June 1992 • £1.50

NEW PRACTICAL ELECTRONICS

SCIENCE AND TECHNOLOGY

TV On The Move

We take a look at the latest products in the world of television

The Latest New Products

The Commodore Amiga 600
A Keyboard for CDTV
ICL's LCD Monitors
Sanyo's Digital Book
Sony's New Cassettes
Pocket Fax
Widescreen TV
CD ROM Security
Videophones
Hard Virus Killer

Plus

Digiscope 92: a new look for an old project
How to make an integrated circuit
Meteor burst communications
Techniques: How to receive military weather forecasts
Barry Fox on the future of Rabbit CT2

Reviews

Fotoman electronic camera
Satellite Dish Positioning Program
Electronic circuit simulator

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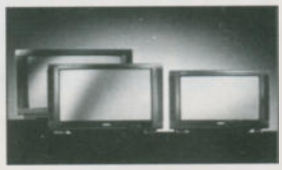
This month...

For those who don't know, brown goods are things like TVs, VCRs and HiFi and the annual Brown Goods Show in London is the UK's showcase for manufacturers of such equipment. The only trouble is that instead of everyone and everything being under one roof, each company has a different venue. This means that the poor old journalists (like myself) who want to take a look at what will be in the shops in the way of consumer electronics get through quite a bit of shoe leather. I can only add my plea to all the others. Please, please hold this event under one, or even two roofs so that we can get to see it all without having to travel all over the city

Kenn Garroch, Editor

Features



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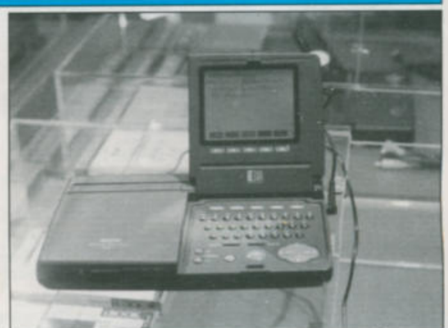
Reviews



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Next month...

The power industry, PE takes a look at the sources including solar, atomic, fusion, gas and oil. Plus all the latest news from the world of electronics

Out On 4 June

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Wavelengths

The great 3DTV hoax, a request for kit and some opinions on what is legal and what is not.

I was quite disappointed to read that the 3D television article in the April edition of PE was all a hoax. Not having the knowledge that your other readers have, I fell for it 100%.

3DTV has always been an interest of mine and I have been working on a few ideas of my own to produce simulated 3DTV. The system is fairly simple and requires that two completely separate video images (left and right) to be recorded on a single video tape by a camera with two lenses and two CCDs. This has led to a couple of problems I hope you can help me with.

In an effort to maintain compatibility with the present video technology. I had hoped to interlace the left and right video tracks using a drum with two video heads positioned close to each other and altering the tape transport speed. Thus, when the tape was played back on a standard video deck at normal speed, the right video channel would be ignored and the picture could be viewed normally.

So much for theory. Is it possible? Can two video tracks and two video heads be this close to one another without causing interference? Alternatively, a more elaborate solution is to write one of the video signals on the opposite side of the tape. Can this be done?

G Shields
Cathcart
Glasgow

As far as I know, the tracks on a video tape are already positioned next to each other so fitting another in between would be difficult – especially with long play systems which reduce the tape speed to half. Writing on the reverse side of the tape is also out since there is no coating in the reverse side of the tape. Perhaps other readers can offer a solution?

Marconi Memorabilia

At the present time, myself and a few other people are in the process of setting up an Interpretive Centre in the Parish of Goleen West Cork. Formerly the Parish of Kilmoe. One of our aims is to research the past history of the parish which we know to be vast.

We hope as our main project to do a research into Marconi as his base was in Brow Head in Crookhaven in the Goleen parish.

We would be much obliged if you could help us out with any information you might have on this and maybe where some Marconi equipment could be found.

Any information you might have, no matter how small, would be very welcome, we feel that this is a worthwhile project and a key to our success.

Michael O'Regan
Goleen
Co. Cork
Eire

Can anybody help?

Illegal

I read your review of the stereo sound sender in the May issue of Practical Electronics and am rather distressed to find you recommending that readers should break the law. As far as I am aware, it is illegal to transmit on frequencies in the general FM radio band without a license. I realise that the transmitter is very short range but the law is there for a good reason. As many people in London may have noticed, pirate radio can be very annoying.

R Head
Shepherds Bush
London
W12

Or Not

Your review of the stereo sound sender and the advert for Creditcall in April 92 (was this possibly an April fool?) both have my approval. I can see no reason why it should be illegal to use a gadget to make free phone calls if the BT system is susceptible to it. Surely it is up to BT to protect their investment, not their clients, especially considering the phenomenal profits made out of them.

The stereo sound sender is an example of a useful gadget invented to perform an ingenious task. Its short range should cause no interference problems to anyone and, as far as I can see from the review, a quick retune will solve any problems.

Carry on the good work.

S Bains
Oldham
G. Manchester

IR Kit

I read with interest Andrew Armstrong's infra-red headphone link and am interested in building one. Can you supply a kit of parts plus full instructions for construction?

J Buerk
Basingstoke
Hants

The idea of Andrew's column is to give some idea of how the circuits work. Practical hardware details are left up to the reader. Unfortunately, as a publishing operation we can't afford to get into producing hardware.

Dry Joints

A couple of minor errors crept into lasts month's construction feature, Getting To The Bottom Of Things. In the circuit diagram on page 41, C3 and C8 should have their +ve leads to the top. A heatsink should be attached to the tab of IC2 on page 43 and R2 should connect to the same tag as R1 on the input potentiometer on page 44. ■

Innovations

This month robotic dinosaurs, videophones, games machine programmers and toll roads.

Computer controlled pneumatic robots have been used to "liven up" the new dinosaur displays in the Ronson Gallery of the Natural History Museum in London. Even though it is still, the above picture shows how realistic the results are.

Hard Virus

Over the past few months there has been much talk of computer viruses with the advent of Friday the thirteenth and the Michaelangelo anniversary. An alternative solution to software virus checkers has recently been brought out by a US company called Multix. The ViruStop PC Immuniser Card slots into a spare slot and scans the computer's hard disk boot sectors for infections before the PC enters DOS. When the computer is running, the card monitors the data and address buses for characteristic virus activity.

If a virus is detected, ViruStop goes into action and stops all processing and allows the user to delete the offending file.

An added feature of ViruStop is password protection of the computer. Once set up, the machine is disabled until the correct text is entered.

Priced at $69, ViruStop is available from Multix, 4203 Beltway Drive, Suite 7, Dallas Texas 75244 USA. Fax 214 239 6826.

Real Translation

AT&T Bell Labs in association with Telefonica in Spain has devised a real time spoken language translation system. Known as VEST – Voice English Spanish Translator – the machine is able to recognise about 450 words as they are spoken in fluent sentences. After determining the language being used, VEST translates to the other and then speaks the result. This takes less than one second using a context-free sentence analyser or parser, a rule-based translator ad a text-to-speech translator.

Demonstrated at the Ideal Home exhibition, BT's new videophone uses the standard telephone network. The phone plugs into a standard phone socket and includes a camera and slow scanning screen.

According to Bell, VEST is the first step in a system that will be able to recognise several thousand words covering a specific task area. By restricting the application to a specific domain, the number of words that need to be recognised can be reduced.

Anyone wanting to see the system in action will have to go along to Expo 92 in Seville where it will be on show at the Telefonica exhibition.

Down The Line

In the bad old days, writing computer games simply meant getting hold of the appropriate computer, an assembler and writing the program – many of the first Spectrum, C64 and Atari ST games were written this way. However, with the advent of hand-held machines such as the Game Boy, GameGear and Lynx, programming has to be done on a separate system and the code downloaded into the handheld before it can be run and tested.

Two new ROM emulators from 21st Century Design aim to speed the programming process up. The systems replace the plug-in ROM cartridges of the games machines with ROM emulators which can have their contents quickly updated by a parallel communications link. ESYS 128 links up to the parallel port of a PC and the ROM socket of the target machine – a Game Boy or Sega Megadrive – to provide up to 128k of emulated ROM. All programming and assembling is then done on the PC and the resulting machine code downloaded to the emulator for testing. An optional comms board allows the contents of the ROM to be accessed by the PC while the games program is running allowing the programmer to check on the operation of the software.

Prices are at £399 for the ESYS 128 and £999 for a 1Mbyte version. The comms board costs £99 and fist both versions. For more information contact 21st Century Electronics at 56b Milton Park, Abingdon, Oxon, OX14 4RX, Tel. 0235 832939.

ESYS ROM emulators for hand held games.

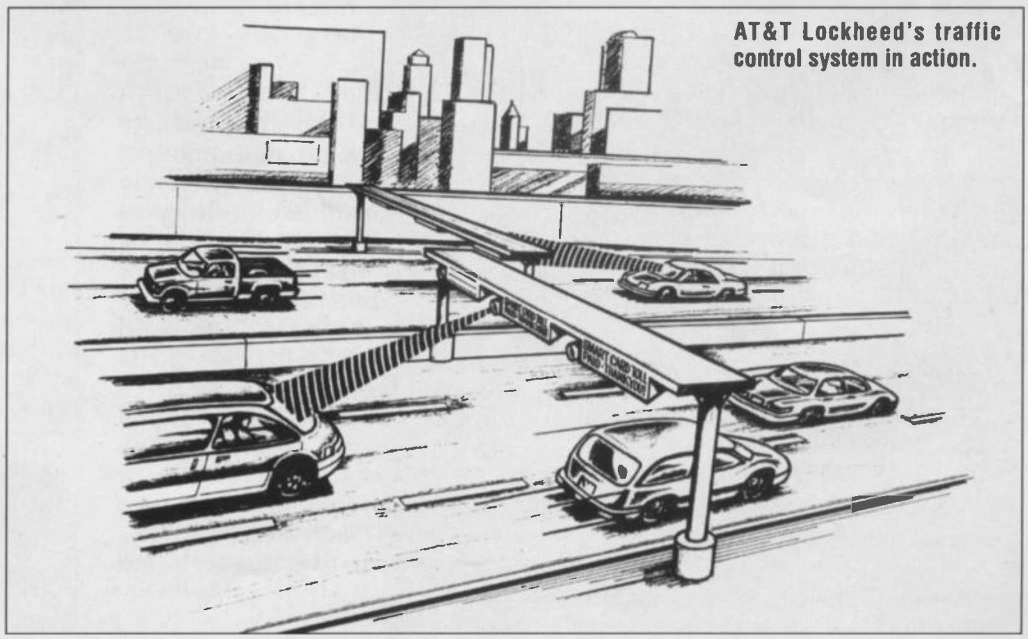
Car Control

As the number of cars increases, the calls for controls and limitations on their use grows. A number of solutions are possible; the efficient management of traffic, driver information systems, automated vehicle control and the use of toll roads.

Until recently, the latter have caused quite a lot of congestion. Now, however, AT&T and Lockheed in the US have come up with an automatic toll collection system using smart cards (plastic cards with embedded micro-processors) which hold information about the driver and the amount of credits available.

As the car approaches the toll collection area, receivers mounted on the side of the road communicated with the smart card via a small radio transmitter mounted on the dash of the car. The system can then track the car and note when it enters and leaves the roadway and deduct the desired toll. The entire transaction takes only a few milliseconds and could easily be extended to take into account the vehicles weight, size and even make in conjunction with other roadside sensing systems.

Currently being tested in the western USA and British Columbia, the idea could well be extended to cover the rest of North America. ■


AT&T Lockheed's traffic control system in action.

PE – Computing

Anthony Robertson describes the latest action in the world of computer electronics.

According to some computer companies, the only machine worth buying is the fastest. The ongoing saga of manufacturers seeking to claim victory in the computing speed stakes has now reached ludicrous proportions.

Eleven years ago when IBM unveiled their first Personal Computer, the Intel 8088 microprocessor fitted to every IBM motherboard ran at only 4.77Mhz. In retrospect, any machine running at this speed, was hopelessly inadequate for all but the most mundane of tasks. Since that time we have seen the rise and fall of the 80286 and 80386 microprocessor, and processor speeds have galloped to 33Mhz and beyond.

The natural replacement for the 80386 processor was the powerful 80486DX design – at its most basic specification an 80486 can function 30% faster than a corresponding 80386 running at the same clock speed. Now the days of the 80486DX processor seem to be numbered with the appearance of the new Intel 80486 DX 2 – a processor which utilises existing technology to provide even more power.

The DX 2 is designed to be a direct replacement for 25Mhz DX designs. Doubling the internal clock speed of the DX 2 effectively brings it in line with existing 50Mhz 80486DX specifications. This approach is a step toward even faster 80586 designs – its specification already includes an extra row of connector pins along one edge, and this row of pins will almost certainly be a feature of next year's 80586 series.

Cyrix 486SLC front runner

Chipping In

Intel is not the only company to release exciting new processors. Owners of 80386 based machines can now upgrade to 80486 performance thanks to a Texas based company Cyrix. Its unique Cx486SLC launched at Comdex on April 6th, is a 25Mhz instruction-set compatible microprocessor. It is currently the fastest 16-bit bus microprocessor available for use in desktop, notebook and pen-book systems.

The Cx486SLC is supplied in a 386SX-type 100 lead, surface mount Quad Flat Pack (QFP). Remarkably, this processor offers more than double the speed of an 80386 running at 25Mhz, whilst costing significantly less. The Cx486SLC is being shipped out at less than 130 US$ per unit, and the UK price is likely to be around £125.

Blind Truth

Computing for the disabled is a growing area of interest amongst UK electronics companies. Recently Sight and Sound technology of Northampton launched "David" – the world's first go-anywhere notebook computer for the blind.

Bright red in colour and weighing only 7.5lbs, David is battery powered and features advanced braille keying and a unique infra-red device which allows the user to place the cursor by touch. This computer is a major technological advance and the result of exhaustive research and development.

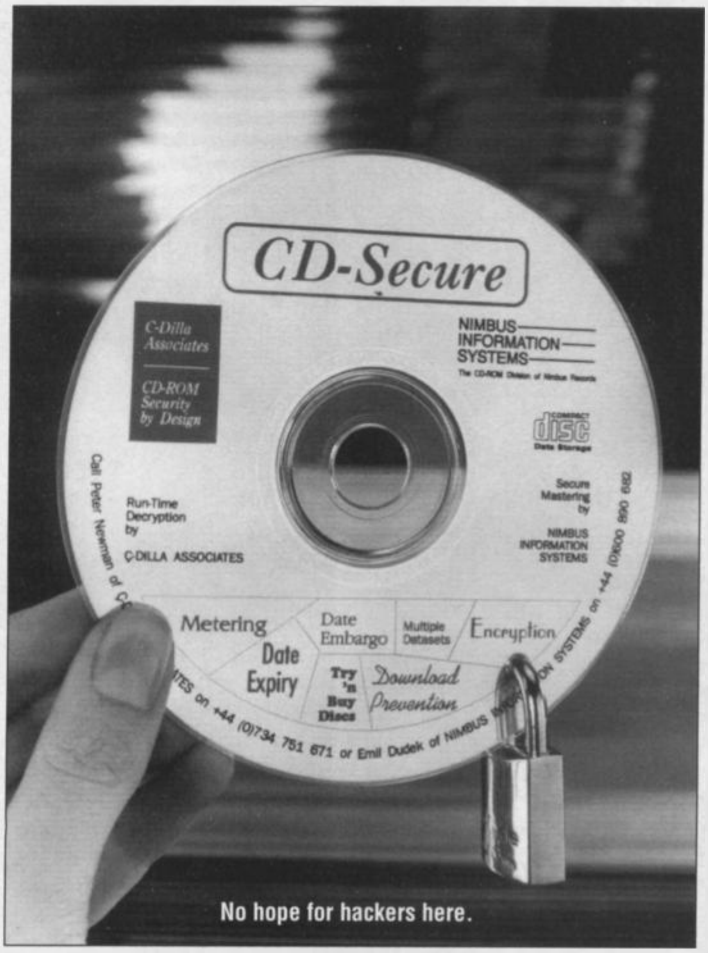
Anyone using David can input information via a braille keyboard and read the text in braille on a special dot-matrix pad. The computer also has a speech facility, enabling blind people to hear what has been written. Another of its major technological attributes is its Advanced Optical Sensored Cursor Routing which allows the user to move the cursor by touch anywhere on the screen, vertically or horizontally.

David has 3Mb RAM plus a 40Mb hard disk and 1.44 Mb 3.5in internal disk drive. It has a range of serial and parallel interface ports and screen connectors and is MS-DOS industry compatible. There is


Portable computer for the blind

also a professional version which has greater memory and a larger hard disk.

The standard model sells at £8150 and the professional version at £8900. For more information, please contact: David Bradburn at Sight and Sound, on 0604-790969.



No hope for hackers here.

CD-Secure

The CD-ROM is here to stay it seems. Already industry bigwigs are bundling Hitachi and Sanyo CD drives with high-end machines. Adoption of this new technology is particularly attractive to software manufacturers as their precious applications are virtually hacker proof.

Suitably mastered CD-ROMs are also free of virus contamination and liable to remain in use well beyond the life-span of convention magnetic storage media. One of the drawbacks with CD-ROM data has been the ease of access to anyone with a suitably equipped drive. This has become a major problem concerning access to valuable or sensitive data.

In many instances CD-ROMs are used to hold data which changes with time. Examples are drug databases or periodicals. Sometimes the vendor wishes the user to view only the latest data, other times it can be positively dangerous to use out of date information.

If only there were some way of placing security levels, embargo limits or expiry dates onto them? Well, now there is, thanks to Nimbus Information systems, who have addressed the problems involved with securing CD-ROM data – the result has been CD-Secure.

There are two main steps to the CD-Secure process, these are encryption during CD-ROM mastering and decryption during CD-ROM reading. Raw data is encrypted using a `Lock' program and after the mastering is completed, the only way to extract data is by using a decryption routine known as the `Unlock' program.

This program represents a `key' to unlocking the data on the CD-ROM. In order for it to operate it requires a code, which can only be issued by the vendor. The system prevents downloading of data too, any attempt to do so, merely results in data files filled with gibberish.

CD-Secure can also be tailored to stop a program from running after a specified date. This facility alone makes CD-ROM disks the ideal medium for distributing demonstration software – if the user wants to license this product, it can be enabled by paying for a vendor code. This may sound simple, but the final product has taken thousands of man-hours to develop. For more information on the technology involved here, please contact Nimbus on: 0600-890682.

Pen Computing

"The Notebook is dead, long live the Pen". This seems to be the message broadcast from Eden Computers of Cheshire. Their mobile, pen-based computer will open up computing to a wholly new market. As familiar and unobtrusive as pen and paper, the pen computer eliminates the technology barrier, so often associated with a computer and keyboard.

Eden's VPI386SX portable pen computer equipped with totally solid state memory, 4Mb of RAM, plus two expansion card slots, industry standard parallel and serial interfaces and a crisp 640x480 pixel VGA LCD screen. The VPi386SX is available now, some day all computers may be made this way. Until that time, you can buy an entry-level machine from Eden for £1,950 (Exclusive of VAT). For more details please contact Alistair Jenkins, at Eden, on 0625-576050. ■

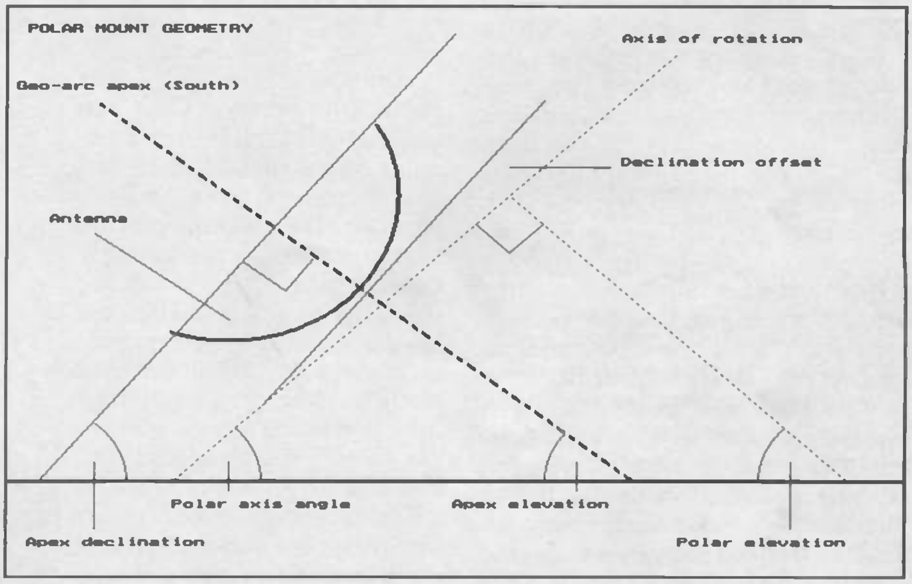

Pen computing – the way ahead?

Review... Satmaster

Setting up a system to receive direct broadcast satellite can involve a lot of calculation. This PC program aims to make it a lot easier as Alan Worthing explains.

The task of installing a satellite receiver is not something to be undertaken lightly. Some of the simpler questions are: what size of dish should be used? what satellites can be received? where should the dish point? More complex considerations require a lot of complicated calculation and quite a lot of knowledge.

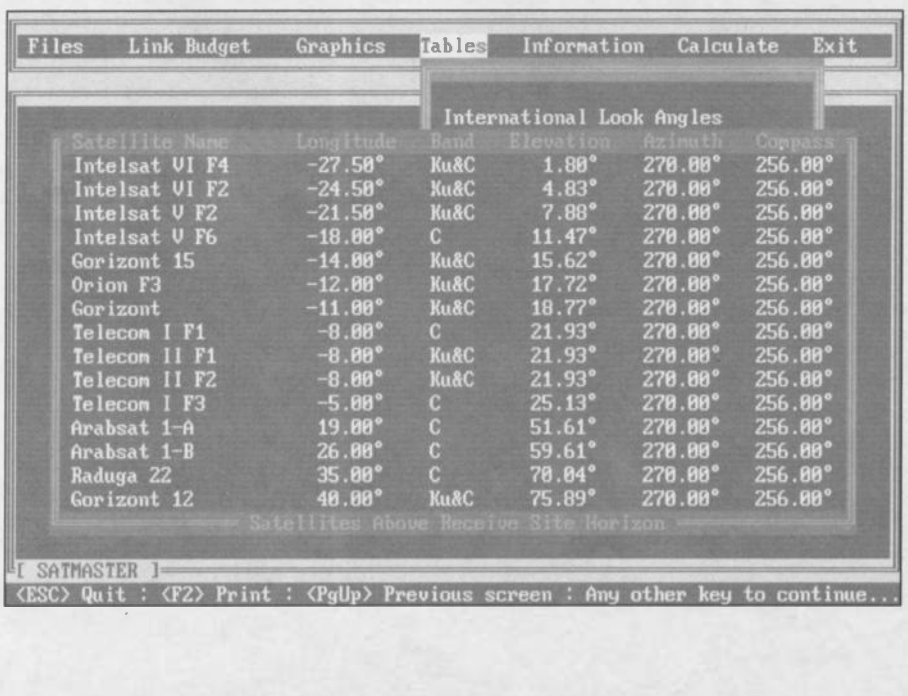
Although there are a number of good books on the subject that will take you through the process of installing a satellite reception system, a great deal of the hard work can be taken on by a computer program. Satmaster is a pretty comprehensive suite of software that covers almost every aspect of setting up the system. It is aimed mainly at knowledgeable amateurs and schools though professionals might find that it saves them some work as well.



The idea of Satmaster is to allow you to design your system and test it before installation. It can be set up to operate for any location in the world and can calculate the full link budget including dish size optimisation for the best possible picture. On screen graphics help identify possible interference problems and can be used to plot beamwidths.

Installation nof the software is simple, just shove in the disk and enter INSTALL C: to get a working version on drive C. Starting it up gives a selection of menuswhich drop down on command to give access to a wide range of functions. For those who are beginners, a full help facility is available to take you through everything up to and including bolting the dish down.

Overall, this is a very comprehensive piece of software and an invaluable tool for anyone wanting to experiment with satellite TV. ■



Files Link Budget Graphics Tables Information Calculate Exit

International Look Angles

Satellite Name	Longitude	Band	Elevation	Azimuth	Compass
Intelsat VI F4	-27.50°	Ku&C	1.80°	270.00°	256.00°
Intelsat VI F2	-24.50°	Ku&C	4.83°	270.00°	256.00°
Intelsat V F2	-21.50°	Ku&C	7.88°	270.00°	256.00°
Intelsat V F6	-18.00°	C	11.47°	270.00°	256.00°
Gorizont 15	-14.00°	Ku&C	15.62°	270.00°	256.00°
Orion F3	-12.00°	Ku&C	17.72°	270.00°	256.00°
Gorizont	-11.00°	Ku&C	18.77°	270.00°	256.00°
Telecom I F1	-8.00°	C	21.93°	270.00°	256.00°
Telecom II F1	-8.00°	Ku&C	21.93°	270.00°	256.00°
Telecom II F2	-8.00°	Ku&C	21.93°	270.00°	256.00°
Telecom I F3	-5.00°	C	25.13°	270.00°	256.00°
Arabsat 1-A	19.00°	C	51.61°	270.00°	256.00°
Arabsat 1-B	26.00°	C	59.61°	270.00°	256.00°
Raduga 22	35.00°	C	70.04°	270.00°	256.00°
Gorizont 12	40.00°	Ku&C	75.89°	270.00°	256.00°

Satellites Above Receive Site Horizon

[SATMASTER]

<ESC> Quit : <F2> Print : <PgUp> Previous screen : Any other key to continue...

Product: Satmaster
Price: £35
Published by
Swift Television Publications
17 Pittsfield
Cricklade
Swindon
SN6 6AN
0793 750620
Requires a PC/XT/AT with DOS 3.0 or later and a 3.5in FDD.

Review... Logitech Fotoman

Richard Milner snaps up the new wave in photography and shows that although it may not be up to professional standards, electronic imaging is definitely the way of the future.

This kit for electronic photography contains the camera and software you need for image capture and manipulation on an IBM-compatible PC, and costs only £700 compared with £10,000 or more for professional systems such as Kodak's Digital Camera System. You get a few accessories; a stand, a mains recharger unit, a nylon carry bag, a filter ring and neutral density filter and the all-important cable to connect the camera to your PC.

The Fotoman is a slim, light plastic unit that can be used one-handed. It's a little bit bigger, but slimmer, than a Nintendo Game Boy. The lens has a fixed focus, 1m to ∞, with fixed exposure time and aperture. The camera has a built-in flash which always operates. The battery/RAM pack the snaps are stored on will hold 32 frames, and must be recharged at every opportunity as it will run down in a couple of days, losing all the stored images. If you wanted to take more than 32 frames in a session you would need some spare RAM packs or a computer to store your first batch of pictures on.

Snapping is simple – just point and shoot. Our pro photographer who tested the unit disliked the lack of control over exposure times and the flash, and the resulting pics are often whited out by overexposure, as you can see from the examples. The best results were achieved outside on a sunny day, when the flash made no difference. and with a little practice it was possible to get some quite good pictures. Fortunately, some of the problems, such as underexposure, can be ironed out later at the editing stage.

Compared with a conventional camera there are a few other disadvantages. The shutter response to the button is quite slow and the time lapse between one shot and the next is several seconds. There is no frame counter and you must listen for warning notes when you get towards the end of the RAM pack's storage capacity. Finally, the images stored are not colour.

Fotoman in action taken with a 35mm camera.

Photograph: Carolyn Vaughn

The bonus of the Fotoman is that you download your picture directly into a computer. The Fotoman software runs only under Windows, so clearly you need a reasonably powerful PC with a fair bit of RAM to capture and manipulate the images.

Downloading from camera to hard drive takes a little more than a minute for each picture, so a full camera load (32 pictures) will take over half an hour. Between each picture the software breaks off, then re-establishes communication with the camera. If there's any trouble at this stage, it doesn't try again in 30 seconds, but puts up a abort/retry message and waits for you to hit the return key. This means you have to spend that half hour sitting by the

Fotoman – the production story

During the1980s computers revolutionised the print medium. Desktop publishing software allows the layout of complete pages on screen, eliminating tedious paste-up and mechanical typesetting. The field of graphic reproduction has been similarly changed; high end colour scanners and picture editing workstations now allow extensive manipulation of images on screen before the separated film is plotted out.

Apart from the actual printing, only two mechanical stages now remain in print production: keying in of text and photography. Fotoman is an example of the way that photography is changing through new technology.

The images that Fotoman captures are stored and manipulated on a desktop computer, using sophisticated image processing software. They can be converted into file formats suitable for incorporation into page layout programs and the finished pages can be plotted out as final film on an image setter. This eliminates conventional photographic processing, scanning or halftone screening and film production.

Within five years electronic cameras such as Fotoman may well replace conventional photography in the same way that video cameras have succeeded ciné film for almost all home and television use.

155 grey levels

400 times enlargement shows pixels.

As above but expanded to 256.

Close-ups tend to flare out.

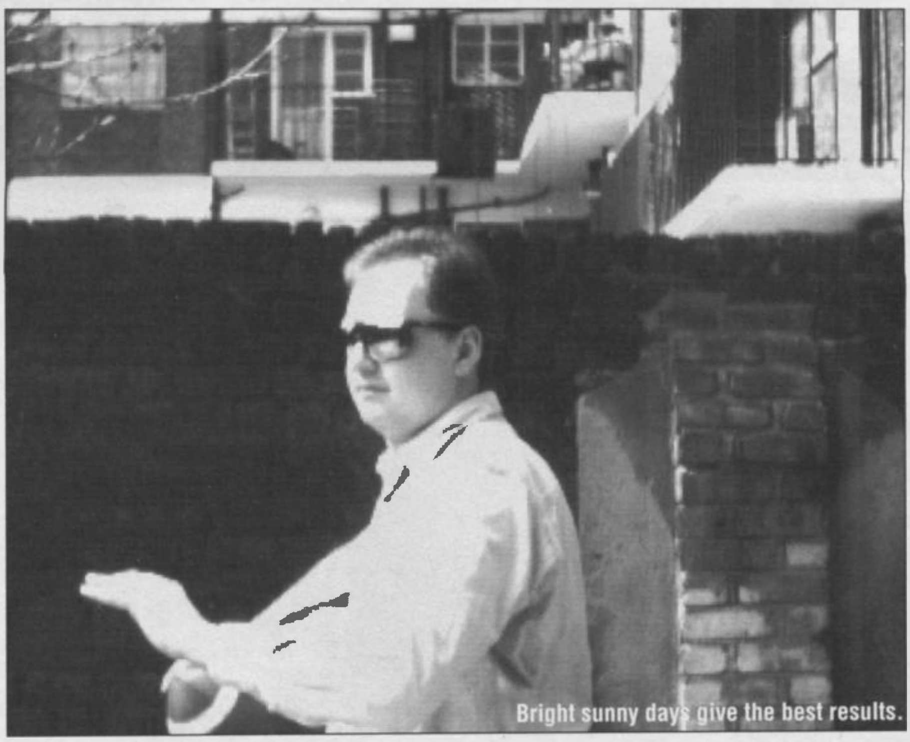
PC reading a book, because by Sod's law if you leave it alone for that time it'll fail as soon as you've gone (I tried it, and it did).

The focus is fine, as is the level of detail. The main problem with the results is the exposure. To get a reasonable shot, you have to get in close, as cropping off the border and zooming in on the centre give a pixellated picture. This is because the Fotoman images are stored at 75 dots per inch, which is a lower resolution than ordinary newspaper pictures. When the flash goes off and you're too close this will overexpose the frame. There is a compromise, which you have to find through trial and error. Luckily, the usual 'redeye' that a fixed flash gun produces can easily be toned down with the editing software included with the package.

The Fototouch software contains some picture editing functions but they only work with greyscale images. You can crop, blow up, zoom in and out, paint over or copy individual pixels, change brightness and contrast and generally modify your images almost any way you like. The images can then be stored in various useful formats. You need a good greyscale monitor and video card, capable of displaying 256 levels of grey, to make proper use of the software. Fototouch's facilities are very good for the price – bearing in mind that the equivalent Macintosh package PhotoShop costs about £600 by itself (though it does manipulate colour).

Outputting is done via conventional printer or imagesetter. The pictures in this feature have been processed directly to printer's film on a Linotron imagesetter. We do not know, until we see the finished magazine, how they are going to turn out. It is possible to get your images output as prints or slides, but this would take a lot more processing and image converting, and would be fairly expensive.

Overall Fotoman achieves the aim it set out with; a low-cost electronic imaging system. The question is, who is this product aimed at? It is no use to the home user, because of the requirement for an expensive computer to display images. It is of some use to a professional publishing company, but because of the relatively low resolution of the images it could not be used for all normal requirements, so conventional photo technology is not yet obsolete. You can get better quality and the ability to edit the image by scanning conventional prints on a desktop scanner. The most likely user would be a small budget publisher such as a school magazine or fanzine. At the moment Fotoman is an expensive toy rather than a useful tool, but as the technology improves similar systems to this will take over from conventional photography. ■



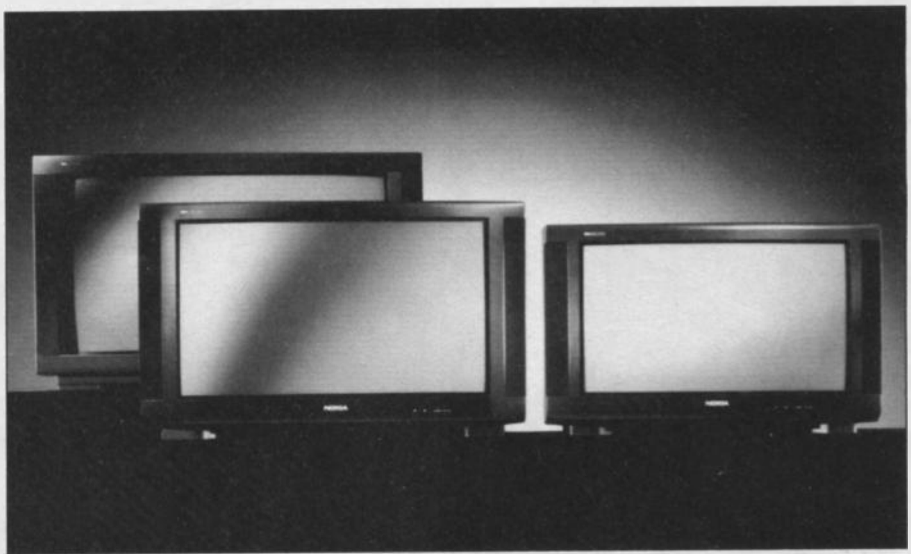
Bright sunny days give the best results.

Television Gets A Wider Screen

Are the wide screen TVs currently being introduced a step towards better pictures or should we wait for HDTV? Kenn Garroch has seen the latest systems

Call it the box in the corner or the one eyed god, it is familiar to over 90% of households in the UK as the good old TV set. It hasn't changed much on the outside since the basic design was finalised in the late 1940s. Internally, there have been a number of improvements but they have mainly increased reliability and decreased in the number of internal components.

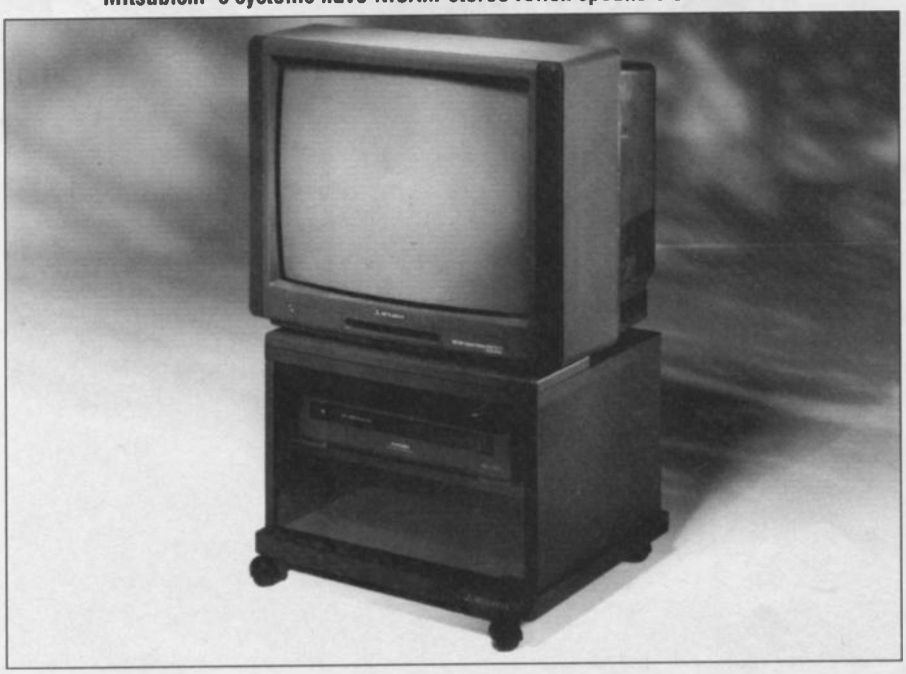
Now things look set to change. With the introduction of widescreen TVs over the past few years plus the advent of direct broadcast satellite TV, easy to use remote control, teletext, NICAM digital stereo, digital sound processing, cable, flatter squarer screens and much more, the revolution in the way we watch TV has begun.



Nokia's range of wide screen TVs.

At the recent Brown Goods Show in London – brown goods include such things as TVs, VCRs and HiFi – most of the big consumer electronics manufacturers were showing off the kit that they hope will make it into the high street in the next year.

Mitsubishi''s systems have NICAM stereo reflex speakers on the sides.



Perhaps the most radical product for the TV industry is the introduction of the 16:9 widescreen TV. A number of manufacturers now make sets of this format and are hoping that the market will soon take off.

The standard shape of a TV screen is 4:3. That is, it is four thirds wider than it is high. This shape was designed into the system from the beginning and has been the format used for TV ever since. Most programme material is put out in 4:3 but it is incompatible with the wider screen favoured by the cinema industry. Cinemascope is much wider than it is tall and provides, some say, a more natural landscape image. widescreen TVs generally have a16:9 screen aspect ratio and work well with videos and TV films that use the letterbox format – shot on 35mm or 70mm film. It must be said that they are

Brief History of TV

There were a number of people involved in the invention of the television. Some had direct involvement with transmitted moving picture systems, others devised elements that were essential to the development of the techniques used in current systems.

Perhaps the most famous name in the history of TV is John Logie Baird who produced his first TV picture in 1925 using a electro-mechanico-optical system whose definition was poor at a mere eight lines. However, an Englishman named A A Campbell Swinton had suggested at the beginning of the century that the recently invented cathode ray tube (CRT) could be used to display moving pictures and a Russian emigre to the USA named Zworykin developed a photo-electric TV camera tube – eventually resulting in the iconoscope.

The first TV pictures were transmitted in 1928. They were low quality at 30 lines with frames repeating at 12.5 times per second but they did get a lot of publicity. However, Baird's system was soon eclipsed by the developments at EMI which used an iconoscope similar to Zworykin's and a CRT. This all electronic system had a reasonable resolution at 405 lines.

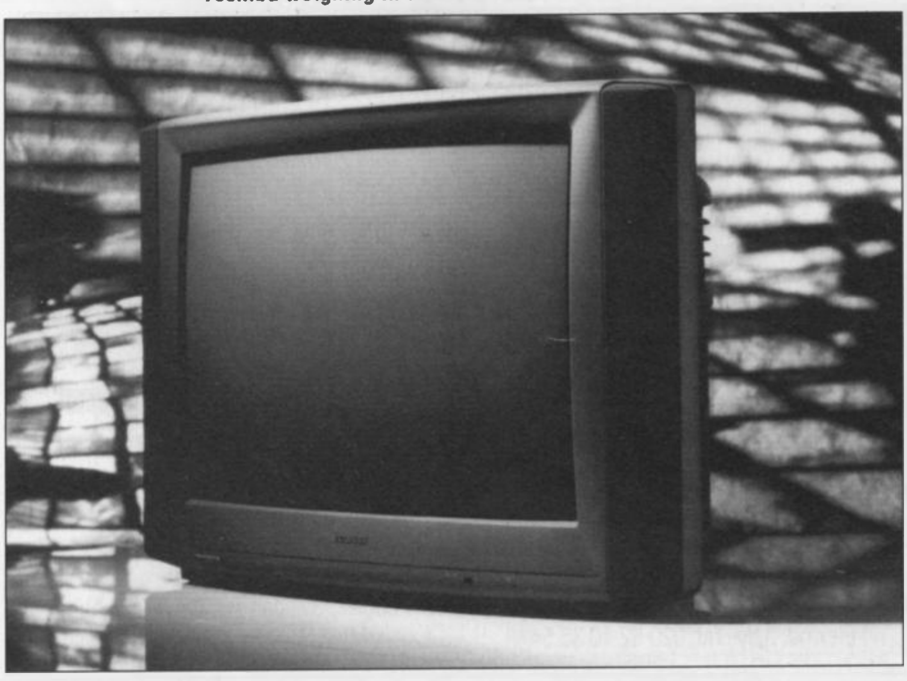
The next step forward was to increase the resolution to 625 lines in 1964 and then colour in 1967. Since then there has been no significant change in the way TV pictures are received and viewed and it has taken 25 years for the TV industry to take the next step with the gradual introduction of wide screen TV and high definition TV.

not high definition and only provide the same quality of picture currently available on standard TV transmissions.

Probably the best examples of commercial widescreen TVs at the brown goods show were from Nokia. It was showing a new set of three, starting with a 28in model for £1100 and moving up through 32in (£1600) to 36in (£2350). The biggest model was a monster aimed more at the pub entertainment market than the home user. The 28in 7291 model, on the other hand, would not look particularly out of place in the average living room.

All three sets offer a wide range of facilities and are able to receive and display normal 4:3 pictures. The remote control handset allows the user to choose between normal display, with the electronics filling in the sides of the screen with black bars, or to chop a portion of the top and bottom from a standard picture and then expand it for a full widescreen effect. For cinemascope type films this is fine since the black bars at the top and bottom are removed. More usual TV programs such as chat shows and those featuring news and current affairs tend to have close-up head-shots with the result that in widescreen format, the tops of the heads are removed. However, after a while, the effect is not too noticeable – for films that have subtitles, the picture can be shifted up so that more of the top and less of the bottom is removed.

Toshiba weighing in with DSP and surround sound.



Of course, Nokia's widescreen TVs have a number of other features such as picture within picture, to allow the user to see what is happening on the video or satellite receivers, and NICAM digital stereo with no less than six loudspeakers including two built-in sub-woofers.

The only remaining problem for widescreen TVs is that most TV programmes transmitted on the standard terrestrial channels (BBC and ITV) are designed for 4:3. However, most manufacturers of widescreen TVs are confident that more and more programmes will be in letterbox format – B Sky B is apparently planning to transmit a large number of its movies in 16:9 and the format is used in a number of adverts and feature films on Channel 4, so demand for the TVs could go up.

Better Sounds

Another big innovation in the latest TVs is digital sound processing (DSP). Toshiba's latest sets offer NICAM sound with the added extra of surround sound.

Where the programme material is transmitted in mono, a pseudo stereo effect can be obtained by adding a slight delay or echo between the left and right speakers. Where NICAM stereo is transmitted, speakers situated behind the listener come into play to offer surround sound. The digital delay offers four settings, disco, theatre, hall or stadium, each providing an extra bit of echo. For video films that come with Dolby

The giant size Ferguson above displays 1250 lines and is fully HDTV compatible

Surround Sound, the system shows its true colours and a full cinema like effect is produced with stunning realism. The cheapest Toshiba set with the DSP circuitry is the 25in priced at £749.99 featuring 60W of music power – not too bad a price compared with the cost of frequent visits to the cinema. Unfortunately, Toshiba are not yet producing a widescreen format TV. Its opinion is that until the European high definition television (HDTV) transmission format is finalised and actually on the air, the number of customers for widescreen low resolution sets will be limited. However, the company does make widescreen TV tubes and the technology is obviously not too difficult so, perhaps if the idea takes off, a Toshiba model will make an appearance. In the meantime, a demonstration version of an HDTV system was on show to prove that the current widescreen formats still have a way to go to match the fantastic picture quality offered by 1250 line HDTV.

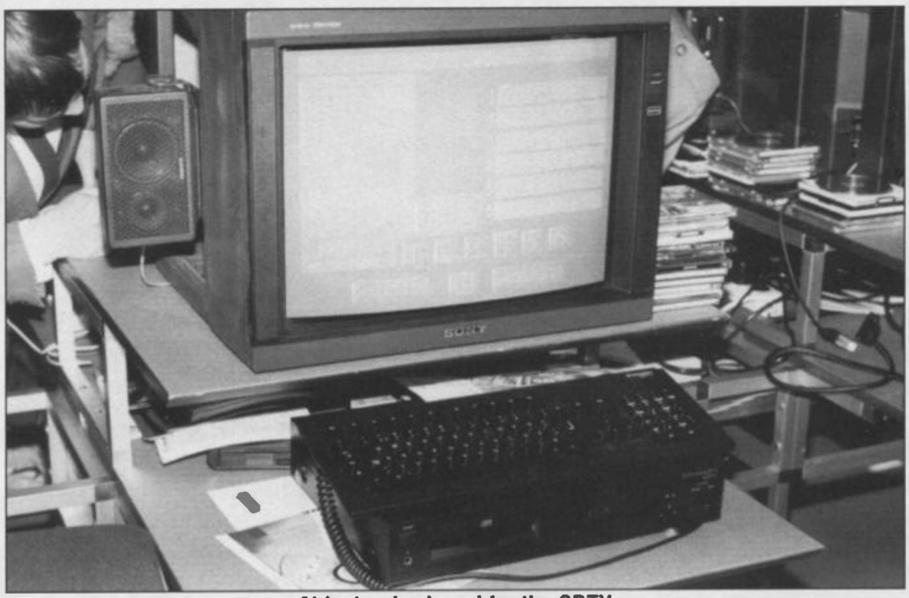
The TV industry is gearing up to allow viewers to watch TV of a quality seen only previously in the cinema. At the moment, it is only the top of the range systems that offer the latest technology but as competition increases, prices will fall and high quality TV will become commonplace. ■

A feature of modern TV systems is simplified remote control as in Mitsubishi's one button system – It seems that manufacturer's have taken to heart the problems encountered by punters faced with a vast array of buttons. Toshiba were also showing a new wave in simple to use portables with its 4in colour screen able to receive multi-standard transmissions anywhere in the world.

All The Fun Of The Fairs

Ian Burley take trips to CeBIT, Which Computer? and Comms'92, and brings back a roundup of the latest news from the world of electronics gadgets.

In this month's column I have more to report from exhibition forays – a look at what was new at the CeBIT Hanover Fair in Germany, plus the odd goody from the 1992 Which Computer? and Communications 92 shows, a little closer to home at the Birmingham NEC. To round things off, a trip to France for a few days holiday reveals wide screen tellys are already on sale there and being heavily discounted too.



At last, a keyboard for the CDTV

CeBIT 92

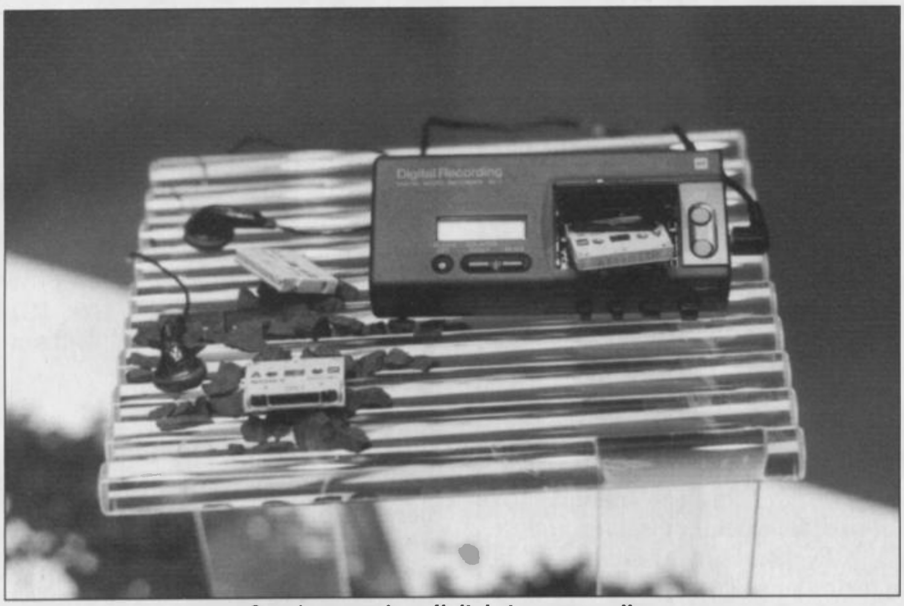
The annual CeBIT (Centrum Buro Information Fair Telekommunikation) event at the enormous Hannover Messe expo complex is a rich mixture of business and commercial technology exhibits as well as PC and consumer electronics displays. This year about 640,000 visitors, up around 100,000 on last year, trekked to Hannover and struggled around the 24 exhibition halls in a venue which fully justifies its own people mover shuttle bus service.

New CDTV And Amiga

One of the main attractions as usual was Commodore's stand, where the computer workstation version of the Amiga-based CDTV multimedia player was launched, as was a new compact replacement to the Amiga 500, called the 600. Commodore is huge in Germany and it was no surprise to see key products getting their worldwide debuts there instead of in the US.

The CDTV workstation had been promised ever since the CDTV was originally launched two years ago. After all, the CDTV has Amiga computer internals – it would be a doddle to connect a keyboard, mouse and disk drives to make it into a fully functioning multimedia Amiga. Sadly, marketing gurus decided that the CDTV was not a 'computer'. Keyboards, mice and floppy drives would only confuse the dozy punter, was the argument. Keep the the thing looking like a HiFi CD player was the policy. Now that Commodore has brought out the full works version, one wonders if the original strategy has

The new Commodore Amiga.



Sony's new micro digital stereo cassette.

fallen on hard times.

Commodore's new Amiga 600 drew a great deal of attention, but its reception was mixed. The 600 is a compact replacement to the venerable Amiga 500. Gone is the numeric keypad so the unit is not much wider than a notebook computer. The case is slightly less deep than its predecessor too. But despite the compact dimensions, inside there is room for an optional IDE hard disc drive. The bulkier Amiga 500 had to make do with an even bulkier external hard drive which attached to the machine's side-facing external expansion port.

The floppy disc drive remains on the right hand side of the case and is still restricted to the Amiga's 880K proprietary double density format when most of the competition has settled on the PC quad density 1.44Mb floppy standard. Much more interesting is the provision of PCMCIA slots to accept credit-card sized expansion devices like battery backed RAM, non-volatile ROM or flash RAM or even tiny modems. In fact a UK modem manufacturer has just announced a PCMCIA modem just a few millimetres thick and we'll be bringing details of this to you next month.

You can't deny the wedge-shaped Amiga 600 looks sporty and it incorporates some interesting technology, but the retention of an aged 7MHz 68000 processor and a totally non-standard floppy disc drive defies logic.

The Amiga 600 is due in the UK any time and should start at £399 without a hard drive.

Micro Digital Cassette

Over at Sony's stand crowds of people were huddled around a rep showing off yet another miniaturised digital marvel; the NT-1 digital tape recorder. It looks like a pocket dictaphone but instead of using ordinary analogue micro-cassettes, Sony has developed an incredibly tiny digital cassette which is almost dwarfed by the supplied in-ear headphones. Like DAT players and video recorders, a helical scan rotating read/write head is used. This Swiss watch-like construction enables a high quality stereo sound track of up to two hours in length to be recorded, though the sampling rate is not as high as DAT. The Sony rep denied the assumption that the NT-1 would replace Sony's Rolls Royce portable recorder, the Walkman Professional – which many radio broadcasters swear by. Sony reps had difficulty in explaining exactly who the target buyer was for the NT-1, though busy and presumably rich business executives, needing both a quality dictating machine and a truly pocketable walkman, were suggested. Pricing has yet to be fixed but is likely to be the best part of £500 when it starts shipping this summer.

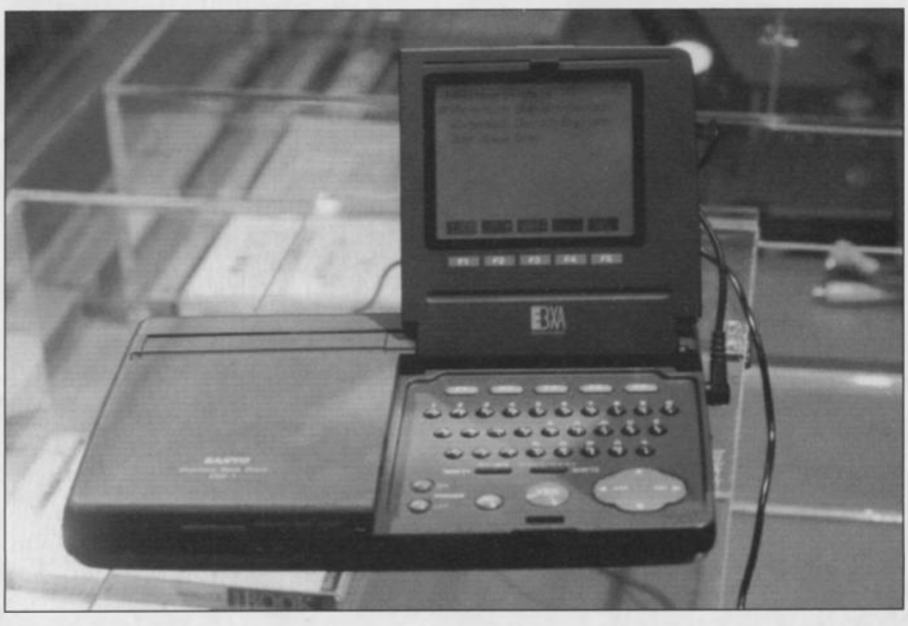
The Sanyo Alternative

Sanyo revealed a Sony DataDiscman electronic book clone at CeBIT. The slimline EXB-1is compatible with the same 8cm optical disc cartridges as the Sony though a major difference is that the Sanyo can combine audio with text. In other words a textual passage displayed on the 3.6in screen could be accompanied by a soundtrack, a music clip for example. Like the DataDiscman, the EXB-1 doubles as a conventional portable music CD player when 8cm CD singles are used. Sanyo expects the EXB-1 to be on sale in August with a price around £450.

LCD Monitor From ICL

The number of flat-panel LCD computer monitors exhibited by various companies was

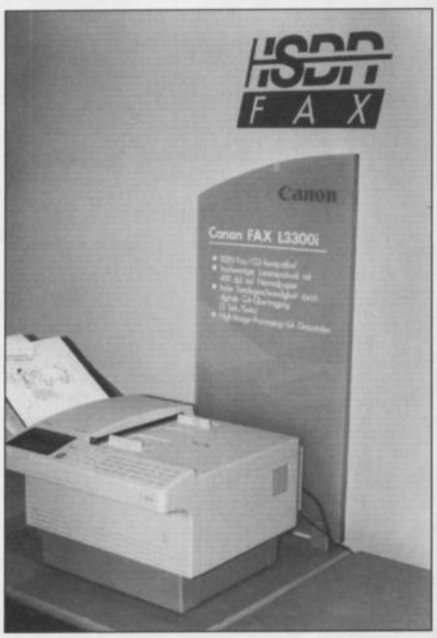
Sanyo's data discman clone.



ICL's colour LCD monitors.

encouraging. ICL has emerged from its somewhat conservative image with a diverse new range of PC clones and a colour LCD monitor option. Originally developed for ICL by partner firm Nokia Data, the Freestyle AE12C monitor uses Sharp's superb ten inch active matrix TFT colour LCD. This offers a maximum 640 by 480 pixel resolution in 256 colours from a palette of 512. ICL points out that a particular attraction of the lightweight Freestyle is that it needn't remain planted on top of your PC. Why not pick it up and sit back in your recliner contemplating your spreadsheets in comfort without having to squint? All this luxury still doesn't come cheap, unfortunately. The German list price is DM7,900 – about £2,800 just for the monitor and display adaptor card alone.

Canon's super fax.



Amstrad's PCs

Amstrad appears to have adopted CeBIT as its major launching pad each year for new products. Last year saw its first notebook PC, colour portable and the cute 'tiny' PC range launched there. This year at CeBIT Amstrad has moved firmly into new territory with top of the range 486 PCs built in Ireland by, of all people, Intel themselves no less.

A PC is a PC you might say, but Amstrad has confounded its critics who had predicted doom and gloom for the company because of its low cost and mediocre specification PC range. The new 486 range is headed by a state of the art 8486 model featuring the relatively new 32-bit EISA expansion bus, a 33MHz 32-bit on-board SCSI peripheral interface controller and EEPROM for low-level firmware upgrades from floppy disc rather than chip replacements.

If that was a little too heavyweight, Amstrad also launched a colour version of its year old notebook PC, this time using a passive matrix colour LCD. Naturally the colour quality of this screen doesn't match the impressive active matrix display of the Amstrad colour portable, or the ICL Freestyle, but twelve months ago you'd be hard pressed to see a prototype battery powered notebook PC with a colour screen of any description. A 25MHz Intel 386SL chip, which has built in power saving features, is used in the notebook and continuous use for up to two hours is claimed before a battery change is required.

ICI's 12in Library

For a complete change of scene we wandered over to ICI Imagedata's stand. Here the marvel is a machine which can store one thousand gigabytes of data on a single twelve inch tape reel of optical tape. The Creo 1003 tape drive itself is made the Canadian firm Creo. According to my rough calculations, a single tape could store the textual content of over 400,000 350 page books. How many books does your typical public library contain? Or how about over 1,500 full to the brim music CDs?

ICL says its optical tape technology is an attractive alternative to magnetic tape, not only because of the significantly greater storage capacity but because there is no danger of accidental magnetic erasure. ICI guarantees an archival life of fifteen years.

Bubble-jet & ISDN Fax

Over at Canon another revised version of their highly successful portable bubble-jet printer was revealed. The BJ20 is a slightly larger and more heavy-duty version of the BJ10ex. Canon says the BJ20 is slightly faster than the BJ10ex and comes with a larger capacity sheet-feeder as standard – the BJ10's one is an optional extra.

Canon also showed some serious looking ISDN (integrated services digital networks) fax machines. For those lucky enough to have an ISDN phone line, you can look forward to fax transmissions at 64K bits per second – seven times faster than the fastest a conventional fax will go and without errors too. Roll on enhanced resolution 300dpi fax (instead of 200dpi) and colour too.

Show Roundup

To round the show off we looked at a collection of experimental ISDN products including a colour videophone system developed for BT's opposite number in Italy, SIP.

ISDN video conferencing was much in evidence too, with show visitors being invited to chat with people over live ISDN video links to studios in various European cities. For those of you who have experienced slow-scan satellite video conferencing, the quality is roughly comparable, except there is no picture break up caused by line noise. The main problem is slow frame refresh – it looked like about 5-6Hz!

Also beginning to attract attention at the show were the emerging digital portable phone lobbies, PCN vs GSM, and don't forget Motorola's ambitious satellite-based global mobile phone system, Iridium. Philips, Panasonic

Just the fax from Dacom

and Nokia Mobira, among others, showed pre-release GSM digital cellular phones at CeBIT. We hope to have a closer look at these technologies in the near future.

Which? And Comms'92

After the Hannover Messe, the Birmingham NEC seems almost village-like. This doesn't help the impression that show organisers, Reed Exhibitions, are trying to portray.

Both these once popular events are now in serious decline. Despite great publicity and marketing efforts over the last twelve months, Which? and Comms'92 couldn't completely fill a pair of NEC's not over-vast halls each. But there were a couple of interesting products to make the journey worthwhile. PC fans were probably satisfied to see the latest 50MHz 486 PCs and Intel's new 486DX2 upgrade technology, while IBM bravely introduced OS/2 version 2.00 to stave off Microsoft's relentless Windows 3.1 competition.

Pocket Fax From Dacom

For me, a self-confessed comms addict, the highlight of Which? this year was a very neat gadget from Psion Dacom – a futuristic looking palm-sized pocket modem with optional fax facilities.

Pocket fax modems are no longer a novelty, but Psion Dacom has taken the basic concept, added some serious industrial design and produced a modular, adaptable device truly aimed at the mobile, global travelling executive.

All versions of the PDM model range have an LCD status display and an interchangeable PSTN module. Different modules for different phone systems around the world are available. Maximum data transmission speed is 2400bps (V22bis), the basic PDM30 model offers MNP4 /V42 error correction, the mid-range PDM40 model adds MNP5/V42bis data compression and the top-end PDM40F includes 9600bps Group 3 Class 2 fax send and receive in conjunction with Breakout+Fax software for PC compatibles.

As we've come to expect from Psion, the PDM series looks beautifully and thoughtfully designed. No critical new ground has been covered by the PDM range, but compared to the cheap-looking competition, Psion has added a touch of class to the pocket modem ranks.

Rabbit Revival

Next door to Which? at the Comms'92 show, Hutchison Telecom surprised many, myself included, by announcing its long delayed entry into the public Telepoint digital cordless phone market, almost a year since all three of its DTI licensed competitors withdrew. A while back Hutchison bought out the most dynamic of the four licensed operators, BYPS, which had announced its Rabbit service but not launched to the paying public.

Hutchison blames the failure of its competitors, the BT-led Phonepoint consortium, Mercury Callpoint and the Ferranti Zonephone system, on a lack of standardisation on CAI (common Air Interface) protocols and not enough installed public base stations. Those more critical would say that the inability to accept incoming phone calls was also a major reason for failure.

Hutchison's efforts at Comms'92 didn't look half hearted. There are four buyer options starting with the basic Rabbit package. This costs £189.95 and includes network registration, a GPT handset and charger plus three months subscription worth £18 (£6 a month). Rabbit Plus for £239.99 includes a private base station - a much welcome reduction in price indeed. Originally the competition asked for around £200 for the base station alone. Rabbit Recall for £259.99 is the basic Rabbit outfit with a message pager. The pager adds £1.50 a month to the £6 subscription charge. Finally, there's Rabbit Recall Plus (£299.99) with pager and private base station. Prices include VAT.

Other CAI compatible phones are available at greater cost, including the very chic Motorola flip-phone style unit. Phone charges will be 20p a minute (8AM-8PM) or 10p a minute (8PM-8AM).

The service was due to go public in the North of England from May, with the rest of the country to follow shortly. Apparently a roaming service to enable Rabbit users to use their phone in some European countries are in the offing. Hutchison, which is based in Hong Kong, says over 15,000 users are already active there after just three months. That's probably more than all of Hutchison's UK competition managed before they gave up last year.

Will Rabbit succeed? Even the Rabbit promotional literature uses headings like 'Rabbit on Trial' – I certainly hope the verdict is not guilty.

Cheap Widescreen TVs?

Last of all this month, a slight distraction from a recent skiing holiday was the view through a local shop window in Courchevel showing a rather nice Philips wide screen TV. Even nicer was a large hand scrawled price tag with FF30,000 crossed out and replaced by FF20,000. That's still two grand, but it's a step in the right direction! The shopkeeper told me that he had stocked the new TVs since February. ■

Ian photographs a videophone.

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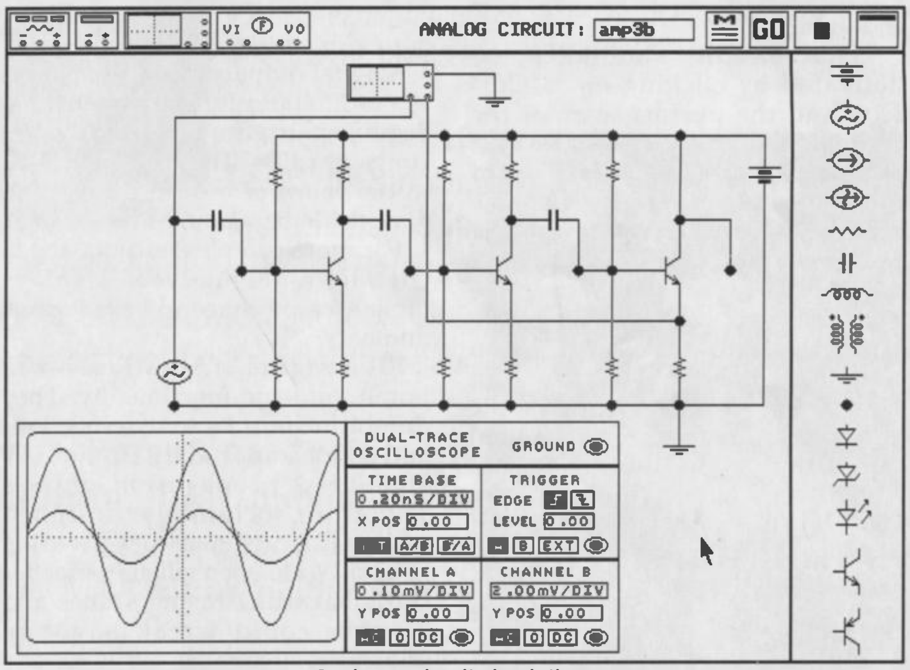
Review... Electronics Workbench

Chris Kelly loads up a sophisticated simulation program on his PC and checks out both analogue and digital electronic circuits.

Industrial software for electronic circuit simulation generally tends to be complex, needing a long learning curve, and is so expensive as to place it out of the reach of experimenters or small companies.

Now LJ Electronics is marketing Electronics Workbench which is a schematic drawing and sophisticated simulation package for analogue and digital circuits. The user can investigate passive and active components, DC circuits, AC circuits, combinational logic and sequential logic. Mixed-mode simulation, where analogue and digital circuits are combined, is not supported.

Schematic drawing packages have flooded the PC market for many years, but none so intuitive as Electronics Workbench which, as version 1.5, runs on IBM PC, XT, AT or PS/2 compatible system with CGA, EGA or VGA graphics. A hard disk is not essential; one 3.5 inch drive will suffice or two 5.25 inch 360K drives.



Analogue circuit simulation.

Using The Workbench

The user initially sees a blank monochrome drawing area or 'workbench' with a components bin on the right and an intriguing equipment shelf top left.

The bin is really a graphical menu showing the analogue or digital component symbols available. Most of the main symbols are available and the software permits the user to edit and draw symbols to add to the library. The bin can be scrolled to reveal other components.

Components can be chosen using a mouse or cursor keys. All actions follow the same point-and-drag method made so popular by Apple Macintosh and Microsoft Windows. By moving a screen pointer over the component and clicking the mouse button, the symbol can be dragged to the drawing area and upon releasing the button it is fixed in that position. Moving an item is done simply by returning the pointer to the item, clicking the mouse button and dragging to the new position. All the components can be labelled and given values.

The maximum number of components used in a design is limited by the amount of free memory, although a cheaper personal version is limited to twenty components.

Wiring between components is also simple. Move the cursor over a connection point of a component in the drawing area, click the mouse and drag the wire to a connection point on another component. At this stage the user sees a rubber-banded or straight point-to-point wire. On releasing the mouse key, the wire is 'auto-routed' and neat orthogonal bends are automatically inserted. Many wires can be routed without the screen looking too cluttered.

The equipment shelf holds icons of the simulated laboratory equipment. Signal generators, power supplies, digital multimeters, oscilloscopes (dual trace) and, no expense spared, spectrum analysers for the analogue version. For the digital version we can use bit-pattern generators, logic analysers and something that has no name but displays truth tables.

The instruments can be dragged

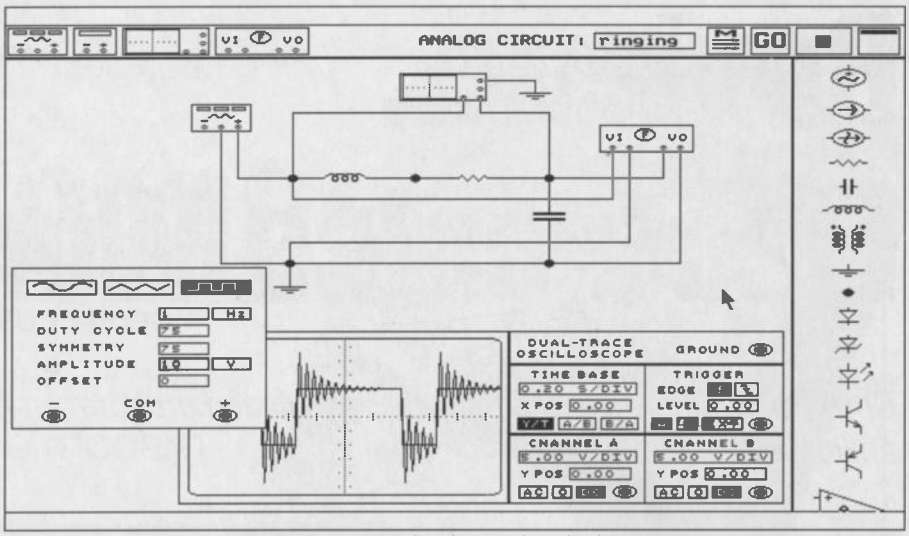
to the drawing area and connected into a circuit in the same manner as components. The icons are simple outlines but double-click the mouse button while pointing at one of these icons and out zooms a detailed front panel which can be adjusted just like a real instrument or moved to any area on the screen.

The drafting part of the package is useful in its own right but the simulation adds a new dimension. Signal generator icons can be exploded and set to give the necessary input signals from the usual choice of sine, square or triangular waveforms. Voltage and current sources can be set individually.

The circuit simulation is activated by clicking on a "GO" icon and the performance of the circuit is displayed on the test instruments. The speed of simulation depends on the complexity of the circuit and the speed of the computer. On a 12 MHz 286-based system the waveforms of a simple inverting amplifier are displayed well within a second. More complex circuits can take twenty seconds or more, quite acceptable for most experimental applications.

The analogue components are simulated using a number of standard mathematical models: resistive components follow Ohm's law, reactive components are calculated using frequency-dependent equations ($X_c=2\pi fC$; $X_L=1/2\pi fL$). Energy storage models for capacitors and inductors use $i=Cdv/dt$ and $v=Ldi/dt$ respectively. Active components are simulated using equivalent circuit equations representing current gain, ohmic resistances, junction potentials and junction capacitances. Tables of parameters can be adjusted from within the software to model any active device performance.

The digital version has a parts bin of standard gates and flip-flops. It simulates circuits by injecting bit-patterns using a word generator with eight outputs plus a clock. These are set up quickly by clicking the cursor on the bit-store for each output and then typing the one-zero pattern from the keyboard. The simulated sequence can be in single-step, bursts of one cycle or cycled repeatedly – again on the click of the mouse button.



An Analogue circuit showing ringing.

Digital outputs can be displayed as on-off states by simple elliptical devices which can be considered as lamps or LEDs. They are connected to the relevant outputs and show dark for logic 0 and white for logic 1. For more complex outputs, the 8-channel logic analyser displays digital waveforms and hexadecimal numbers.

The digital simulations work purely on logic functionality. They do not include fan-out restrictions and more importantly do not use simulated propagation delays. Therefore, originally designed circuits can be shown to work using Digital Workbench when in practice static hazards causing spikes and glitches could wreak havoc in sequential circuits.

Macro Facility

Any part of a circuit can be saved as a macro and called into any other circuit later. This is useful for commonly used circuits, particularly for the digital version where standard devices from the TTL and CMOS families can be saved by name, building to a very useful library.

However, this is where the limitation of simulation speed becomes apparent. A binary-coded decimal counter with decoder and seven-segment display takes a couple of seconds to change from one digit to the next. Because the macro facility makes it so easy for the enthusiastic user to add more and more to a circuit, the simulation times begin to increase enormously.

Workbench is clearly designed and marketed as a hobbyist or educational aid. The circuits are easy to compile on screen but the only output is to a dot-matrix printer giving a chunky look to the diagrams. Plotter drivers designed to work with the software would give a much more professional-looking finish.

As yet there is no way of designing PCB layouts from the schematic drawings. However, if the internally generated netlists could be exported to simple PCB drafting packages it would have some use for the practical realisation of simple circuits. Certainly this kind of feature would be very useful in an educational environment as students would learn about the important concept of a netlist carrying information from the stages of design and simulation to production.

In an educational environment, I have used this software with students ranging from fourth year schoolgirls tasting engineering for the first time to day-release Higher National Certificate students. All found it quick to learn and enjoyed using it. A brief demonstration of the main points and they were away, rapidly gaining confidence to experiment.

This software is superb when used alongside practical work. To begin with, it removes the uncertainty and frustration of real laboratory instruments which may malfunction or have broken leads. It has the advantage that incorrectly wired circuits do not damage the instruments.

Electronics Workbench is marketed by LJ Electronics, Norwich. ■

Space Art

Astronomy Now's Art Editor Paul Doherty is one of Britain's foremost space and astronomical illustrators. His pictures have featured in numerous books and regularly appear on The Sky at Night. Dr. Patrick Moore CBE said of Paul Doherty, *"Paul's paintings are without doubt the most beautiful and technically accurate, which is why I select them to illustrate my books."*

Astronomy Now Magazine is pleased to offer a special limited edition of four of Paul's most attractive paintings. Each picture is printed on heavy grade 200 gsm acid-free paper, to eliminate fading, and is available in a limited edition of only 300, individually signed and numbered by the artist. Select individual prints at £24.95 each, including P&P, or collect all four for only £89.95.The prints available are:

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How It Works... Electronic Plug-in Timer

Derek Gooding removes the glue from the case of an accurate mains timer for a quick peek inside and explains how it compares with the old-fashioned mechanical variety.

It's so easy these days to leave our video recorder to tape various programmes while we are out, or away, but how easy is it to attempt to record a radio programme?

Plug in timers are available that allow you to switch on and off the lights at set times throughout a twenty four hour period, some even allow days of the week to be selected for the switch actions to take place. Usually these timers are mechanical, being driven by a synchronous 240 volt motor powered from the mains socket. Switching is also a mechanical function achieved by adjusting levers around a moving dial, a centre nut when tightened by hand clamps the levers which in turn rotate until a switching position is reached and the rotation action pushes the spring loaded switch into the operate position.

Unfortunately, the accuracy of this system is not very good so an allowance of about five to ten minutes has to be tolerated. Of course, a half hour programme can be recorded onto a C90 and an hour long programme on a C120. Some people even go to the lengths of connecting their radio audio output to their video audio input to record a number of programmes over a period of days but they have to leave the radio set on all the time they are away!

A Solution

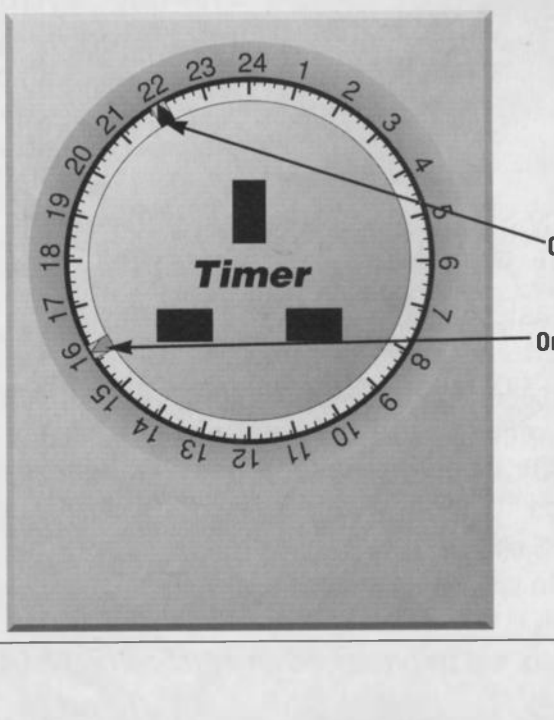
This month's *how it works* can assist in the simple task of recording from radio whilst away, or could be used to switch lights on and off at different times without involving a mechanical switch action, thus delaying the early "death of a light bulb" on switching on.

The electronic timer can be set precisely to the correct time (to the second) and each of the three control periods can be set precisely (to the second) for am or pm operation. The unit looks like a plug in adaptor but is actually battery driven enabling it to be moved around the house without resetting the time – it is also immune to power cuts.

Once set, the timing sequence repeats daily. The switch action is accomplished by means of a counter chip. When this counter reaches the exact time of a switch action, a relay is energised connecting the live pin of the 13Amp socket to the output line socket on the face of the unit. The right hand push switch overrides the internal counter and allows on and off control at any time.

More Flexibility

If an older, mechanical, seven day timer is available then greater flexibility and usefulness can be achieved by first plugging in the mains driven seven day timer and setting it to operate on selected days at certain times (approximately 15 mins before the required programme begins). The specific times set on the plug-in electronic time switch will only provide mains power to the radio and tape recorder on those days and at those times when the mechanical timer switches power from the wall socket to the electronic timer and thence on to the recording and radio appliances. This can even allow accurate recording of four separate 15 minute broadcasts on just one C60 with nothing lost. ■



A mechanical timer only allows very rough setting of the on and off times.

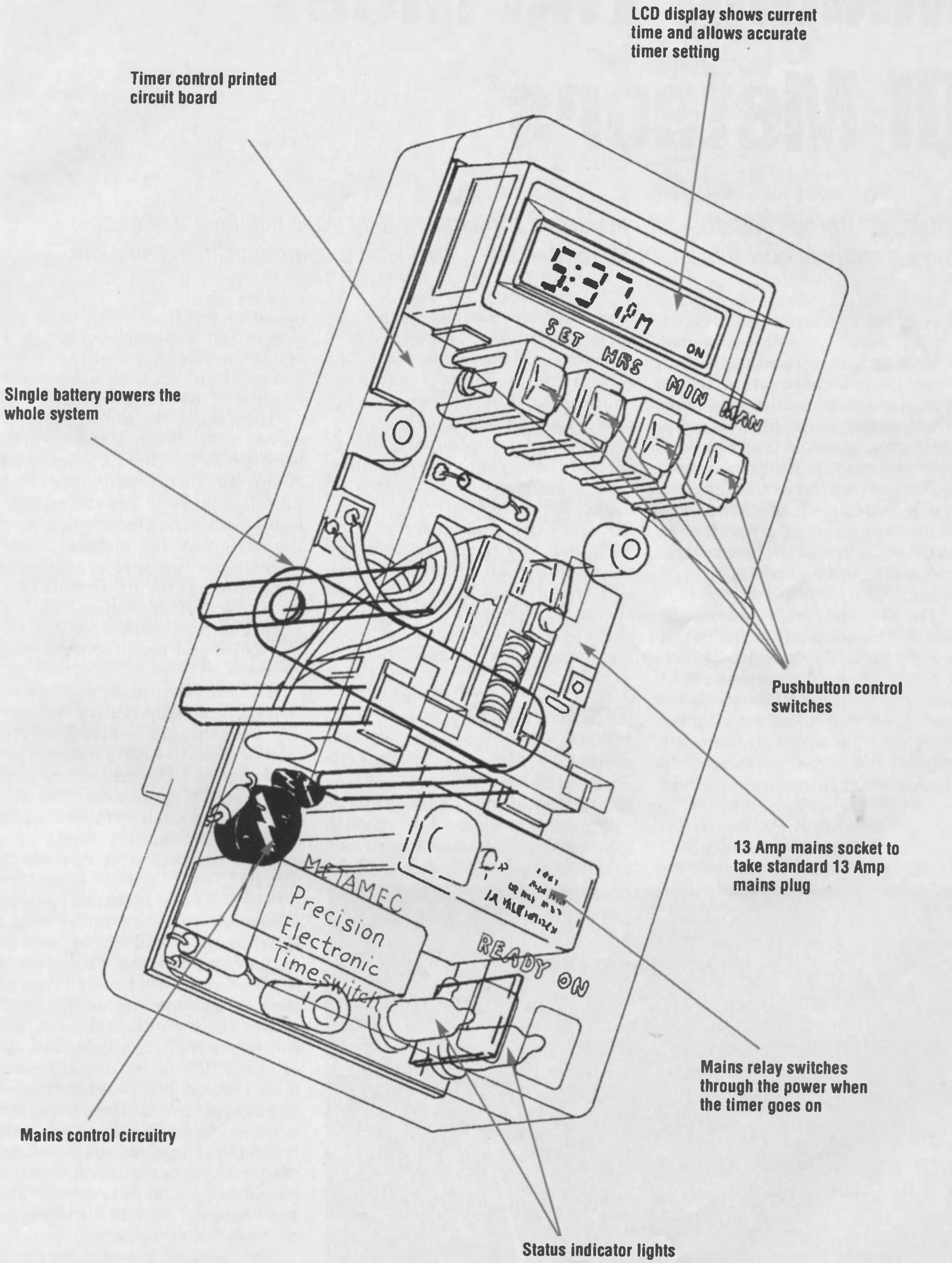


Illustration by Derek Gooding

Making The Most Of Meteors

When bits of rock and dust hit the Earth's atmosphere they leave behind a trail of debris. Ian Poole describes how this is put to good use in a novel radio communications system.

Meteor Scatter or Meteor Burst has many advantages over other forms or radio propagation. It can be used to great advantage in some circumstances although it is not a widely recognized method for radio communication. With the computer technology which is available today it is becoming viable for many applications and as a result it is being used increasingly where data links are required over distances of up to 2000km.

The idea for meteor scatter has been around for many years. In fact as early as the 1930s it was known that radio communications could take place using this mode of propagation but it was not until the 1950s that the first systems were built. However, they were only experimental in nature and very few systems were set up. One reason was that they required a very high degree of control which could only be provided by computers.The trouble was that at this time computers were very expensive and not widely available. A little later satellite communications opened up offering a high degree of reliability for long distance communications. Unfortunately, their high costs meant that people soon started to look for alternatives. High frequency (HF or short wave) links with their low reliability were not suitable for many applications and this meant that meteor scatter systems began to be considered again as computers became cheaper and more readily available.

Ions In The Sky

Meteor scatter relies upon the meteors which are constantly entering the earth's atmosphere. Every day about 75,000,000 are estimated to enter the earth's atmosphere. The vast majority of them are small and do not produce the characteristic visible trail in the sky. In fact most meteors are only about the size of a grain of sand. Those about an inch across are considered to be large.

Photograph courtesy Astronomy Now

They enter the atmosphere at speeds up to 75 km/s and begin to burn up at heights of more than 80km. As they disintegrate their kinetic energy is converted into heat which vaporizes the atoms on the surface of the meteor. These atoms initially travel at about the same speed as the meteor and as a result they become ionised leaving a trail of positively charged air molecules and negatively charged electrons.

The trails are usually short lived, lasting for a second or so, but they are very highly ionised which allows them to reflect and refract radio waves. However, as they only cover a very small area they can only reflect a small amount of radio energy. Fortunately, it is just enough for a sensitive receiver to pick up.

There are two main types or meteors: those which occur sporadically and those which appear in showers. The meteor showers come at specific times of the year, happening as the earth passes through areas around the sun where there is a large amount of space debris. At night during these showers it is possible to see a large number of meteors when the weather is clear. It is also noticeable that the meteors tend to come from the same spot in the sky. As a result the shower is often named after the star or constellation in the sky from near where they come.

Sporadic meteors are far more numerous and occur all the time, although they tend to be smaller

Major Meteor Showers

Shower	Begins	Maximum	Ends
Quadrantids	1 January	3 January	6 January
April Lyrids	19 April	21 April	24 April
Eta Aquarids	1 May	4 May	7 May
June Lyrids	10 June	15 June	21 June
Ophiuchids	17 June	20 June	26 June
Capricornids	10 July	26 July	15 August
Delta Aquarids	15 July	27 July	15 August
Pisces Australids	15 July	30 July	20 August
Alpha Capricornids	15 July	2 August	25 August
Iota Aquarids	15 July	6 August	25 August
Perseids	25 July	12 August	18 August
Orionids	16 October	21 October	26 October
Taurids	20 October	4 November	25 November
Cepheids	7 November	9 November	11 November
Leonids	15 November	17 November	19 November
Geminids	7 December	14 December	15 December
Ursids	17 December	22 December	24 December

Fig. 1

they are rarely seen from the ground. Their numbers do vary somewhat according to a number of factors including the time of year, time of day, and even the position in the 11 year sunspot cycle.

Making It Work

A meteor scatter system has to be fairly sophisticated in order to provide a commercially viable communications link. In the first instance the signal strengths are relatively low. Secondly the intermittent and short lived nature of the meteor trails means that the two stations in the link will only be able to hear each other for short periods of time.

Normally a link will consist of a master station and one or more slaves. As the name suggests the master transmits for most of the time sending out a probing signal so that any reflections can be detected. When a reflection is detected by the slave it sends back a signal to the master informing it of the path. Once this has been done data can then be passed over the link. The rate of transfer can be anywhere between 2000 and 9600 bits per second, but the average rate is much less than this because of the discontinuous nature of the link.

In view of the intermittent path data is sent over the link in blocks or packets. Once each packet has been successfully received an acknowledgement is sent back by the receiving station. Only when this acknowledgement has been received can the next packet be sent. If the acknowledgement is not received then it is assumed that the path has been broken. The transmitter will store the packet and the probe signal will be sent out again.

As each meteor trail can last for as little as a few tenths of a second, changing from transmit to receive to send the acknowledgments can take up valuable time. To overcome this problem some systems can operate in duplex mode – they transmit and receive at the same time but on different frequencies. By doing this the acknowledgments can be sent more easily and in addition data can be sent in both directions at the same time. Naturally this greatly increases the capacity of the link with the penalty being an increase in the cost of the equipment. Very high grade filters are needed to prevent the transmitter from swamping the receiver and reducing its sensitivity.

Protocols

It is possible to use a number of different types of modulation (a method of imposing the data on the radio wave) for meteor scatter, the usual method being a form of frequency shift keying (FSK). This changes between two frequencies a kilohertz of so apart according to whether a mark or space (a one or zero for digital information) is being transmitted.

In the early days of meteor scatter, basic FSK was used because it was the easiest to implement, but it had some disadvantages. As technology advanced it was possible to use some more sophisticated formats with some systems opting for phase shift keying (PSK) where the phase of the signal was changed instead of the frequency. By doing this an improvement of 3 dB gain in the signal to noise ratio is achieved – very important in reducing the number of errors in the link.

Further advances in integrated circuit technology made more advanced forms of phase shift keying possible. Now most systems use either a method called binary phase shift keying (BPSK) or quadrature phase shift keying (QPSK).

Whilst the form of modulation is very important, so are the protocols, or rules for sending the packets. In order to enable both ends to know what the other is doing and react

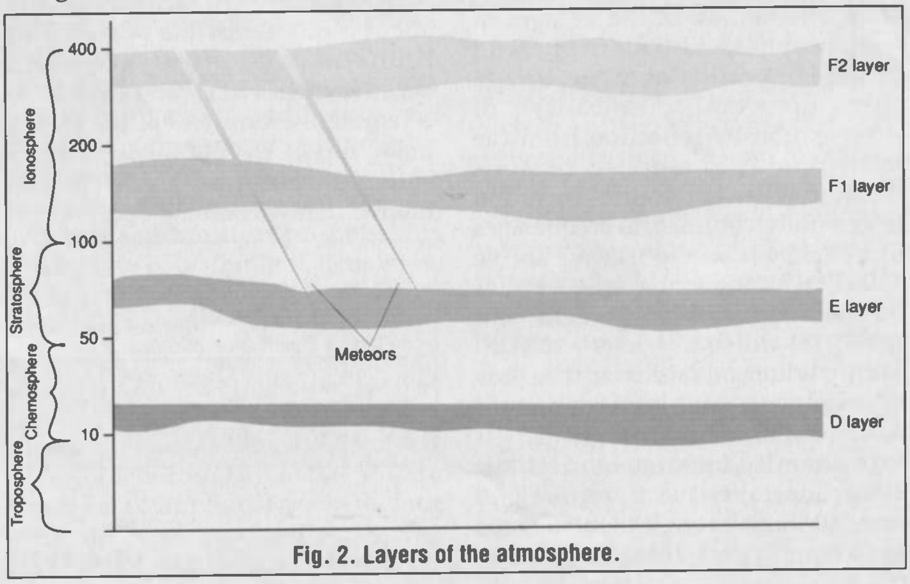


Fig. 2. Layers of the atmosphere.

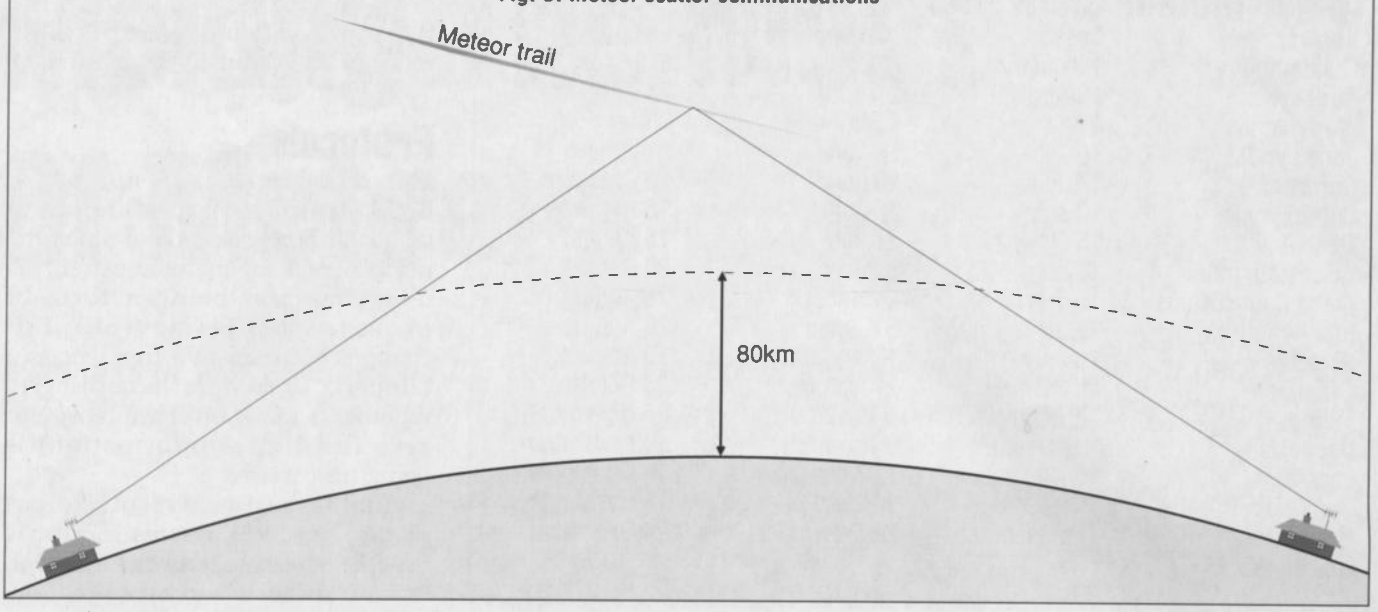


Fig. 3. Meteor scatter communications

accordingly a rigid protocol is required. Whilst many manufacturers have developed their own, they are now beginning to standardise around the internationally agreed X25 system.

The communications protocol provides a number of functions. It identifies the destination – particularly important when there are a number of remote stations in range of a single master station. It marks the beginning and end of the packet with flag bits and includes a frame check sequence which allows error checking to be performed by the receiver.

Frequencies

A wide range of frequencies can support meteor scatter communications. However, at lower frequencies signals suffer from attenuation in the D layer of the ionosphere. Also for frequencies in the HF portion of the spectrum there is the possibility of propagation by reflection from the ionosphere. These two reasons mean that meteor scatter operation is generally confined to frequencies above 30 MHz. Operating above these frequencies has the further advantage that both galactic and artificial noise are less – a vital factor when considering the low signal levels involved in meteor scatter communications.

Generally most meteor scatter operation takes place between 40 and 50MHz although there is some between 30 and 40MHz. The top limit is governed more by the fact that television transmissions previously occupied frequencies above 50 MHz, and still do in some countries. In addition to this reflections from the meteor trails start to deteriorate above this frequency although radio amateurs still use them up to 144 MHz.

The Hardware

A wide variety of equipment is available from several different manufacturers and suppliers. Each station is tailored to suit the requirements of its particular situation.

Often master stations will be capable of delivering about 1kW to the aerial although some stations use up to 10kW or even more. Remote stations tend not to be quite so powerful, often delivering only about a quarter of the power. This limitation is often necessary because the slave station may be in a remote location where the power may have to be supplied by batteries which can only be charged intermittently. Battery operation is possible because the duty cycle of the transmitter (the percentage of time which it is actually transmitting) is generally quite low and usually around 1%.

For duplex operation very selective or high Q filters are required because the separation between receive and transmit frequencies is only about 10Mhz and at maximum 20MHz. These filters are often as large as the transmitter itself and very costly.

In addition to the transmitter and receiver a controller is also needed. This does not need to be very large and it is quite usual to use a standard personal computer. Not only does this control the changes from transmit to receive but it generates the correct operating protocols, performs all the error checking and so forth.

Another vital part of the equipment is the aerial. These need to have a reasonable amount of gain. Typically a Yagi with 10 to 15dB of gain is used to give optimum results. There is no advantage in having an aerial with more gain since as the gain

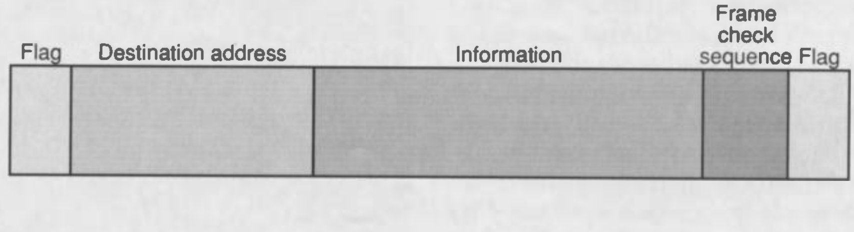
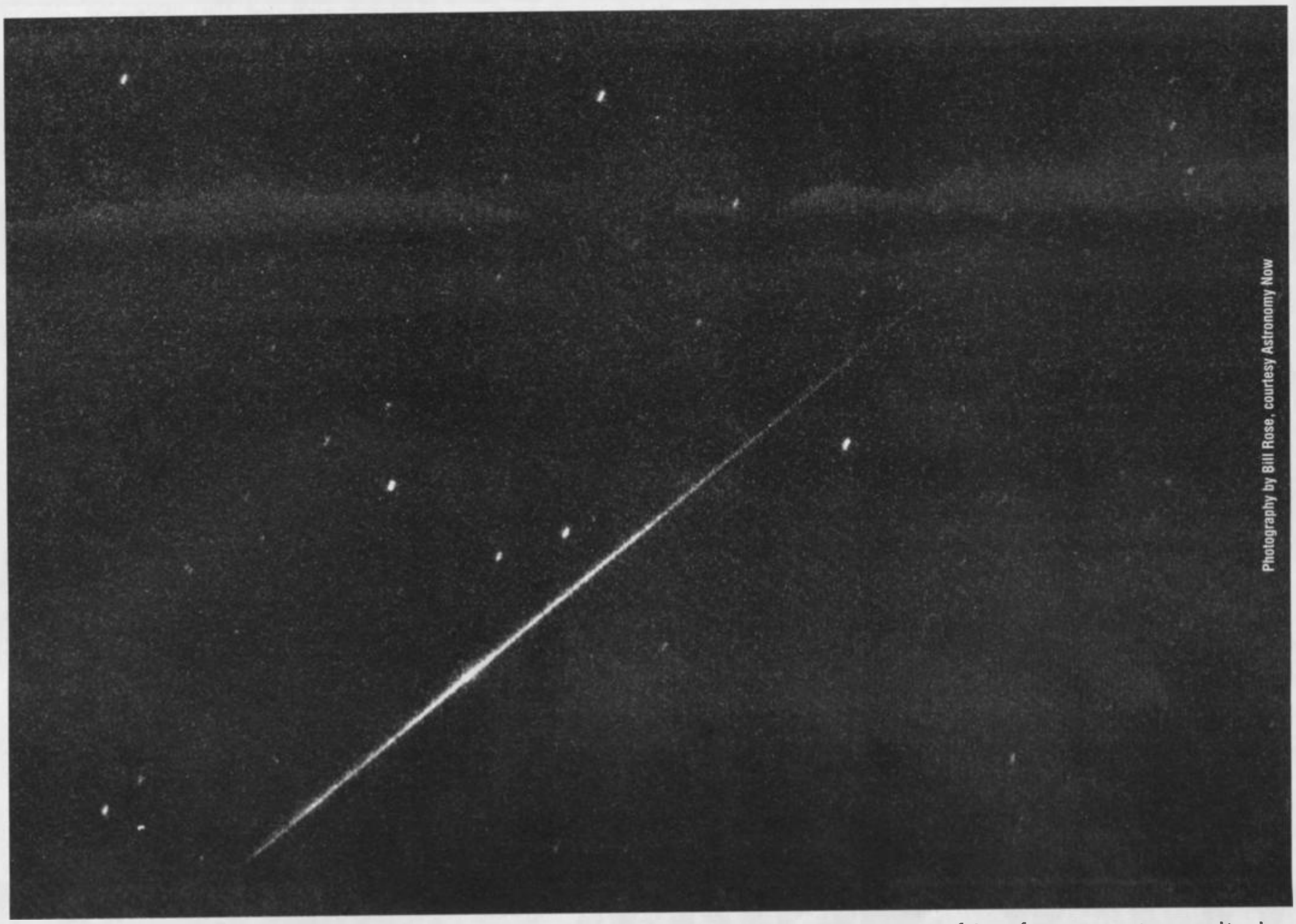


Fig. 4. Format of a data packet.



increases, the width of the transmitted beam and the angle over which the aerial can receive is reduced. This, in turn, reduces the number of meteor trails which can be seen making communications more difficult.

It is also worth noting that where links are not operating at maximum range the aerials do not need to be very high. This can be a great advantage when remote stations are located in areas which are very inhospitable.

Pros And Cons

Meteor scatter is a form of communication which is often used by radio amateurs. Although it may not seem like a viable method for reliable commercial applications, there are certain situations when it is an extremely attractive solution. For example a meteor scatter link is much cheaper than a microwave or a satellite system. It is far more reliable than an HF link which has to contend with all the uncertainties of the ionosphere. Meteor scatter also has a considerable range, extending up to 2000km or further if relay stations are used. However the best communications are achieved between about 500 and 1500km. The aerial systems are fairly compact, especially when they are compared with some of the aerials which are used for HF communications.

Of course, there are some disadvantages. The first is the rate at which data can be transmitted. This is fairly low, averaging up to 600 bits per second on the fastest systems. The reason for the low data rate is the waiting time when no trails are present to enable the link to be made. In addition to this real time communication cannot be performed as data has to wait until there is a suitable meteor trail to support communication between the two ends of the link. This may mean that data is delayed for up to 30 seconds or so.

Uses

Meteor scatter is not ideal for all forms of communication but it excels in an application where data needs to be transmitted at regular intervals. This can include everything from remote monitoring instruments and data to set them up right through to faxes and the like and other digital systems.

One area where it has come into its own is for monitoring remote weather stations. Another is for data links too and from oil platforms. In both of these situations expensive satellite links are not necessary and meteor scatter provides a very convenient and cost effective means of communication.

Conclusion

Meteor scatter has only been used extensively since the mid 1970s as a viable form of communication. It was used before this but without the invention of the microprocessor, it would not be commercially viable. Systems are still in their infancy and with all the advances that are likely to be made with investigations into propagation using meteor trails as well as further advances in computer technology it is likely that much more will be heard of this system of communications in the future. ■

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Tales Of Vacuum Pumps And Silicon

Mike Sanders continues his examination of the semiconductor manufacturing process with a view to making some chips..

When integrated circuits are fabricated they require metal contacts so that they can be placed into electrical contact with other devices. Although no metal can satisfy all of the requirements aluminium is a suitable compromise and most commonly used.

Unfortunately, aluminium will react with the silicon of the substrate but this can be reduced by adding between 1% and 2% silicon to the metal. Also, the resistance to electromigration can be improved by a factor of 10 to 100 by adding between 3% and 5% copper.

In military and scientific applications with stringent requirements and when cost is not a problem, several layers of different metals are employed. In this way, each of the layers contributes a little towards the overall requirements.

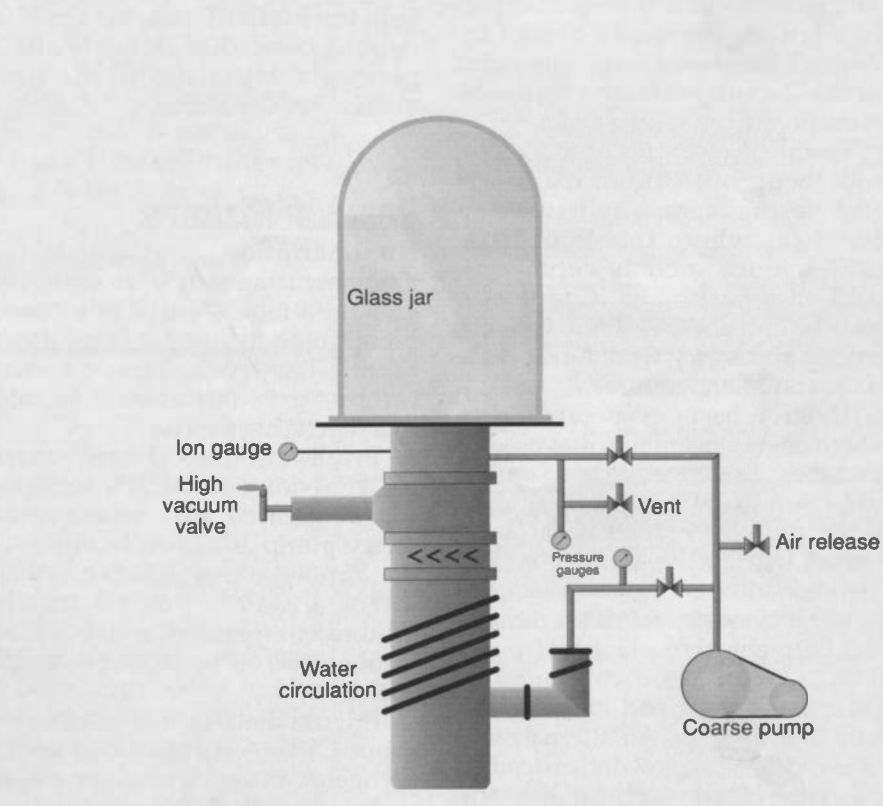


Fig. 1. Vacuum deposition pump.

Creating A Vacuum

To make the metallisation process compatible with the other processes, a vacuum deposition process is employed. A typical set-up is shown in Fig. 1. The coarse pump creates an initial vacuum or 3.3^{-3}Pa and a further pump then goes on to create a higher vacuum – Pascals are a measure of pressure. 1mm of mercury = 133Pa and atmospheric pressure is around 101kPa. Instruments monitor the vacuum levels and a means of depositing the metal layer is provided.

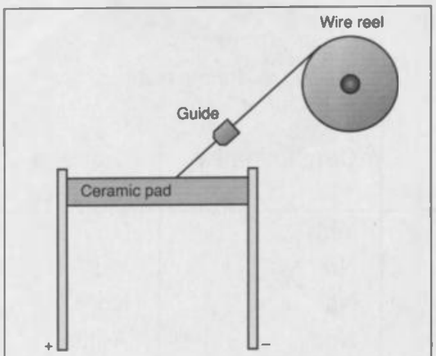


Fig. 2. Flash evaporation.

A typical process would clean and dry the wafers and then load them onto a rotating platform called a planetary. This ensures that steps on the wafer are covered uniformly. After the pressure has been reduced the metal source is turned on and a small amount of metal evaporated onto a shield between the source and the wafer. This process cleans the surface of the metal source and gets rid of oxidised metal. The wafers are heated to improve the deposition of metal and when the required thickness is achieved, the source is turned off and the wafers cooled.

Techniques

The most commonly used methods of producing the required metal particles are filament evaporation, electron beam evaporation, flash

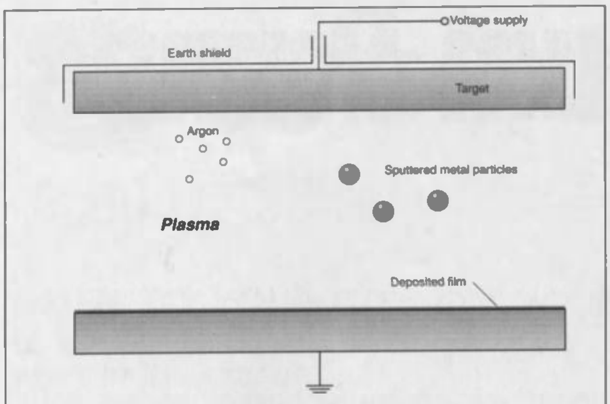


Fig. 3. Sputter evaporation.

evaporation and sputtering.

In filament evaporation, loops of the metal are placed on a filament. This is then gradually heated by thermal resistance until the metal melts. The current is then increased to evaporate the source metal.

Filament evaporation is simple and cheap but contamination is high so the technique is used in instances where this is of little consequence such as depositing gold on a backplane. Composite metals cannot be used in this process since they would evaporate at different temperatures.

Electron beam evaporation uses a high energy beam like that used in TV tubes. The electrons are focused and used to evaporate the metal. Since only electrons come into contact with the metal there is little contamination.

Flash evaporation uses a ceramic rod between two electrical posts (Fig. 2). Wire is fed continuously onto the heated rod causing the wire to evaporate. An alternative is to use pellets or powder instead of the wire. This method has the advantage of producing low contamination and the ability to be used with composite metals.

The sputter method uses ions of an inert gas such as argon. When the chamber has been evacuated, the gas is introduced and either a DC or RF voltage is applied to ionise it – Fig. 3.

The source metal is connected to one electrode called the target and the wafer is connected to the electrode facing the target. The electric field accelerates the ions which bombard the target removing atoms of metal and depositing them on the wafer.

The rate of deposit is low and can be improved by a magnetic field at the target. This is called magnetron sputtering. The sputter method can be used to deposit composite metals – Fig. 4 gives a comparison of the four methods of deposition.

Vacuum Makers

No description of semiconductor manufacturing would be complete without a look at the sophisticated pumps used to take pressures down to ultra low levels. Three pressure ranges are important to the manufacturing process:

From atmospheric pressure (101kPa) down to 0.133Pa vacuums can be created with an oil filled rotary pump as shown in Fig. 5. In the Vare type pump, air enters the inlet and is pulled around,compressed and expelled through the oil sealed valve at the outlet.

Intermediate to low vacuums – about 1.3^{-3}Pa – are generated with a cryogenic pump. This uses a cold metal surface to capture any remaining molecules of gas. Fig. 6 shows tubes carrying nitrogen but cylinders or discs could be used instead.

Low vacuum to ultra low vacuum – 1.3^{-7}Pa – requires the action of an ion pump. Both electric and magnetic fields are used to ionise atoms and trap them.

Equally important are the means of measuring the vacuum levels. A diaphragm which moves with changes in pressure and drives a mechanical or electrical meter is sufficient for intermediate vacuums. For lower pressures, either thermocouple or Pirani gauges are used. Both rely on the cooling effect that air has on a heated filament. Therefore, the less air that is present, the less the cooling effect. Another method of measuring pressures uses ionisation. Air is drawn into a tube and ionised by a heated filament. These ions are accelerated towards an electrode and cause current to flow in an external circuit. The current flowing is proportional to the vacuum in the chamber.

Devices

All the processes described previously are used in the manufacture of discrete components as well as integrated circuits. Bipolar and metal oxide semiconductors (MOS) are the main technologies and although they both use the processes already described, the process sequence is different. Also, the geometry's of the layers are different giving the

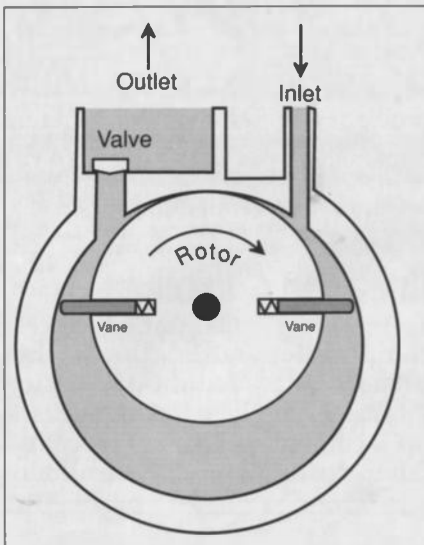


Fig. 5. Rotary pump.

Method	Rate of deposition	Composite materials	Thickness of film	Step coverage	Contamination	Damage to device
Filament	Medium	No	Thin	Good	Yes	No
Electron beam	High	No	Thick	Good	No	Yes
Flash	High	Yes	Thick	Good	No	No
Sputter	Low	Yes	Thick	Very good	No	A little

Fig. 4. Comparison of metal deposition techniques.

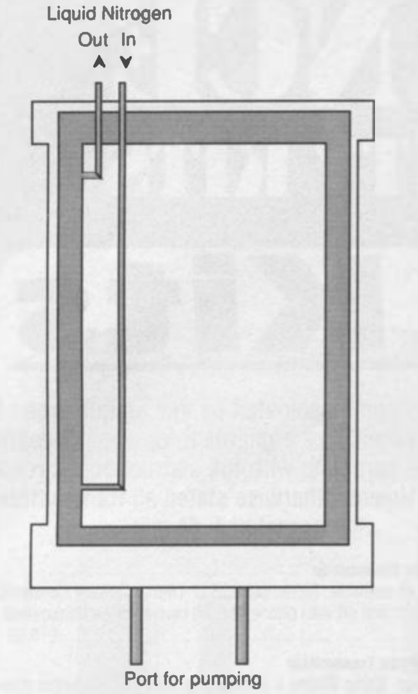


Fig. 6. Cryogenic pump.

devices physical and operating characteristics which are different from each other.

Research on MOS technology in the 1960s resulted in commercial devices becoming available at the end of that decade. The first devices were PMOS and the manufacture process was simpler than that for bipolar devices. These were slower than bipolars and also used less current and operated with lower voltages. Although the range of MOS devices was limited they were suitable for digital circuits in computer memories and logic gates.

NMOS devices started replacing PMOS in the mid 1970s and increasing numbers were sold with the explosive growth in the computer market. Large scale integration in order to meet more ambitious demands on digital

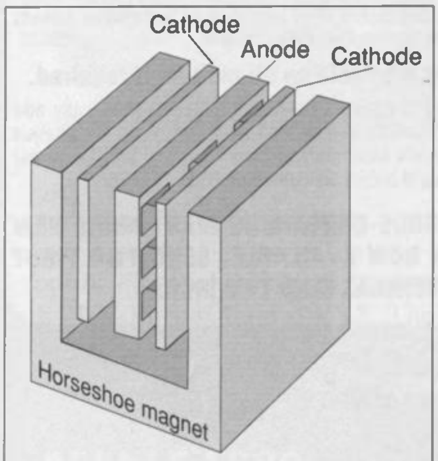


Fig. 7. Ion pump.

signal processing ran into the inevitable problem of heat dissipation on small chips. That's when complimentary metal oxide semiconductors (CMOS) using both PMOS and NMOS made their appearance and were used in increasing numbers because of their low heat dissipation. Over the years, CMOS technology closed the gap with bipolar technology in choice of devices, operating speed, range of current and voltage.

However, there are still instances where one device can perform circuit applications better that others and it is not unusual to find a number of different kinds in the same circuit.

Bipolar Devices

There are usually about seven masks used in the making of bipolar systems. The first produces a buried layer such as a heavily doped N+ region in the substrate with an epitaxial layer on top. The second provides a P-type diffused region for electrical isolation between regions. The third mask sets up a P-type diffusion to make the base of NPN transistors or the body of a resistor. Fourthly, a mask can be used to define an N+ region to form the emitter and collector of NPN transistors. The fifth mask produces openings so that regions may be connected. The sixth mask provides the metal contacts and the seventh a layer such as silicon dioxide to protect against chemical or physical damage.

A typical small NPN transistor can handle a current of 1mA to 10mA and has a gain of 50 to 500. There are two structures for a PNP transistor, the vertical or lateral. Fig. 8 shows a plan view and elevation of a vertical structure. The collector goes down to the substrate which is the circuit

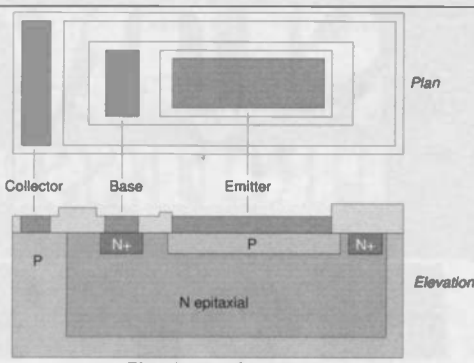


Fig. 8. Vertical PNP.

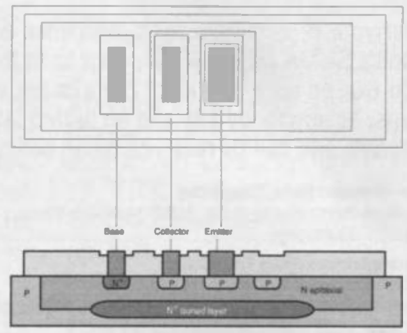


Fig. 9. Lateral PNP.

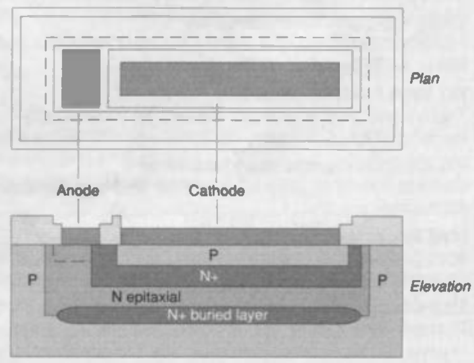


Fig. 10. Emitter base diode.

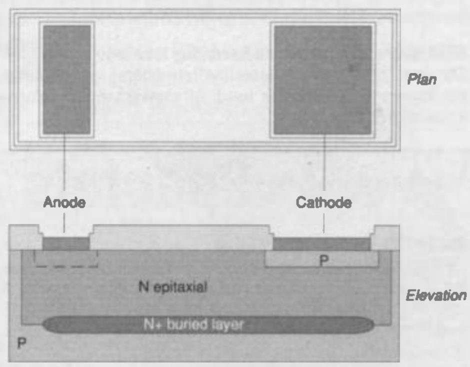


Fig. 11. Base collector diode.

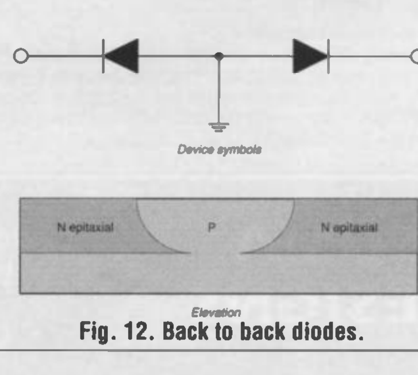


Fig. 12. Back to back diodes.

ground. Fig. 9 shows a plan view and elevation of lateral PNP. The current gain of this structure is less than that of a vertical PNP. Also, the current gain of the lateral device drops to unity at a lower frequency than for the vertical device.

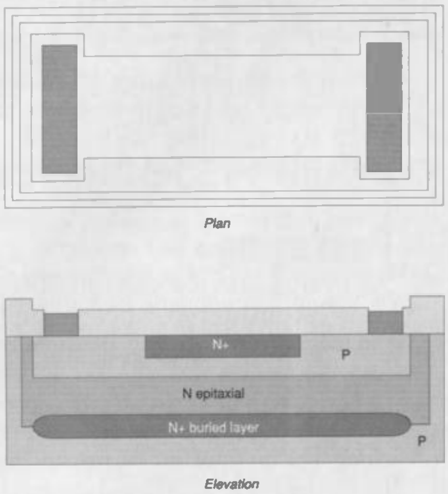


Fig. 13. Emitter resistor,.

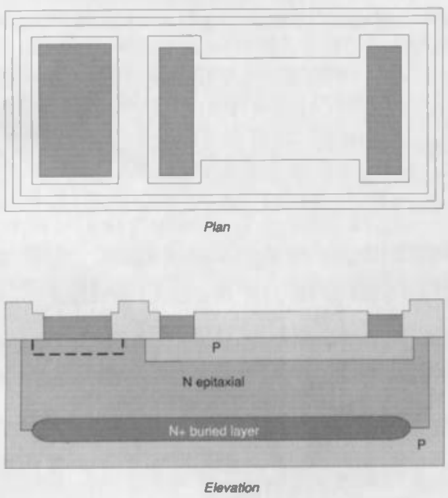


Fig. 14. Base resistor,.

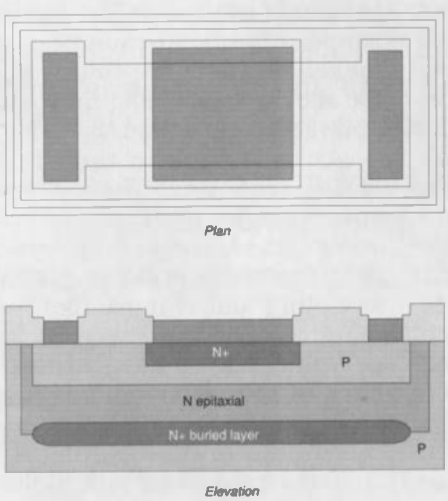


Fig. 15. Base resistor,.

One Way Only

Diodes exist at every PN junction, therefore a transistor can be turned into a diode simply by short-cutting the base and collector of an NPN transistor to form the anode and the emitter the cathode. This is the emitter base diode shown in Fig 10 and is often used as a Zener diode since it has a reverse breakdown voltage in the 6V to 10V range.

Base-collector diodes can also be derived from NPN transistors by using the base as the anode and the collector as the cathode – Fig. 11. The reverse breakdown voltage of the base- collector diode is 15V to 50V.

In order to prevent electrical interference between unrelated areas of the chip, diodes are connected back-to-back whenever the opportunity arises – Fig. 12. This can be done quite simply by placing a P-layer in the N-type epitaxial layer. These types of diodes are called epi-diodes.

Many types of resistor can be manufactured. One is the emitter resistor, set up by making contacts either side of the emitter – Fig. 13. Resistor values of 5Ω to 100Ω are achieved. In order to make the resistor stable and avoid parasitic interference, one end of the resistor is usually connected to the base.

A base resistor is made by applying contacts to both sides of the base which is a P-type layer as seen in Fig 14. Typical resistors are 50Ω to 50kΩ.

Larger resistors in the range 10kΩ to 500kΩ can be manufactured by diffusing an emitter region over the centre of a base resistor as in Fig. 15. Such resistors are called pinched base resistors, but control over their values is not good.

The epitaxial layer also lends itself to the manufacture of resistors if a portion is isolated and N+ contacts placed at each end – Fig 16. Typical resistor values are 2kΩ to 50kΩ but the control of the values is not good since the epitaxial layer varies in thickness.

A pinched epi-resistor is made by diffusing an additional P-type layer over the centre of an epi-resistor. This reduces the current and increases the resistance, Resistors in the 5kΩ to 100kΩ range are possible – Fig. 17.

Capacitors are manufactured by using the emitter or base as one of the plates and the metal layer as the other – Fig. 18. A layer of oxide is forms the dielectric.

If the constant capacitance and low leakage of dielectric capacitor are not required then a reverse biased PN junction can be employed as a capacitor as in Fig 19. This is valid for small voltage variations either side of the point of operation.

Clean Machines

Any air introduced during the manufacturing process must have a low level of particles and the humidity and temperature must also tightly controlled. The absence of particles is also important during photoresist steps and during loading and cleaning.

The gases used in the manufacture of semiconductors such as oxygen, nitrogen, hydrogen and dopant gases are a potential source of contamination. The piping for supplying the gases can also pollute them and, although copper pipes can be used for nitrogen and oxygen, more expensive stainless steel must be used for other gases since it is less likely to corrode.

Pollution From Water

Almost every step in the manufacturing of semiconductors requires the use of water, particularly the cleaning steps which use water to rinse the wafers. Even tap water fit for human consumption is not good enough for the semiconductor manufacturing industry. Some of the pollutants that exist in tap water are particles such as silica and inorganic salts from soil and rocks and organic material from living things.

As a comparison, tap water might contain 100,000 particles per cubic centimetre. Water purified for the semiconductor industry would contain fewer than 150. Also, tap

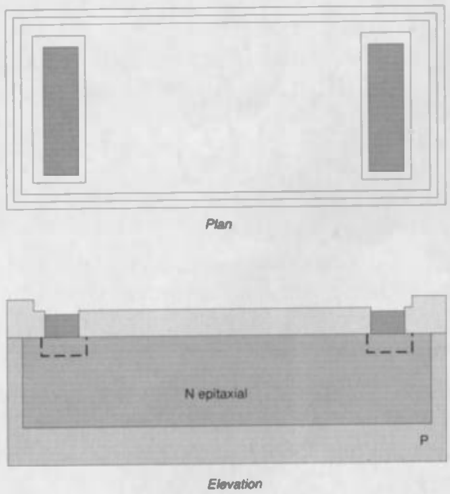


Fig. 16. Epitaxial resistor.

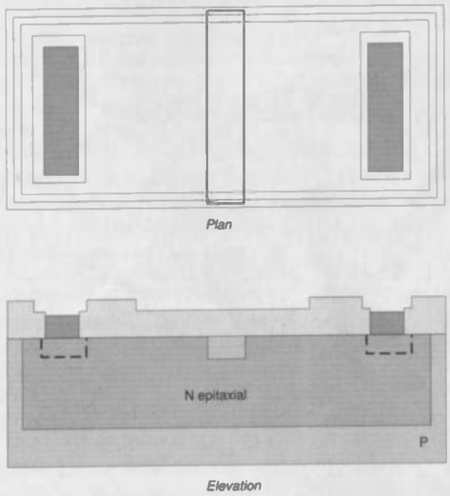


Fig. 17. Pinched epitaxial resistor.

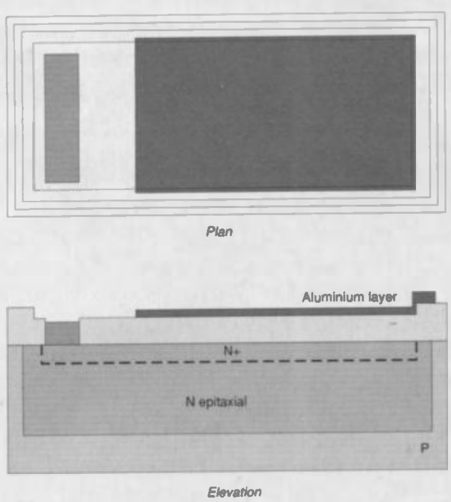


Fig. 18. Capacitor using oxide as a dielectric.

water could contain up to 10 000ppb (parts per billion) living organisms whereas pure water would contain less than 10ppb. There could be 200,000ppb electrolytes in tap water but purified water should have less than 25ppb.

There are two main purification processes used for cleaning water, de ionisation and reverse osmosis. Until recently, de ionisation or ion exchange was the only purification system. It works by removing positive and negative ions using active resins.

The reverse osmosis system works on the principle that when water is fed under pressure to a membrane, it passes through leaving behind suspended particles and dissolved substances. The reverse osmosis process also uses resins to trap ions but the resins need renewal less often.

Cleaning Up

Wafers are degreased by dipping them into trichloroethane and then rinsing them in acetone and alcohol. They are also dipped in other solutions, each of which specialises in removing a particular impurity.

A typical cleaning cycle would be to remove organic compounds such as photoresists. The wafer is heated in sulphuric acid and then dipped in aqua regis to remove gold and other metals. In order to skim the top off the silicon dioxide and remove contamination, the wafer then gets a quick dip in dilute hydrofluoric acid. The wafer is finally rinsed in water and dried.

Two of the most common contaminants are sodium and gold. The gold dissolves into the wafer at high temperatures and is precipitated out when the wafer cools. This interferes with the hole and electron flow and it is difficult to remove the impurity. In this instance, preventative measures certainly pay dividends.

Sodium contamination causes atoms of the metal to drift through the silicon dioxide and into negatively charged regions. This causes a change in characteristics of the device such as excessive leakage.

Not only are the wafers cleaned but also the equipment associated with semiconductor manufacture such as vacuum wands, wafer boats, glass domes, rods and so on.

Packaging

Although device manufacture is now complete, the efficient packaging and testing of devices is just as important.

The application of the metal layer does not mean that the electrical contact is sound. In order to ensure a low resistance contact between the aluminium and silicon, an alloying process is usually carried out.

The lowest temperature at which both the aluminium and silicon would melt is 577C and is called the eutectic temperature. This would damage any devices present so alloying usually takes place between 450C and 550C for periods between 10 and 30 minutes.

Annealing can be used to repair damage and combine hydrogen with any loose atoms at the silicon /silicon dioxide border which might otherwise degrade the performance of the device.

Annealing is carried out for 30 to 60 minutes at temperatures of 400C to 500C. It is performed in the presence of hydrogen and may happen directly after alloying. Since the temperatures are similar to that for alloying, annealing may also be done at the same time.

At this stage in the life of a wafer, the devices are tested automatically by means of probes and a curve tracer in the production line. This stage is called post alloy sampling and is more than just a quick check on the devices.

The next step now turns to the back of the wafer. This is lapped and metal is deposited. Lapping is the progressive skimming of the surface which serves to make the wafer thinner, separate the die and remove any diffused layers which interfere with the performance of the device.

The metal coating on the back of the wafer is usually made from gold. The eutectic temperature of 370C is low enough to prevent the gold interfering with the parameters of the device. The metal also makes it easier to bond the

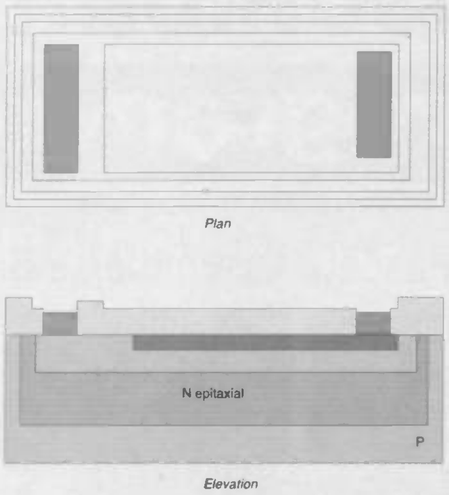


Fig. 19. Junction capacitor.

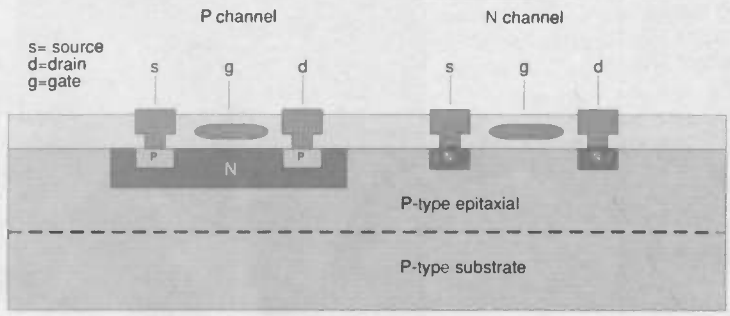


Fig. 20. Basic CMOS structure.

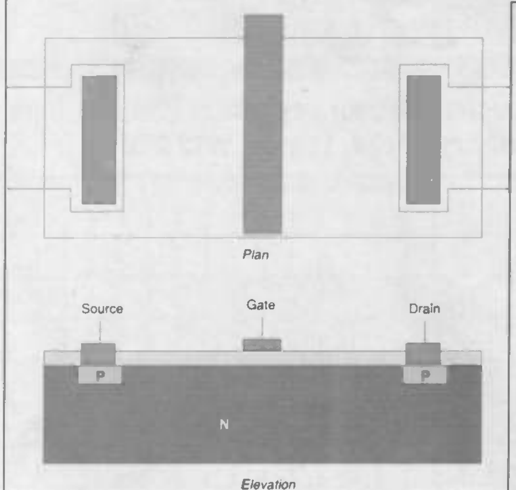


Fig. 21. MOS transistor using P-channel.

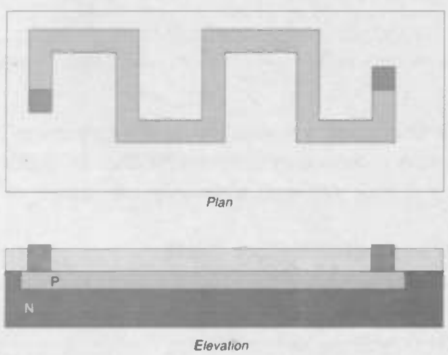


Fig. 22. Source-drain resistor.

silicon wafer to the packaging.

Next, the die are sorted. For this purpose, another testing station is required in order to separate the good ones. The bad chips are marked with ink so that they can be discarded later. A more vigorous sort may be carried out to distinguish good quality die from the average and two different colours of ink are required which are hard baked so that they stay put for the rest of the processing.

The die is separated by scribing with a diamond or laser or by sawing. When the wafer was originally set up, the planes of the silicon crystal were orientated so that this stage could be carried out easily. The chips are broken apart along the scribed lines and crystal planes.

With laser scribing, a pulsed laser is used to make a series of holes along the break line. A drawback of this method is that the silicon evaporated by the laser condenses on the die reducing the yield. Two ways of overcoming this are to use a protective casing or by scribing the wafer on the back.

A newer method of separating the die is to use a circular saw. Advanced technology has enabled the production of thick enough blades which avoid two much loss of wafer. The advantage of using the blades over lasers is that nice vertical sides are produced for handling the dies.

Each die is now ready to be packaged. With the large scale manufacture of semiconductors, the cost of chips has come down whereas the cost of the packaging has not and is, therefore, a significant proportion of the total cost.

Originally, chips were packed in containers made of metal or metal and ceramic newer methods use plastic. However, newer does not always mean more reliable since the ceramic metal cases are tougher and still used in military specification items.

An epoxy resin is used to stick the die to the package and is baked to cure the resin. A perform attachment uses a material like lead-tin that will attach to both the package as well as the die. The perform is melted on the package and the die rubbed on it do that it matches. The assembly is then cooled.

There are three popular methods for connecting and the bonding pads to the package pins. These are thermo-compression, ultrasonic and thermosonic. Gold wire is used in thermo compression where the package is heated and the wire pressed onto it.

Aluminium wire is used in ultrasonic bonding where an ultrasonic pulse is sent through the wire. This produces a rubbing action to form the bond. Gold wire is used in thermosonic bonding which is a combination of the first two methods.

Before the devices are packed they undergo a final test. This is similar to that after the wafer sort and the electrical testes are merely meant to confirm that all is well since damage can occur when the wires are bonded. The devices are then stamped with the date and the device code and packaged in protective containers. ■

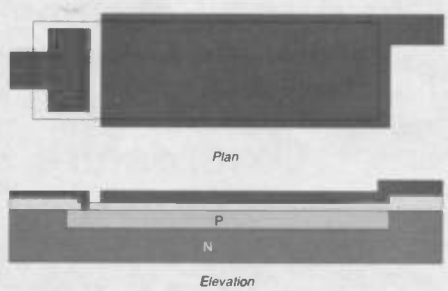


Fig. 23. Gate oxide capacitor.

Digiscope 92... Solid State Signal Sensor

Check out your electronic circuits the easy way with John Becker's LED matrix circuit signal monitor and tracer.

Sixteen years ago it required 23 integrated circuits and over 140 other components to produce an oscilloscope-type waveform on a matrixed display consisting of 80 individual LEDs (light emitting diodes). This project shows one way in which improvements in technology allow the concept to be more simply implemented.

This design uses only six integrated circuits and a handful of other parts to display signal waveforms on 105 matrixed LEDs contained within three packages. Although the use of an LCD (liquid crystal display) was considered, it was concluded that the relatively high cost of the display and greater complexity of the control circuit was unjustified.

Each of the three LED modules contains 35 LEDs in a matrix of seven rows by five columns, as shown in Fig.1. The modules are butted side-to-side on the printed circuit board, resulting in a 7 x 15 point display illustrated in Fig.2.

The 1976 version.

Three banks of switches select input signal gain factors, sampling rates, and synchronisation modes. The useful AC signal input frequency range is from less than 10Hz to greater than 100kHz. Fig.3 shows the block diagram for the basic concept and Fig.4 details its practical implementation.

The circuit around IC1a controls the gain of the input signal brought in via C1. Signal gain is determined by the ratio of the input and feedback resistances set by R1-R4 as selected by S1/1 and S1/2. The ranges are x100, x10, x1 and 1/10. Fig.5 shows the selection details. From IC1a, the signal is AC-coupled to the bar-graph driver chip IC2. VR1 presets the DC input bias to allow for optimum positioning of the output display.

Displaying Logic

IC2 is a monolithic IC containing 10 comparators each of which can sink current from an LED. The comparator reference levels are derived from an internal chain of resistors and the display response is linearly related to the input voltage. The chip can be configured so that the LEDs are controlled as a bar-graph or moving dot display. In this application, the chip is used in dot-mode as determined by leaving its pin 9 unconnected (taking the pin to +ve would have set the chip for bar-graph mode). Current sinking for the LEDs is internally regulated in accordance with the load on the reference output pin 3 as set by the total resistance of VR2 and R7, the least resistance resulting in a brighter display.

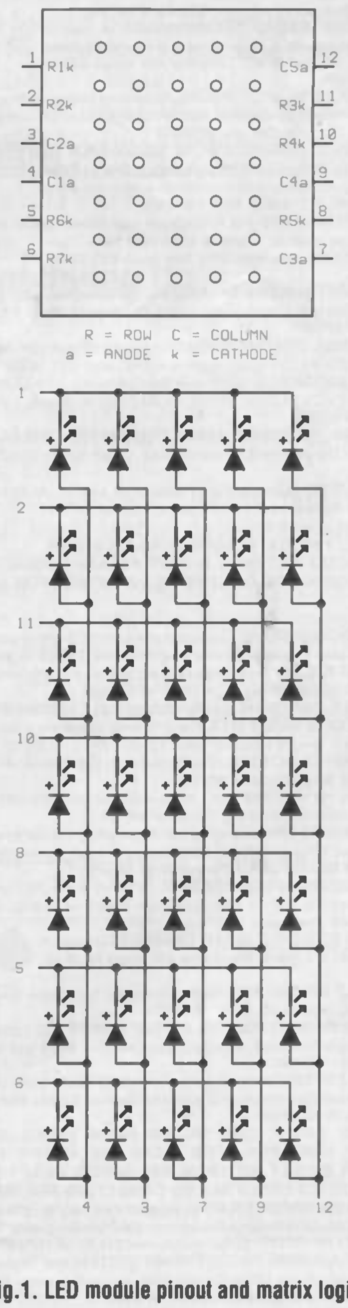


Fig.1. LED module pinout and matrix logic.

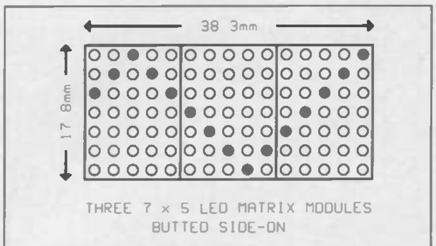


Fig.2. Waveform display example

Additional resistors in series with the LEDs are not required.

Only seven of IC2's 10 outputs are used, controlling the vertical aspect of the LED display. The horizontal aspect is selected by the 4-to-16 way multiplexer IC5. This device has four control inputs, A0-A3, the binary address on which control a corresponding output pin, causing it to go high when selected, so providing power to the respective matrixed LED column. Although power is applied to all LEDs in the column, only the LED in the row selected by IC2 will be illuminated.

The control address is provided by the 'A' half of the dual 4-bit binary counter IC4. The latter can be triggered either from an external source via R10, or from an internal counter under control of the master clock signal generated by the circuit around IC6a. VR3 presets the master frequency within the range set by C3. As selected by S3, the clock can either be routed directly to IC4, or at a subdivided rate via the multiplexed 5-decade counter IC3.

Selection of which of the five internal decade divisors is routed to the BCD (binary coded decimal) outputs Q0-Q3 is determined by the chip's decade select (DS) multiplexer in conjunction with S2, the master clock generator and the OR gate around D1, D2 and R8. The multiplexer is clock controlled and its DS1-DS5 outputs reflect the counter decade selected. When S2 is switched from one DS output to another, the selected output is initially low, consequently the OR gate allows the master clock signals to trigger the DS clock counter via D2. When the counter triggers the selected DS output high, the OR gate is biased hard on and the counter input is inhibited. The selected decade counter is thus permanently routed to the Q0-Q3 outputs until S2 selects another DS output. The table in Fig.6 shows the clock rates seen by IC4a in respect of different settings of S2 and S3 with the master clock generator set to 1MHz.

Sync Control

Two modes of display synchronisation are provided and are selected by S1/3, hard and soft sync. The input AC signal is additionally routed from IC1a to the comparator formed around IC1b. VR4 presets the trigger threshold reference level. When the signal rises above the threshold, the comparator output goes low, generating a negative-going signal across C4. Since the output swing of IC1b is insufficient to satisfy logic requirements, the pulse is maximised to full line-level swings by TR1. The output of TR1 controls one input to the dual NAND gate IC6d, the other input is controlled by the final (Y15) output of IC5, which also controls the enable input (ENA) of IC4a via the inverter IC6b. When Y15 is low, IC4a is enabled and the count cycles IC5 through its output sequence. During this time the low state of Y15 prevents IC6d from reacting to sync signals from TR1. When Y15 goes high, IC4a is inhibited and so Y15 will remain high until the counter is reset. With Y15 high, IC6d will now respond to the next available sync pulse from TR1. On receipt of pulse, the output of IC6d goes low, is inverted by IC6c and via S1/4 resets IC4a and IC4b. The sequence then repeats.

In hard sync mode, with S1/3 open, the display will be unilluminated if the AC signal is too low to trigger the sync circuit. Soft sync mode allows the display to be triggered either by the AC sync signal, or by a delayed pulse following the end of each multiplexed cycle. In the absence of an AC signal, the display shows a mid-range straight line. With S1/3 switched for soft sync mode, IC5 is cycled through its sequence as usual until Y15 goes high. The high level now allows IC4b to start counting the clock pulses from S3. On the 16th pulse, IC4b Q3 goes high and triggers the comparator IC1b via D4 and S1/3. The sync circuit responds as previously, resetting both IC4a and IC4b. If the AC sync signal arrives before IC4b Q3 goes high, normal syncing is maintained.

Switch S1/4 allows the display to be confined to just one column, a facility beneficial if signal amplitude is the only factor of interest. In this mode, sync is switched out of circuit and IC4a/b are held reset.

Powering Up

As shown in Fig.4, the circuit is powered from a 9V DC source regulated down to 5V by IC7. Alternatively, it may be powered directly from a 5V supply, omitting IC7 and C7.

Printed circuit board component and track layout details are shown in Figs 7 and 8. Sockets should be used for all ICs. 12-pin sockets for the LED modules do not appear to be available but it is possible to use 14-pin sockets with two pins removed. If narrow (0.3 inch) 24-pin

Fig.3. Digiscope block diagram.

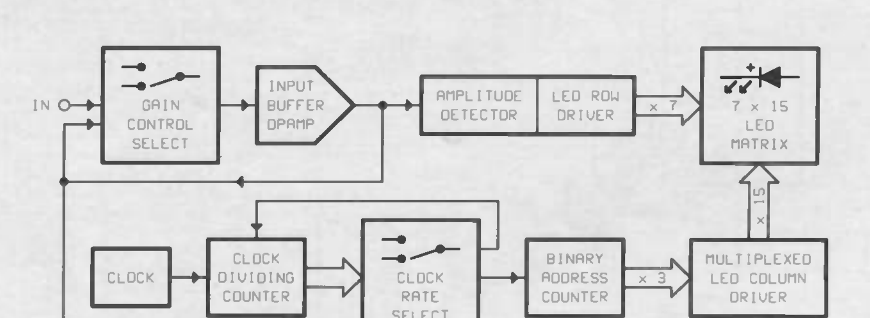
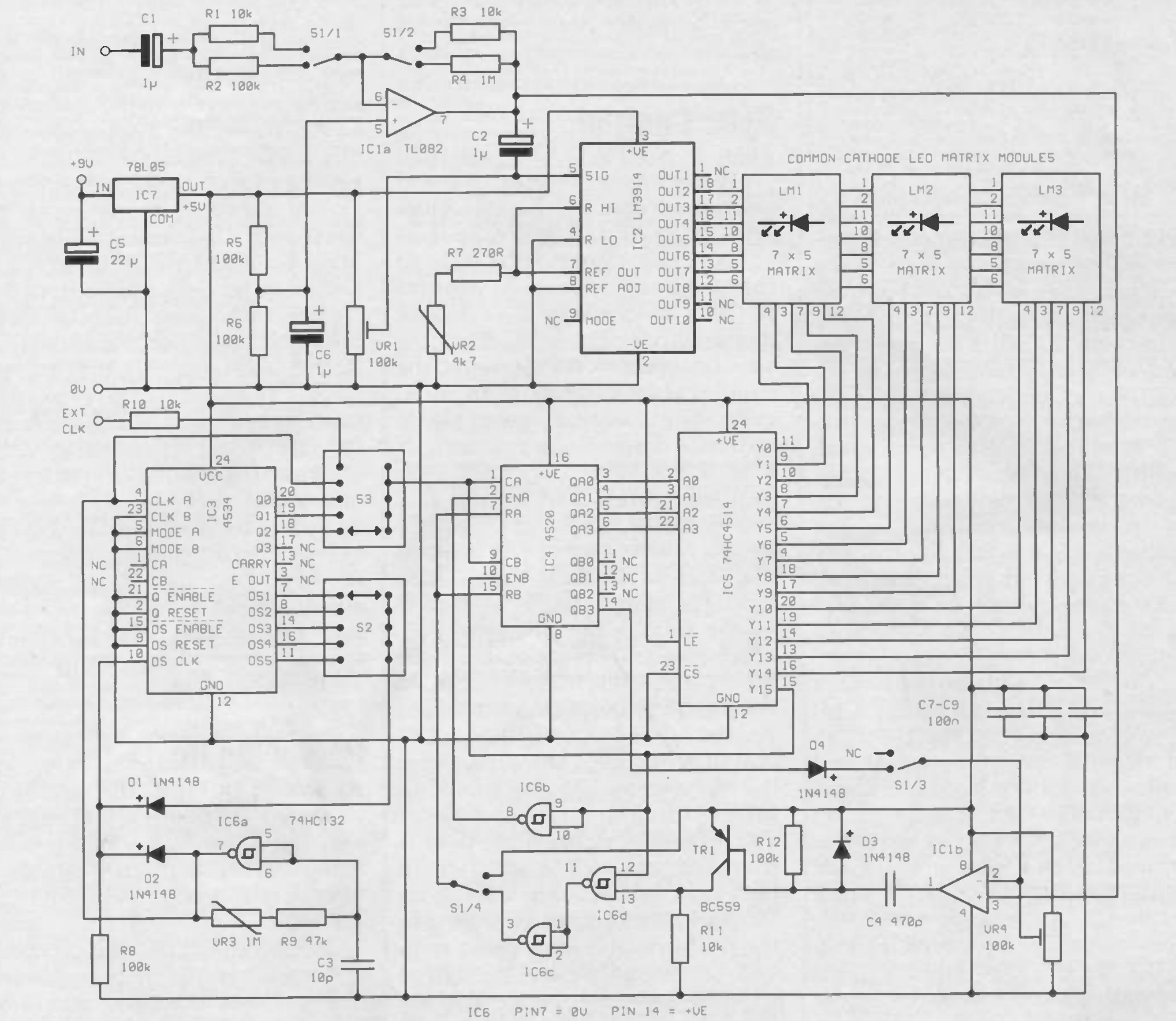
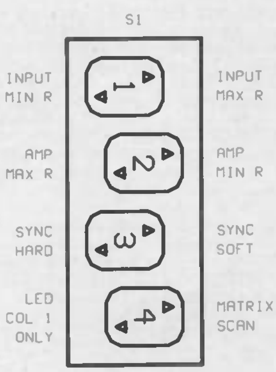


Fig.4. Complete circuit diagram



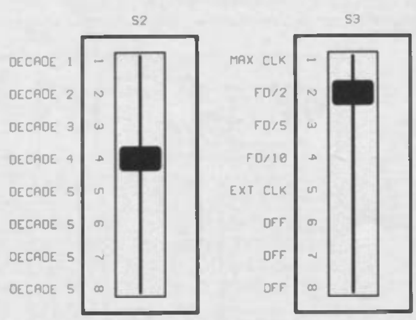
sockets are not available for IC5, use a 16-pin and an 8-pin socket end-to-end. Note that some of the link wires go below the sockets. There seems to be little merit in boxing the unit and it is suggested that tedious metal work should be avoided by using it in its open-plan form. (If a box is used, though, any of the PCB-mounted controls may be replaced by standard rotary panel-mounted types.)

For the initial checking, set all presets to midway, S1/1 and S1/2 for a gain of x1, S1/3 to soft sync, S1/4 to single column, S2 and S3 to positions 1 and 2 respectively. Temporarily couple the input to 0V.



S1/1	S1/2	GAIN
→	→	1/10
←	→	x1
→	←	x10
←	←	x100

Fig.5. S1 function details and input gain truth table



S3 \ S2	1	2	3	4	5-8
1	1MHz	1MHz	1MHz	1MHz	1MHz
2	500kHz	50kHz	5kHz	500Hz	50Hz
3	200kHz	20kHz	2kHz	200Hz	20Hz
4	100kHz	10kHz	1kHz	100Hz	10Hz
5	EXT	EXT	EXT	EXT	EXT
6-8	OFF	OFF	OFF	OFF	OFF

Fig.6. Sampling rate selection details

Components

Resistors
R1, R3, R10, R11 10kΩ
R2, R5, R6, R8, R12 100kΩ
R4 1MΩ
R7 270Ω
R9 47kΩ
All 0.25W 5% or better

Capacitors
C1 C2 C6 1μF 16V electrolytic
C3 10pF polystyrene
C4 470pF polystyrene
C5 22μF 16V electrolytic
C7-C9 100nF polyester

Potentiometers
VR1 100k min horiz preset
VR2 4k7 min horiz preset
VR3 1M min horiz preset
VR4 10k min horiz preset

Semiconductors
D1-D4 1N4148
TR1 BC559
IC1 TL082
IC2 LM3914
IC3 4534
IC4 4520
IC5 74HC4514
IC6 74HC132
IC7 78L05 (see text)

Switches
S1 4PCO DIL lateral
S2, S3 1P8W DIL slide (common pole)

DIL IC Sockets
8-pin x 2, 14-pin, 16-pin x 2, 18-pin, 24-pin

Miscellaneous
LM1-LM3 7 x 5 dot matrix common cathode LED module (RS585-371).
Printed circuit board, PCB supports x 4.

Switch on and adjust VR1 until the single illuminated LED in column 1 is in the middle row. Switch S1/4 to multiplex mode, resulting in all LEDs in the centre row to appear to be illuminated. Switch S2 and S3 through their different settings and check that the rate at which the 'trace' moves across the display varies with the settings. Couple the input to an adjustable waveform signal source and vary the amplitude and frequency in relation to different settings of S2 and S3, observing their best settings for clear displays at given frequencies. Check that the synchronisation point can be adjusted by VR4. (Do not take the wiper too close to the extremes of resistance as this could put an excessive load on IC4b.) If a frequency counter is available, adjust VR3 to set the master clock generator to a known rate, say 1MHz, otherwise adjust VR3 to a rate best suited to your applications. VR2 can be used to adjust the display brilliance. ■

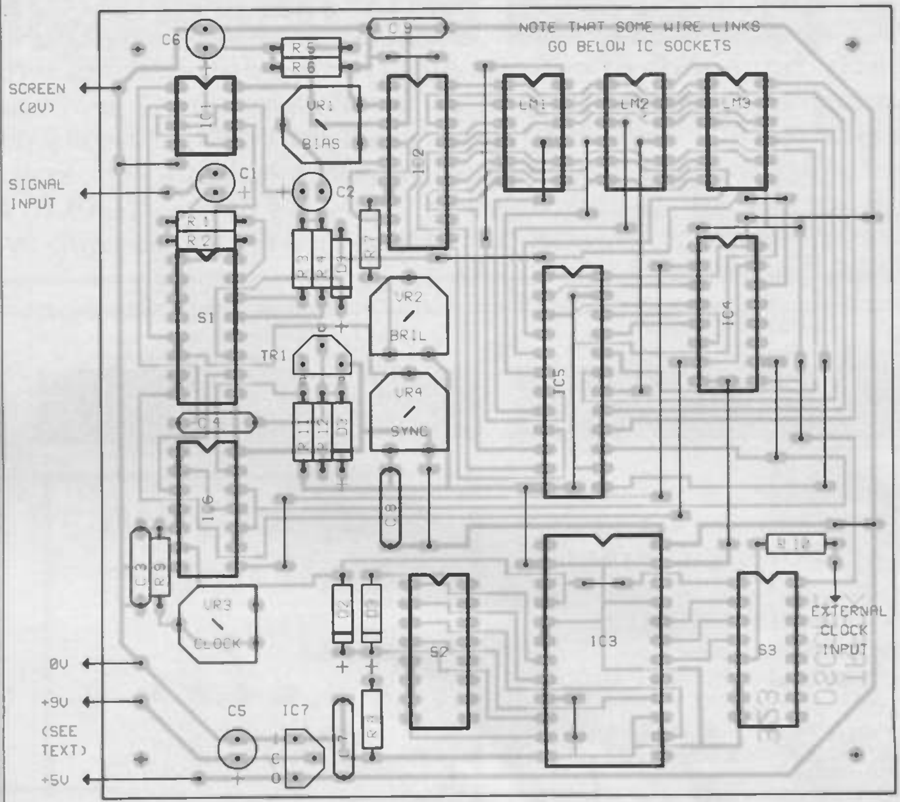


Fig.7. Printed circuit board component layout

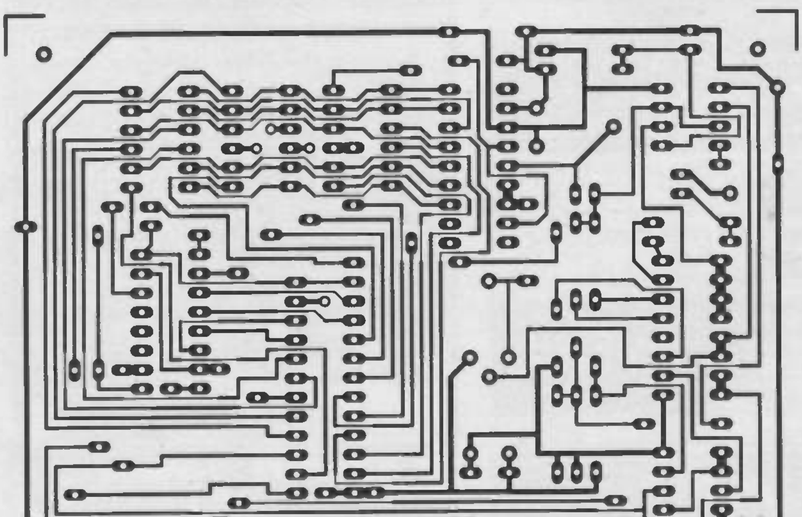


Fig.8. PCB track details

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4. Pretend to be your prospective customer. Ask yourself what it is you would like to know about the product or service that you are selling that would make you want to buy it. For example, you could include information such as brand names, colours and specifications.

Advertising Index

Techniques

Andrew Armstrong shows how to design a radio to receive the military weather forcasts.

This month's enquiry comes from a reader in Leighton Buzzard who would like to build a receiver to listen to the aviation weather forecasts on 11.2 MHz. It strikes me that, while few readers indulge in private aviation, the design of a shortwave receiver suitable for fixed or tuneable reception might interest a number of people.

The normal design of receiver is still the superhet, whose principles are well known. Had the requirement been for a broadcast receiver, then I would have chosen a standard IC to do most of the job, and added RF or other circuitry as necessary. The particular transmission in question, however, is in upper sideband. If only single sideband reception is required, then there is a different receiver design which is simpler but which offers very good performance.

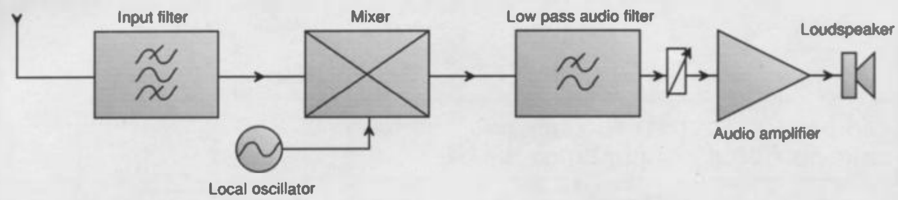


Fig. 1

SSB Only

The design technique in question is that of direct conversion, the principle of which is illustrated in Fig. 1. The radio frequency signal is passed through a frequency-selecting circuit (either a simple tuned circuit or a filter covering the bandwidth required) and is then mixed straight down to audio by means of a local oscillator at the carrier frequency. This technique is ideally suited to single sideband reception, because no actual carrier is transmitted. Reception of ordinary amplitude-modulated signals by this technique is less effective, because it is difficult to avoid the local oscillator making an audible beat with the carrier.

For those familiar with the circuitry used in communications receivers, the direct conversion technique is very much like the product detector used for SSB reception. The main differences are that the carrier insertion is done at a variable rather than at a fixed intermediate frequency, and that RF gain and tuning is often incorporated in the circuit.

There is only one drawback to this circuit technique for SSB reception: it receives both sidebands. What this means is that any signal on the other side of the oscillator frequency from the wanted signal will be heard and may interfere with intelligibility of

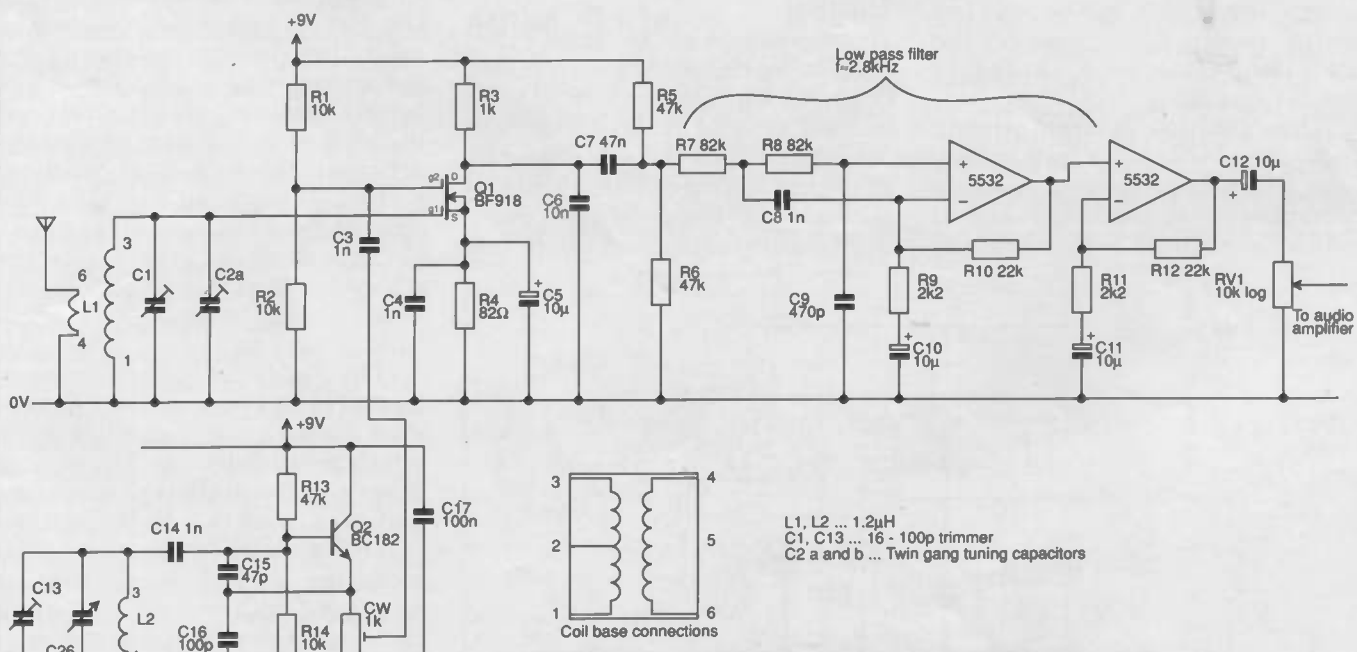


Fig.2.

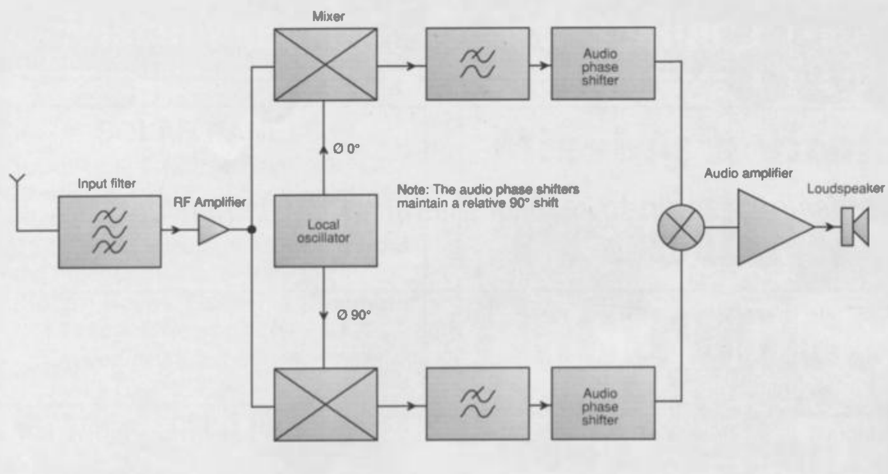


Fig. 3.

the wanted signal. This drawback is not critical in many applications, however.

The Circuit

The circuit diagram is of a simple direct conversion receiver believed to be suitable for reception of the relatively strong meteorological weather forecast signal on 11.2MHz. As it stands, it is not a highly sensitive shortwave receiver, but with a reasonable aerial, it should prove effective.

The aerial is link-coupled into a tuned circuit which feeds to gate 1 of a dual-gate MOSFET. The local oscillator is fed to gate 2, so the FET acts as a mixer, and the signal on the drain comprises the two input signals plus the beat-frequency between them. It is this beat frequency which is the wanted audio, so, the RF signals on the output of Q1 are decoupled to ground via C6.

The resulting low-amplitude audio signal is fed to a further low-pass filter to provide a suitable communications bandwidth and to remove unwanted high-frequency heterodynes. The filter and the following stages are made from a low-noise op-amp, to avoid degrading the weak audio signal by adding a lot of noise to it. The gain in these two stages should be sufficient to drive a small audio amplifier chip such as the LM390, but if it is not, then the value of R13 and R11 should be increased until there is enough gain.

The local oscillator is of a conventional design in which a transistor provides current gain, feeding a signal back into the oscillator tuned circuit at a low impedance tapping point, so as to provide overall power gain. The oscillator signal amplitude is adjusted via RV2 and should be set for best reception.

Tuning

The component values in the tuned circuits are chosen to give a tuning range of approximately 12MHz centred around 11MHz. Different frequency bands can be covered by changing inductor values and, if necessary by using different types of trimming capacitors. Note that the tuning capacitor is of the dual-gang variety.

To adjust the circuit to give good reception of the required frequency range, C13 should first be adjusted so that the oscillator tuning range covers the required band. Then, an aerial should be connected and the receiver should be tuned to find a signal which can be heard. C1 should then be adjusted to peak the received signal. Alignment is now complete and the receiver can be used. If no signal can be heard before C1 has been adjusted, then it may be necessary to tune over the band with several different settings of C1 until a signal can be found. As soon as anything can be heard, C1 can be adjusted with no difficulty.

Readers are reminded that this circuit is intended to work as drawn, but because it has not been prototyped, some experiment may be necessary.

Improvements

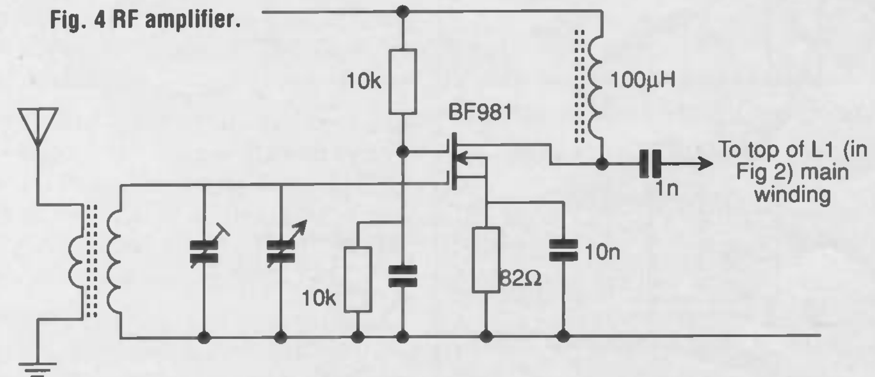
Several lines of improvement are possible for this design. The sensitivity could be improved by the addition of an RF amplifier. If an RF amp were to be added, the choices would be between a triple-ganged tuning capacitor (not easily obtainable), a triple-ganged varicap tuning, which might impair overload performance, or the use of a broad-band filter on the input to select the required range of frequencies.

A more radical improvement to the circuit could be effected by extending the concept to null out the unwanted sideband. The method of doing this is illustrated in Fig. 3: in this design, two mixers are used, fed with local oscillator signals in phase quadrature. The outputs from the mixers are phase-shifted so as to give a relative phase-shift of 90° of one signal relative to the other over the audio band of interest.

The audio frequency range is limited prior to the phase-shifters to limit the frequency range to a range which they can handle. The outputs from the frequency shifters are summed, and this nulls out one sideband or the other. Sideband-switching can be accomplished by swapping audio phase-shifters or exchanging local oscillator outputs.

The first part of the circuitry could comprise the mixer and low-

Fig. 4 RF amplifier.



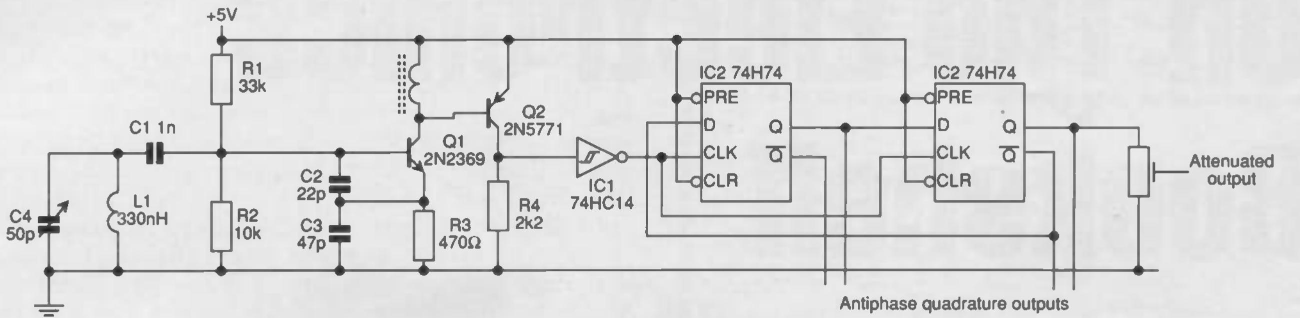


Fig. 5.

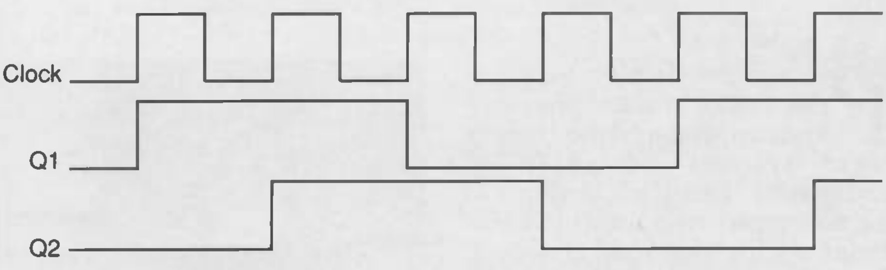


Fig. 6. Quadrature generator waveform diagram.

pass filter shown in Fig. 2 but with an extra RF amplifier added to improve the sensitivity. A circuit for the RF amplifier is now shown (Fig. 4).

One possible means of generating a quadrature local oscillator signal is shown in Fig. 5 and its waveform diagram is shown in Fig. 6. This circuit generates accurate square wave quadrature signals which could be used to drive an FET ring-type mixer. However, buffering might be required and considerable experiment and development might be needed to make a fully-workable circuit. One idea which might prove useful would be to use CMOS analogue switches such as the 4066, if the frequency range is suitable.

To avoid the need to design yet more circuitry, I am assuming here that the FET mixer shown in Fig. 2 will be used, in which case the quadrature outputs may need to be attenuated, as shown in Fig. 5.

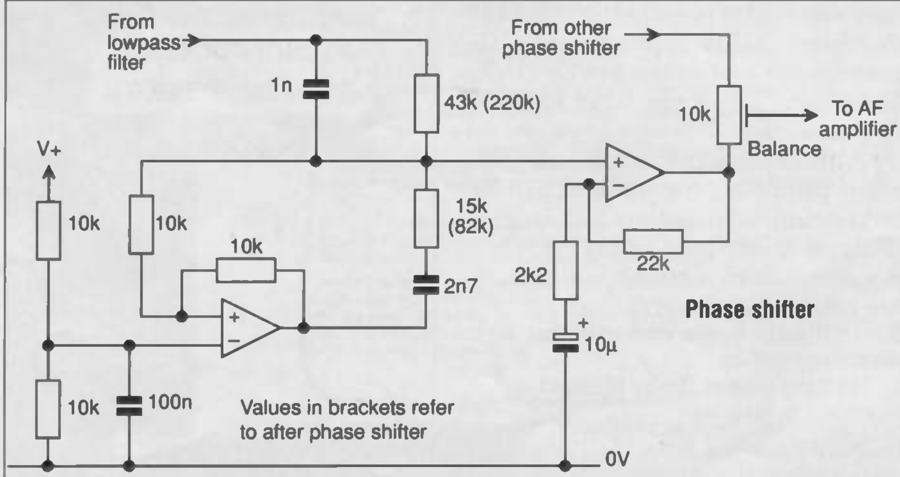
The disadvantage of this type of circuit is that it divides the oscillator frequency by four, so that to receive a signal on 10 MHz a 40 MHz oscillator is required. Therefore, the frequency range over which this type of circuit can be useful is limited to approximately 5 MHz. Above this frequency, a faster logic family such as ECL could be used. An RF phase shift circuit also an option.

The operation of the quadrature is as follows: Q1 and the components around it form a conventional RF oscillator whose output signal is amplified by Q2 to give a sufficient signal level to switch a Schottky inverter. The output from this inverter clocks two D-type flip flops, connected as a twisted ring counter, which gives rise to the waveforms shown in Fig. 6.

Audio Shifter

Fig. 6 shows a circuit which produces an audio phase shift dependent upon frequency. The two ends of the network are driven by anti-phase signals, so that at extremes of frequency the phase shift could approach plus or minus 90°. A second phase-shifter, using the resistor values shown in brackets, is used in the other signal path. These values are chosen so that the frequency at which significant phase-shift starts and finishes is different, and is so arranged that over a middle frequency range there will be 90° difference in the phase-shift produced by each network. The output from each frequency shifter is amplified and then fed to an audio amplifier via a balance control, which must be adjusted to provide the best possible nulling of the unwanted sideband.

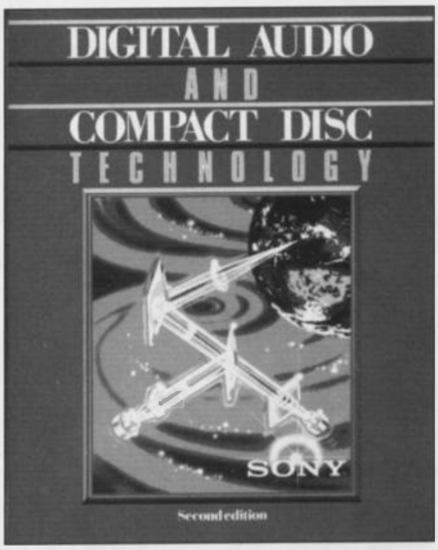
To make this type of design work would require significant further development and experimentation and is only recommended for constructors who have some experience of the type of circuits involved. The circuits shown here are provided mainly for the purposes of interest and to illustrate the technique. Further investigation may suggest that a slightly different approach to one or more of the circuit blocks shown here would be likely to work better.



Phase shifter

On The Electronics Bookshelf

Kenn Garroch opens up some of the latest books on audio technology, microprocessor design and PC interfacing.



If you wanted to know anything about digital audio then this is the book for you. Starting off with a nice short history of audio technology, the authors move on to look at virtually every aspect of modern digital audio systems. No detail is spared and in places the reading gets very technical indeed. However, with a little application it is not incomprehensible and should give rise to a good understanding of modern HiFi equipment from how the music is coded up, stored, decoded and reproduced, to examinations of video-8, CD, DAT, Nicam and all of the other formats in general use.

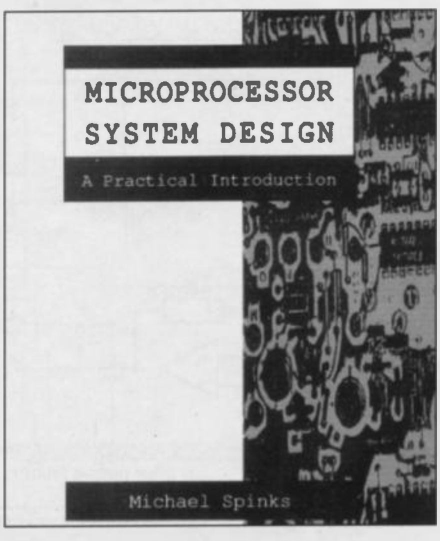
Although there is a bias towards Sony products, the book is full of interesting information and facts – did you know that audio compact discs are silver whereas video discs are gold? neither did I.

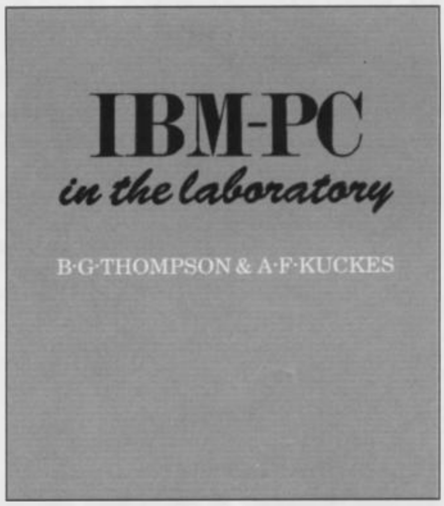
Book: Digital audio and compact disc technology 2nd ed
By The Sony Service Centre (Europe)
Published by Newnes
Price £16.95
ISBN 0-7506-0614-2

Perhaps the simplest aspect of electronics is microprocessor systems design since there is logic systems are easy to understand. This book is aimed at the non-expert who wants to know about microprocessors. However, its style is chatty and the use of HI and LO for 1 and 0 is non-standard and makes truth tables hard to understand.

Contentwise the book is good as it takes the reader from simple logic through to real microprocessor circuits – the in-depth look at the 6809 as an example processor is marred somewhat by not looking at a Z80 as a comparison of a common processor that has some radically different concepts. All of the standard logic circuit ideas and components are described and a good glossary makes up for having to wade through lots of text to get at the real meat of the subject.

Book:Microprocessor System Design
By Michael Spinks
Published by Butterworth Heinemann
Price £19.95
ISBN 0-7506-0279-1





Interfacing to PCs is a subject of interest to a number of people and good books on the subject are scarce. IBM-PC in the laboratory fails to rectify this as it tries to explain how to hook up a computer and perform some simple interfacing experiments. Unfortunately, the book is based on US machines and what little information there is on interface boards simply gives the names of a few US systems, most of which will probably not be available in the UK. All programming is done in TurboPascal – a familiarity with the language is assumed – and although a number of interesting experiments are described, the practicalities of carrying them out are rather sparsely documented.

Of the 246 pages in the book, only the first 127 contain the main text. The rest is filled out with data sheets and instruction set listings, all of which can be obtained more cheaply elsewhere.

Book: IBM-PC in the laboratory
By Thompson and Kuckes
Published by Cambridge University Press
Price £15.95
ISBN 0-521-42867-X

Barry Fox continued from page 54

for PCN, but says clearly that there will be no launch within a year, and more likely two or three.

As the dust settles, a reasonably clear picture emerges.

Cellnet and Vodafone will continue coining profits. Vodafone will try and win new customers by offering a reduced tariff for MCN, with the understood proviso that the reduced tariff buys only the facility to make calls in the London area. Hutchison will find out the hard way whether people prefer finding and using a Rabbit Telepoint, to finding and using a public payphone. Mercury will find out the hard way whether there is a market for a new kind of cellphone, which looks much the same as an existing small cellphone, and delivers much the same service.

As TV manufacturer ITT found out in the 80s, when it launched the Digivision range of TV sets which use all-digital circuitry, the great British public does not give a stuff whether equipment is working with analogue waves or digital pulses. It is whether the equipment works and how much it costs to use, that matters.

Why, you may well ask, is Mercury so anxious to push ahead with PCN, despite the recession, despite the competition, and apparently despite commonsense? The very simple answer comes in two words, Lord Young.

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It would clearly be a major loss of face for Lord Young to cancel Mercury's PCN project. ■

Telepoint Rides Again

The once dead CT2 or Telepoint service is set to be reincarnated as a rabbit.

Although there are still some Telepoint signs up at London tubes stations, all three of the "first generation" of CT2 or second generation cordless phone services (British Telecom's Phonepoint, Mercury's Callpoint and Ferranti's Zonephone) have failed. Failure was absolutely predictable and inevitable. We can only boggle at the incompetence of the three supposedly businesslike businesses that wasted tens of millions of pounds on attracting a few hundred customers.

I felt quite embarrassed about this spectacular disaster. In the mid eighties, when the CT2 idea was first floating, I wrote what a wonderful idea it was. Instead of buying an analogue cordless phone and base station for home use, we would pay a bit extra and buy a digital CT2 system. Later, if we wished, we could subscribe to a Telepoint service which let home handsets make calls from public base stations.

Because the DTI granted four licences with no requirement for compatibility, because the licencees built incompatible systems and because they launched expensive handsets ahead of home base stations, CT2 quickly became a joke.

The BYPS consortium, of Barclays Bank, Philips and Shell was licensed to be the fourth rival operator. But BYPS decided to hold back on a service launch until able to meet the new European standard, the Common Air Interface. In the meantime Hong Kong-based telecommunications giant, Hutchison Whampoa, had set up a UK subsidiary, Hutchison Telecommunications, and bought out BYPS.

Encouraged by the success of CAI or "second generation" CDT in the Far East, particularly Singapore and Hong Kong, Hutchison is now taking the plunge in the UK. It launches its Rabbit CT2 system in Manchester on 21 May, moving to Yorkshire from 29 June, with roll-out planned for the rest of the country by the end of October.

So will Hutchison and Rabbit have better luck than BT, Mercury and Ferranti had with Phonepoint, Callpoint and Zonephone?

Clearly Hutchison starts with the advantage of being the only player in the game. Hardware prices are more sensible too, kicking off at £190 for a handset and £240 for a package of handset and home base station. Rabbit subscribers will pay a one-off network connection charge of £15 and then a network access charge of £6 a month. This is well below cellular rates, of £50 or £60 for a one-off connection and £25 or £30 a month access charge. But of course Rabbit CT2 phones can only make outgoing calls from public base stations, they cannot receive incoming calls.

It looks as if everything will come down to call charges. Hutchison has set the Rabbit tariff at 20p per minute for peak rates (between 8am and 8pm) and 10p per minute at other times. (Calls made from home base station are of course at standard domestic rates).

Does this really mean that someone with a Rabbit CT2 phone can make calls to any number in the UK for 10p or 20p a minute if they find a Rabbit Telepoint? If so the system is undercutting BT's domestic charges and has a good chance of success. But can Hutchison really afford to run the service at a loss? We shall see.

We shall also see what happens over PCN, the Personal Communications Network system which is also due soon to start service. PCN will be in competition with CT2, with the existing analogue cellular phone systems Cellnet and Vodafone, with the new all-digital pan-European GSM systems (to be run in the UK by Cellnet and Vodafone), with the all-digital Micro Cellular Network which uses GSM technology (to be offered within the Vodafone network by Racal) and with the cellular satellite phone systems promised by Motorola (Iridium) and international maritime satellite organisation Inmarsat.

It is clear that the three consortia licensed by the DTI to operate PCN services have looked at the recessed economy, looked at the failure of the three telepoint services, recognised that Cellnet and Vodafone can easily afford to cut costs if they need to compete with PCN, and taken stock. British Aerospace was first to crack, selling its licence to run the Microtel PCN service, to Hutchison. Last year the two remaining competitors, Mercury Personal Communications and Unitel (now owned by US West) agreed to share a network. Now Mercury and Unitel have merged.

The merged network, to be called Mercury Personal Communications, has also drastically cut back on its launch plans. Instead of building a nationwide PCN network, costing around £1 billion, MPC will now spend a couple of hundred million pounds on building a network within the M25 London ring. The merger with Unitel halves the real cost to each company.

Of course this makes a complete nonsense of the original licence scheme which was intended to generate competition. MPC will now have to hand back one of the two sets of frequencies it now owns. Hutchison is cagey about its plans

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