THEN EXIT SUB

    month = (ASC(MID$(nodeinput$, 9, 1)))
    day = (ASC(MID$(nodeinput$, 6, 1)))
    year = (ttv2(MID$(nodeinput$, 7, 2)))
    hour = (ASC(MID$(nodeinput$, 5, 1)))
    MIN = (ASC(MID$(nodeinput$, 10, 1)))
    SEC = (ASC(MID$(nodeinput$, 11, 1)))
    msec = (ttv4(MID$(nodeinput$, 12, 4)))

    latit = (ttv4(MID$(nodeinput$, 16, 4)))
    longit = (ttv4(MID$(nodeinput$, 20, 4)))
    mslheight = (ttv4(MID$(nodeinput$, 24, 4)))

    DIM lat AS DOUBLE, lon AS DOUBLE, trulat AS DOUBLE, trulon
AS DOUBLE
    DIM a AS DOUBLE, b AS DOUBLE, e AS DOUBLE, n AS DOUBLE, m
AS DOUBLE
    DIM v AS DOUBLE, p AS DOUBLE, eta AS DOUBLE, bigE AS DOUBLE,
bigN AS DOUBLE
    DIM bigE AS DOUBLE, bigV AS DOUBLE, I AS DOUBLE
    DIM II AS DOUBLE, III AS DOUBLE, IIIA AS DOUBLE, IV AS
DOUBLE, VI AS DOUBLE

    lat = (latit / 3600000) * (3.1415926534# / 180)
    lon = (longit / 3600000) * (3.1415926534# / 180)

    trulat = 49 * (3.1415926534# / 180)
    trulon = -2 * (3.1415926534# / 180)

    'Calculate parts for conversion to NGR

    a = 6377563.396#        'scales by Fo
    b = 6356117.697#        'scaled by Fo
    e = .0066934800225#
    n = .0016732203#
    m = b * (((1 + n + ((5 / 4) * n ^ 2) + ((5 / 4) * n ^ 3))
* (lat - trulat)) - ((3 * n + 3 * n ^ 2 + (21 / 8) * n ^ 3) *
SIN(lat - trulat) * COS(lat + trulat)) + (((15 / 8) * n ^ 2 + (15
/ 8) * n ^ 3) * SIN(2 * (lat - trulat)) * COS(2 * (lat + trulat)))
- (((35 / 24) * n ^ 3 * SIN(3 * (lat - trulat)) * COS(3 * (lat +
trulat))))
    V = a / (((1 - e * SIN(lat) ^ 2) ^ .5))    'nu
    p = (v * (1 - e)) / (1 - e * (SIN(lat) ^ 2))'rho
    eta = (v / p) - 1       'actually eta-eta^2
    bigE = lon - trulon
          I = m + (-100000)
          II = (v / 2) * (SIN(lat)) * (COS(lat))
          III = (v / 24) * (SIN(lat)) * ((COS(lat)) ^ 3) * (5
- (TAN(lat) ^ 2) + (9 * eta))
          IIIA = (v / 720) * SIN(lat) * (COS(lat) ^ 5) * (61
- 58 * (TAN(lat) ^ 2) + (TAN(lat) ^ 4))
          bigN = I + ((bigE ^ 2) * II) + ((bigE ^ 4) * III) + ((bigE
^ 6) * IIIA)
          IV = v * COS(lat)
          bigV = (v / 6) * (COS(lat) ^ 3) * ((v / p) -
(TAN(lat) ^ 2))
          VI = (v / 120) * (COS(lat) ^ 5) * ((5 - 18 *
(TAN(lat) ^ 2) + (TAN(lat) ^ 4) + (14 * eta) - 58 * (TAN(lat) ^
2) * eta))
    bigE = 400000 + (bigE * IV) + ((bigE ^ 3) * bigV) + ((bigE
^ 5) * VI)

  x = INT(bigE / 100000)

FOR nnn = 0 TO 3
  IF nnn = 1 THEN x = x + 1
  IF nnn = 2 THEN y = y + 1
  IF nnn = 3 THEN x = x - 1
  IF x = 0 AND y = 0 THEN xo = 92
  IF x = 1 AND y = 0 THEN xo = 93
  IF x = 2 AND y = 0 THEN xo = 94
  IF x = 3 AND y = 0 THEN xo = 95
  IF x = 4 AND y = 0 THEN xo = 96
  IF x = 0 AND y = 1 THEN xo = 87
  IF x = 1 AND y = 1 THEN xo = 88
  IF x = 2 AND y = 1 THEN xo = 89
  IF x = 3 AND y = 1 THEN xo = 90
  IF x = 4 AND y = 1 THEN xo = 91
  IF x = 0 AND y = 2 THEN xo = 82
  IF x = 1 AND y = 2 THEN xo = 83
  IF x = 2 AND y = 2 THEN xo = 84
  IF x = 3 AND y = 2 THEN xo = 85
  IF x = 4 AND y = 2 THEN xo = 86
  IF x = 0 AND y = 3 THEN xo = 77
  IF x = 1 AND y = 3 THEN xo = 78
  IF x = 2 AND y = 3 THEN xo = 79
  IF x = 3 AND y = 3 THEN xo = 80
  IF x = 4 AND y = 3 THEN xo = 81
  IF x = 0 AND y = 4 THEN xo = 72
  IF x = 1 AND y = 4 THEN xo = 73
  IF x = 2 AND y = 4 THEN xo = 74
  IF x = 3 AND y = 4 THEN xo = 75
  IF x = 4 AND y = 4 THEN xo = 76
  IF nnn = 0 THEN xxii = xo
  IF nnn = 1 THEN xxii = xo
  IF nnn = 2 THEN xiii = xo
  IF nnn = 3 THEN xiii = xo
NEXT nnn

  dx = bigE - x
  t = dx / 350000
  y = INT(bigN / 350000)

FOR nnn = 0 TO 3
  IF nnn = 1 THEN x = x + 1
  IF nnn = 2 THEN y = y + 1
  IF nnn = 3 THEN x = x - 1
  IF x = 0 AND y = 0 THEN yo = -62
  IF x = 1 AND y = 0 THEN yo = -68
  IF x = 2 AND y = 0 THEN yo = -62
  IF x = 0 AND y = 1 THEN yo = -73
  IF x = 1 AND y = 1 THEN yo = -75
  IF x = 2 AND y = 1 THEN yo = -78
  IF x = 0 AND y = 2 THEN yo = -56
  IF x = 1 AND y = 2 THEN yo = -52
  IF x = 2 AND y = 2 THEN yo = -60
  IF x = 0 AND y = 3 THEN yo = -47
  IF x = 1 AND y = 3 THEN yo = -52
  IF x = 2 AND y = 3 THEN yo = -54
  IF x = 0 AND y = 4 THEN yo = -40
  IF x = 1 AND y = 4 THEN yo = -49
  IF x = 2 AND y = 4 THEN yo = -52
  IF nnn = 0 THEN eyo = yo
  IF nnn = 1 THEN eyi = yo
  IF nnn = 2 THEN eyii = yo
  IF nnn = 3 THEN eyiii = yo
NEXT nnn

  dy = bigN - y
  u = dy / 350000

  ee = (1 - t) * (1 - u) * exo + t * (1 - u) * exi + t * u * exii
+ (1 - t) * u * exiii
  an = (1 - t) * (1 - u) * eyo + t * (1 - u) * eyi + t * u * eyii
+ (1 - t) * u * eyiii


    Velocity = (ttv2(MID$(nodeinput$, 22, 2)))
    heading = (ttv2(MID$(nodeinput$, 24, 2)))
    dop = (ttv2(MID$(nodeinput$, 26, 2)))
    doptype = (ASC(MID$(nodeinput$, 28, 1)))
    visnats = (ASC(MID$(nodeinput$, 29, 1)))
    tracnats = (ASC(MID$(nodeinput$, 60, 1)))

recstatus = (ASC(MID$(nodeinput$, 66, 1)))

    PRINT ; "Date "; day; "/"; month; "/"; year; "]     [Time
"; hour; MIN; SEC; "]"
    PRINT
    PRINT "Lat:   "; today$(latit)
    PRINT "Lon:   "; today$(longit)
    PRINT
    PRINT "NGR: [E/N] [ "; : PRINT USING "######.##"; bigE + xo;
    PRINT " / "; : PRINT USING "######.##"; bigN - xo; : PRINT
" ]"
    PRINT
    PRINT "Height (MSL): "; : PRINT USING "#####.##"; mslheight
/ 100
    PRINT
    PRINT "Velocity:   "; : PRINT USING "#####.##"; velocity /
100
    PRINT "Heading:    "; : PRINT USING "#####.#"; heading / 10
    PRINT
    PRINT "DOP"; : PRINT USING "##.#"; dop / 10;
    IF doptype = 1 THEN PRINT "  HDOP";
    IF doptype = 0 THEN PRINT "  PDOP";
    PRINT
    PRINT
    PRINT "Visible Sats:"; visnats
    PRINT "Tracked Sats:"; tracnats
    PRINT
    PRINT "recstatus = "; recstatus
END SUB
```

Listing 1

```
[Date  1 / 3 / 1996 ]      [Time  15  1  43 ]

Lat:     51 33 194 880
Lon:     0 36 403 894

NGR: [E/N] [ 581203.87 / 187146.69 ]

Height (MSL):    149.75

Velocity:        0.31
Heading:       124.6

DOP 4.4  PDOP

Visible Sats: 7
Tracked Sats: 5

recstatus =  32

                                        Press ALT+q to quit
```

Screen shot of the NGR QBASIC program

that the ONCORE receiver is in Motorola Binary Format mode. NGR.BAS expects to receive data on COM1, however this may be changed by editing the appropriate line in the body of the main program, as indicated by annotation in the program.

The basic NGR.BAS program is found in the NGRBAS directory on the GPS Utilities Installation Disk and should be copied into a suitable working directory. To run the NGR.BAS program, run QBASIC, open the NGR.BAS file, then choose RUN from the menu-bar. NGR.BAS will display on screen: date, time, current position (or last position if the receiver cannot obtain a fix) – position is displayed in both LAT/LON and OSGB coordinates, satellites in view/tracked, velocity, heading, height above mean sea level, dilution of precision and receiver status.

Subroutines which contain information for converting latitude and longitude to NGR are shown in Listing 1.

Use this program and subroutines to develop your own programs. If you wish to use the program and/or subroutines commercially, please take note of the information given at the beginning of the NGR.BAS program listing. If you develop any programs or routines that you think will be of use to others, please contact the R&D Manager at Maplin (address given below) so we may consider including them on future versions of this disk.

NGR.BAS	QBASIC program to display data from ONCORE module. Requires ONCORE module to be in Motorola Binary Format. Displays position in LAT/LON and OSGB coordinates. Use this program to develop your own applications.

For detailed information on The Ellipsoid and the Transverse Mercator Projection and the National Grid/ETRF89 Transformation Parameters (Geodetic Information Papers No.1 and No.2.) contact the Ordnance Survey (OS) at:

Control Sales, Geodetic Surveys, Room C325, Ordnance Survey, Romsey Road, Southampton, SO16 4GU. Tel: 01703 7925219.

Sunninghill Systems GPSS Software

This is a demonstration program provided on a floppy disk (second disk also available with more maps and sounds) which will work with a Global Positioning System (GPS) receiver with NMEA output.

GPSS.EXE is a program to be run under Microsoft Windows 3.1, 3.11 or '95. It requires a colour VGA screen and a Windows-compatible sound system.

GPSS expects to receive NMEA data on COM1, however this can be changed by editing the GPSS.CFG file, see GPSS documentation files for details.

To use this software, the ONCORE module must be configured to send NMEA Format data.

The following messages are required:

GLL, VTG and GSV, these should be enabled by using Windows Terminal as described above. It is recommended that only the three messages required are enabled.

From Windows, RUN A:INSTALL or click on A:INSTALL.BAT from file manager.

INSTALL.BAT creates directory C:\GPSS01, copies and decompresses the files from floppy disks A: If you have a different configuration you will need to change INSTALL.BAT

Install the second disk, if you have one, for more maps & sounds.

Use File-New to link an Icon to C:\GPSS01\GPSS.EXE

Click on the Icon to execute GPSS.

The Icon in the bottom right corner provides HELP.

The main documentation file is BOOK.TXT which will be found in the GPSS01 directory after the software has been installed and decompressed.

Further information about GPSS is available direct from Sunninghill Systems. Please note: GPSS is provided free of charge and is supplied 'as is' - neither Motorola Inc., or Maplin Electronics Plc., give any warranty as to its suitability for any given application; neither do Motorola Inc., or Maplin Electronics Plc., accept any liability whatsoever arising from its installation or use; neither do Motorola Inc., or Maplin Electronics Plc., offer any technical or user support in respect of this software.

This software is provided free of charge on two additional disks (Order Code: xxxxx).

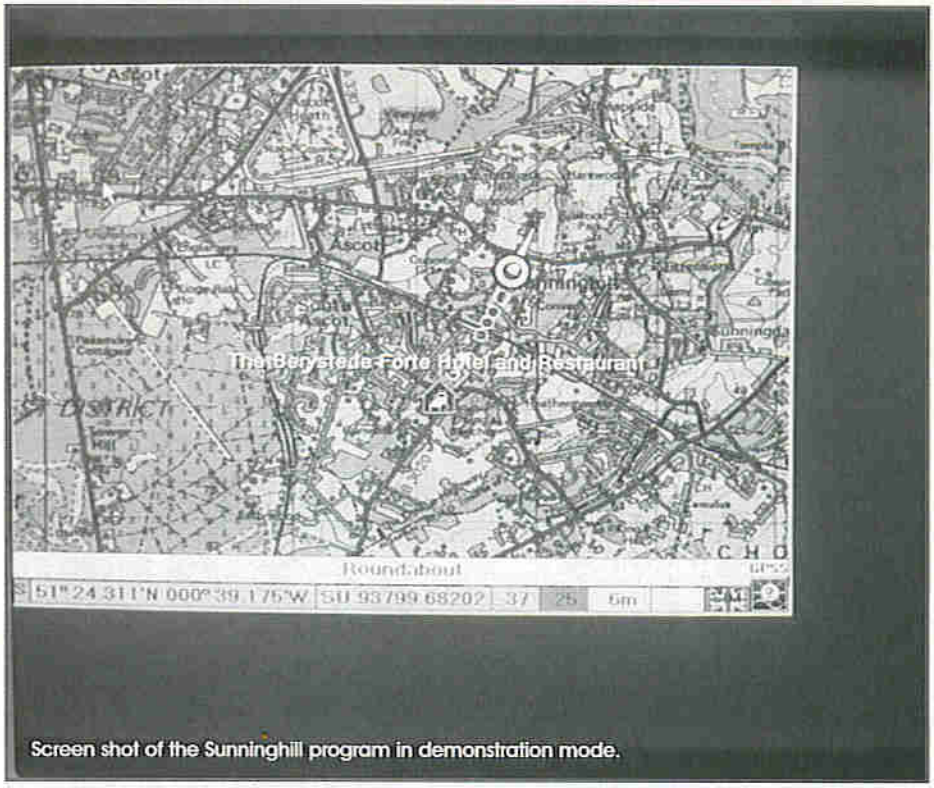
Additional and Modified Files

README.DOC	Additional information added by Maplin Electronics Plc. Copyright Motorola Inc., and Maplin Electronics Plc.
README.BAT	Batch file to display this README.DOC file
NMEA.DTA	Macro to switch ONCORE module into NMEA-0183 Format Use with GPS Control Program
NMEA1.TRM	Setup files for use with Windows Terminal to NMEA2.TRM select/deselect NMEA messages

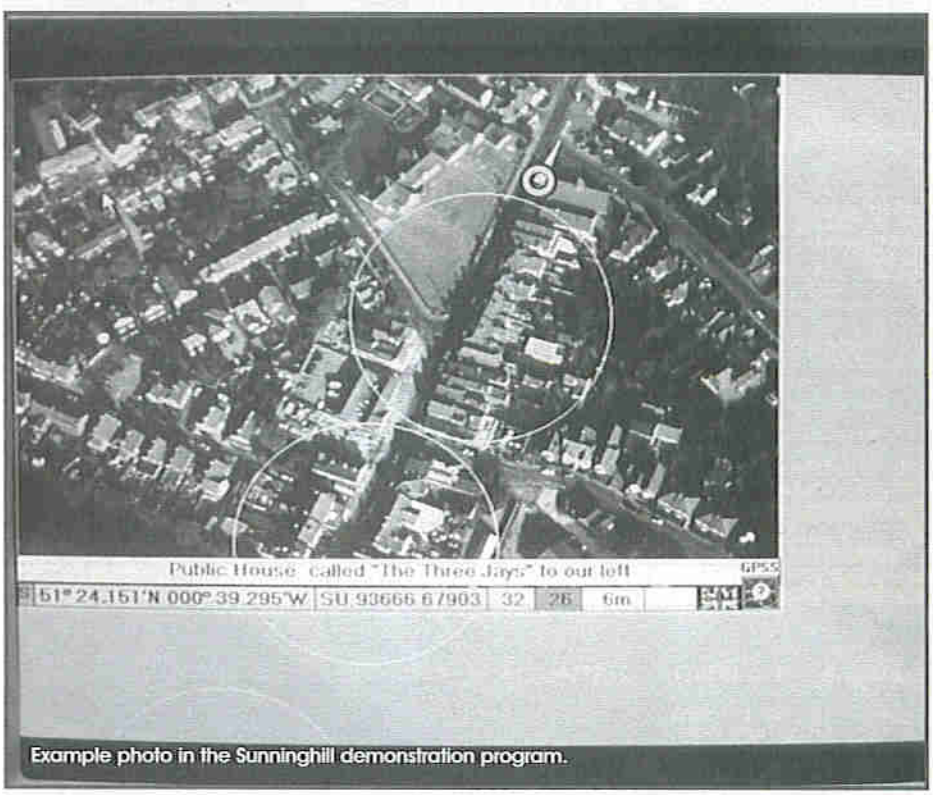
Differential GPS using RTCN SC-104

The ONCORE receiver employs a decoding algorithm that allows the unit to directly decode the RTCM SC-104 type 1 differential message from the input serial port. The technique employed allows the unit to simultaneously accept the RTCM SC-104 type 1 format data stream along with other receiver commands (in either Motorola binary or NMEA format) on the receivers single RS232 port.

To input both RTCM SC-104 type 1 data as well as Motorola binary or NMEA protocol commands, there is a simple set of rules that must be employed to ensure that one type of data is not interpreted as the other.



Screen shot of the Sunninghill program in demonstration mode.



Example photo in the Sunninghill demonstration program.

RTCM SC-104 Type 1/9 Message Decoding

When using the RTCM SC-104 type 1/9 data (6 of 8 type with two significant bits always 01) in conjunction with either the Motorola binary or the NMEA protocol, special care must be exercised by the user to ensure that the RTCM SC-104 type 1/9 data messages and the Motorola Binary/NMEA data messages do not interfere with each other.

To better understand what the user must do to insert both RTCM SC-104 data AND either Motorola binary data or NMEA format commands, the user should understand how the receiver RS232 message decoding software operates.

The ONCORE receiver RS232 decoding logic operates as follows:

The received data from the RS232 port is placed into two buffers via interrupt driven software. These two data buffers are labelled B1 and B2. The Motorola binary data format and the NMEA data format is orthogonal to the RTCN data. Consequently the receiver message decoding logic first looks for Motorola format data (or NMEA data, depending on the message format selected) first by decoding the appropriate format data from buffer B1, if any GPS input commands or data is detected in the stream, the internal software executes that command and then removes the Motorola binary data

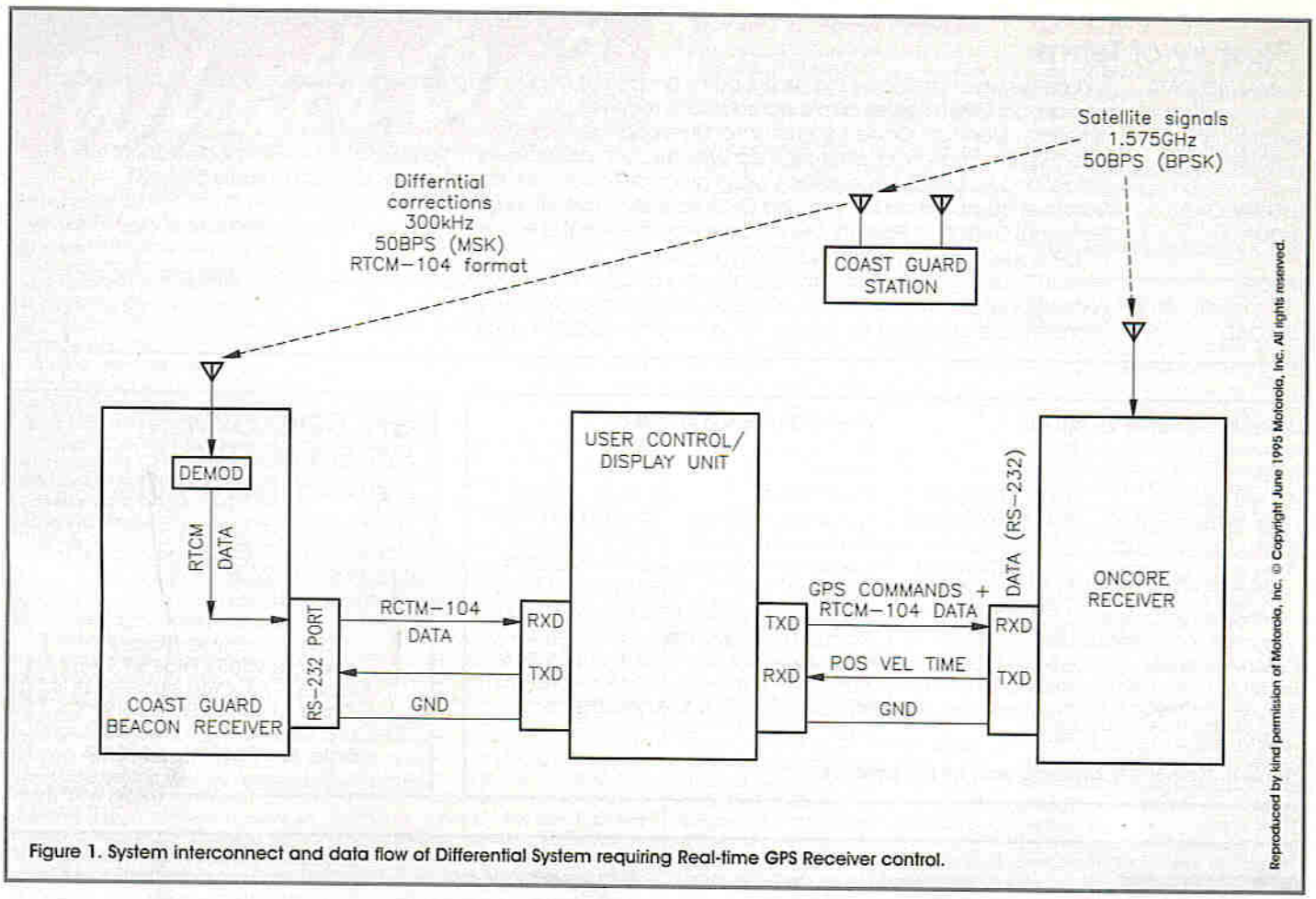


Figure 1. System interconnect and data flow of Differential System requiring Real-time GPS Receiver control.

message out of buffer B1 and B2. Any remaining data left in B2 is passed back to the RTCN SC-104 decode software.

The User of the receiver in a differential system (based on the RTCM SC-104 type 1/9 correction stream) can configure the system into two classes, depending on the requirements. These two configurations consist of:

1. Applications NOT requiring real-time GPS control.
2. Applications requiring real-time GPS control.

Applications Requiring Real-Time

The ONCORE receiver is designed to accept its normal I/O commands and at the same time accept RTCM SC-104 format differential corrections.

In order to utilise the ONCORE receiver's I/O port for both input and differential corrections and receiver commands, the user must install some form of system controller between his source of the RTCM SC-104 data and the receiver (see Figure 1).

The User Controller/Display unit can pass RTCM SC-104 data stream directly from its beacon output port to the ONCORE receiver output port.

When it is time for the Control/Display unit to issue a series of commands to the ONCORE receiver, the Control/Display unit buffers the RTCM SC-104 data stream in a local buffer, while the commands are being passed to the ONCORE receiver.

After all the commands are sent to the ONCORE receiver, the Control/Display unit can then send all buffered RTCM SC-104 data to the ONCORE receiver without loss.

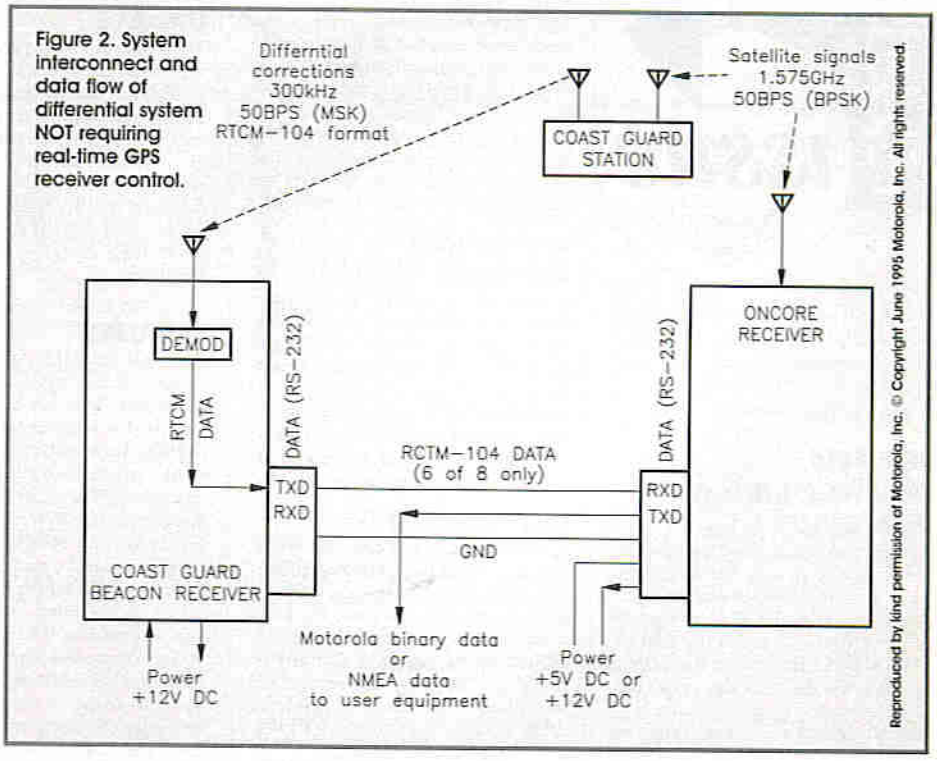


Figure 2. System interconnect and data flow of differential system NOT requiring real-time GPS receiver control.

Applications NOT Requiring Real-Time

To operate the ONCORE receiver with a beacon receiver, the ONCORE receiver must first be configured into its desired operating mode with the Operating System Program. This requires connecting the ONCORE receiver I/O port directly to a PC with a standard serial cable, running the GPS Control Program, and setting the configuration desired (Motorola binary or NMEA).

In the differential application shown in Figure 2, the ONCORE receiver cannot be controlled by an external device while in operation as the input port is tied up by the beacon receiver input. In addition, the output port of the ONCORE receiver is dedicated to the user's output data logging or display system.

The Motorola program incorporates provision to convert the normal data output to NMEA format which is required by mapping programs and a compatible data format acceptable to LORAN equipment.

Glossary of Terms

ALMANAC DATA	A data file which indicates the orbital paths and status of all known satellites. Almanac data is transmitted by operational GPS satellites and is stored in GPS receivers.
ASCII	American Standard Code for Information Interchange.
DATUM	Selective information for different map systems such as European 1950, European 1979 and Ord Srvy GB. 49 predefined Map Datums covering world areas are available, and two user defined Datums 50 to 51.
DOWNLOAD	Transference of a data file from the GPS module to a PC through an RS232 interface.
HDOP	Horizontal Dilution of Position. This indicates the quality of a horizontal position (latitude and longitude). A low HDOP value indicates better position accuracy.
PDOP	Position Dilution of Precision. This indicates the quality of a horizontal and vertical position (latitude, longitude and altitude). A low PDOP value indicates better position accuracy.
UPLOAD	Transference of a data file from a PC to the GPS module through an RS232 interface.

Week 842 almanac for PRN-01		Week 842 almanac for PRN-02	
ID:	01	ID:	02
Health:	000	Health:	000
Eccentricity:	3.339767456E-03	Eccentricity:	1.500606537E-02
Time of Applicability(s):	204800.00000000000	Time of Applicability(s):	204800.00000000000
Orbital Inclination(rad):	9.545878768E-01	Orbital Inclination(rad):	9.471396804E-01
Rate of Right Ascen(r/s):	-7.954617409E-09	Rate of Right Ascen(r/s):	-8.057479128E-09
SQRT(A) (m^ 1/2):	5153.71093750000	SQRT(A) (m^ 1/2):	5153.62744140625
Right Ascen at TOA(rad):	3.501783013E-01	Right Ascen at TOA(rad):	2.389236927E+00
Argument of Perigee(rad):	-1.431447506E+00	Argument of Perigee(rad):	-2.475491762E+00
Mean Anom(rad):	1.028584719E+00	Mean Anom(rad):	-2.964451551E+00
Af0(s):	4.863739014E-04	Af0(s):	-2.355575562E-04
Af1(s/s):	-1.818989404E-11	Af1(su/s):	-3.637978807E-12
week:	842	week:	842

Table 4. Typical GPS Almanac data for two satellites.

In the July 1996 issue (No. 103) of *Electronics – The Maplin Magazine*, there is another sizzling variety of projects to build and informative features to read, including:

PROJECTS

DYNAMIC RANGE PROCESSOR

A useful project that allows the dynamic range of a signal to be increased (expanded) or decreased (compressed) by a variable amount of up to a factor of three times. A must for anyone who takes the art of sound recording seriously, the design of this circuit has been optimised to produce the best possible results on a wide range of music.

PATTRESS MOUNTING DIMMER SWITCH

This smart-looking and simple to use touch-dimmer switch is fitted in place of conventional wall-mounted light switches, and provides smooth, stepless up and down dimming of the light so that you can obtain just the right light level and atmosphere in a room. An added bonus is that there are no moving parts or contacts to wear out.

4-CHANNEL RUNNING LIGHT

Controlling up to four mains voltage lamps, of up to 2W each via triacs, this multi-function project enables the lamps to be flashed in four different sequences – left or right chasing effect, flip-flop or all flashing simultaneously, with adjustable speed. Ideal for disco and party lighting, or for attention-grabbing advertising displays.

LASER POINTER

A simple to build and cost-effective kit to create a compact, hand-held Class IIIA laser pointer, ideal for teachers, lecturers and demonstrators. The focus of the high-intensity red beam is widely adjustable to provide a sharp or dispersed circular dot, and an optional line generating lens is available to create a single line – useful for safely demonstrating laser properties.

NEWTON TONE CONTROL MODULE UPDATE

This project is an updated and improved version of the Tone Control Unit previously featured in *Electronics*. The updated version incorporates features designed to further reduce distortion, including a modified pentode stage and detail changes to create a quality valve-based tone control unit, ideally matched to the acclaimed Newton stereo valve amplifier.

FEATURES

Aerogels from Douglas Clarkson, describes the development of an extremely light yet highly efficient silicon-based thermal insulating material, which has additional applications in optics and sound absorption. The second part of Sound Reinforcement Systems for Gigging Bands by Andy Rimell covers the use of mixing desks and effects units, building of speaker/PA systems, practical advice on hiring of equipment for gigs, and touring. The final instalment of Ray Marston's Practical Guide to Modern Digital ICs shows how to use special-purpose chips, including bus transceivers, parity generators/checkers, analogue switches, priority encoders, rate multipliers and other such 'exotic' devices from the CMOS and TTL stables. Client-server from Frank Booty concerns computer network management that provides companies with the ability to conveniently integrate computer systems across multifarious platforms. Also, the third part of Value Added Internet Services, by Keith Brindley, offers more useful guidance on how best to go about getting hooked up to the information superhighway. Driving for Control, by Stephen Waddington, concerns the methods used to accurately govern the speed of motors appropriate to their applications in drills, pumps and power-assisted systems.

All this, plus all your favourite regulars as well!

ELECTRONICS
The Maplin Magazine

BRITAIN'S BEST SELLING ELECTRONICS MAGAZINE

What's On?

intermediaWORLD – Show Report

We were to bring you a show report from CeBit this month. Unfortunately, our Diary Dates reporter spent the whole of his stay at the Hannover show, in bed at the Hotel Intercontinental with flu. Or at least, that's his story.

Instead, we bring you a report from intermediaWORLD '96, which took place in the sunny climes of San Francisco in March. This show gave 15,000 Internet developers, publishers, WWW designers and digital artists a first look at some of the tools that are set to become available for professionals looking to enhance their Internet and multimedia development skills.

A number of companies used intermediaWORLD as the forum for product and development announcements. Here, we take a look at some of the major announcements at the show:

Macromedia unveiled Director 5.0, which allows people to take their WWW sites to a new level of interactive multimedia by integrating even faster 3D graphics, professional quality sound, video and new special effects. Shockwave for Director, a Netscape plug-in that allows net users to take advantage of WWW sites built using Director 5.0, is available free to all Internet users at **http://www.macromedia.com.** More than 100,000 net surfers have already downloaded the software.

In a keynote address, Intel Fellow, Fred Pollack, revealed the details of the long-awaited multimedia extensions (MMX). This new microprocessor technology will lead to new enhancements and capabilities in multimedia, communications, and Internet applications. Microsoft confirmed it would support Intel's chip-based MMX specifications in its software-based DirectX multimedia extensions to Windows '95.

The next generation of cross-platform digital video technology for the desktop and the Internet has arrived, in the form of Microsoft's ActiveMovie. Many companies have announced support for this technology that delivers stunning effects on multiple platforms with crisp synchronised audio, video and special effects. Direct 3D will allow software developers the ability to create virtual worlds, 3D computer games and business applications that will redefine the look and experience of the Internet. For example, Direct 3D will allow Internet users virtual access all over the world, taking people on frame-by-frame tours of cities, towns and buildings.

As developers of DVD-ROM technology, Philips and Toshiba displayed their initial prototypes, and marked what some claim to be the beginning of a new era in home entertainment. DVD-ROM is the same size as a conventional CD-ROM, but enables images to be stored at three times the quality of VHS tape. Providing surround sound capability, DVD will allow for more interactive viewing by providing various language tracks, four half-hour straight-through play, parental rating control and the ability to change viewing camera angles.

Home PC Show Preview

The Home PC Show at Earls Court, London from 30 May to 2 June, is a new exhibition which aims to help the consumer through the maze that is home computing.

The Home PC Show responds to the non-technical consumer's needs for jargon-free information, and aims to answer all visitors PC queries including buying a PC, Internet access or home software. Key players from the Home PC market will be supporting the show, including: Compaq, Packard Bell, Hewlett Packard, Dorling Kindersley, Living Books and UK Online.

The demand for Internet applications, word processing, games, general education and accounts packages has helped the home market for PCs explode. Research from analysts Romtec claims that in 1995, the home PC market doubled over the previous year, with home PC sales accounting for a third of the total market. Furthermore, Romtec predicts that the home PC market is growing faster than the business market. The predicted annual growth rate for the home market is 100% against 20% for the total PC market.

The Home PC Show will address the different needs of its audience through a number of feature areas, including the Home PC Show Interactive Theatre. This will focus on four key areas: Designing a Home Office which gives a practical insight into the various technologies required for an office in the home, Learning with PCs, an area dedicated to children's needs – from entertainment to education, Choosing a PC which will be staffed by expert independent advisors, and Online and the Internet, which will explore these areas of technologies.

Contact: Home PC Show, Tel: (0181) 849 6200.

Northern Mobile Amateur Radio Rally

Ripon and District Amateur Radio Society (RADARS) will be presenting the 39th Northern Mobile Amateur Radio Rally (NMR '96), at Ripon Racecourse, on Sunday, June 2nd 1996. Doors open at 11:00 (disabled 10:30). Listen out for the talk-in from 9:30. Details from: Gerald Brady G0UFI, Tel: (01765) 640229, by packet from: G1UXP@GB7CYM, or e-mail: **woody@tangon.demon.co.uk**.

Rugby A.T.S. Amateur Radio Rally

The 8th Annual Rugby A.T.S. Amateur Radio Rally will be held on July 28th 1996 at the BP Truckstop on the A5, 3 miles East of Rugby. Open from 10am, admission is £1 per car, and facilities include a good cafeteria and toilets. Talk-in on S22 by GB8RRR. Pitches are £7 pre-booked or £10 on the day. Further details from Peter on (01455) 552449 or Steve (for bookings) on (01788) 824214.

Technology Foresight Reaches Out to the Engineering and IT Industries

A national programme has been launched to encourage small and medium engineering businesses to plan for the future. Called 'Thinking ahead: getting ahead', the programme distils the lessons of the Market and Technology Foresight programme to meet the needs of specific sectors in electronic, electrical and mechanical engineering, and IT. The Thinking ahead: getting ahead workshops are designed for senior executives of small and medium sized companies and will be held in all English regions, Northern Ireland, Scotland and Wales. For further details contact the DTI, Tel: 0171 215 5000.

DIARY DATES

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

23 to 25 April. The Institute of Physics Annual Conference, Telford International Centre, Telford. Tel: (0171) 235 6111.

29 April to 3 May. Sixth International Conference on AC and DC Transmission, IEE, London. Tel: (0171) 344 5472.

4 May. RSGB Open Day, Potters Bar. Tel: (01707) 659015.

13 May. Astronomy, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

16 May. World Class Manufacturing for SMEs – Some of the Issues, IEE, The Dudley Centre for Competitive Manufacturing, West Midlands. Tel: (0171) 344 5446.

17 to 19 May. Mac Shopper Show, Wembley Centre, London. Tel: (0171) 831 9252.

20 May. Visit to Nickelodeon, Ashorne, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

21 to 22 May. International Conference on Public Transport Electronics Systems, IEE, London. Tel: (0171) 344 8432.

21 to 23 May. Internet World, Olympia, London. Tel: (01865) 730275.

27 May. Open Evening, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

30 May. Home PC Show, Earls Court, London. Tel: (0181) 849 6200.

10 June. 2m Direction Finding Contest, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

15 June. RNARS, HMS Collingwood, Hants. Tel: (01707) 659015.

18 to 20 June. Multimedia, Business Design Centre, London. Tel: (0171) 359 3535.

24 June. Repeater Management Group Chairman, Geof Dover G4AFJ, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

26 to 27 June. Electrical Engineering Exhibition, Airport Skean Dhu, Aberdeen. Tel: (01732) 359990.

30 June. Radio Rally, Longleat, Wiltshire. Tel: (01707) 659015.

6 July. Summer Social Event, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

8 July. 160m Direction Finding Contest, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

8 July to 30 September. Science Museum Superhighway UK Tour, Exploris, Northern Ireland. Tel: (0171) 938 8192.

22 July. Construction Competition, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 295257.

4 August. RSGB National Mobile Rally, Woburn, Beds. Tel: (01707) 659015.

11 August. 39th Annual Derby Mobile Rally, at the Littleover Community School (off A5250), Pastures Hill, Littleover, Derby, opening at 9:30am. Large flea market and famous monster radio and computer 'junk' sale, starting at 11:00am. Trade bookings and information from Martin G3SZJ, QTHR, Tel/Fax: (01332) 556875.

18 August. Radio Rally, Manchester. Tel: (01707) 659015.

18 August. Radio Rally, Great Eastern, Kings Lynn. Tel: (01707) 659015.

1 September. Radio Rally, Telford, Shropshire. Tel: (01707) 659015.

4 to 5 September. Internet, Wembley Centre, London. Tel: (01923) 261663.

7 September. Annual Wight Wireless and Computer Rally at the Wireless Museum, Arreton Manor, Newport, Isle of Wight. 11a.m. to 5p.m. Free entry and parking, free tables for business or private sales. Collection for RAIBC – the wireless charity. Details from Douglas G3KPO. Tel: (01983) 567665. Fax: 564708.

8 September. The Fifteenth Lincoln Hamfest, Lincolnshire Showground. Entry is £1.50. Morse tests available, plus all usual attractions. Caravans welcome (Saturday night only). Details from Sue Middleton, (XYL) (G8VGF) (QTHR), Tel: (01522) 525760.

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

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

24 to 29 September. Live '96, Earls Court, London. Tel: (0181) 742 2828.

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

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

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

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

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

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

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

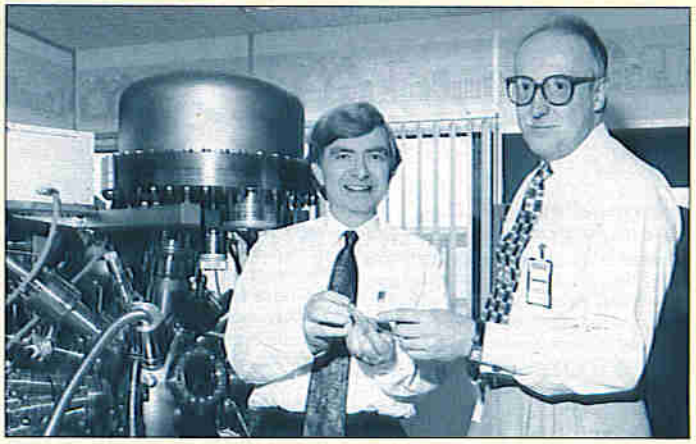
1 to 3 November. Acorn World, Olympia, London. Tel: (01295) 788386.

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

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

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

NEWS Report



Notebook Prices Slashed as 30% Growth Predicted

Compaq has announced price cuts of 23% across its entire LTE 5000 product lines. Compaq's LTE 5000 is based on a 64-bit architecture, and offers a full range of Pentium processors, memory expansion up to 72M-bytes RAM, and the option of an integrated CD-ROM drive.

The LTE 5000 price reductions are effective across the UK, bringing the selling price of an entry-level model featuring a Pentium 75MHz processor, 510M-byte hard disk and a 10in. display to £2,260. For further details, check: **http://www.compaq.com**.

After moderate growth last year of 15%, the world-wide laptop market is expected to increase by 30% in 1996, according to Dataquest. Until now, most laptops have been sold with a 486 processor, but Dataquest expects the transition to Pentium chips to be completed this year. The top seller last year was Toshiba, with Compaq, NEC, and IBM following. For further details, check: **http://www.dataquest.com**.

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

Demand for ATM Switches

Corporate organisations are moving to ATM in the backbone wide area network. According to StrataCom, sales of its ATM kit in 1995 jumped by more than 825% over the previous year.

Meanwhile, DataQuest's recent 'Wide Area ATM Switch Update', put the value of ATM WAN shipments made in the first half of 1995 at $126 million, a 50% growth over 1994, with revenue projected to exceed $1·4 billion by 1998.

Contact: Stratacom, Tel: (01252) 815554.

Modem Price Update

Modem prices continue to fall. Hayes has dropped the price of its ACCURA 144 + FAX144 to £89, compared to the previous recommended retail price of £129. The ACCURA 144 + FAX144 is packaged with one month's free membership to CompuServe, plus an additional £10 credit to the service.

The price of 14.4 modems will continue to drop as 28.8 is accepted as the defacto standard. In the UK, analysts are predicting that the 28.8 modem will take the majority of modem sales, until such time that BT reduce ISDN line prices. For further details, check: **http://www.hayes.co.uk**.

Contact: Hayes, Tel: (01252) 775555.

LEP Production by 1997

Two UK companies, Cambridge Display Technology (CDT) and Xyratex, have signed an agreement to take CDT's pioneering Light Emitting Polymer (LEP) technology from the laboratory into full production. The agreement will enable CDT to further develop its technology and begin to embed it in consumer market applications that currently depend on Light Emitting Diodes (LEDs) or liquid crystal displays (LCDs), such as mobile phones and PDAs.

Over time, LEP technology is set to replace the Cathode Ray Tube (CRT) in TVs and PC monitors. The potential for light-emitting polymers is immense; they are likely to form a substantial proportion of the global electronic displays market estimated by analysts Stanford Resources Inc. at $22.5 billion in 1994, and forecast to exceed $42 billion by the year 2000.

In the initial stages, CDT and Xyratex are working together on technical development and to build a business plan which will maximise the capabilities of each partner in developing a manufacturing facility. A pilot plant is currently planned for the end of 1997, and this will be followed by a full-scale manufacturing production line. For further details, check: **http://www.cityscape.co.uk/users/fq22**.

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

Colour Scanner for the Home

The price of scanners is dropping to within the bounds of home user. At CeBit, Plustek launched the OpticPro, an A4 full colour single pass device with a SCSI-2 interface, priced £269.00 + VAT.

Colour documents and images can be scanned to a maximum resolution of 2,400 × 2,400dpi at a colour depth of 30 bits per pixel, approximating to one billion colours.

Contact: Solution Point, Tel: (0345) 400300.

Drive Through Upgrade Centre

Realising that few computer users are confident of performing their own PC upgrades, Carrera Technology has announced a dedicated PC upgrade centre offering a range of upgrades.

Carrera will offer expert advice on which upgrade best meets the customer's needs in terms of value for money and performance. As part of this service, customers will be able to choose from a menu of upgrade options which clearly illustrate all costs.

Carrera staff will also suggest other ways of optimising performance, such as system configuration. In addition, every machine that arrives at the upgrade centre will receive a complimentary anti-virus check.

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

ASIC Interface for Storage Peripherals

A single-chip ISA and floppy interface from UK-based Shuttle Technology allows OEMs to interface tape, disk, CD-ROM and other removable devices to standard parallel port interfaces, to enable data transfer rates of up to 1·5M-bytes per second. The EPAT Plus Parallel port ASIC features Microsoft plug-and-play compatibility. The device is supplied with device drivers for Windows, DOS, OS/2 and UNIX.

Contact: Shuttle Technology, Tel: (01734) 770441.

Philips Opens Phone Card Market

In a bid to take a slice of Siemen's prepaid phone card action, Philips has launched the PCF2033 IC. Also known as the Eurochip, this second-generation IC is designed for systems using the German Telecom phone card concept. The IC is based on CMOS technology, enabling Philips to take advantage of a choice of fabrication and manufacturing technologies.

"Phone card manufacturers and telephone companies have been concerned that there was only one source for phone card ICs", explained David Moorhouse, senior industry analyst at Dataquest. "Now that Philips is providing an alternative source, the whole market is set to expand at a tremendous rate".

The pre-paid phone concept enables users to buy a card with a certain number of call units pre-programmed. These are deleted as the card is used to make calls. The use of an ASIC-based device enables phone companies to include encryption mechanisms on each individual card to prevent fraud. By comparison, BT prepaid phone cards are based on magnetic strip technology, and are completely unintelligent.

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

Job Market is Electric!

Electronics is the most buoyant industry in the manufacturing sector in terms of job prospects, according to the latest Manpower Survey of Employment Prospects. Along with leisure, electronics is the most optimistic industry in the survey overall, predicting a 36% growth in jobs over the second quarter of 1996. Manpower conducted the Survey among over 2,000 employers in the UK.

Contact: Manpower, Tel: (0171) 224 6688.

Big Screen Computing

Gateway 2000 has unveiled a PC that looks like a TV, complete with 31in. screen, and remote keyboard and mouse that can be operated from about 5m away. The system can be used in business for presentations, or at home for playing interactive games, cruising the Internet or just plain old watching TV. Prices are expected to range from £2,500 to £3,000. For further details, check: **http://www.gw2k.com**.

Survey Criticises Poor Standard of IT Advertising

Most UK computer industry advertising is ill-conceived, badly targeted and carries the wrong messages, according to a report published by IT marketing services specialists, PCMC.

The survey, which studied over 30 current and recent IT advertising campaigns and their perception by a wide range of consumers and IT professionals, revealed that most computer-related campaigns carried the wrong messages, to the wrong audience, without addressing real buyer issues.

Particular criticisms included confusing or vague propositions, leaving the majority of the sample unclear as to whom the ads were targeted. Many cited the postal response mechanisms contained within many of the ads as awkward and time consuming, preferring instead freephone, e-mail or web site options.

Contact: PCMC, Tel: (01734) 880437.

Rapid Growth Takes ADI into Top Ten

Taiwanese monitor giant, ADI, reports that its UK office achieved a turnover of £6 million in 1995, its first year of operation. This performance was twice as high as company forecasts and takes the company into the top ten listing of UK monitor vendors.

"We have been rather surprised by our rapid growth here", claims ADI Systems UK sales director, Alan Jai. "We budgeted for a turnover of just £3 million in our first year, so we're more than happy with this performance. In the light of our first year results, we have raised our sights for 1996 and are looking to achieve 100% growth, a turnover of £12 million". For further details, check: **http:\\www.adi online.com**.

Contact ADI Systems, Tel: (0181) 236 0801.

Cut Price ISDN Line with Adapter

Racal partner, Electronic Frontier, is intensifying its efforts to bring ISDN to the broad mass of PC users with the offer of half-price connection to BT's Basic Rate service. The offer is available to purchasers of the Racal DAP 6200A terminal adaptor, for which Electronic Frontier charges £499 + VAT.

Electronic Frontier is providing those PC users who already have an ISDN connection an alternative: a free desktop videoconferencing package, comprising the QuickCam camera and Videophone software from Connectix, normally retailing at £179 + VAT. For further details, check: **http://www. elecfron.com**.

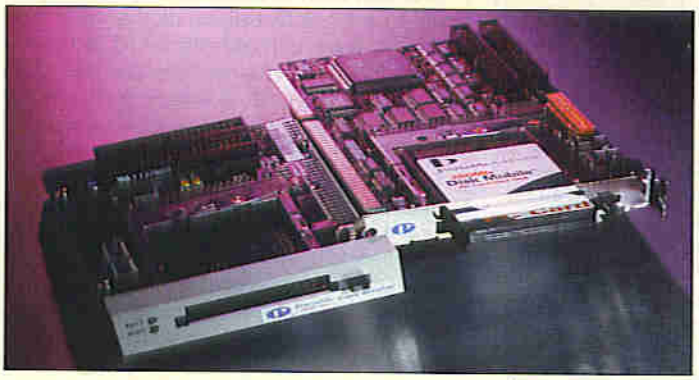
Contact: Electronic Frontier, Tel: (01734) 810600.

I/O Card Chosen for Flight Simulator

Blue Chip Technology's ADC PC I/O Card has been chosen as the interface for the motion system and flight controls in a revolutionary flight simulator, designed to demonstrate flight mechanics theory to graduates at City University.

The simulator, designed by Merlin products, is a single-seat, fully enclosed cockpit on a motion system with flight controls and an in-cockpit visual display. The simulator is capable of demonstrating the practical effects of changing aircraft design parameters such as wingspan, tailspan and engine position. It also has the distinction of being the first simulator to use compressed air for movement, rather than more expensive hydraulics.

Contact: Blue Chip Technology, Tel: (01244) 520222.



Master PC Card Dilemma

One of the great features of PC Cards is their *interoperability* – they can be switched easily between different machines. Or at least, that's the theory. In practise, this only applies for laptops, but not necessarily desktop PCs.

While PC Card slots are commonplace on laptop machines, they are not so familiar on desktop machines. Portable Add-ons has got round this problem with a device that will allow a PC Card to be swopped from laptop to desktop. Card Master allows any PC Card peripheral to be connected to the desktop PC. Card Master is priced at £85 for a single PC Card slot, or £139 for a device able to handle two PC Cards.

Contact: Portable Add-ons, Tel: (01483) 241202.

Apple Crumbles

Apple is in difficulty. Burdened with around $1 billion worth of unsold personal computers and facing falling sales, the company has fired its chief executive – but what impact will this have on users?

Apple Macs have traditionally been renowned for their ease of use. The Apple Operating System is designed by Apple to run on Apple machines. Consequently, the company has been able to maximise the use of its hardware, without concern for other platforms. By comparison, IBM-compatible PCs, these days more commonly referred to as Windows PCs, are completely open. The Microsoft Windows environment will operate across any IBM-compatible machine.

Here lies the crux of Apple's current problems: whereas Microsoft Windows is completely open, Apple has an overall monopoly on its Operating System. As the only manufacturer of Apple Macs, Apple has historically been able to charge a premium price. This has limited the potential size of the market. For further details, check: **http://www.apple.com**.

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

Reclaim PC Hard Disk Space

A new piece of software from POW! Distribution allows PC users with large hard disks to reclaim hundreds of megabytes of space that are lost due to inefficient cluster sizes. The File Allocation Table (FAT) file system used by DOS, Windows, and Windows '95 was not written with high-capacity hard drives in mind, and is consequently, grossly inefficient.

For instance, with a partition of over 1G-byte, each file requires a 32k-byte cluster, regardless of whether it is 50M-byte or 50bytes in size. This can lead to wastage of as much as 40% of disk space. With PartitionMagic 2.0, as you resize a partition, cluster sizes are automatically optimized to a more efficient size, of 2 or 4k-byte.

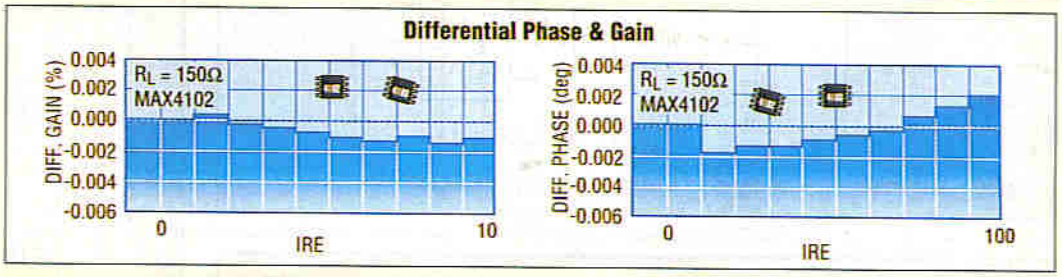
PartitionMagic for Windows 3.1x, Windows '95 and DOS costs £49.95 for a single user version.

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

Getting the Max Video Quality

The MAX4102 and MAX4103 video op-amps are designed for buffer applications such as broadcast and high-definition TV systems, pulse/RF amplifiers and ADC/DAC amplifiers. The devices combine low differential gain and phase errors across 180MHz for the MAX4102, and 250MHz for the MAX4103.

Contact: Maxim, Tel: (01734) 303388.



IBM Supercomputer Order by US Environmental Dept

The US Department of Energy's (DOE) Pacific Northwest National Laboratory, molecular sciences laboratory, Washington, has placed an order for what will be the most powerful IBM parallel computer ever. The multi-million dollar IBM RS/6000 Scalable POWERparallel system will form the cornerstone of the EMSL's molecular science computing facility, and will be used primarily for research on critical environmental problems, such as cleaning up polluted sites and safely treating and storing radioactive waste.

Computational simulations and modelling performed on the new computer will further molecular-level understanding of the physical, chemical and biological processes that underlie environmental remediation, waste processing and related health and ecological effects.

When fully installed in the spring of 1997, the EMSL's supercomputer system will be the most powerful RS/6000 SP in the world, with 472 nodes or processors, and the capacity to operate at over 200 peak GigaFLOPS (billions of floating-point operations per second). For further details, check: **http://www.rs6000. ibm.com**.

Contact: IBM, Tel: 1 914 766 3250.

PC Card White Paper

PC Card distributor, Grey Cell, has launched a white paper on its multi-functional cards. The paper provides executives with an introduction to the benefits and features of multi-functional PC Cards for mobile communications.

Grey Cell created the White Paper for laptop users, whose key priority is being able to access and send information when out of the office. The paper is intended as a comprehensive reference point for individuals looking to invest in multi-function cards and advises users which PC Cards should be selected for particular mobile applications.

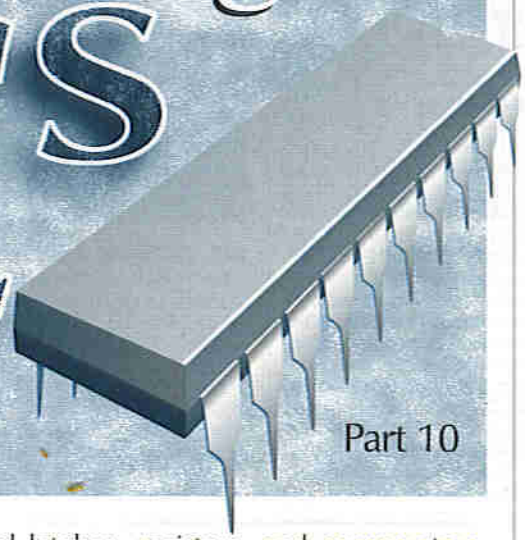
Contact: Grey Cell Systems, Tel: (0181) 902 8998.

Paperless Office

The paperless office could become a reality, with a keyboard launched by Compaq. The new full-function keyboard incorporates an A4 paper scanner. Costing £275, the scanner supports an optical resolution of 200dpi horizontally and 400dpi vertically. This means A4 pages can be scanned into a PC and stored on the hard disk for later retrieval, manipulation or editing. The scanner-keyboard is compatible with 486-based PCs or higher, Windows 3.1, Windows for Workgroups 3.11, or Windows '95, and requires a minimum of 8M-byte of RAM. For further details, check **http://www.compaq.com**.

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

A Practical Guide to Modern Digital ICs



by Ray Marston

Part 10

This month Part 10 looks at digital latches, registers, and comparators. Data latches and shift registers are widely used members of the flip-flop family of devices, and are often used in conjunction with logic comparators and code converters. This article looks at practical versions of all of these devices and shows how to use them.

Data Latches

Flip-flop circuit elements of the Set-Reset, D-type, and JK types (see Part 8, Issue 100, April) are often called 'latches', because their outputs can be latched into either a logic-0 or logic-1 state by applying suitable input signals. JK and D-type latches are fairly versatile elements, and can be made to act as either data latches or as divide-by-two circuits by suitably connecting their input and output terminals. A pure 'data latch', on the other hand, is an element that is built as a dedicated data latch and can be used for no other purpose; an element of this type acts as a simple memory that can store one 'bit' of binary data for an indefinite period; four such elements can store a complete 4-bit binary 'word'.

A data latch stores and outputs whatever logic-level is applied to its 'D' (data) terminal when activated by a suitable 'store' command; the 'store' terminal may be either level or edge sensitive, and Figure 1 shows the basic data latch symbols that apply in each case. Level-triggered elements of the (a) type are 'transparent' when the En (enable) terminal is high (i.e. the Q output follows the D input under this condition), but latch the prevailing D state into the Q output when En goes low; data can thus be latched by applying a brief positive pulse to the En terminal. Edge-triggered elements of the (b) type are not transparent, and the Q output ignores the D input until a clock-pulse trigger-edge is applied to the CLK input, at which point, the latch stores and outputs the data and holds it until a new clock-pulse arrives.

A 4-bit data latch can be built by connecting four 1-bit latches together as shown in Figure 2, with all En (or CLK) terminals wired in parallel so that all elements activate at the same time. Edge-triggered 4-bit data latches are not as useful, popular, or as readily available as level-triggered types, but can easily be built from JK or D-type flip-flop ICs such as the 74LS73 or 74LS74, etc. Level-triggered 4-bit (or greater) 'transparent' data latch ICs are readily available, at very low cost.

Level-triggered 4-bit data latches are widely used as temporary memories in digital display-driving applications, and may be used in either of the two basic ways shown in Figure 3. Assume here, that the decade counter shown is one of a cascaded chain of such counters, each of which has its BCD outputs fed to a 7-segment digital display via a 4-bit data latch and a decoder/driver IC, as shown. In simple counting applications, the data latch may be used as in (a), with its En terminal connected to the +5V rail via a 4k7Ω resistor so that it is biased high when S1 is set to the ENABLE position but is grounded when S1 is in the FREEZE position. Thus, in the ENABLE position, the latch is transparent, and the counter's state is instantly shown on the display (which may appear as a blur if fast counting is taking place), but when S1 is moved to the FREEZE position, the data is immediately latched and the display is effectively frozen (i.e. changes in the counter's states are no longer displayed).

In the alternative control mode shown in (b), the data latch's En terminal is fed with a timed chain of positive LATCH DATA pulses,

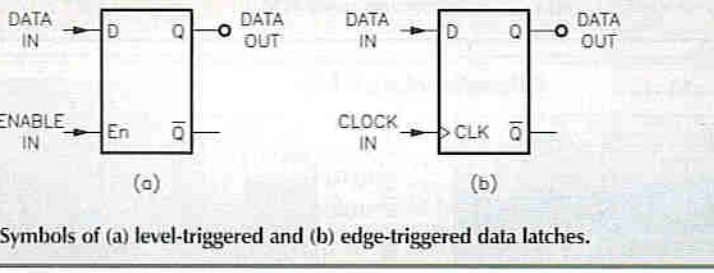
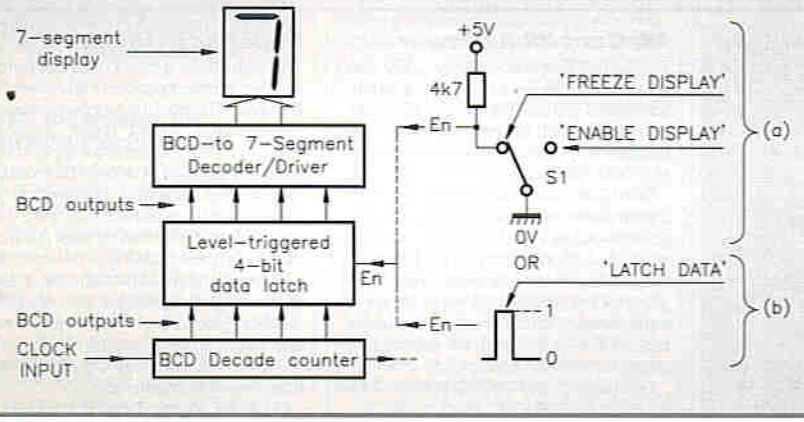
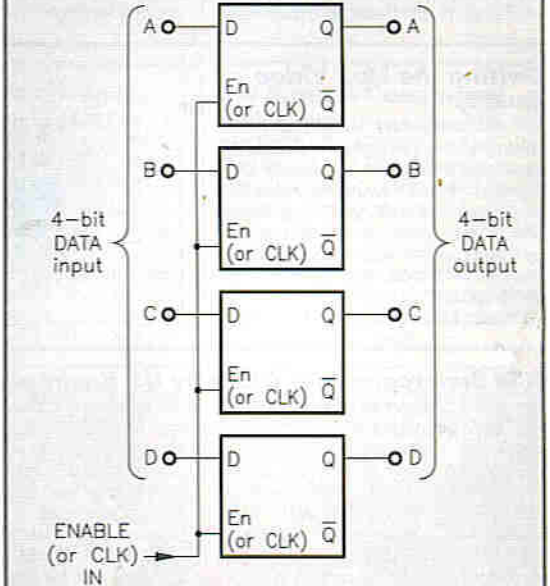


Figure 1. Symbols of (a) level-triggered and (b) edge-triggered data latches.





Above: Figure 2. A 4-bit data latch is made from four 1-bit latches connected as shown.

Left: Figure 3. Basic ways of using a level-triggered 4-bit data latch in a display-driver application.

and the display thus shows a grabbed snapshot of the counter's instantaneous state each time one of these pulses terminates, and displays it until the arrival of the next pulse's termination point. This technique is useful in cases where the display normally appears as a fast-changing blur; by feeding-in the LATCH DATA pulses at (say) a ten-per-second (100ms) rate, the display can be strobed so that it appears in a varying but clearly readable form. This technique is widely used in digital frequency meters, which use the basic operating principle shown in Figure 4.

The circuit shown in Figure 4 is that of a simple 3-digit frequency meter, in which the test frequency is fed to the input of the counter chain via a 2-input AND gate, which is controlled via a timebase generator that produces a repeating timing cycle. At the start of this cycle, the gate is closed and a brief RESET pulse is fed to all three counters, which clear to zero; the gate then opens, and the counters start to sum the input signal pulses. This count continues for precisely one second, during which the 4-bit data latches prevent the counter outputs from reaching the display. At the end of the one-second timing period, the GATE closes and terminates the count, and an En pulse is simultaneously fed to the set of data latches; this pulse has a width of (say) 100ns or greater, so all the counters have settled down and any glitches have disappeared by the time the En pulse terminates and latches the summed one-second end-count, which is fed to the display and reveals the input test signal's frequency, in Hz (cycles per second). The timing sequence is then complete, but a few moments later it starts to repeat, with the counters resetting and then counting the input pulses for another second, during which time, the display gives a steady reading of the results of the previous count, and so on.

The Figure 4 circuit thus generates a stable 'frequency' display that is regularly updated. In practice, the actual count period can be made any decade multiple or sub-multiple of one second, provided that the output display is suitably scaled. Thus, on a 3-digit display, a 'count' period of one second gives a maximum frequency reading of 999Hz, and a 1ms period gives a maximum frequency reading of 999kHz, and so on.

Data Latch ICs

The most popular and readily available TTL 4-bit 'transparent' or level-triggered data latch ICs are the 74LS75 and 74LS375, which are internally identical and differ only in their IC pin notations. Both of these ICs, in fact, house two independent 2-bit data latches, but can be made to function as standard 4-bit data latches of the type shown in Figure 2 (which are transparent when En is high but latch when En is low), by simply joining their En pins together; these ICs have a full set of Q and Q outputs, enabling any individual 4-bit code to be decoded via a 4-input AND (or NAND) gate connected to the appropriate set of output pins, and are also available in fast CMOS versions as the 74HC75 and the 74HC375.

The best-known '4000B-series' 4-bit 'transparent' data latch IC is the 4042B, in which all four latches are controlled via a single ENABLE (En) terminal. The IC is unusual, in that it provides the option, via its pin-6 polarity (POL) terminal, of either normal or inverted 'En' action.

If you need an 8-bit level-triggered data latch and don't need Q outputs, or do need 3-state outputs, the most economical option

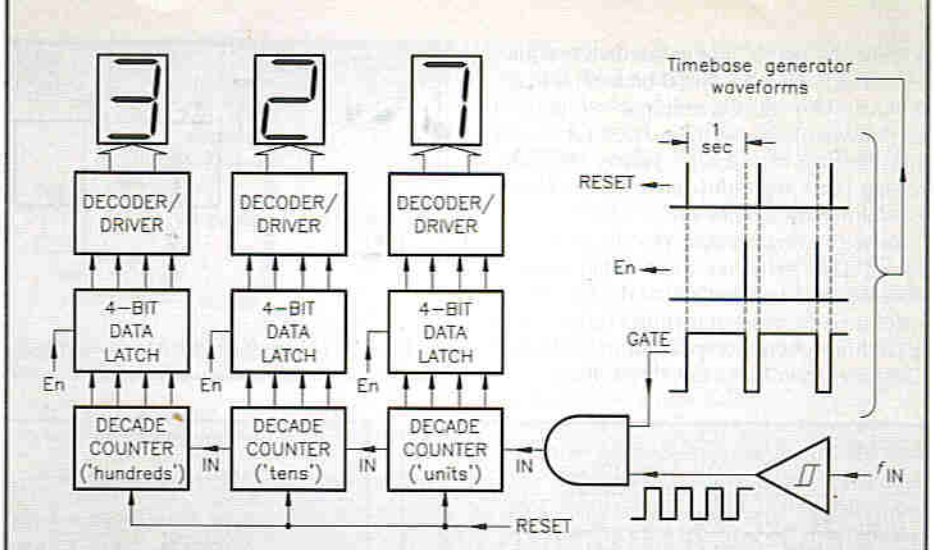


Figure 4. Basic 3-digit digital frequency meter circuit.

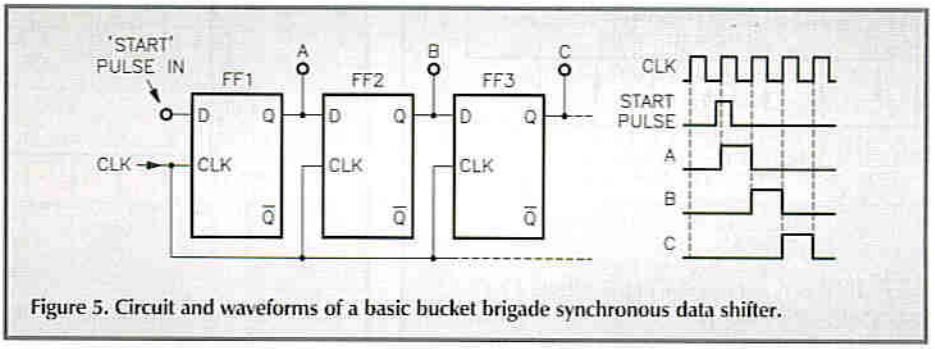


Figure 5. Circuit and waveforms of a basic bucket brigade synchronous data shifter.

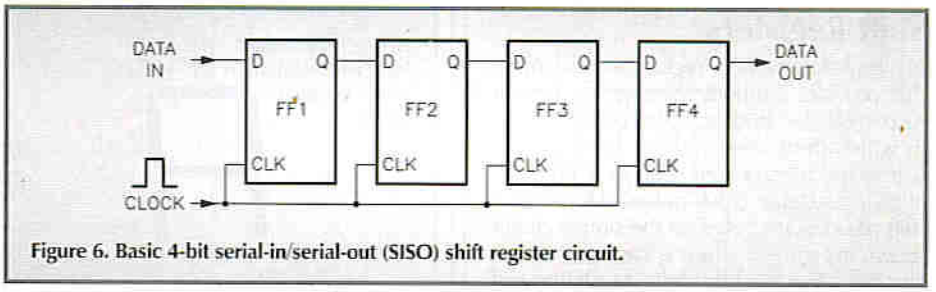


Figure 6. Basic 4-bit serial-in/serial-out (SISO) shift register circuit.

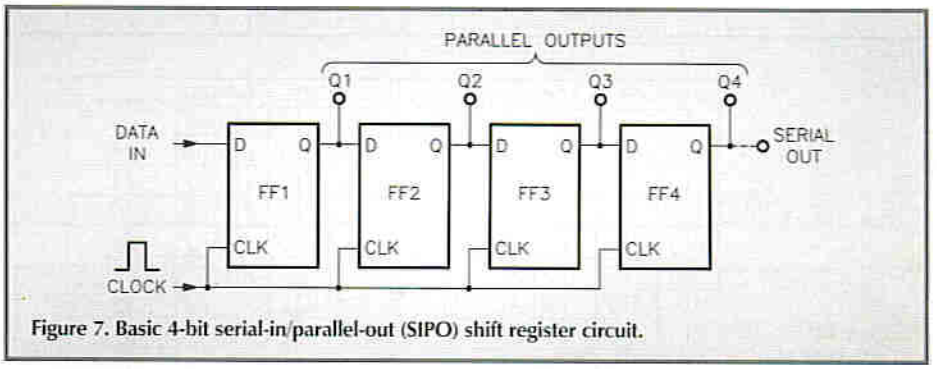


Figure 7. Basic 4-bit serial-in/parallel-out (SIPO) shift register circuit.

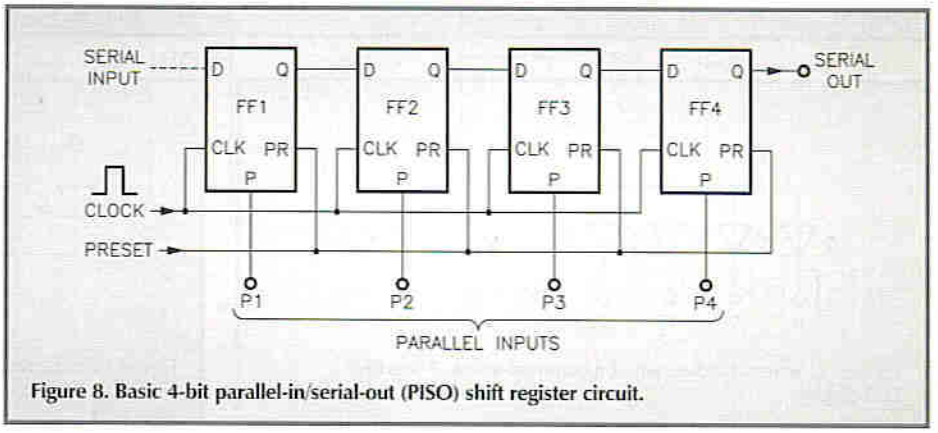


Figure 8. Basic 4-bit parallel-in/serial-out (PISO) shift register circuit.

is to use the 74LS373 or its fast CMOS equivalent, the 74HC373. This 8-bit latch is transparent when the En terminal is high and latches when it is low; the outputs can be set into the high-impedance (3-state) mode by biasing pin-1 high (this pin must be biased low for normal operation).

Before leaving this subject, note that transparent data latches are most widely used as elements in 7-segment digital display driving systems of the types shown in Figures 3 and 4, and are often incorporated in dedicated 'Latch/decoder/7-segment-driver' ICs.

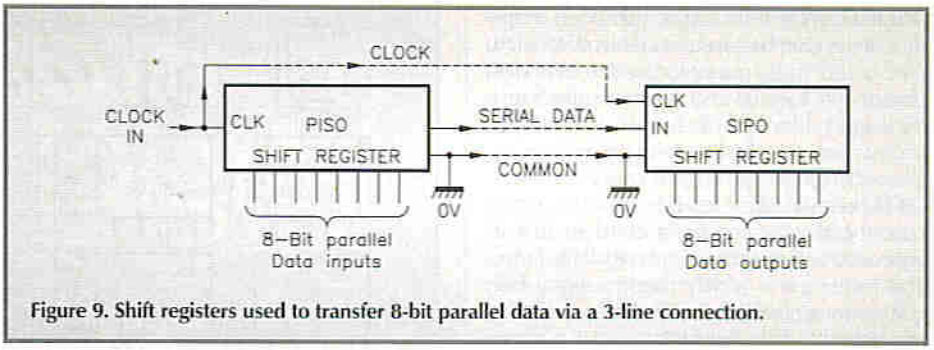


Figure 9. Shift registers used to transfer 8-bit parallel data via a 3-line connection.

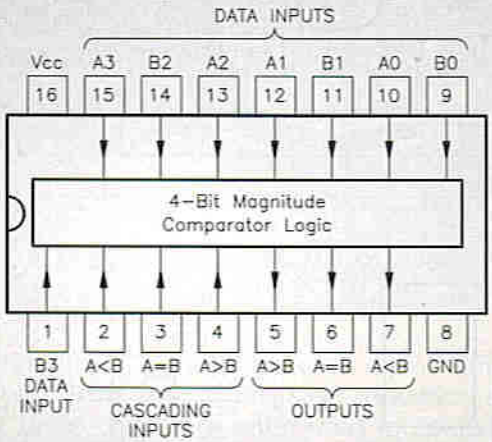


Figure 10. Functional diagram of the 74LS85 4-bit magnitude comparator IC.

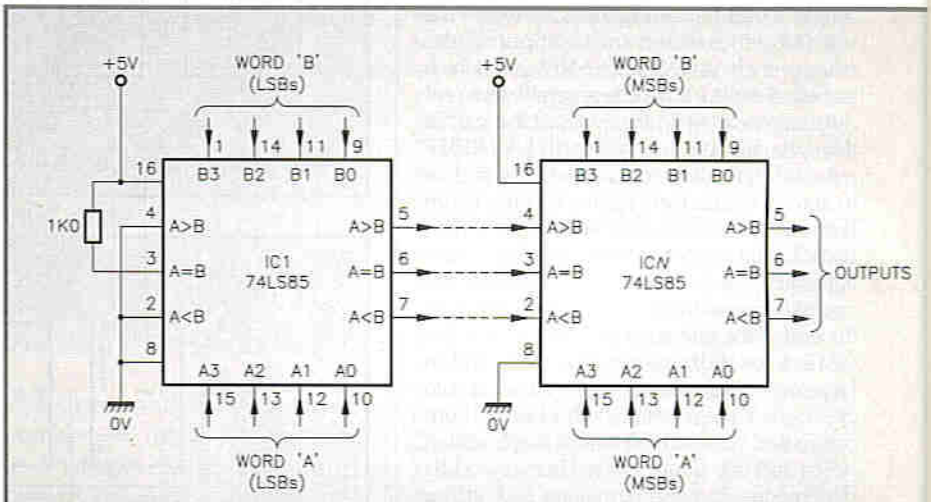
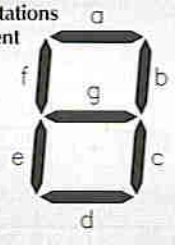


Figure 11. Basic connections for using the 74LS85 'comparator' IC.

Shift Registers

In digital electronics, a 'register' is an element that provides temporary storage for one or more bits of binary data; a 'shift register' is one in which the stored bits can be displaced within the register (one step at a time) by applying suitable clock pulses. All practical shift registers are based on the simple circuit shown in Figure 5, which is known as a synchronous 'bucket brigade' data shifter and operates as follows:

Figure 12. Standard form and notations of a 7-segment display.



SEGMENTS = (✓=ON) a	b	c	d	e	f	g	DISPLAY	SEGMENTS = (✓=ON) a	b	c	d	e	f	g	DISPLAY
✓	✓	✓	✓	✓	✓		0	✓	✓	✓	✓	✓	✓	✓	8
	✓	✓					1	✓	✓	✓			✓	✓	9
✓	✓		✓	✓		✓	2	✓	✓	✓		✓	✓	✓	A
✓	✓	✓	✓			✓	3			✓	✓	✓	✓	✓	b
	✓	✓			✓	✓	4	✓			✓	✓	✓		C
✓		✓	✓		✓	✓	5		✓	✓	✓	✓		✓	d
✓		✓	✓	✓	✓	✓	6	✓			✓	✓	✓	✓	E
✓	✓	✓					7	✓				✓	✓	✓	F

Figure 13. Truth table of a 7-segment display.

Note that the Figure 5 circuit is shown built from parallel-clocked cascaded D-type flip-flops, and remember that these flip-flops latch the 'D'-terminal data (logic-state) into 'Q' on the arrival of the rising-edge of a clock pulse. Thus, if all flip-flop outputs are initially in the logic-0 state, output A latches into the logic-1 state for one full clock cycle if a brief edge-straddling 'start' pulse is fed to FF1 at the start of that cycle, as shown. At the start of the next clock cycle, the A waveform latches into FF2 and appears at output B, and in the next cycle, it shifts down to C, and so on, down the line for as many flip-flop stages as there are, until it is eventually clocked out of the circuit. Thus, the initial 'A' waveform passed through the circuit one step at a time, bucket-brigade style, in synchrony with the clock signal.

Figure 6 shows the basic circuit of the simplest type of practical 4-bit shift register, which is very similar to the circuit already described. Here, the bit of binary data present at the input of FF1 is passed to FF1's output on the application of the first clock pulse, then to the output of FF2 on the second pulse, to the output of FF3 on the third pulse, and finally to the output of FF4 on the fourth pulse. The circuit can hold four bits of data at any given

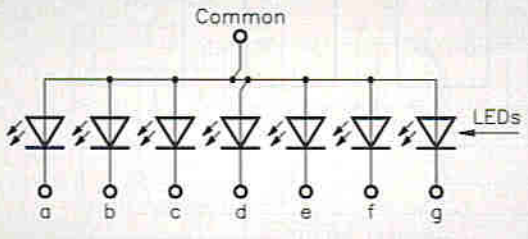


Figure 14. Schematic diagram of a common-anode 7-segment LED display.

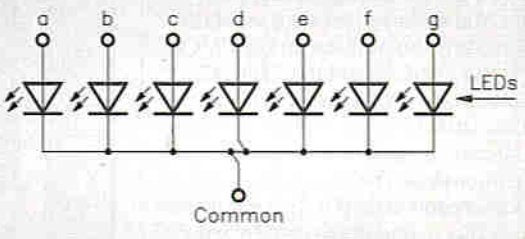


Figure 15. Schematic diagram of a common-cathode 7-segment LED display.

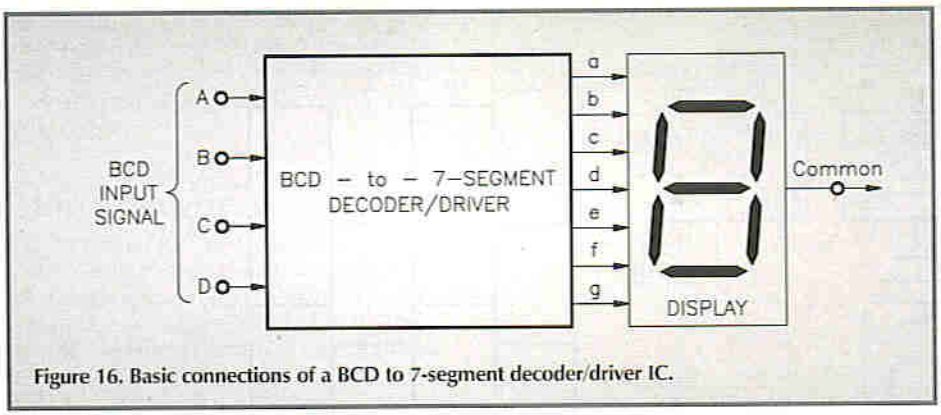


Figure 16. Basic connections of a BCD to 7-segment decoder/driver IC.

BCD Signal				DISPLAY	BCD Signal				DISPLAY
D	C	B	A		D	C	B	A	
0	0	0	0	0	0	1	0	1	5
0	0	0	1	1	0	1	1	0	6
0	0	1	0	2	0	1	1	1	7
0	0	1	1	3	1	0	0	0	8
0	1	0	0	4	1	0	0	1	9

0 = logic low 1 = logic high

Figure 17. Truth table of a BCD to 7-segment decoder/driver.

The value of the basic shift register can be further increased by fitting it with PRESET terminals, as shown in Figure 8, so that it can be directly loaded with four bits of parallel data via pins P1 to P4. If the resulting circuit has no serial input facility, it is known as a parallel-in/serial-out (PISO) shift register, but if it does have a serial input facility (as shown dotted in the diagram), it is known as a PISO/SISO shift register. If it is configured to have only parallel-in and parallel-out facilities, it is known as a PIPO shift register. If a register has both parallel and serial inputs and parallel and serial outputs, it is simply called a 'universal' shift register.

Figure 9 shows, in greatly simplified form, one widely used shift register application. Suppose here, that a stack of 8-bit data words need to shifted from one point to another; normally, eight data links and one clock and one common link would be needed for this task, making a total of ten links, but by using shift registers, the number of links can be reduced to three. This is achieved by first changing each 8-bit parallel word into serial form via a PISO shift register, then sending it and the clock and common signals down the 3-line link to be converted back into 8-bit parallel form via a SIPO shift register at the des-

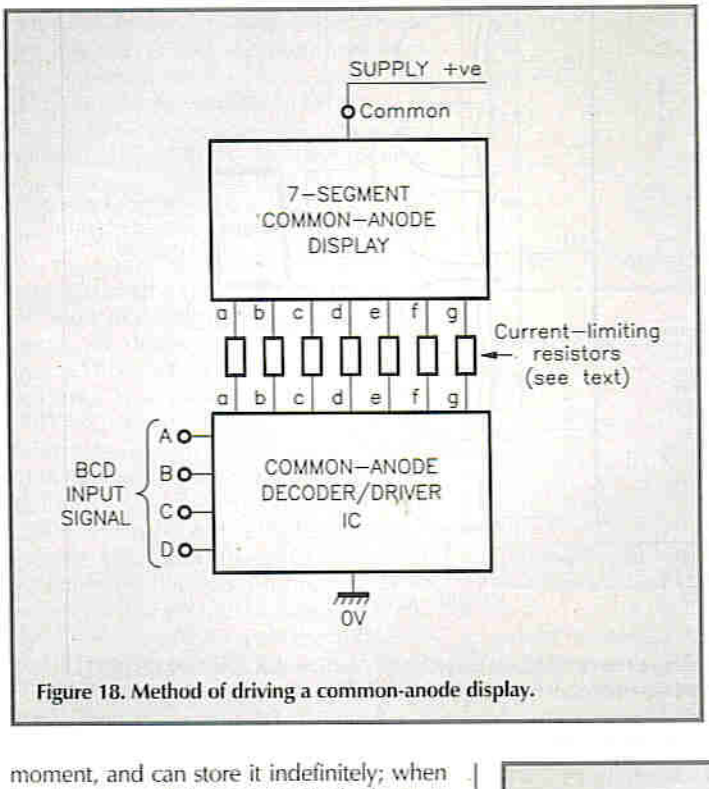


Figure 18. Method of driving a common-anode display.

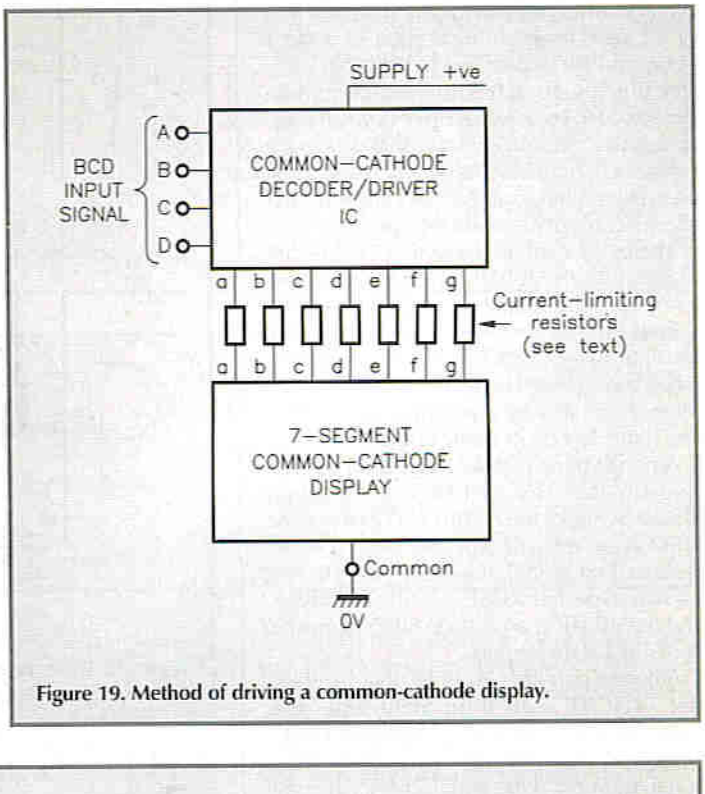


Figure 19. Method of driving a common-cathode display.

moment, and can store it indefinitely; when the data is needed, it can be clocked out (in serial form) by applying another set of clock pulses.

Note that the Figure 6 circuit's data is clocked in and out in serial form, so it is known as a serial-in/serial-out or SISO shift register; it is useful for storing binary signals or delaying them by a fixed number of clock pulses, but not for much else. Its value can be greatly increased by converting it to a serial-in/parallel-out (SIPO) shift register, by simply taking the 'parallel' outputs from the Q terminals of all four flip-flops, as shown in Figure 7; it is then useful for converting serial data into parallel form. This basic type of register can be made to give both serial and parallel outputs by adding a 'serial out' connection, as shown dotted in the diagram; such a unit is known as a SIPO/SISO shift register.

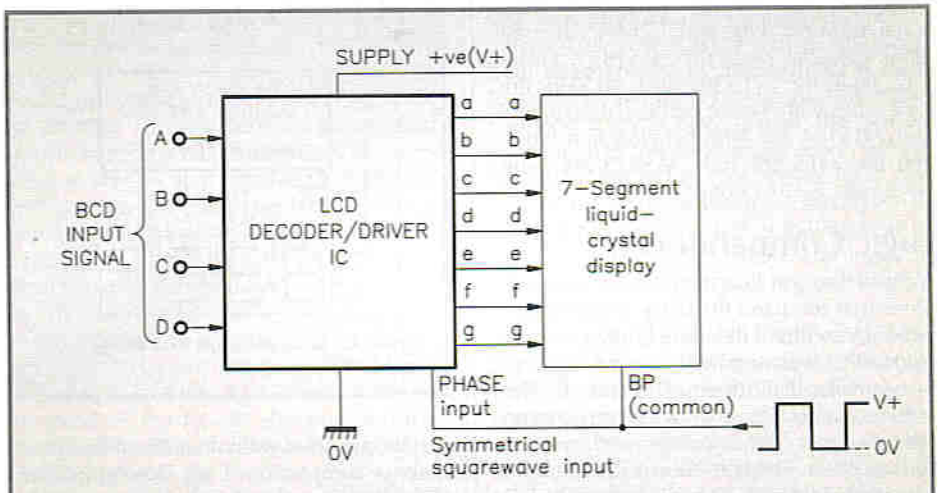


Figure 20. Method of driving a liquid-crystal display (LCD).

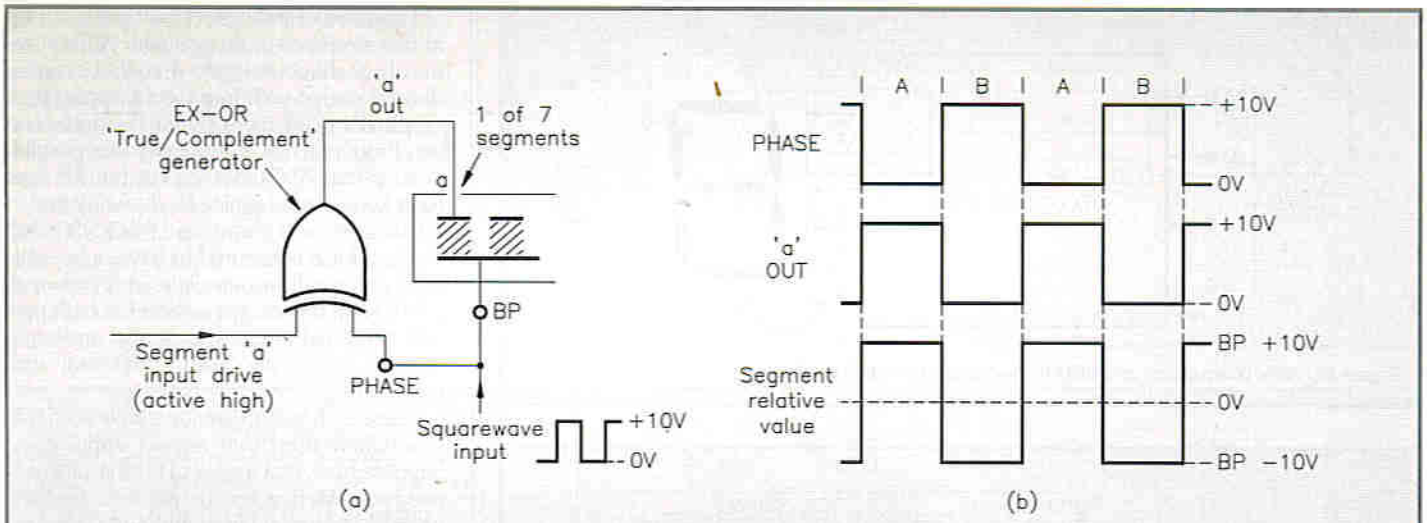


Figure 21. Basic LCD segment-drive circuit (a), and voltage-doubling 'bridge-driven' segment waveforms (b).

tination point, as shown. This same basic technique can be used for transferring multi-bit words into or out of modern memory or data processing ICs in which only single IN, OUT, CLK and COMMON pins are allocated to these tasks.

The basic registers of Figures 6 to 8 give an action in which the stored data shifts one step to the right on each application of a clock pulse, and are thus known as right-shift registers. But, just as an ordinary counter can be configured to count either up or down, a register can easily be configured to shift data to the right or left, or to have its direction selectable via a control terminal. A large variety of shift register configurations are thus possible.

The oldest current-production CMOS shift register IC is the 4006B, which the manufacturers describe simply as an '18-stage static shift register', but which actually houses four separate 4-stage SISO shift registers, two of which are followed by an extra stage, with all stages controlled by a common clock signal that shifts data on its falling edges.

Amongst other popular '4000B-series' shift register ICs, the 4014B is an 8-stage PISO/SISO type, the 4015B is a Dual 4-stage SIPO type with RESET, the 4021B is an 8-stage PISO/SISO type, the 4031B is a 64-stage type, the 4035B is a 4-bit PIPO type, and the 4094B is an 8-stage SIPO type with buffered 3-state outputs.

Amongst popular '74-series' shift registers, the 74HC91 is an 8-bit SISO type, the 74LS164 and 74HC164 are 8-bit SIPO/SISO types, and the 74HC194 is a 4-bit bidirectional 'universal' type with CLEAR. Amongst other 'universal' types, the 74LS195 is a plain 4-bit type, the 74LS295 and 74LS395 are 4-bit types with 3-state outputs, the 74LS95 and 74LS194 are 4-bit right/left shift types, and the 74LS299 and 74LS323 are 8-bit types with 3-state outputs.

Logic Comparators

A digital 'logic' or 'magnitude' comparator IC is one that compares the binary codes of two words (A and B) of the same bit-size and has outputs that indicate whether code A is greater than, smaller than, or equal to code B. This action is useful in, for example, triggering some action when a counting chain reaches a certain value, etc. The best-known TTL IC of this type is the 74LS85 4-bit comparator, which is functionally identical to the 74HC85 and 4063B CMOS versions of the IC, and which

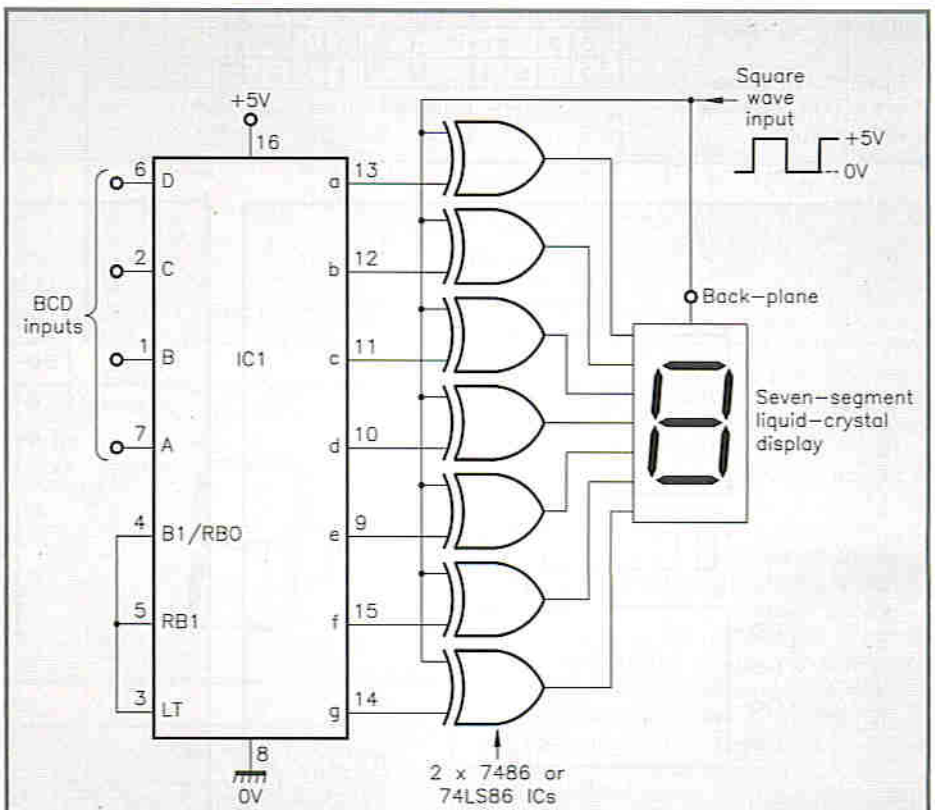


Figure 22. Basic way of using an 'active-high' LED-driving IC (such as the 7448 or 74LS48 TTL types) to drive a 7-segment liquid-crystal display (LCD) via a 'bridge-driven' 7-section EX-OR array.

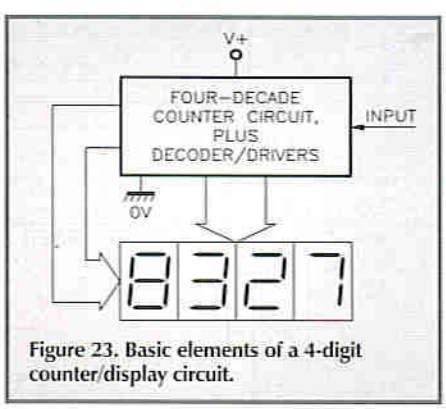


Figure 23. Basic elements of a 4-digit counter/display circuit.

can be cascaded with other ICs of its type to make a comparator of any desired bit size; Figure 10 shows the functional diagram of the 74LS85. Note that, as well as having four input terminals for each 4-bit word plus three active-high output terminals (notated A>B, A=B, and A<B), this IC also has three input terminals (also notated A>B, A=B, and A<B), that are used to implement cascaded operations.

The 74LS85 (and 74HC85 and 4063B) is very easy to use, as shown in Figure 11. If two 4-bit words are being compared, a single IC is used, connected in the manner of IC1, with the A>B and A<B cascading terminals grounded and the A=B cascading terminal biased high, and with the three outputs taken from pins 5, 6 and 7. If the words have bit-lengths that are whole-number multiples of four, they can be compared by cascading an appropriate number of 74LS85 ICs on a basis of 4-bits per IC (e.g., three ICs for 12-bit comparison, etc.). In this case, the four least-significant bits (LSBs) must be allocated to IC1, which must be connected as already described, and the four most-significant bits (MSBs) must be allocated to the final IC (IC_N),

and so on; then the three outputs of each lower-order IC must be connected to the three 'cascading' inputs of the following IC, the final outputs being taken from the last IC in the chain.

Code Converters

Code converter ICs are widely used in digital electronics to change electronic codes from one format into another. The most widely used device of this type is the BCD to 7-segment decoder/driver IC, which takes the 4-bit BCD-coded output of a counter, etc., and converts it into a form suitable for directly driving a 7-segment LED or LCD digital display. Before looking at specific ICs of this type, however, it is necessary to note a few points about 7-segment digital display basics, as follows:

A 7-segment display is a unit that houses seven independently accessible photoelectric elements such as LEDs or liquid crystals, arranged in the form shown in Figure 12. The segments are conventionally notated from a to g in the manner shown, and they can be made to display any number from 0 to 9 or letter from A to F (in a mixture of upper and lower cases), by activating these segments in various combinations, as shown in the truth table of Figure 13.

Practical 7-segment displays need at least eight external connectors, one of which acts as the 'common' terminal. If the display is an LED type, the seven individual LEDs may be arranged as shown in Figure 14, with all LED anodes connected to the common terminal, or as in Figure 15, with all LED cathodes connected to the common terminal; in the former case, the 7-segment display unit is known as a common-anode type, and in the latter, it is called a common-cathode type.

In most practical applications, 7-segment displays are driven (via a suitable decoder/driver IC) from a 4-bit BCD input, and the IC and display are connected as shown in Figure 16. The IC houses a moderately complex set of logic gates, as is implied by Figure 17, which shows the standard relationship between the BCD input codes and the displayed 7-segment numerals. In practice, dedicated BCD to 7-segment decoder/driver ICs are usually available in a dedicated form suitable for driving only a single type of display unit, e.g., a common-anode LED type, common-cathode LED type, or a liquid-crystal display (LCD). Figures 18 to 20 show the basic ways of interconnecting each of these IC and display types.

Note in the LED circuits, that in most cases, a current-limiting resistor (about 150Ω with a 5V supply, or 680Ω at 15V) must be wired in series with each display segment. To drive a common-anode display (Figure 18), the driver must have an active-low output, in which each segment-driving output is normally high, but goes low to turn a segment on. To drive a common-cathode display (Figure 19), the driver must have an active-high output.

In the LCD-driving circuit of Figure 20, the display's common 'BP' (back-plane) terminal and the IC's PHASE input terminal must be driven by a symmetrical square wave (typically 30 to 200Hz) that switches fully between the two supply rail voltages (0V and V+), as shown. The full explanation for this is a little complicated, as follows:

To drive an LCD segment, the driving voltage must be applied between the segment and BP terminals. When the voltage is zero, the segment is effectively invisible. When the drive voltage has a significant positive or negative value, however, the segment becomes effectively visible, *but* if the drive voltage is sustained for more than a few hundred milliseconds, the segment may become permanently visible and be of no further value. The way around this problem is, in principle, to drive the segment on via a perfectly symmetrical square wave that switches alternately between identical positive and negative voltages, and thus has zero DC components and will not damage the LCD segment even if sustained permanently. In practice, this type of waveform is actually generated with the aid of an EX-OR True/Complement generator, connected as shown in Figure 21(a).

In Figure 21(a), the basic segment 'a' input drive (which is active-high) is connected to one input of the EX-OR element, and the other EX-OR input terminal (which is notated PHASE) is driven by a symmetrical square wave that switches fully between the circuit's supply rail voltages (shown as 0V and +10V) and is also applied to the LCD display's BP pin. When the segment 'a' input drive is low, the EX-OR element gives a non-inverted (in-phase) 'a' output when the square wave is at logic-0, and an inverted (anti-phase) 'a' output when the square wave is at logic-1, and thus produces zero voltage difference between the 'a' segment and BP points under both these conditions; the segment is thus turned off under these conditions. When the segment 'a' input drive is high, the EX-OR element gives the same phase action as just described, but in this case, the 'a' OUT pin is high and BP is low when the square wave is at logic-0, and 'a' OUT is low and BP is high when the square wave is at logic-1; the segment is thus turned on under these conditions.

Figure 21(b) shows the circuit waveforms that occur when the 'a' segment is turned on, with the 'a' segment and BP driven by anti-phase square waves. Thus, in part A of the waveform, the segment is 10V positive to BP, and in part B, it is 10V negative to BP, so the LCD is effectively driven by a square wave with a peak-to-peak value of 20V but with zero DC value. This form of drive is generally

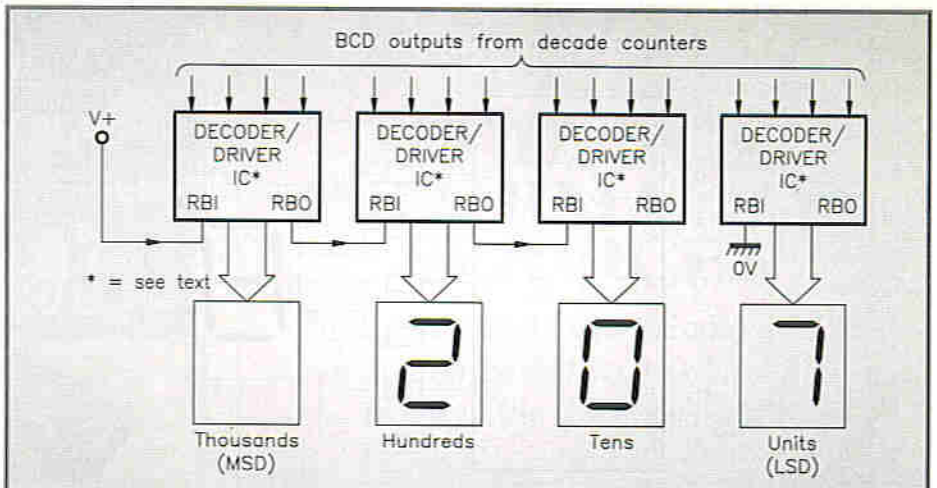


Figure 24. Ripple-blanking used to give leading-zero suppression in a 4-digit counter.

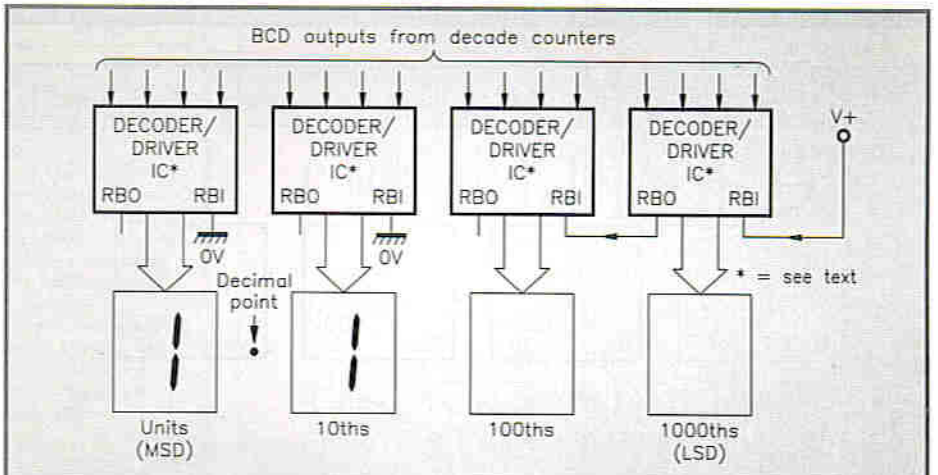


Figure 25. Ripple-blanking used to give trailing-zero suppression in a 4-digit voltmeter.

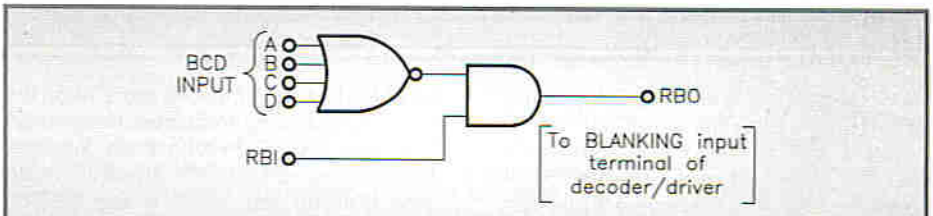


Figure 26. DIY ripple-blanking logic (active-high type).

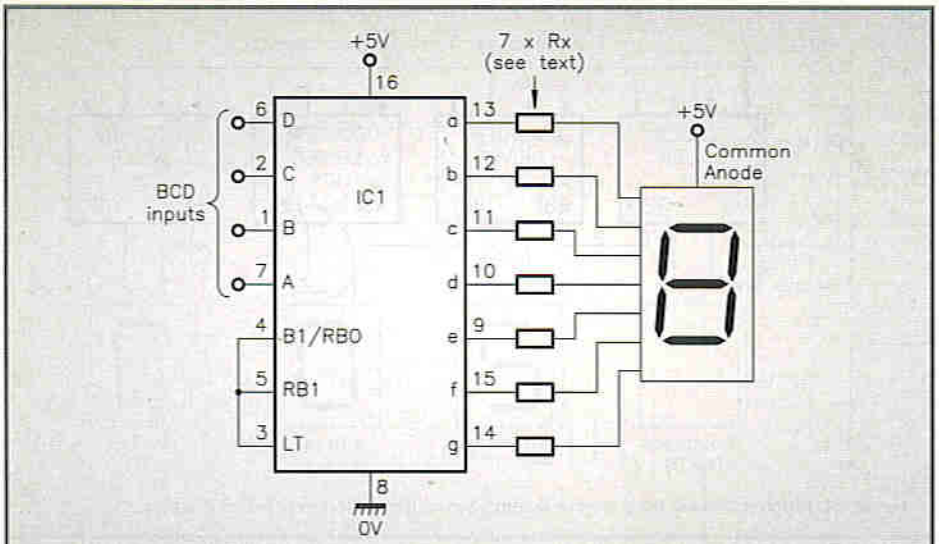


Figure 27. Basic ways of using a 7447A or 74LS47 to drive a common-anode LED display.

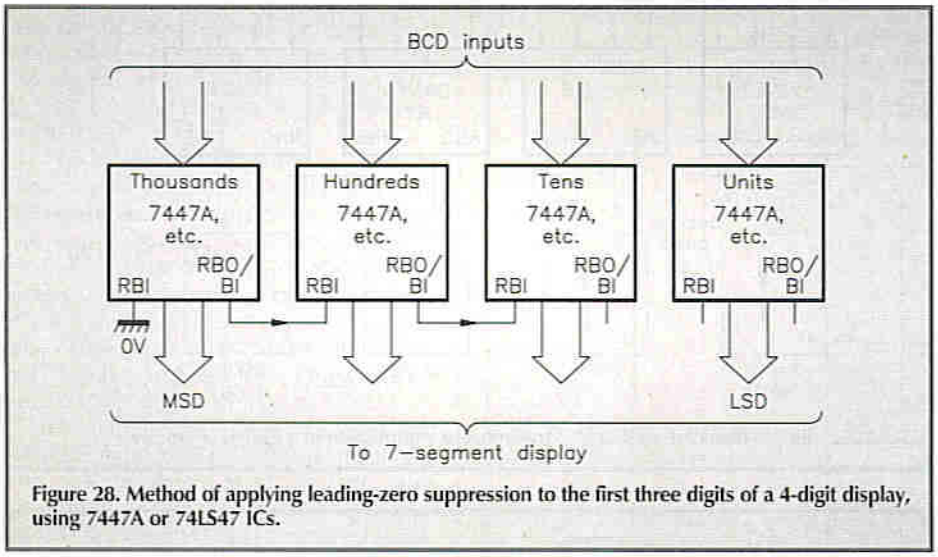


Figure 28. Method of applying leading-zero suppression to the first three digits of a 4-digit display, using 7447A or 74LS47 ICs.

known as a voltage-doubling 'bridge drive' system. In practice, many LCD-driving ICs (such as the 4543B) incorporate this type of drive system in the form of a 7-section EX-OR gate array interposed in series with the segment output pins, with access to its common line via a single PHASE terminal.

Note that any 'active-high' 7-segment LED-driving decoder IC can be used to drive a 7-segment LCD display by interposing a 'bridge driven' 7-section EX-OR array (etc.) between its segment output pins and the segment pins of the LCD display, as shown in Figure 22, which depicts a 7448 or 74LS48 TTL IC circuit so adapted.

Multi-digit Displays

In reality, 7-segment displays are usually used in multi-digit applications such as that shown in Figure 23, which shows the basic elements of a 4-digit counter/display circuit that can give a maximum reading of '9999'. Note that if this circuit is used to measure a count of (say) 27, it will actually give a reading of '0027', unless steps are taken to automatically suppress the two (unwanted) leading zeros. Similarly, if the same display is used on a 4-digit voltmeter scaled to read a maximum of 9·999V, it will give a reading of 0·100V if fed with a 0·1V input, unless steps are taken to suppress the two trailing zeros.

In practice, many modern decoder/driver ICs have facilities for giving automatic blanking of leading and/or trailing zeros, using the basic ripple blanking techniques illustrated in Figures 24 and 25. Note in these diagrams, that each decoder/driver IC is provided with ripple blanking input (RBI) and output (RBO) terminals; if these terminals are active high, their actions are such that the IC gives normal decoder/driver action and RBO is disabled (driven low) when RBI is biased low, but the display is blanked and RBO is driven high under the 'zero' (BCD input '0000') condition when RBI is biased high. Thus, the RBO terminal is normally low and goes high only if a BCD '0000' input is present at the same time as the RBI terminal is high. With these facts in mind, refer now to Figures 24 and 25.

Figure 24 shows the ripple blanking technique used to provide leading-zero suppression in a 4-digit display that is reading a count of 207. Here, the RBI input of the 'thousands' or most significant digit (MSD) decoder/driver IC is tied high, so this display is automatically blanked and RBO is driven high in the presence of a zero. Consequently, RBI of the 'hundreds' IC is driven high under this condition; its display reads '2' and its RBO terminal is thus low. The RBI input of the 'tens' unit is thus also low, so its display reads '0' and its RBO output is low. The least significant digit (LSD) is that of the 'units' readout and does not require zero suppression, so its RBI input is grounded and it reads '7'. The display thus gives an overall reading of '207'.

Note in the Figure 24 leading-zero suppression circuit, that ripple blanking feedback is applied backwards, from the MSD to the LSD Figure 25 shows how trailing zero suppression can be obtained by reversing the direction of feedback, from the LSD to the MSD Thus, when an input of 1·1V is fed to this circuit, the LSD is blanked, since its BCD input is '0000' and its RBI input is high. Its RBO terminal is high under this condition, so the '100ths' digit is also blanked in the presence of a '0000' input.

Not all decoder/driver ICs are provided with RBI and RBO ripple blanking terminals, and some of those that are have an active-low action. If a decoder/driver IC does not incorporate a ripple blanking feature, it can usually be obtained by adding external logic similar to that shown in Figure 26, with the RBO terminal connected to the *blanking* input pin of the decoder/driver IC. In Figure 26 (an active-high circuit), the output of the 4-input NOR gate goes high only in the presence of a '0000' BCD input, and the RBO output goes high only if this input is present while RBI is high.

Decoder/driver ICs

In TTL, the two most popular decoder/driver ICs are the old 7447A and 7448 types and their modern counterparts, the 74LS47 and 74LS48. These ICs are functionally very similar, and have integral ripple-blanking facilities. The 7447A/74LS47 has an active-low output, and is specifically designed for driving a common-anode LED display via external current-limiting resistors R_x (typically 150Ω), as shown in Figure 27. The 7448/74LS48 has an active-high output designed for driving a common-cathode LED display in a manner similar to that of Figure 27, but with the display's common terminal taken to ground. Figure 28 shows how to connect the ripple-blanking terminals of 7447A or 74LS47 (etc.) ICs to give leading zero suppression on the first three digits of a 4-digit display (this basic circuit can be used with any IC within the 7447/7448 family of devices).

In '4000B-series' CMOS, the most popular BCD-to-decimal decoder IC is the 4028B, and the most popular full 4-bit decoder ICs (which provide an individual output for each of sixteen possible codes) are the 4514B and 4515B, which are also available as the 74HC4514 and 74HC4515; the 4514B and 74HC4514 have active-high outputs, in which all except the selected output are normally low, and the 4515B and 74HC4515 have active-low outputs, in which all but the selected output are normally high.

The most popular CMOS BCD to 7-segment LED-driving IC is the 4511B (also available as the 74HC4511), which has a built-in data latch and is well suited to driving common cathode LED displays, since its outputs can each source up to 25mA. Finally, the most popular CMOS BCD to 7-segment LCD-driving IC is the 4543B (also available as the 74HC4543), which has a built-in data latch and incorporates an EX-OR array in its output driver network, which can source or sink several mA of output current; this feature enables the IC to act as a 'universal' unit that can drive common cathode or common anode LED or LCD 7-segment displays with equal ease.

Next month Part 11 concludes this 'Practical Guide' series and describes special-purpose ICs such as multiplexers, addressable latches, full-adders, and bus transceivers.

VALUE ADDED INTERNET SERVICES PART 2

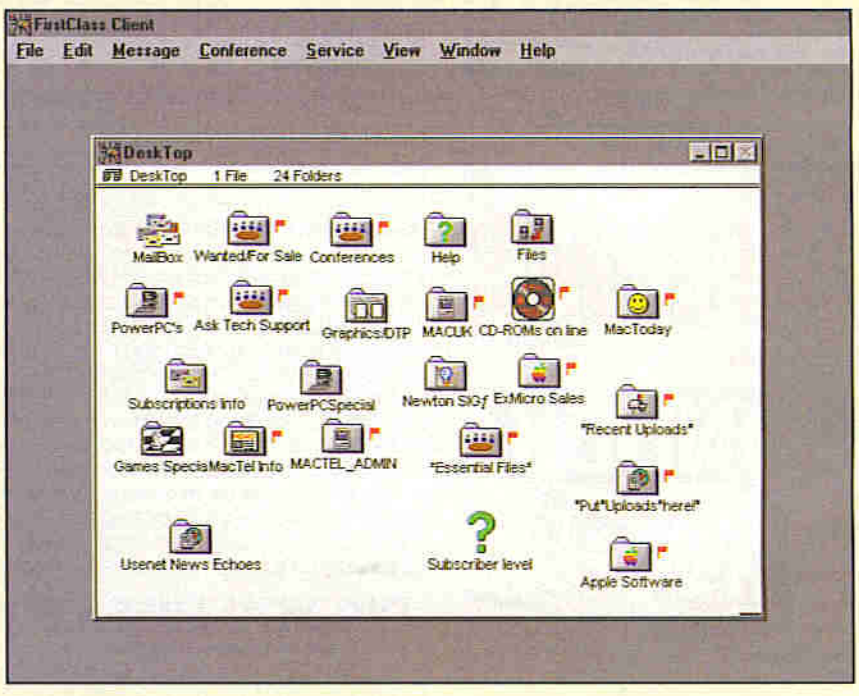
This month, Keith Brindley our intrepid Cybernaut, turns his elucidating light on more alternatives to the basic connection.

To date, getting onto the Internet over a telephone line has entailed getting TCP/IP access with an Internet service provider. Over the last few years, and particularly over the last few months, the proliferation of Internet service providers has been remarkable, as the rush to accommodate new users means considerable business for providers. We looked at a few of these last month. Of these, some of the oldest (Demon Internet and Pipex Dial) were compared with one of the newest (Worldscope Connect). These dial-up Internet service providers can form an effective first step to using the Internet.

It says a lot, however, when the standard telephone provider (i.e., British Telecom) starts to muscle in on the act. At the end of March, British Telecom launched its BT Internet service. This is intended as a mass-market service, aimed at residential and small business customers, as well as users new to the Internet. Subscription rates are competitive with the likes of Demon Internet, Pipex Dial and Worldscope Connect – a monthly charge of £12.77 (in other words, £15 including VAT), giving unlimited use of BT Internet services and applications. Being a national telephone provider, British Telecom automatically ensures itself the ability of providing national access at local call rates, allowing dial-up connection at rates of up to 28,800bps.

The fact that British Telecom sees such a service as necessary is important. After all, British Telecom's main business is in providing telephone lines, so it can charge customers for each and every call a customer makes. To add a dial-up Internet service to its range means that it has seen the writing on the wall. The Internet software British Telecom is providing users with is a good example of the sort of thing we're looking at in our study of value-added Internet services. While it's nothing out of the ordinary, it is an integrated package and so is worth a look. It was too late to include details as we went to press, but we'll do so next month.

New users of BT Internet receive a starter pack which includes all software. Available now for Windows computers, a MacOS version is to be available shortly. After an online registration procedure which ensures secure transfer of customer details, a user can be online immediately. Software includes the usual components – World Wide Web browser, an e-mail system, file transfer ability, Usenet newsgroup reader, and so on. Perhaps the most interesting aspect, however, is an Internet chat application, which allows live discussions with other Internet users. Nothing special here, except that the service is organised and maintained by one of the world's biggest telecommunications providers. That, in itself, will draw many new users to the service.



FirstClass desktop.

Adding More Value

So, we've taken a good look at the basic Internet service providers. The likes of Demon Internet, Pipex Dial, Worldscope Connect, and now BT Internet, are out there, waiting to take new business. But any new user should bear in mind that these services are little more than just sockets in the Internet, into which computers can be plugged.

I'll elucidate here, and to turn on my elucidating light, I'll start with a generic question. Your computer might be able to plug into the Internet with the help of an Internet service provider, but do you know what to do with the Internet once you're connected? New users – or, for want of a better term, non-technical users – might find themselves a little overwrought when first signing up, with no experience or idea of what they should expect.

The trouble is, things available on the Internet vary considerably. As a result of this, the software needed to access the Internet is equally varied. And, as a direct result of this, the learning curve to get the best out of all the software is steep. Even quite experienced Internet users find it difficult to get right on top of the curve. Often, users get as far up the curve as they can, then stick there.

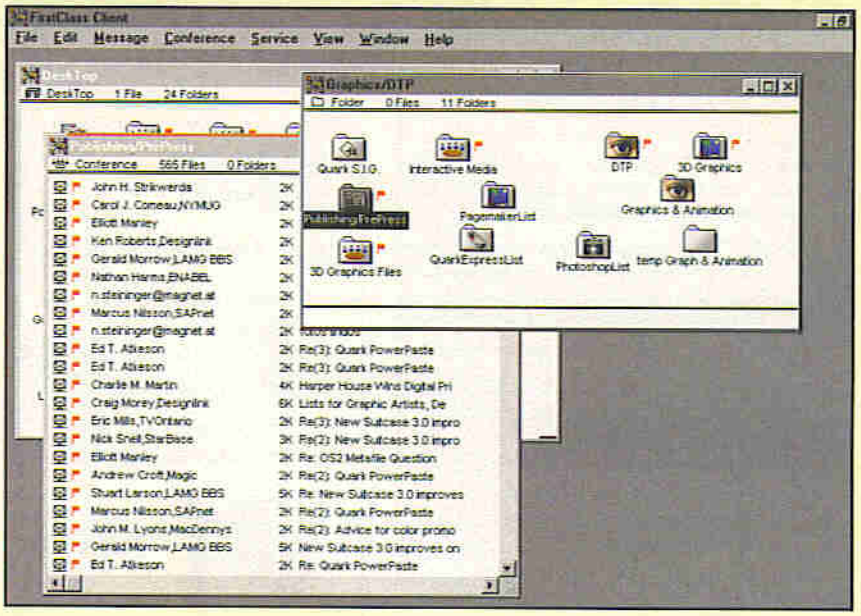
Software such as Turnpike, Pipex Dial's own interface, and Worldscope Connect's interface help new users enormously. BT Internet's interface is a similar method. All of these packages do a similar job, in that they control your computer, letting it access the Internet service

providers' computers over dial-up telephone lines, then transfer data to and from the Internet itself. In that respect, they are pretty similar and, in fact, the packages can often be used to connect to different Internet service providers' computers, as long as the correct details can be entered. Turnpike prides itself in that ability. This can be useful if you need to access more than one Internet service provider for any reason. If you can have the same interface whichever way you surf the Internet, things are more familiar and, of course, you can be more effective.

The Alternatives

But these advantages can be outweighed by the disadvantages of complexity. Not everyone wants, or has the time, to climb the learning curve. Another important point is that not everyone needs the full abilities these Internet service providers give.

So, what if this form of Internet access is too daunting for you? What if you don't want all the extraneous potential of the Internet? An alternative can exist in a much cheaper way, in the form of bulletin boards. Bulletin boards have been around for a long time, almost as long as computers themselves, I suppose. The idea is that an organisation dedicates a personal computer as a server and attaches it with a modem to a telephone line. Users can dial-up the computer server, and receive (download) or post (upload) messages or files, in a basically similar way to accessing the Internet itself.



FirstClass in action.

The Frame desktop.

The Frame in action.

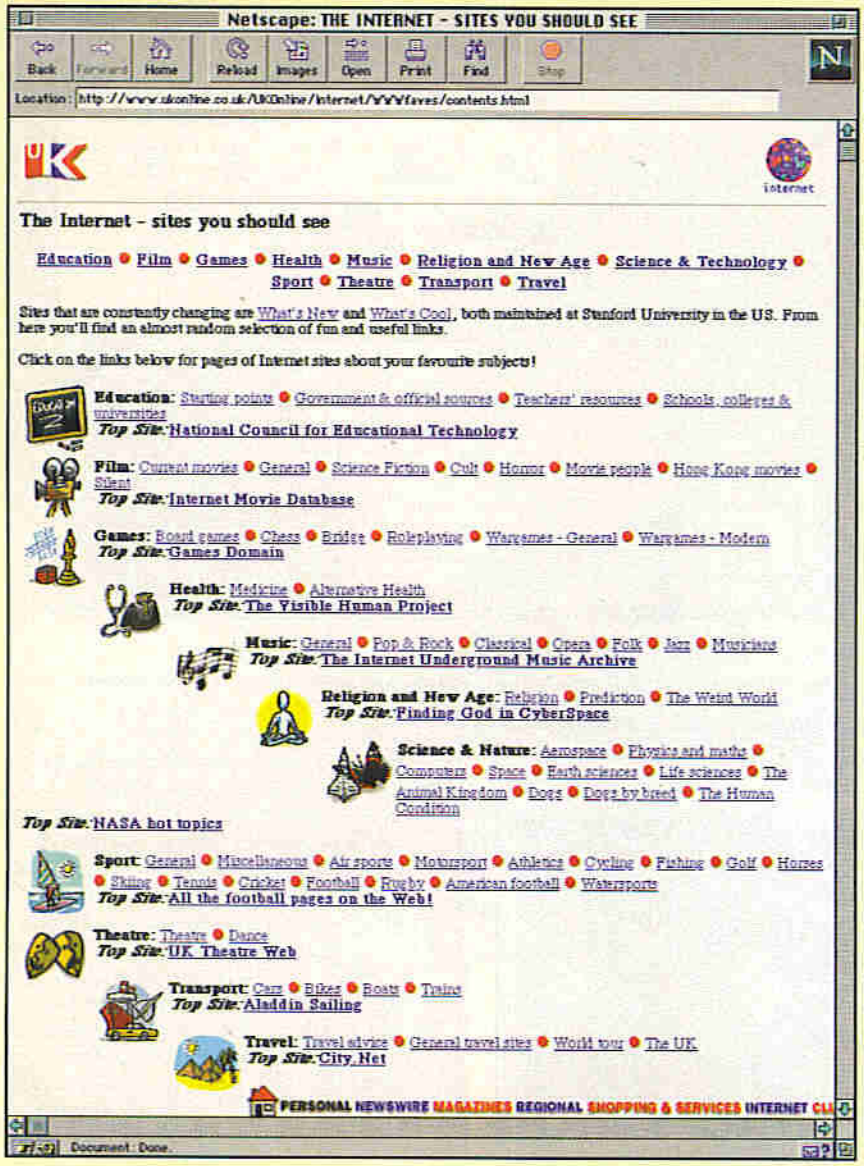
What's the advantage of this? Well, while the Internet is a largely lonely place when you first access it, bulletin boards can be extremely friendly. Server software for bulletin boards is generally streets ahead of Internet access software in user-friendliness, because the job it's doing is far simpler than the job needed to control Internet access.

On the other hand, bulletin boards usually only provide limited facilities, so you need to check out what you're getting. It all depends on the bulletin board itself. Many bulletin boards can give you an Internet e-mail address. Some will give Usenet newsgroup access. Some might even provide full Internet access with World Wide Web browsing and full file transfer abilities.

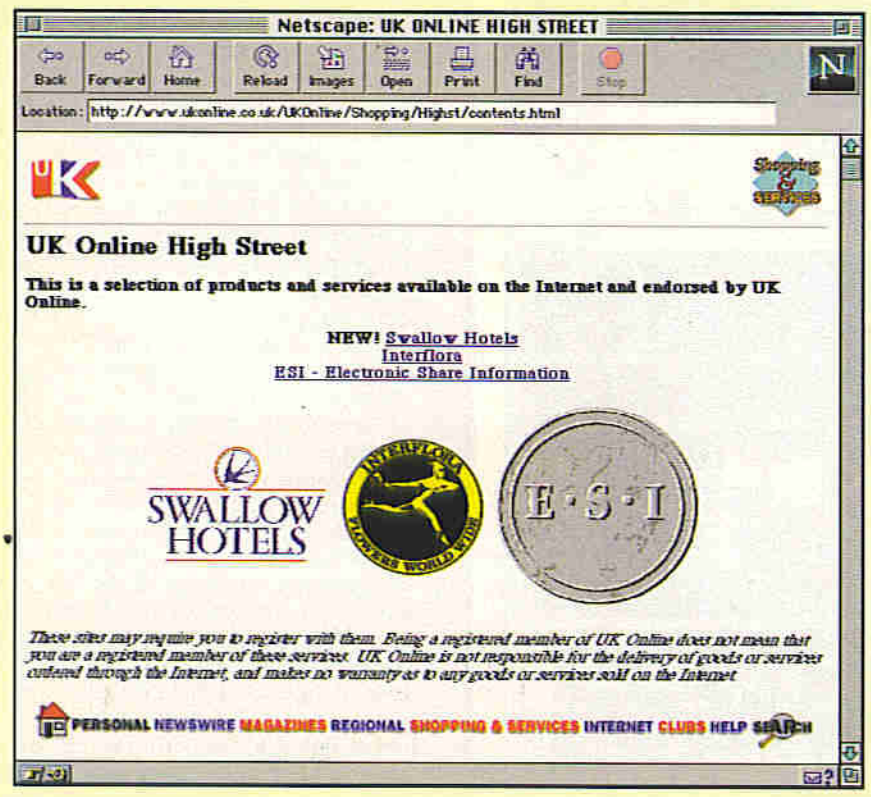
One of the best bulletin board server software packages I've yet seen is FirstClass. To say that FirstClass is simply bulletin board server software is a bit of an understatement, however, as it is capable of much more. Nevertheless, to many bulletin board users around the world, that's how FirstClass first comes to their attention.

There are several bulletin boards around the UK which use FirstClass – too numerous to mention, so I'll just take a close look at two, for comparison purposes. The first I want to highlight (one I use every day) is MacTel. MacTel operates from two sites, London and the Midlands, and subscribers can access either. Users ideally need the FirstClass Client application, which is freeware and readily available on magazine cover disks and the like. FirstClass supports command line logon as well, after which, the Client software can usually be downloaded from the bulletin board, and for many users, this is a convenient way to get it.

Once connected using the FirstClass client, things take a wonderful turn for the better.



UK Online favourite sites.



UK Online shopping page.

FirstClass gives a full graphical user interface which is simplicity itself to use. The FirstClass desktop comprises folders (some set up by the bulletin board supervisor, some added by the user), which are opened by double-clicking.

Inside, any folder can be further folders or files. The overall concept is, therefore, very much like a decent modern computer operating system. This makes the bulletin board easy to get around. Folders and their contents are initially set up then maintained by the supervisor (often called the system operator, or sysop), but subscribers have the ability to create folders or move things around their personal desktops, without affecting any other users' desktops.

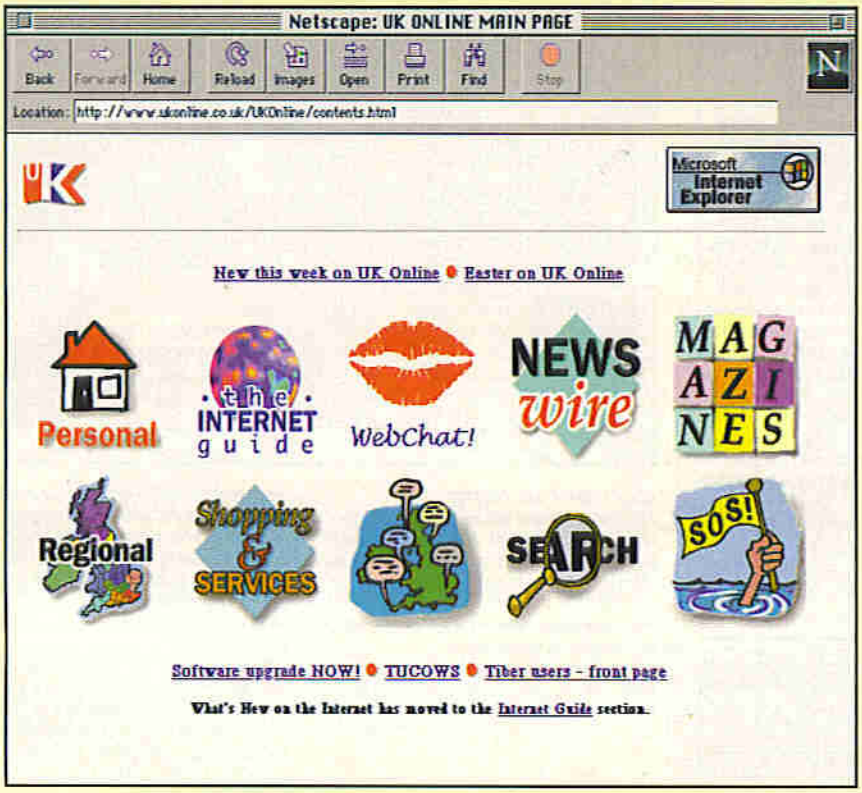
MacTel subscribers are allocated an Internet e-mail address. This is a true e-mail address, and from there, any user can post and receive e-mail to and from any other Internet user worldwide. E-mail messages to other MacTel users on the bulletin board are routed immediately to the other users' mailboxes. On the other hand, like the majority of other UK FirstClass bulletin boards, MacTel isn't live on the Internet, so Internet e-mail posting doesn't take place immediately. Instead, MacTel's FirstClass system logs onto the Internet (via an Internet service provider, in the same way we've already seen) automatically each night, taking advantage of cheap rate telephone calls.

With this small proviso of overnight Internet e-mail delivery, though, the MacTel service (at £28 a year) is incredible value. For instance, as part of the Internet logon overnight, MacTel watches and maintains Usenet newsgroup echoes, so subscribers can request, read and post to any newsgroup of choice. Also, a huge amount of shareware and information is maintained in a wide-ranging archive, which subscribers can download to their own computers, or upload to from their computers. As readers might surmise from the name, MacTel's content is biased towards Macintosh users, though this is probably because Mac users were the first to embrace the FirstClass way of working as being closest to their own computer operating system's way of working. There's nothing to prevent Windows and DOS computers from accessing MacTel (or any other FirstClass bulletin board), provided the Windows or DOS Client software is used. For reference, the screen shots of MacTel were taken off a computer running Windows '95, which proves this.

The Best of Both Worlds

So, if all you want is e-mail, access to newsgroups and file transfer abilities, then a bulletin board like MacTel may do you proud. It's friendly, easy to use and, above all, fun. However, FirstClass is capable of a lot more than this. In-built is an ability to access the Internet through a live (that is, full-time) link. In other words, such a FirstClass server can be the front-end of all the usual Internet services. You can log on onto the server and treat it like a bulletin board, you can e-mail messages world-wide instantly, you can access archives in distant computer systems, and you can surf the Web. Indeed, the FirstClass Client software has the necessary tools built in.

To date, however, due to the costs of maintaining a live Internet link, such FirstClass bulletin boards are few and far between in the UK. There are quite a few in the US, of course. One UK FirstClass system to take the plunge

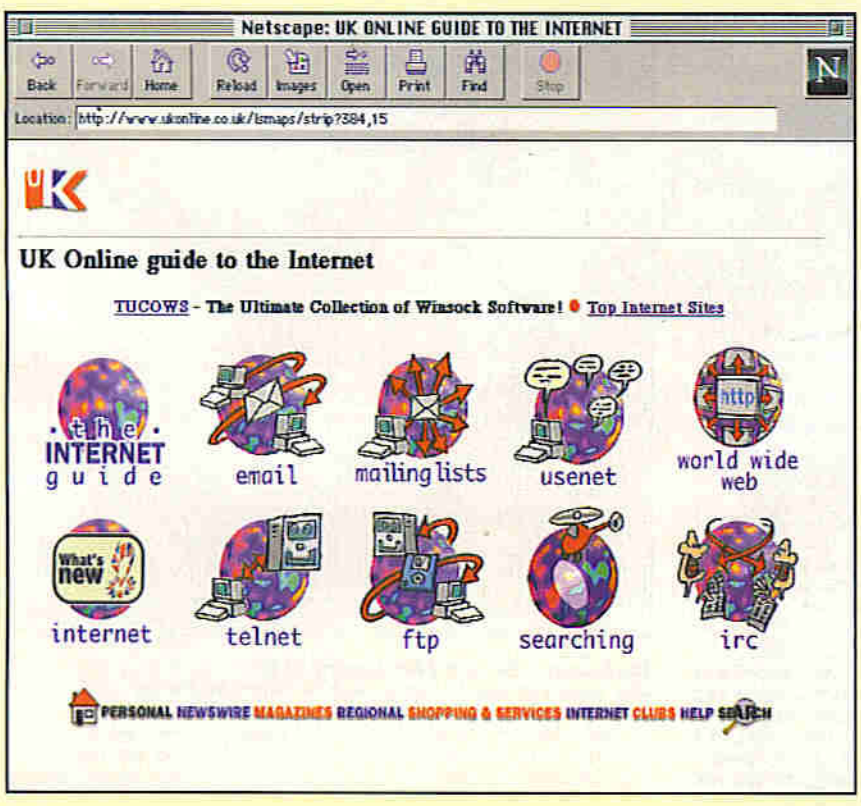


UK Online home page.

is the frame. To access the frame you have two choices. First, you can dial up the server over a standard telephone line using the FirstClass Client as the controlling procedure. Alternatively, you can log on over a TCP/IP link in the same way ordinary Internet service providers require. Again, though, this is controlled with, and built into, the FirstClass Client software. Subscribers choose whichever is cheapest.

Where MacTel is a general bulletin board for all computer users, the frame exists for a specific group of computer users – those in the media. Its desktop illustrates the way FirstClass can be adapted to suit just about any purpose. All subscribers need to access the desktop is a copy of a settings file, which gives the FirstClass Client the information required.

Like MacTel, subscribers to the frame have a bulletin board as a central focal point, which



UK Online guide.

takes the hassle out of on-line computer use. However, while it's just as easy to use and just as convenient, there is the option of full Internet access. That's the beauty of FirstClass; it's so adaptable.

There are significant changes due in FirstClass over the coming year, and it's just possible that some Internet service providers may change from the traditional socket-to-the-Internet mode and start thinking about how to improve the service. Systems which create a decent graphical user interface, like FirstClass, might be the way they move forward. Let's hope so.

On-line in the UK

Meanwhile, there are a few Internet service providers who don't want to wait for standards to become standards merely by default. Instead, they want to take matters in their own hands, and provide services which are significantly better than basic Internet provision now. Such a service provider is UK Online, which opened for service only in September. UK Online realised that competing for business against traditional Internet service providers would be heavy work, so is targeting a specific market (that of families) rather than competing head-on. UK Online realises that while the Internet can be fun for kids, parents don't necessarily want them surfing where the Internet waves are too deep. So, parents can specify which services, and for how long, children can access. It's a simple principle, which seems to work well in practice.

UK Online charges aren't high, either. For £9.99 (including VAT), subscribers have one e-mail account and ten hours' access. For £14.99 (again, including VAT – just compare these prices with other Internet service providers' prices), subscribers have a nifty four e-mail accounts and unlimited access.

Cost isn't the only benefit of UK Online, though. The interface features an easy-to-use format, not unlike a FirstClass one, built around a well-conceived and well-designed World Wide Web home page. It's presented as an electronic magazine, from where you can access the various UK Online elements. Continuing with the magazine appearance, UK Online's editorial policy ensures that material provided on the pages is suitable for its intended family audience. There's enough on these pages, with all their links, to keep most families happy, but if desired, users have the option of using the traditional Internet resources in a more traditional way.

While the in-built Tiber World Wide Web browser incorporates on-line mail facilities (using Windows, at least), UK Online has recently licensed Microsoft's Internet Explorer for Web browsing and NETcetera for off-line mail and Usenet news reading. On the MacOS, any Web browser and off-line mail and news reader has always been usable.

Therefore, it's the UK Online format, like the FirstClass format, which starts to give Internet services added value. Yes, we know we can log on to the Internet with a traditional Internet service provider, but it's pretty basic, isn't it? What can we have which gives us added value? What makes the Internet worthwhile? How can we tap into its vast resources in a sensible, easy-to-use way? Is FirstClass or UK Online the way forward? For more answers to these questions, watch this space.

@Internet

Of special interest to Macintosh Internet users, is the latest update of system software. The US version, System 7.5 Update 2.0 is now available from Apple's many US ftp sites, along with AOL, CompuServe and many bulletin boards. It's not yet been localised for other countries, although Apple UK expects the localised UK version to be available within weeks. Meanwhile, those who can't wait should download the US version, which runs perfectly happily on a UK machine (we can vouch for this from personal experience), in the full knowledge that Americanisms can be expected – Trash for Wastebasket, color for colour and so on.

The update once more brings System 7 back into line for all Macintoshes. The last batch of Macs required System 7.5.2, which couldn't actually be used on previous Macs. With System 7.5 Update 2.0 (which is also known as System 7.5.3 to illustrate its total compatibility), every machine from the original 1984 Mac Plus upwards can use it, and it brings several new features. Most important of these (as far as we're concerned here) is the general release of Open Transport, Apple's new TCP/IP Internet connection utility.

Open Transport has several advantages over the Mac's previous TCP/IP connection tool. For a start, it supports high-performance datalinks such as ISDN, ATM and so on. Another plus is its multiple TCP ability. For anyone with more than one Internet service provision, Open Transport can access each service (over whatever connection method you might use) reliably, steadily, and there is never any need for restarting when changing method. It's also extremely stable, and considerably faster in data transfer. 'Nuff said. Get it while it's hot!

UK Online Now on the Mac

It cannot be a coincidence that in the same month that Apple abolished eWorld, UK Online (**http://www.ukonline.co.uk**), announced a Mac version of its dial-up software.

Nevertheless, according to Dr Tim King, UK Online's managing director, it is a natural extension to the UK Online service. "We have been overwhelmed by requests from the Mac community to offer access to our service from the Apple platform. We are pleased to say that this is now available and is fully supported by our help desk team", said King.

Family membership of UK Online is priced at £14.99 per month. This includes four individual e-mail addresses and unlimited access to the Internet and the UK Online service. The individual service, known as Personal Service, will allow up to ten hours of access to UK Online and the Internet at a cost of just £9.99 per month.

Existing Internet users can take advantage of UK Online's newswires, information, clubs and magazines for £4.99 per month. Once online, there are no additional charges. Full software is provided to users, including Microsoft's Internet Explorer, e-mail and a trial version of the Newshopper off-line reader.

Contact: UK Online, Tel: (01273) 709977.

Three's a Crowd? But Four?

Microsoft (**http://www.microsoft.com**) and AOL (**http://www.aol.com**) have announced an alliance that will make the software giant's Internet browser a key feature of the AOL online service.

In return, Microsoft has agreed to include a desktop folder in future versions of its Windows '95 operating system to allow easy access to AOL. The announcement is a blow to Netscape (**http://www.netscape.com**), which days earlier, announced its own licensing deal with AOL.

However, AOL chairman and chief executive, Steve Case, said that the Netscape deal was aimed at the relatively small number of people who subscribe to the company's new Internet-only service, known as GNN.

Clearly, Case's counterpart at Netscape was hoping for more. Jim Barksdale, President and CEO of Netscape claimed, "The agreement enables Netscape to immediately extend its reach into the consumer market by providing AOL's 5 million customers with access to Netscape Navigator".

Meanwhile, AOL rival CompuServe (**http://www.compuserve.com**) is also in talks to have its software bundled with the Windows '95 operating system, after Microsoft ditched its online network. CompuServe has already tied up a deal with Netscape to bundle the Navigator browser with access to the CompuServe Information Service. Interesting times?

Content in King

AOL (**http://www.aol.com**) continues to launch new content in a bid to attract new members to its online service. This month, the company introduced a Formula One Area, as well as content from the Daily Mirror and Independent into its virtual news room.

The Formula One forum covers all race, circuit, team and driver information, and Grand Prix devotees can keep up to date with every aspect of the sport, live and online from their own home computers. The area also includes details of the full UK television schedules.

Meanwhile, the New Media team at Mirror Group and Newspaper Publishing has created exciting online versions of the Daily Mirror and The Independent. Both titles are updated daily and made available every morning. The group's other titles – Sunday Mirror, The People, Sporting Life, Daily Record and Sunday Mail, as well as elements of LIVE TV – will follow shortly.

If you missed out on the AOL cover disk last month, AOL software can be ordered by ringing (0800) 2791234. New members will receive one month's free subscription, including 10 free hours access to the AOL UK service. Subsequent costs will be £5.95 for up to five hours of use and £1.85 per hour for each additional hour.

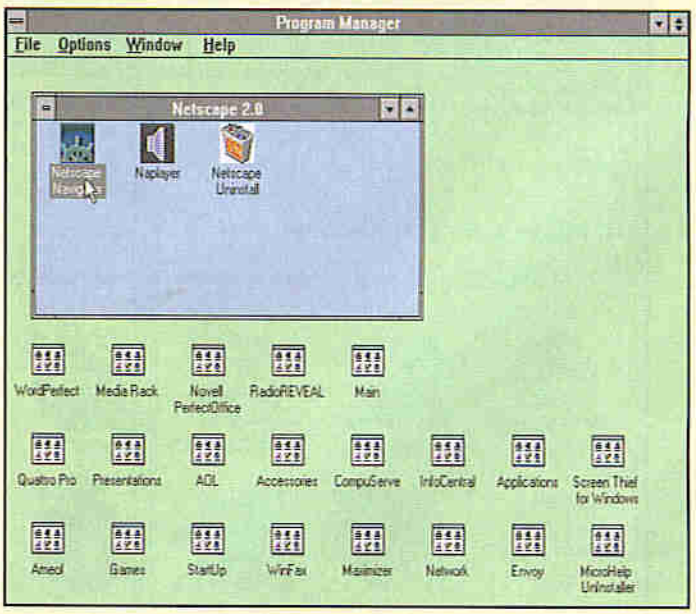
BT to Launch Internet Service

BT (**http://www.bt.com**) now wants a slice of Internet action. The company launched a mass market, dial-up Internet service at the end of March. Called BT Internet, the service is aimed at residential and small business customers.

BT Internet consists of a full range of Internet services, including WWW access, newsgroups and e-mail. The service is based around an integrated suite of Internet software, including a BT Internet launcher to control all applications.

However, BT clearly hasn't worked out what's going on in the Internet service market. While most service providers abolished up front fees six months ago, the BT service has a start up fee of £20. Thereafter, the monthly subscription fee is £15, giving unlimited use of all BT Internet services and applications. Alternatively, customers can pay an annual subscription fee of £150, a discount of 16%. Meanwhile, calls to the service will be charged at local rates nationwide, at speeds of up to 28,800bps. A telephone helpdesk is available at local call rates.

For a BT Internet information pack, call (0800) 800001.



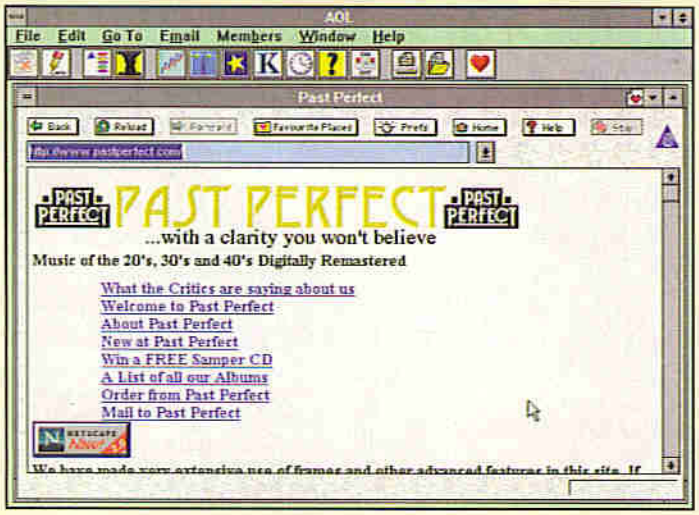
Netscape Ships Navigator 2.0

After months of Beta testing, browser king, Netscape, is shipping the final version of its Netscape Navigator 2.0 Internet client software. The new browser can be downloaded at **http://home.netscape.com**, and is available for Apple Macintosh Microsoft Windows 3.1, Windows '95 and Windows NT operating environments.

Netscape Navigator 2.0 includes a full suite of Internet applications, including WWW browsing and new collaboration features such as interactive e-mail, integrated threaded discussion groups and support for interactive multimedia.

Gramophone Recordings

Past Perfect Recordings is moving forward with the launch of its WWW site. The UK record company specialises in remastering the great sounds of the 20s, 30s, and 40s from the likes of Duke Ellington, Billie Holiday, and Louis Armstrong. Visitors to the site can listen to samples, access the company's extensive archive of jazz memorabilia, and place orders online at **http://www.pastperfect.com**.



3D Techniques

It was only a matter of time before someone came up with a 3D approach to surfing the WWW. Well, not quite. Old Town Crossroads provides a familiar place for first time users to start their Internet adventure. The site is laid out like a small town in the US. Stops at the site include a cinema feature with links to movie and television sites, a newspaper feature with links to major news periodicals, and the town hall with links to political sites. Old Towns Crossroads is at **http://www.gic.net/xroad.html**.

Free AOL Access into the Classroom

All secondary schools in England, Wales and Scotland are being offered free access to the Internet by AOL.

All secondary schools and local education IT centres can apply for free AOL accounts, which will give unlimited access to all of AOL's channels, including an in-depth National Curriculum area provided by Anglia Multimedia, the Internet and WWW.

Jonathan Bulkeley, AOL's managing director said, "We believe that it is imperative that schools become an active part of the wider electronic community, which is why we are opening up AOL, a worldwide online service, free of charge for schools to use".

A key feature of AOL's easy to use interface, which will reassure adults supervising children online, is a powerful parental control facility, which enables teachers and parents to block access to specific areas of the AOL service, as well as certain Internet newsgroups.

Site Survey

The month's destinations

For satellite watchers, check out **http://www.eutelsat.org**, where you'll find Eutelsat's brand-new Web site. Eutelsat's aim is to provide easily accessible information regarding its services, and that's the exact nature of the Web, of course. There are six main areas, covering topics as diverse as television channels, radio stations, satellites, corporate information, Eutelsat on-line, and highlights.

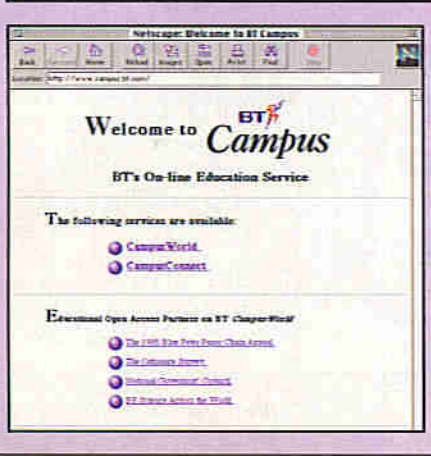
If you've ever thought there should be a Yellow Pages for the Internet, rest safe in the knowledge that there is. Correction – are! Two that have come to our attention recently are WhoWhere?, at **http:www.whowhere.com/**, and Four11 at **http://www.four11.com/**. In either of these, you can register to have your details stored, and search for other Internet users you want to find.

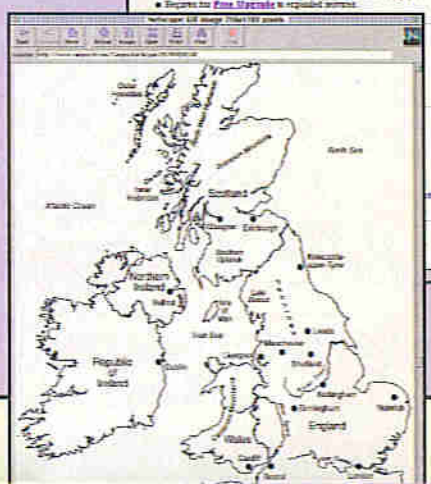
British Telecom is starting to become quite active in the Internet race. One of its services, BT Campus World, is specifically for education, but is still of interest to any UK Internet freak. Catch it at **http://www.campus.bt.com/**. The system operates for schools as an enclosed space (called the Walled Garden), where children can have free access. Internet sites within the Walled Garden are checked for suitability by British Telecom, and to get out of the Walled Garden and surf the rest of the World Wide Web (or should that be sow wild seeds?), a password is needed. In other words, teachers can get out, kids can't. Even if you're not a registered user with password, however, you can access certain areas such as Ordnance Survey pages, like that shown.

▼ Eutelsat Web site

WhoWhere directory ▶

◀ BT Campus





▲ Four11 directory

◀ Ordnance Survey page

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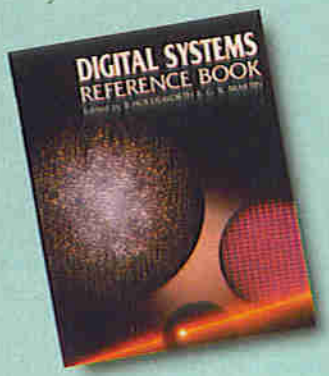

Digital Systems Reference Book

Edited by B. Holdsworth & G. R. Martin

The Digital Systems Reference Book has been designed to provide comprehensive coverage of digital systems for everyone working in the digital field, including engineers, academics and scientists. It has five sections – Fundamentals, Devices for Digital Systems, System Design & techniques, System Development and Applications – each made up of self-contained chapters written by an acknowledged expert from within industry or academia.

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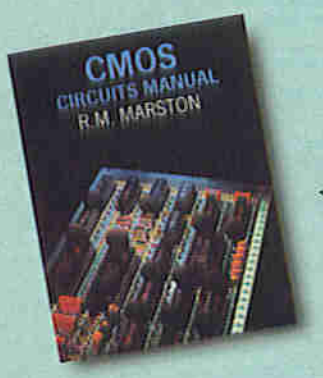


CMOS Circuits Manual

by R. M. Marston

CMOS digital ICs have considerable advantages over other digital IC types and this useful single volume guide takes design engineers, technicians, experimenters, students and enthusiasts through their basic principles and characteristics. It deals with the subject in an easy to read and non-mathematical manner while still managing to be very comprehensive. It contains a number of fully tested circuits, all making use of inexpensive, easily available components.

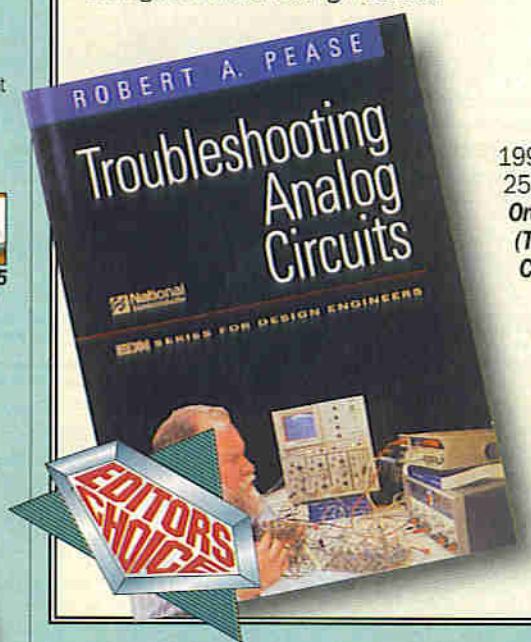
190

1988. 216 × 136mm. ***Order As 95124 (CMOS Circuits Manual) £14.99 NV***

TROUBLESHOOTING ANALOG CIRCUITS

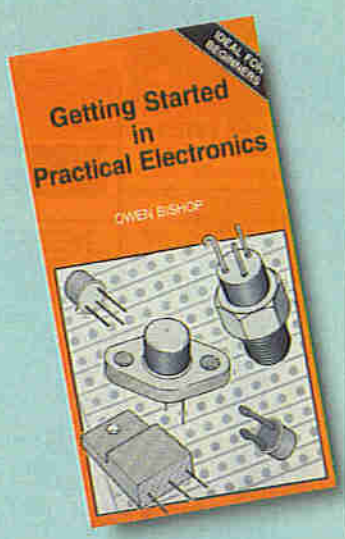
by Robert A. Pease

This book contains a wealth of tips on the techniques and methods used to debug and troubleshoot analogue circuits. Aimed at analogue/digital engineers, students and enthusiasts, the book highlights the issues, gives advice on the range of equipment that can be used to troubleshoot and supplies step-by-step procedures to 'walk you through' analogue troubleshooting methods.



1991. 255 × 178mm, ***Order As 95123 (Tble Sht Analog Crct) £17.95 NV***

218



Getting Started In Practical Electronics

by Owen Bishop

Owen Bishop is the author of over 60 books, mostly in electronics, and this is his guide for the absolute beginner who wants to get a good grasp of electronics and to begin to competently build their own projects. The book is in two sections. The first takes you through the theories, components and techniques that you'll need to be able to build the 30 electronics projects of increasing complexity – including such items as a moisture detector, glittering party wear, a fire alarm, night light, lie detector and mini organ – that make up the book's second section.

198

1994. 178 × 110mm. ***Order As 95127 (Get Start Pract Elec) £4.95 NV***

Auto Audio

by Andrew Yoder

Choosing a stereo system for a car can be intimidating. With the vast range of components to choose from many audiophiles and enthusiasts just pick what they can afford and hope for the best – or rely on a dealer. As well as offering practical advice on how to select and install in-car systems, it also shows you how to maintain and keep your system sounding at its best. There are complete chapters on amplifiers; speakers and speaker enclosures; filters and crossovers; antennas; wire, cabling, connectors and transmission systems; installations; maintenance. A wealth of information in an easy to read style.

360

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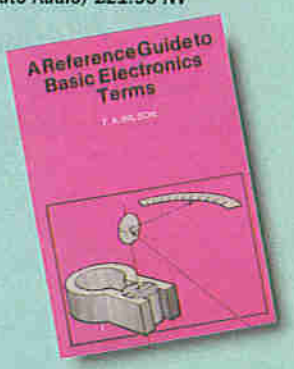

A Reference Guide to Basic Electronic Terms

by F. A. Wilson

This book is an ideal aid for all those, experienced or otherwise, who encounter an electronics term that's unfamiliar, forgotten or never really been understood. The author's system of references ensures that every term is backed up by a list of other relevant or more fundamental terms so that a chosen subject can be studied to any depth required. It is an invaluable source-book that should really be viewed as a whole range of basic text books rolled into one. This book is likely to appeal to those in disciplines as diverse as engineering, science and medicine where electronics is increasingly becoming a part of everyday life.

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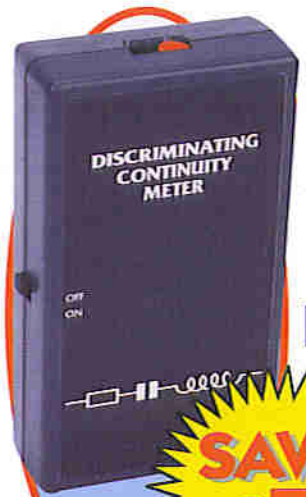

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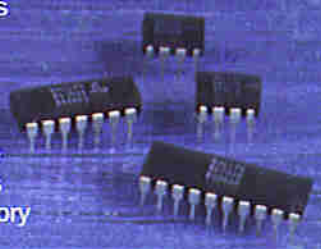

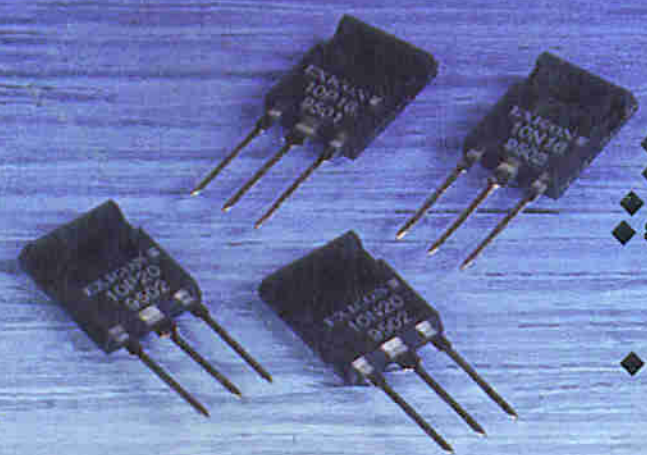

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