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ELECTRONICS

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No. 93
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The technological details concerning our 'Tunnel Link' with Europe

Don't throw away your old batteries – find out how they can be 'recycled'

Build the Mains Power Switch to provide safe switching of mains appliances

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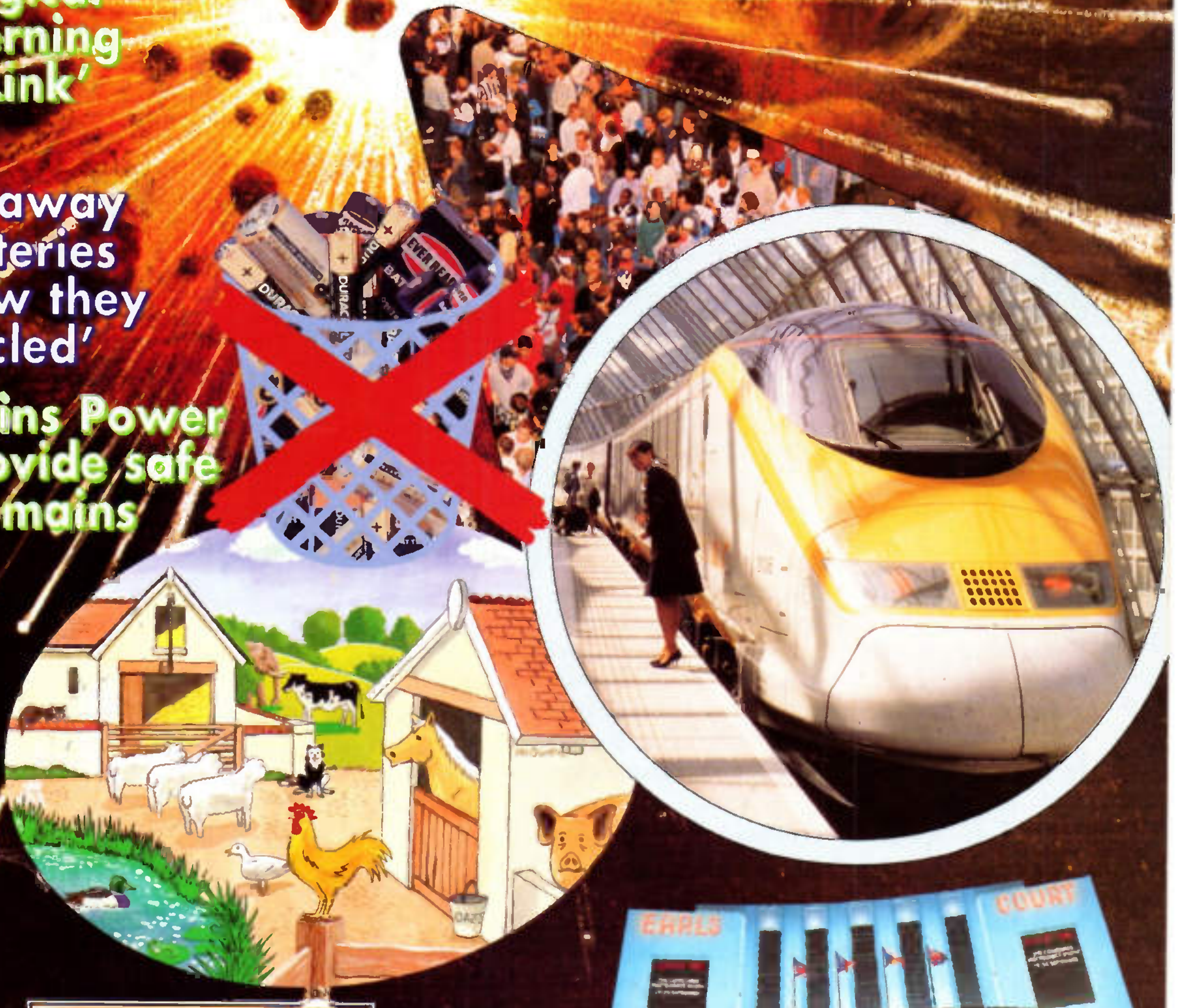

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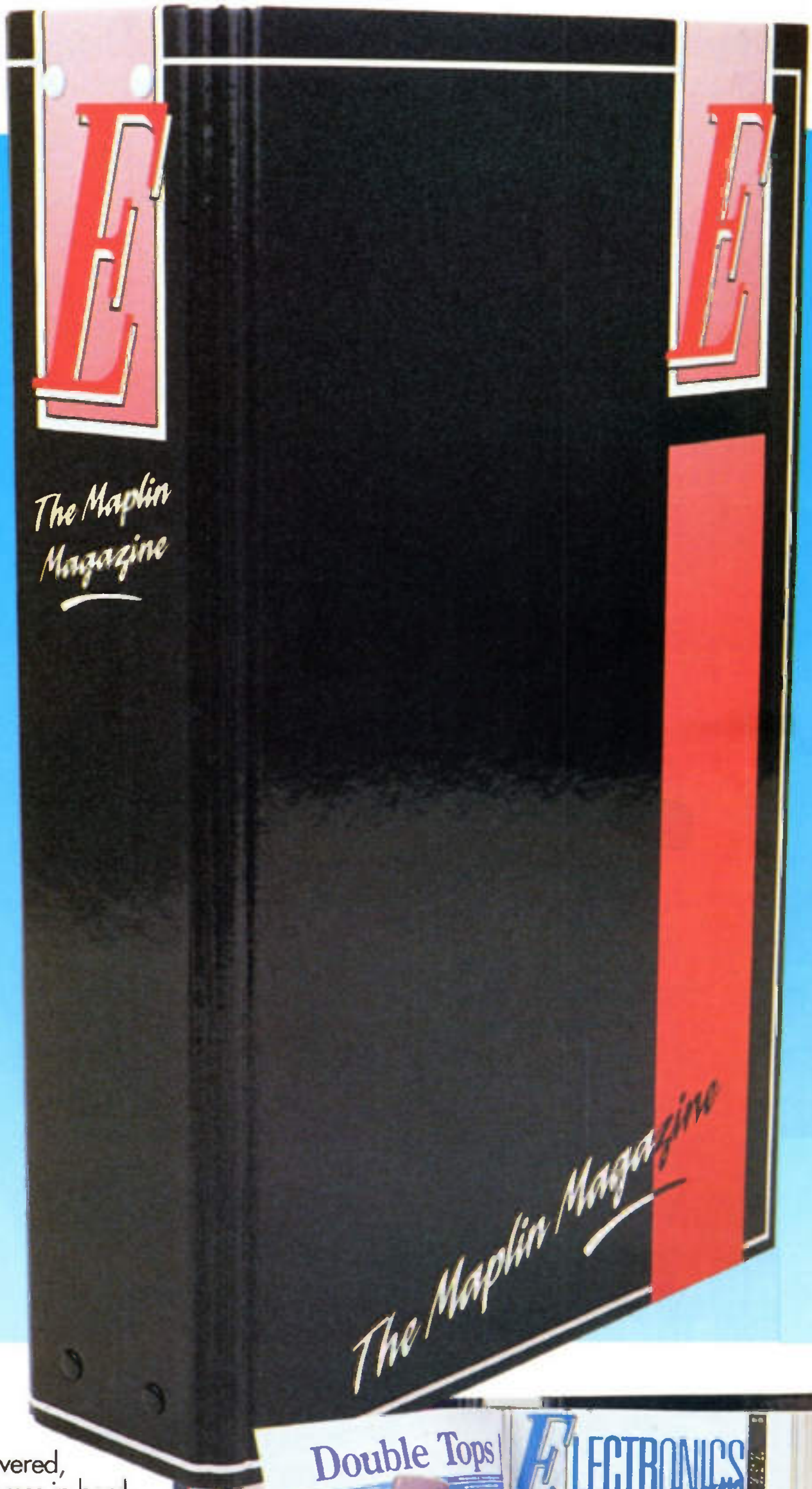
See page 38 for details

Twelve great reasons to get Electronics under cover...



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SEPTEMBER 1995
VOL 14. No. 93

IN THIS ISSUE...

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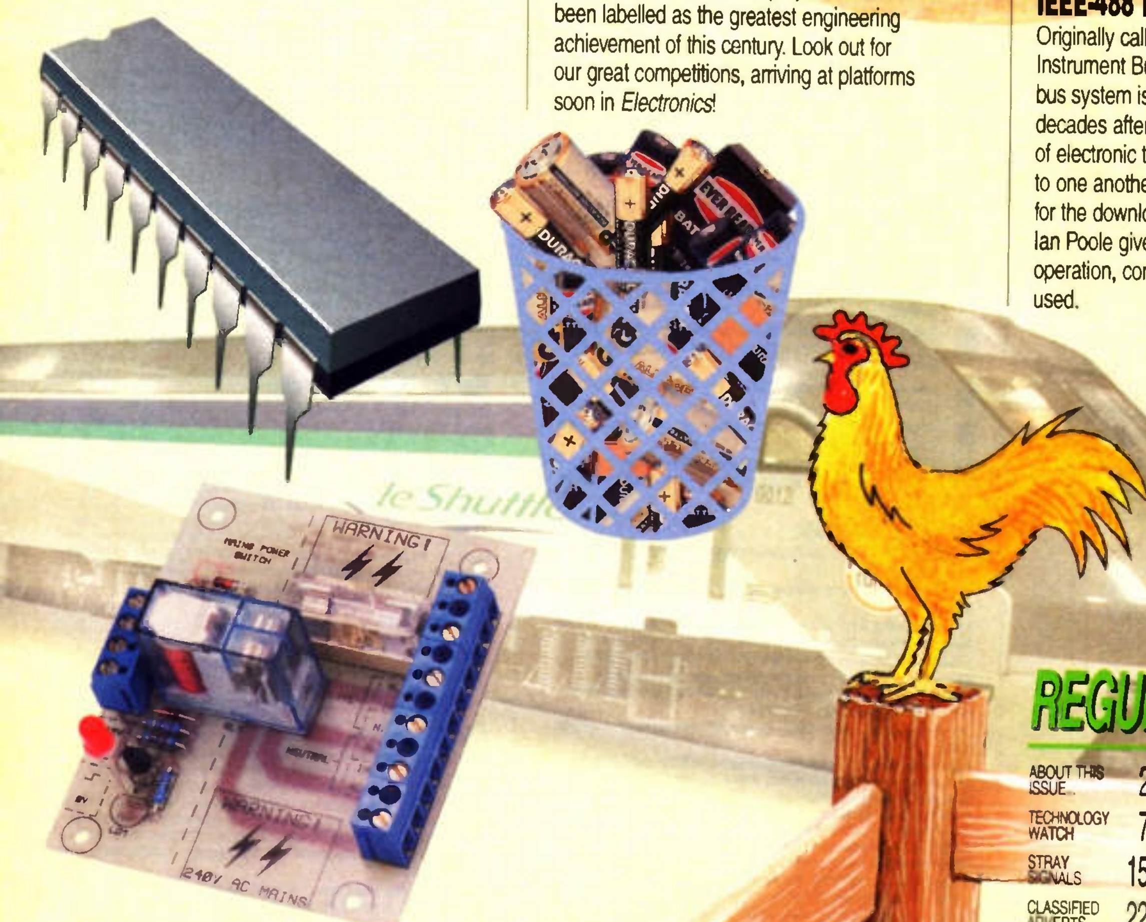
FEATURES ESSENTIAL READING!



REGULARS NOT TO BE MISSED!

ABOUT THIS ISSUE . . .

Hello and welcome to this month's issue of *Electronics!* As usual there's a fine collection of projects and features for you to enjoy, and I'm sure that you will agree.

Cable Ties

The pipework for a new cable network has now been installed in my area, and I am now waiting for it to be connected. Personally, I am very interested in the new service, as I want to see how it performs, as opposed to my normal terrestrial/satellite TV and telephone line, but mainly I want to see the cost difference. If at the end of the day, the running costs do not work out any cheaper for television programmes and telephone calls, then it will have to offer some other incentive? Let's hope it's a nice cheap Internet access . . .

CD-ROMs

Recently I have been most impressed by a CD-ROM that I bought, that operates on both PCs and AppleMacs. I think this is the way to go for multimedia. I find reading text off the computer screen from a CD-ROM tiring, it's not like reading a book or magazine at all, but with extra sound and graphics it can enhance the original source material. As an added bonus to the sound card installed in my PC, it can read out TXT files. Another facility I have been trying out, is to teach the computer to recognise my voice commands, but I think that it has some way to go.

LIVE '95 – THE CONSUMER ELECTRONICS SHOW

This is Britain's most exciting consumer electronics event; don't forget that Maplin Electronics will be there, so visit our stand, and have a good look round. As last year we will be having a competition beforehand, so that twelve lucky *Electronics* readers need not pay a penny for admission, and can bring a friend along for free as well! See page 26 about this, and other competitions coming your way.

Apologies

We would like to apologise to those of you waiting for the PC Teletex Decoder projects; due to unforseen circumstances, we have had to postpone these until a later date.

Get Well Soon

Since receiving the copy for PC's latest article, we have learned that he is in hospital, so from all of us at *Electronics* we wish him a speedy recovery.

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

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Project Ratings

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

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

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

Visit your local Maplin store, where you will find a wide range of electronic products.

If you do not know where your nearest store is, Tel. (01702) 552911. To avoid disappointment when intending to purchase products from a Maplin store, customers are advised to check availability before travelling any distance.

Write your order on the form printed in this issue and send it to Maplin Electronics, P.O. Box 3, Rayleigh, Essex, SS6 8LR. Payment can be made using Cheque, Postal Order, or Credit Card.

Telephone your order, call the Maplin Electronics Credit Card Hotline on (01702) 554161.

If you have a personal computer equipped with a MODEM, dial up Maplin's 24-hour on-line database and ordering service, CashTel. CashTel supports 300-, 1200- and 2400-baud MODEMs using CCITT tones. The format is 8 data bits, 1 stop bit, no parity, full duplex with Xon/Xoff handshaking. All existing customers with a Maplin customer number can access the system by simply dialling (01702) 552941. If you do not have a customer number Tel. (01702) 552911 and we will happily issue you with one. Payment can be made by credit card.

If you have a tone dial (DTMF) telephone or a pocket tone dialler, you can access our computer system and place orders directly onto the Maplin computer 24 hours a day by simply dialling (01702) 556751. You will need a Maplin customer number and a personal identification number (PIN) to access the system. If you do not have a customer number or a PIN number Tel. (01702) 552911 and we will happily issue you with one.

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Full details of all of the methods of ordering from Maplin can be found in the current Maplin Catalogue.

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Prices

Prices of products and services available from Maplin, shown in this issue, include VAT at 17.5% (except items marked NV which are rated at 0%) and are valid between 4th and 31st August 1995 errors and omissions excluded. Prices shown do not include mail order postage and handling charges, which are levied at the current rates indicated on the Order Coupon in this issue.

Technical Enquiries

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

'Get You Working' Service

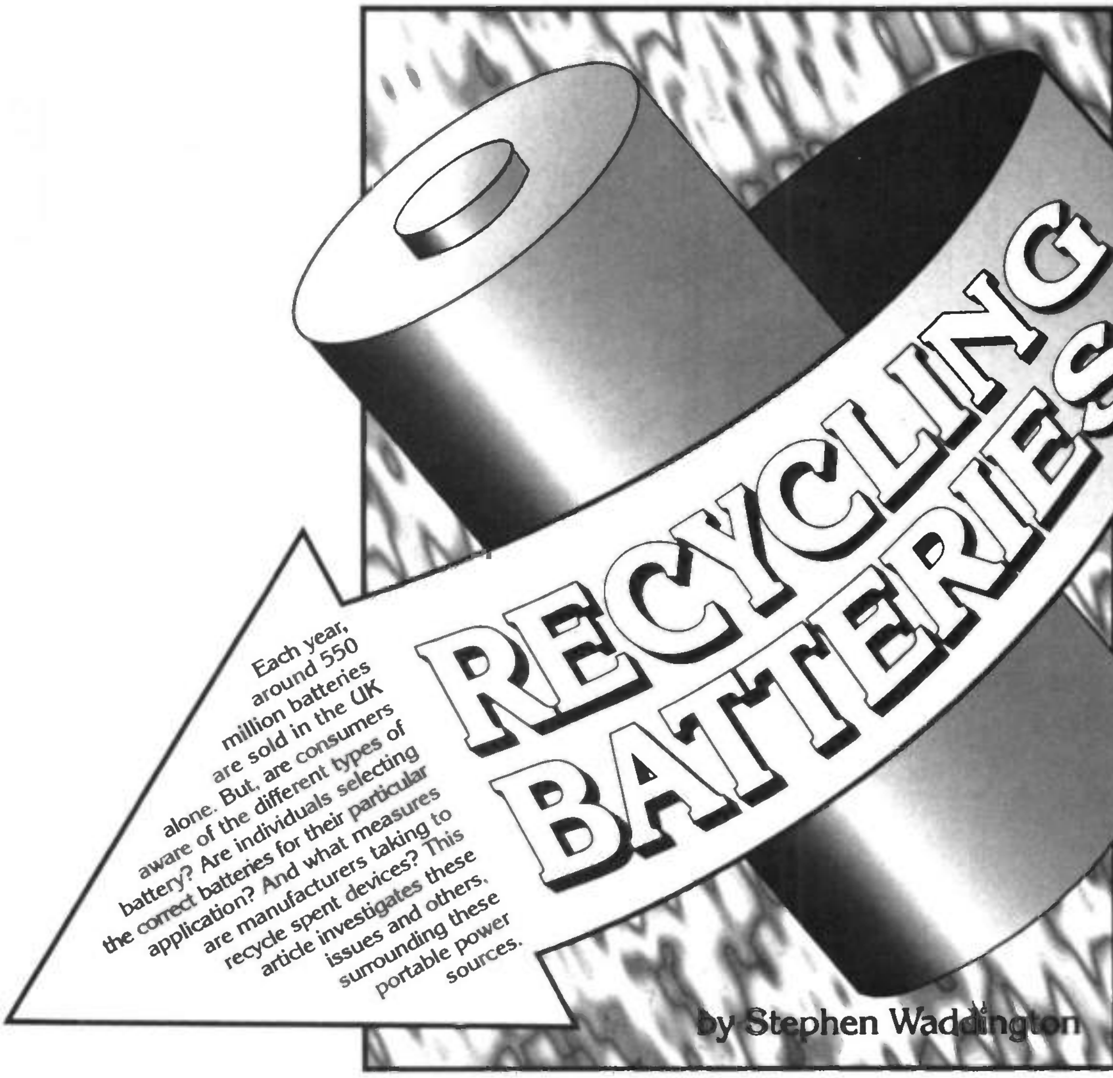
If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin Get You Working Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with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

Kit Retail Price	Standard Servicing Cost
up to £24.99	£17.00
£25.00 to £39.99	£24.00
£40.00 to £59.99	£30.00
£60.00 to £79.99	£40.00
£80.00 to £99.99	£50.00
£100.00 to £149.99	£60.00
Over £150.00	£60.00 minimum

Readers Letters

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

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



AA, SP7, HP7, R6-SP, R6 and UM-3, all describe the same battery type (size). Here lies a fundamental problem, despite IEC standards, there is no single scheme for describing the size of batteries. In an attempt to carve through this disarray, Figure 1 shows the five basic sizes, while Table 1 provides individual manufacturers' reference codes.

Good Chemistry

Household batteries do not just come in different shapes and sizes, but also a variety of chemical constructions. Amid all the marketing hype and consumer advertising, there are only four main types. Here, we look at the chemical construction of each type alongside its performance, typical applications and price.

Zinc Carbon

Chemical Content

The most common household battery. May contain very small amounts of cadmium.

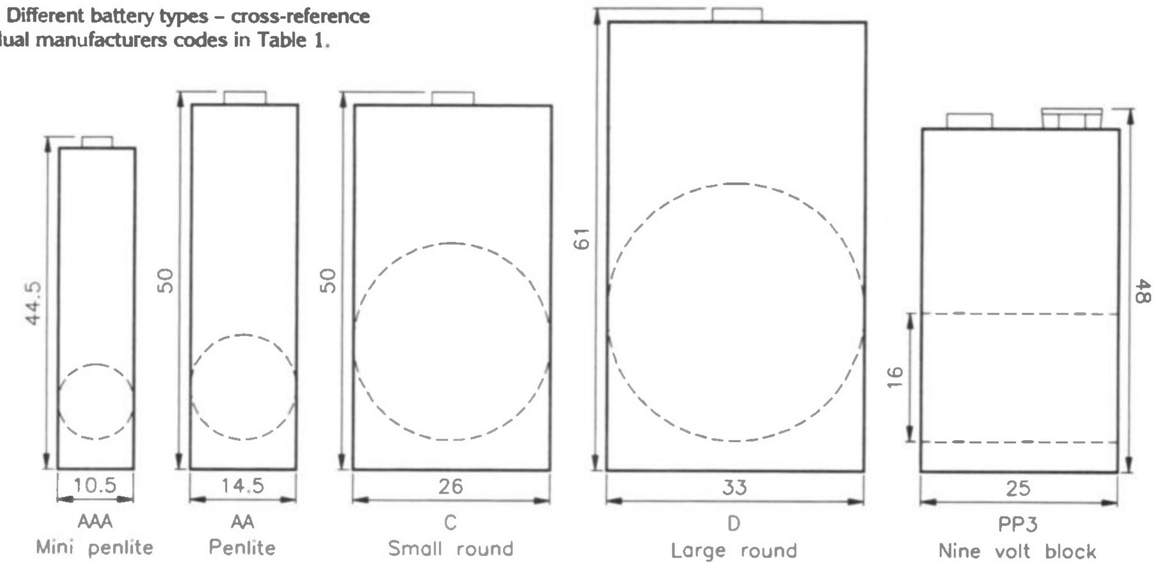
Performance

Best suited to products which have low to medium current demands, and which are not used for extensive periods. Zinc carbons can recover some of their capacity if allowed to rest between fairly light periods of use. This is because the reaction between the chemicals within the battery is tempered, and is consequently less harsh than would otherwise be for continuous applications. Do not leave zinc carbons in products once they have been exhausted, since they are prone to leak.

Battery Type	Make	Battery Size/Case Style				
		AAA (Mini-penlite)	AA (Penlite)	C (Small round)	D (Large round)	PP3 (9V Block)
Zinc Carbon	Ever Ready	SP16/HP16	SP7/HP7	SP11/HP11	SP2/HP2	PP3
	GP	R03	R6	R14	R20	6F22
	Panasonic	R03/UM-4	R6/UM-3	R14/UM-2	R20/UM-1	6F22E
	Philips	–	R6S	R14S	R20S	6F22S
	Varta	–	2006/HP7	2014/HP11	2020/HP20	2022/PP3
	Vidor	–	R6-SP	R14-SP	R20-SP	PP3-SP
Zinc Chloride	Ever Ready	R03S/HP16	R6S/HP7	R14/HP11	R20S/HP2	6F22S/PP3
	GP	R03	R6	R14	R20	6F22
	Panasonic	R03G	R6G	R14G	RF22G	6F22G
	Philips	R03P	R6P	R14P	5F22P	6F22P
	Varta	3003/HP16	3006/HP7	3014/HP11	3003/HP16	3022/PP3
	Vidor	R03-HP	R6-HP	R14-HP	RO13-HP	PP3-HP
Alkaline	Duracell	MN2400	MN1500	MN1400	MN1300	MN1604
	Ever Ready	LR03	LR6	LR14	LR20	6LF22
	GP	R03	R6	R14	R20	6F22
	Kodak	KAAA/	KAA/	KC/	KD/	K9V/
		MN2400	MN1500	MN1400	MN1300	MN1604
	Panasonic	LR03/AM4	LR6/AM3	LR14/AM2	L20/AM1	6LR61/ 6AM6
	Philips	LR03	LR6	LR14	LR20	6LR61
	Varta	4003	4006	4014	4020	4022
	Vidor	MN2400	MN1500	MN1400	MN1300	MN1604
Nickel-Cadmium (Rechargeable)	Ever Ready	RX03	RX6	RX14	RX20	RX22
	Memorex	R03	R6	R14	R20	R22
	Panasonic	P-4R	P-3R	P-2R	P-1R	P-9R
	Philips	R03 NC	R6 NC	R14 NC	R20 NC	7R22 NC
	Varta	5003	5006	5014	5020	5022

Table 1. Battery cross-reference chart – see Figure 1.

Figure 1. Different battery types – cross-reference to individual manufacturers codes in Table 1.



Applications

Typical uses include radios, cycle lamps, torches, shavers, clocks and TV remote control units.

Typical Cost

AAA (Pack of four): £1.48
AA (Pack of four): £1.18
C (Pack of two): £1.23
D (Pack of two) £1.23
PP3 (Single) £1.33

Zinc Chloride

Chemical Content

These are a modern, but more expensive version of zinc carbon batteries. Unlike their zinc carbon counterparts, zinc chloride batteries will not leak, since they are based on a dry powder construction.

Performance

While zinc chlorides represent a step up the performance ladder based on chemical content, this is not always the case in reality. According to a recent survey by the Australian Consumers' Association, performance varies from manufacturer to manufacturer, and at this level, it is probably better to shop on price rather than performance claims.

Applications

Zinc chloride batteries are suited to the same applications as zinc carbons.

Typical Cost

AAA (Pack of four): £1.65
AA (Pack of four): £1.54
C (Pack of two): £1.49
D (Pack of two): £1.49
PP3 (Single): £1.86

Alkaline Manganese

Chemical Content

The most expensive of the widely available disposable battery types, matched with highest capacity. While the majority of manufacturers have removed both mercury and cadmium from zinc carbon and chloride batteries, few have removed cadmium totally from alkaline batteries.

Performance

These batteries offer a far superior performance in most applications. But remember, when manufacturers claim that their alkaline batteries 'last up to six times longer' or 'do 50% more beats more per battery', they are comparing them to zinc carbon batteries.

Applications

Alkaline batteries are best for products which are used for extended periods, or which have high current demands. Also recommended for anything for which you want the longest possible life, whether used or not. Typical uses include personal stereos, camera flash guns and portable Hi-Fi equipment.

Typical Cost

AAA (Single): £0.79
AA (Single): £0.78
C (Single): £1.25
D (Single): £1.70
PP3 (Single): £2.95

Nickel-Cadmium (Ni-Cd) – Rechargeable

Chemical Content

Contain 7 to 15% of the toxic chemical, Cadmium – 70,000 to 150,000 parts per million.

Performance

Rechargeable batteries do not hold their charge well, and will have to be recharged several times during the normal life of an equivalent alkaline battery, so do not put them in products that are in frequent use, and/or ones that consume very little power, e.g., clocks.

Applications

Superior and environmentally-friendly choice for things like personal stereos, shavers, motorised toys and audio equipment.

Typical Cost

Typically, twice the price of their alkaline equivalents, without the cost of a charger. That said for products which have medium to high current demands, and are used regularly, they do work out cheaper. For example, using two rechargeable batteries and a charger, assuming the batteries last for 400 charges, the cost of running a personal stereo would work out to be 1p per hour, compared to alkaline batteries which would cost 6p an hour. View these figures with caution, we have not made any allowance for differing charge capability, opting to normalize on an 85mA device.

AAA (Single): £3.18
AA (Single): £3.06
C (Single): £4.11
D (Single): £4.63
PP3 (Single): £4.92

Other Batteries

Apart from the four types of batteries outlined above, there are a couple of others within the grasp of the consumer, that should be considered from both a price/performance and an environmental point of view. Both mercury button cells and lithium batteries have specific uses in applications where size is the primary concern.

Button cells require materials of the highest energy density, because they are so small. Mercury oxide and silver oxide are preferred materials, although silver oxide is more expensive and has a shorter shelf-life, so the more toxic mercury oxide has tended to win out.

Lithium batteries offer greatest performance where a high power density is required. Lithium offers higher voltages in small batteries, without the need for materials such as mercury and silver. Kodak claim that its lithium batteries last up to ten times longer than normal zinc carbon batteries, and twice as long as current, high-performance alkaline batteries. Prices are typically two to three times more expensive than the latter.

Price

Our typical cost figures have been produced by taking the average recommended retail price from six different manufacturers. Please note that these were only accurate at the time of going to press, and make no allowance for promotional offers or regional price variations.

A survey undertaken by the UK Consumers' Association in 1990, found that price variations were sufficient to make finding a cheap stockist worthwhile. Despite the dated nature of the Consumers' Association research, our findings almost five years later confirm this position. Best value for money is found at large retail outlets, such as Maplin. This is because organisations such as Maplin purchase large quantities direct from the manufacturer, and can thus afford to pass discounts on to the customer.

Close on their heels, are own-name brand batteries, but these will often be at a compromise of charge capability. It is also worth looking out for promotional offers. Duracell recently ran a scheme, whereby if you sent them the battery packaging, together with proof of purchase, you received a pound by return.

Almost all batteries now carry a date stamp, which should always be checked. Fresh batteries have a far greater capacity than older ones. Apply the same rules of logic that you would to consumable products. You would not buy a loaf of bread that was out of date, so apply similar logic to batteries.

Life-Cycle Study

Before a battery ever leaves a factory, it has already used up to 50 times the power in its manufacture than it will ever be able to provide the consumer as shown in Figure 2. Add to this, the environmental cost of disposal. In the UK, the majority of batteries are disposed of in to landfill sites.

But, the environmental impact of disposal is not as harsh as it once was. In 1985, because of environmental concerns over the raw disposal of batteries, the European Primary Battery Industry represented by EUROPILE, were committed to reducing the mercury content of batteries as far as technology would allow. Together with environmental protection groups, EUROPILE was concerned about the leakage of mercury into water systems as a consequence of batteries being dumped into landfill sites.

EUROPILE far exceeded its aims, and by January 1994, all zinc carbon, zinc chloride and alkaline batteries were mercury free. Since 1994, the use of mercury has been restricted to mercury oxide button batteries used for applications such as hearing aids, calculators and photographic equipment. These devices are now collected by distributors, for return to battery manufacturers for recycling.

Recycling Technology

Wholesale recycling for all battery groups is costly, and unless new technologies are discovered, will never be profitable. Projected estimates show that the use of dedicated recycling technology throughout Europe would require 45 plants, necessitating a capital investment of approximately US$700 million. In turn, these plants would consume four to nine times the energy required to produce the same material through the metal industry, with operating costs in excess of US$600 million per annum. And this is without considering the cost of collection and sorting of batteries into different types.

The European Community has issued a directive (91/157 EEC) which calls for the establishment of separate collection schemes for mercury button cells, Ni-Cd and industrial lead acid batteries, as well as their gradual reduction into the waste stream. There is little point in the collection and recycling of general-purpose batteries, since they are already mercury-free and, as yet, no economic recycling techniques exist.

Nickel-Cadmium (Ni-Cd) Recycling

To date, the greatest amount of activity has focused upon rechargeable Ni-Cd devices. In response to the EU directive, a UK industry working group has been established, led by the International Cadmium Association, called The UK Ni-Cd Battery Recycling Group. The Group, comprising battery manufacturers, appliance manufacturers and recyclers, such as Motorola, NEC, Hitachi, Black & Decker, Uniross and Varta, is committed to devising a collection strategy for used Ni-Cd devices. Schemes in operation to date, tend to be based on industrial Ni-Cd batteries of the sort used in power tools or mobile telephones, but the Group is developing models for the collection of consumer devices.

Collection and Sorting

Collection and sorting schemes are a primary concern. Roadside newspaper or glass collection schemes offer the potential to be extended to include batteries, along with other consumer waste, such as tin cans and plastic bottles. But, the cost of separation schemes to remove Ni-Cd devices from zinc carbon, zinc chloride or alkaline manganese devices, would render the whole process uneconomic. One possibility, is to mark each battery type with a distinguishing label or tag, easing the collection and sorting process. But again, this will need an initiative from manufacturers, and standardisation on a particular system.

Schemes in operation today, are based around a reverse engineering principle. Here, batteries are returned to their place of purchase, for return via the distribution chain and eventual reprocessing by the manufacturer. This enables the recycling agent or manufacturer to be confident that it only receives spent Ni-Cd devices, often adding incentive schemes to make it in the consumer's interest to return the spent device.

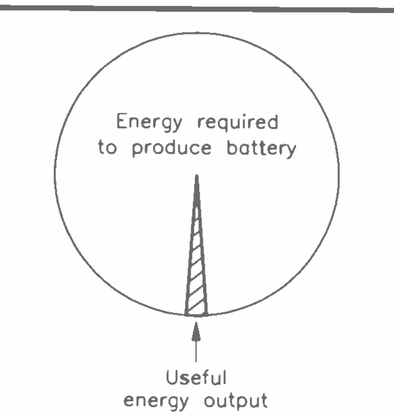
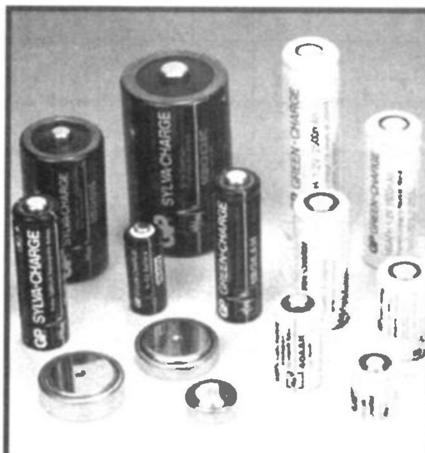


Figure 2. It takes 50 times more energy to produce a battery, than it will ever be able to produce.



A selection of Ni-Cad batteries.

For example, Makita, a manufacturer and supplier of cordless power tools, has placed recycling bins in each of its distribution outlets, the largest being the B&Q DIY chain. The company offers five pounds against the purchase of any of its product range, in exchange for spent devices.

Ni-Cd batteries are relatively easily recycled, through either pyrometallurgical or hydrometallurgical recovery processes. These processes result in almost 100% recovery of pure cadmium metal, which can then be reused in new Ni-Cd batteries, or other products. Nickel is usually recovered as a ferro-nickel material, for use in the steel industry.

Profitability

There are currently six pyrometallurgical plants in the world, and four hydrometallurgical. Together, these ten plants have a combined capacity of 25,000 metric tonnes of nickel-cadmium batteries per year, of which an estimated 10,000 metric tonnes is presently utilised.

The cadmium metal and ferro-nickel material generated through recycling are both marketable products. But, as with recycling technologies for other types of batteries, when nickel or cadmium prices are at low levels, these raw metals will not generate sufficient revenue to recover recycling costs. That said, refinement of the collection process and greater use of recycling plants, will enable recyclers to become increasingly profitable.

Look for the Green Label

With environmental concerns hot on the shopping list of the green consumer, battery manufacturers are keen to label their products with an eco-friendly tag, as shown in Figure 3. Consequently, there has been an extraordinary profusion of different labels, matching the determination of companies to capture a market share from the green consumer.

The variety of labelling is confusing, and has little value to the consumer left to analyse one manufacturer's claims against another. The root of the problem is that there is no standard method of comparison. There is not much point in buying a mercury and cadmium-free battery with a green tag, that gives half the charge of an alternative device. The end result is far from environmentally-friendly, if you have to use two batteries, implying twice the cost, and of course twice the chemicals, albeit non-toxic ones.

Consumers need a European Community (EU) Green Label scheme, to ensure quality control in this area. Alternatively, the UK should take the lead, and implement a Government-backed strategy. Lack of international standardisation is a major problem for the industry.

The vetting of batteries should be carried out by a independent panel, supported by technical assessors, with the standards effected by EU or UK government agencies. As the flood of new products grows, so the need for quality assurance will increase.

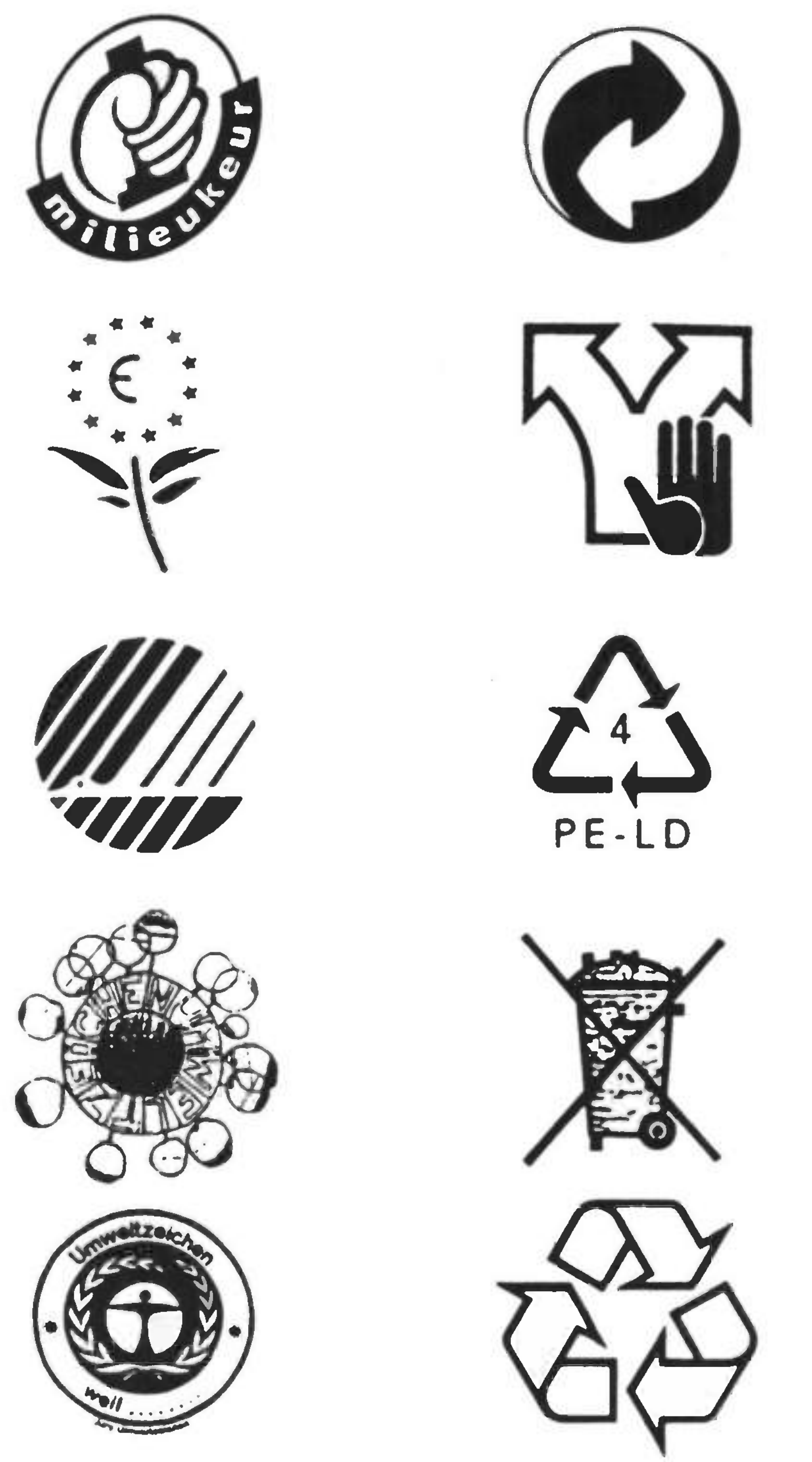


Figure 3. Examples of European Community environmentally-friendly logos.

Does it Really Matter?

Environmental concerns and price performance issues aside, does it really matter which batteries a consumer selects? Market research by Philips, indicates that batteries rarely appear on a shopping list. Indeed, no other product seems so sensitive to impulse buying. Choice is often made on the grounds of the position of the battery stand in a store, rather than the conscious decision to select a particular brand. Whether this is correct or not, is down to an individual's conscience.

Readers must set their own requirements for a particular application against environmental concerns and the economic viability of products offered from an array of manufacturers. While batteries may not be the number one environmental problem, they are an environmental concern, especially in an annual UK market of £425 million.

Battery Buying Issues

- Use mains power where possible. Remember that manufacturing batteries can take up to 50 times more energy than they produce.
- Switch to rechargeable in power-hungry products that use a lot of batteries. Frequent recharging is less expensive than even occasionally replacing alkaline batteries.
- Buy green batteries. Look for batteries that are mercury- and cadmium-free.
- Never mix old batteries with new. The new batteries try to recharge the old, cutting their useful life.
- Avoid throwing batteries away outdoors – put them in the dustbin.
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Contacts

Consumers' Association, 2 Marylebone Road, London NW1 4DF. Tel: (0171) 830 6000.

British Battery Manufacturers Association, Cowley House, 9 Little College Street, London SW1P 3XS. Tel: (0171) 233 0335.

The Ni-Cd Battery Recycling Group, International Cadmium Association, 42 Weymouth Street, London W1N 3LQ. Tel: (0171) 499 8425.

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MAPLIN STORES NATIONWIDE

TECHNOLOGY WATCH!

with Keith Brindley

Multimedia, of course, is the in word at the moment in technology. It used to be *digital* when I was a lad. I remember the days when transistors ran hotter than most soldering irons, when integrated circuits were considered by many as just another flash in the pan, and when Stanley Matthews ran down the wing faster than an MG Midget on aircraft fuel.

But times move on, and no-one in their self-respecting minds would consider buying a computer these days unless it was capable of playing audio CDs, Doom, hooking up to a television aerial to watch the Test Match in-between bouts of work, and editing your holiday video recordings before creating a QuickTime movie clip of them to send to your mum and dad back home over the Internet.

All this progress is brought about by standards. Without them technology would be no more use than an umbrella in a gale, simply because the cost of development of any one feature would be too much for one manufacturer and one user to pocket. With standards, on the other hand, everyone is working vaguely it seems at times, towards one goal – to keep the cost to the customer as low as possible to encourage the customer to buy. But (like acceleration is the derivative of velocity) one of the things that technology itself brings is a *convergence* of the standards of technology. In European Community terms, standards are *harmonised* into common derivatives. Computer hardware and software are no exceptions.

Traditionally, there have been several camps in the computing field. The PC, the Apple Macintosh, and dedicated workstations of a few varieties. Over the last few years there has been jocular rivalry between them all. No-one will actually admit that their computer platform is any worse than any other. However, this situation is about to change and, to take the metaphor even further, they are all about to come under one marquee (which some might even call a *big top*?).

For example, I am already accustomed to being able to run *your* PC software on *my* Mac (I have been doing that for a year or so now) but what I am really looking forward to is you being able to run *my* Mac software on *your* PC. As odd as this might sound to you PC xenophobes it *will* happen, and it is not going to be that long. Once the PC sees an upgrade in performance and ability to a new hardware standard on the horizon, it will be able to run all sorts of operating system software.

Next year the common hardware reference platform (CHRP) will see the light of day. This is a new standard being developed by several manufacturers including (as you might expect) Apple, IBM and Motorola, which will be driven by PowerPC integrated circuits, and will be capable of running just about any operating system there is. Unix, WindowsNT, the MacOS, and so on.

The new common hardware reference platform will achieve for the very first time, a computer platform that is truly universal. So whatever application you want to run, you can. If it runs only on Windows then launch your computer with Windows running, and if it runs only on the MacOS, *use* the MacOS.

More to the point, however, everybody now has the chance to use the operating system of their choice whatever their computer. Most applications, after all (with one or two notable exceptions), are available for all the major computer platforms. So no longer do you need to buy a computer from a particular manufacturer to run an operating system (such as Mac users have had to do for over ten years), and no longer do you have to use a particular operating system to use a program – as most PC users have had to do for over ten years. The common hardware reference platform will stop all that and, due to convergence of standards, allow everyone to choose the *environment* of their choice.

This poses an interesting couple of questions. First, will anybody (apart from a few people in specialist areas) actually use their computers to run more than one operating system? Indeed, will most users know the difference? Once there is a common hardware standard, along with a common software standard, the difference is largely irrelevant, and comes down to a very *personal* choice.

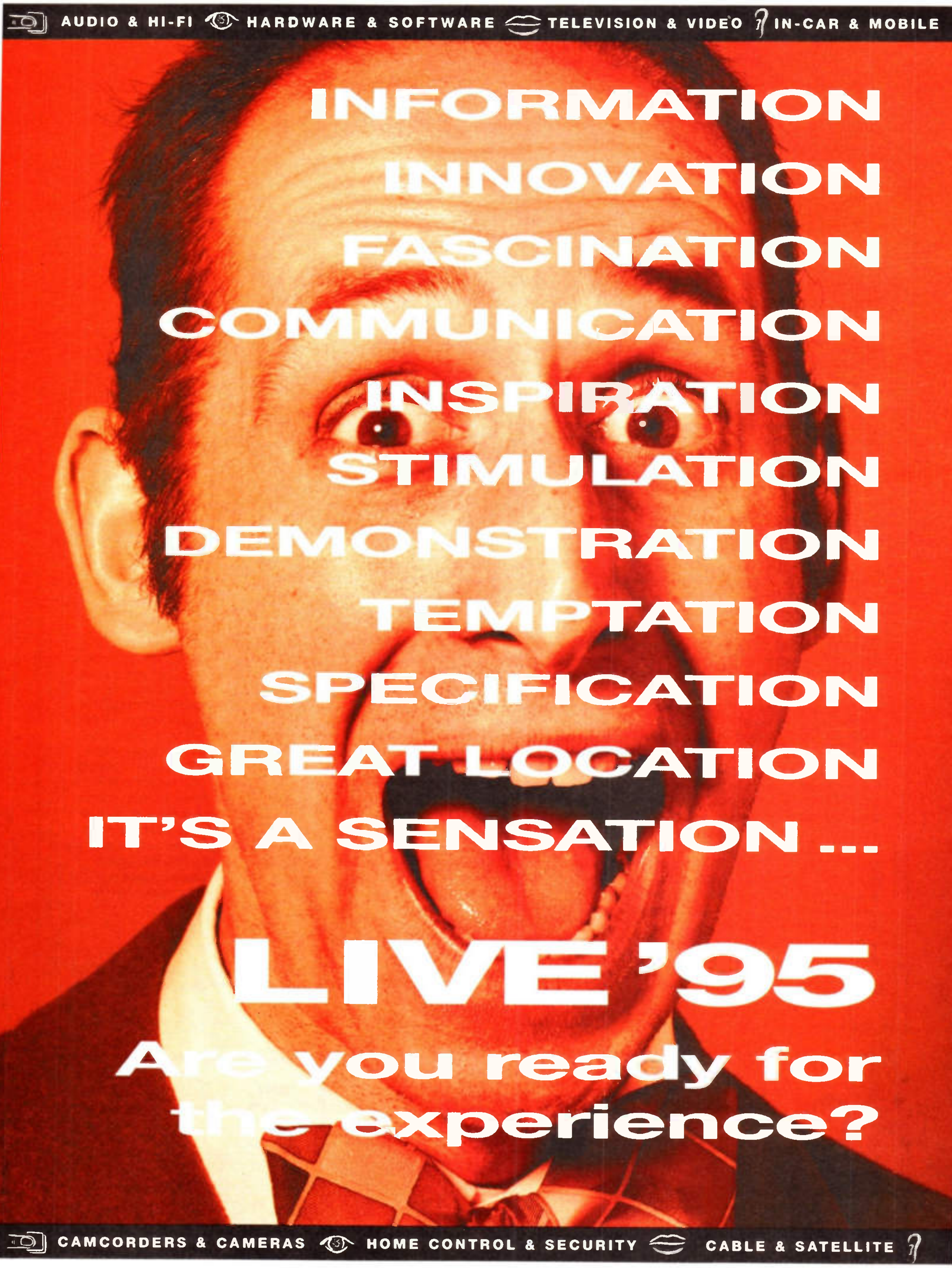
I've Lost My Memory

Interestingly, one of the factors that define computer performance (and which will *even* more so in the coming years) is the amount of random access memory (RAM) machines possess. Pure computational speed is only one side of a computer's power. If your PC's slogging data back and forth to your hard drive using virtual memory processes, then, however fast the data bus is, the disk drive itself is going to limit severely the computing ability.

RAM is the only answer, but computers are becoming more and more memory hungry. A couple of years ago 2M-bytes of RAM was considered plenty. Now 16M-bytes is OK, but a little more would help. Next year who knows . . .

As a consequence, RAM prices have remained at a premium over the years – it will not get cheaper while it is in demand. RAM modules are the single most expensive part of a computer these days. A bank of single in-line memory modules (SIMMS) is worth far more than your actual microprocessor, and that's a moot point. It has not taken high-tech thieves long to work this out for themselves, knowing that they can probably get good money for these things second-hand down at the pub on a Friday night (hey man, wanna buy couple of 4M-byte SIMMS for £50 each?). Indeed, there have been several cases reported of thieves entering premises to steal exactly that. Quite often, thieves have dismantled computers to remove the RAM, fitted the machines back together and left without being caught. It is only later that users have realised the computer's were not running up to par and found out that the RAM was missing.

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

The ART of Electronic Music

Part 2 – Music Goes Digital

As we saw last month, traditional analogue synthesizers use a collection of different analogue circuits to create and shape new sounds. While analogue equipment has a much prized sound all of its own, it also comes with its own set of problems.

THE first of these is thermal stability – analogue oscillators are notoriously bad at staying in tune. Early equipment needs to be retuned by hand regularly, and this can be very time consuming when there are more than a couple of oscillators involved. Later, microprocessor controlled designs were introduced with extra hardware and software, which makes the tuning process automatic, but even this can cause problems. A tuning routine that can take a minute or two to go through its cycle can be ungainly for live use, especially if it has to be used regularly to keep up with ambient temperature changes.

Another problem with analogue designs is their bulk. Even with the use of specially designed integrated circuits, such as those from Solid State Music and Curtis, a medium sized synthesizer can take up a fair amount of rack space.

One final difficulty occurs when users attempt to link machines together. Early modular systems are mostly *monophonic* – like a flute, or a human voice, they can only produce one note at a time. This makes it easy to link machines, as in theory only two wires are needed – a keyboard control voltage (CV) source to set the pitch, and a gate line to trigger envelope generators. In practice, other control voltage sources are used to add expression. *Polyphonic* designs need to keep track of many notes at once, each of which needs its own individual CV and gate lines, and this can soon get unwieldy, as Figure 1 illustrates.

Going Digital

To get around these difficulties, in the late 70s, designers started to go digital. The first step down this road was the introduction of memories, which could store panel settings for future recall. The sounds were created in the usual analogue way, but a microprocessor system was interposed between the panel controls and the sound generation circuits. This monitored the panel settings using a multiplexer and an analogue-to-digital converter, and passed on panel information via a demultiplexer and a digital-to-analogue converter, to a large bank of sample and hold circuits, these in turn being connected to the sound generation electronics, as per Figure 2. By including some on-board RAM, panel potentiometer positions could be remembered and then reproduced at the touch of a button. The collection of settings that created a certain kind of sound became known as a *patch* or *program*, and the act of creating new sounds became known as *programming*.

Later, analogue designs also included tuning hardware which directly measured the pitch of an oscillator with an applied reference voltage, and then compensated for any mistuning by adding a small correction voltage offset to each oscillator's tuning control voltage input, as shown in Figure 3.

MIDI

Designers soon realised that they could solve the interconnection problem by digital means too. There were a number of abortive early tries at this, but eventually the music-making fraternity settled on a world standard – MIDI (Musical Instrumentation Digital Interface). MIDI uses a serial link between machines, and transfers information by means of a set of defined data packets. A *note-on* packet, for example, specifies which note on a keyboard is to be played, and also how hard it is to be struck. Also included is MIDI channel information, which is somewhat like a station ident on a radio transmission. Only machines which have been tuned into that particular channel will respond. Thus, MIDI provides a simple and elegant way of controlling a whole orchestra of synthesizers using a single lead. (See the 'More on MIDI' section for details).

Once a microprocessor controlled superstructure was in place, the next step was digital sound generation, which appeared in stages. First, analogue oscillators were replaced by digitally-controlled counter circuits. These produced precisely timed square or pulse waves, which could be converted into other waveshapes using analogue techniques – see Figure 4. These early machines were effectively hybrids, which retained most of the distinctive sound quality of analogue synthesis, but added the tuning stability of digital instruments. In fact, in many ways they were *too* stable. One of the charms of analogue synthesis is the slight randomness of the sounds it produces. Digital machines have to deal with a different problem – a *lack* of randomness, and the way that this can easily produce a boring and static sound.

To get around this, early hybrid machines included a special circuit known as a *chorus*. This used an array of analogue bucket brigade delay chips with continually varying delay times, to add interest and liveliness to the sound, as Figure 5 illustrates.

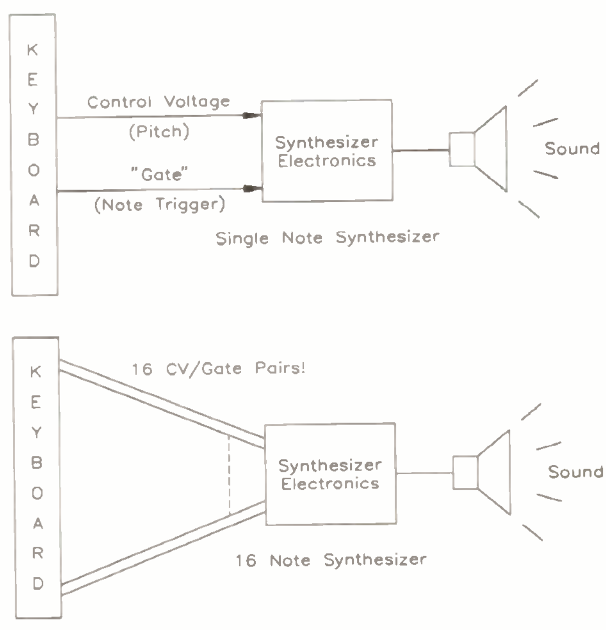


Figure 1. While the two wire CV/Gate technique is acceptable for single note machines, it soon gets unwieldy and speghetti-like for more complicated and versatile designs!

With the chorus circuit turned off, many of these early hybrid machines do indeed sound dull and lifeless compared to their earlier counterparts.

The next stage was the development of all-digital synthesis systems – and at this point, something strange and unusual happened. At the time (the early 80s), it was not possible to emulate an analogue synthesizer circuit in digital form – the filter section particularly was too computationally

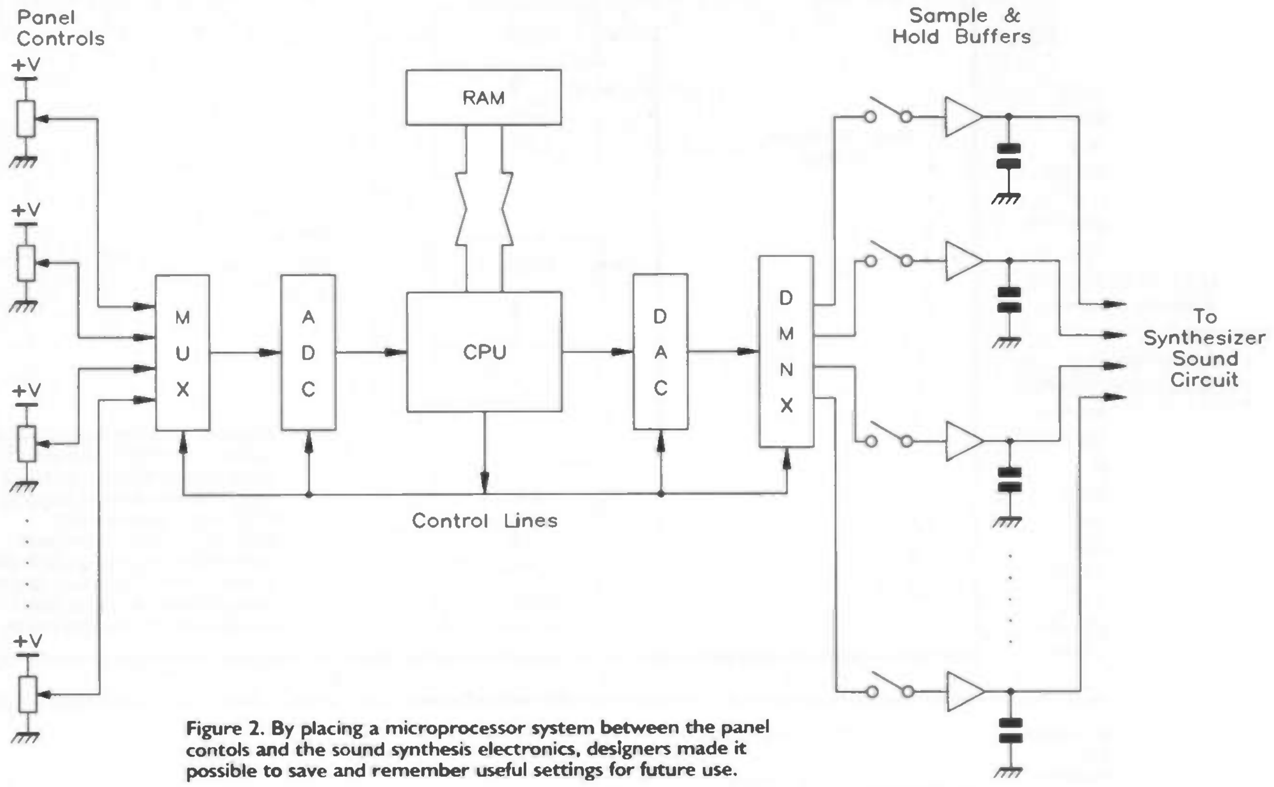
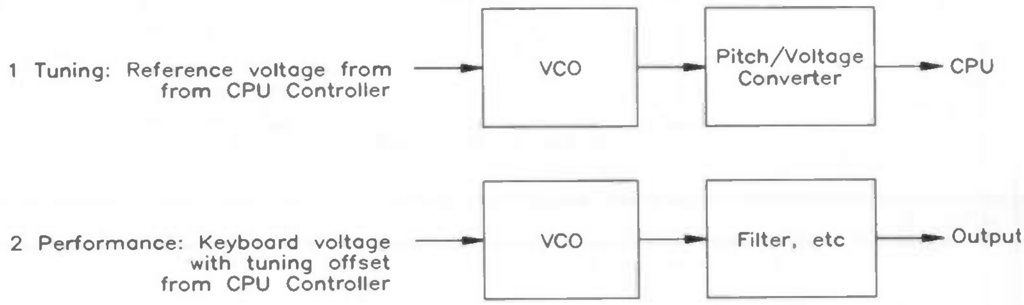


Figure 2. By placing a microprocessor system between the panel contols and the sound synthesis electronics, designers made it possible to save and remember useful settings for future use.

Figure 3. The microprocessor controlled oscillator tuning cycle starts when a reference voltage is applied to an oscillator. The pitch is measured against a reference. Any offset is nulled out by applying an opposing offset to the oscillator's voltage pin.



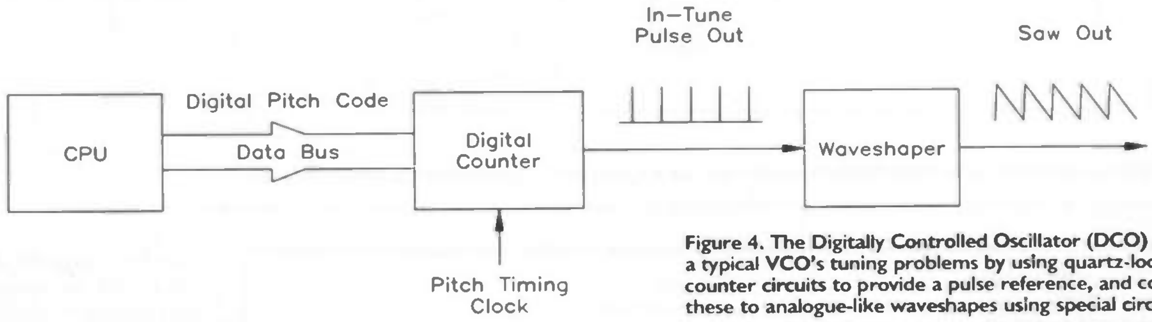


Figure 4. The Digitally Controlled Oscillator (DCO) gets over a typical VCO's tuning problems by using quartz-locked digital counter circuits to provide a pulse reference, and converting these to analogue-like waveshapes using special circuitry.

demanding. And for that reason, manufacturers started looking for other options.

FM Synthesis

The most influential of these was called Frequency Modulation (FM), and it first appeared in an affordable form on the now legendary Yamaha DX7 synthesizer. The FM synthesis technique uses no filters at all. Instead, sounds are generated by wobbling the pitch of one or more sine wave oscillators with other sine wave oscillators running at audio frequencies, as indicated by Figure 6. Instead of vibrato, this produces a spray of harmonics around the fundamental with a rich, interesting and deceptively acoustic-like sound quality. To add even more animation to the sound, each oscillator has its own amplitude contour – a technique that, strictly speaking, is known as *dynamic depth* FM, see Figure 7. Each oscillator can of course be separately tuned, although on the DX7, these pitch offsets are fixed. In FM terminology, the bottom oscillator in a stack is known as the carrier. It defines the fundamental pitch and amplitude envelope of the sound. The other oscillators are known as *modulators*. The tone quality of the final sound depends on the amplitude of these modulators, and also on their pitch relative to the carrier. Brass-like sounds are easy to generate using whole number pitch ratios, while interesting clangorous bell-like textures are created by using fractional pitch offsets, depicted in Table 1. The more oscillators used, the more complex the resulting sound – but also the harder it is to understand and control.

Carrier	Modulator	Sound
1·00	1·00	Mellow brass
1·00	2·00	Bright brass
1·00	3·00	Reedy
1·00	3·50	Bell-like

Table 1. By changing the pitch ratio between the two oscillators, different effects can be produced.

The DX7 was an offshoot of research performed in the computer music labs of Stanford University – see Reference 1. Computer musicians are used to having 'virtual' synthesizers at their disposal. There are a number of computer languages for sound generation (one of which will be discussed in the last part of this series), which give a user the ability to call up as many sound generators and modifiers as he or she needs. The downside is that computer music systems are not usually real time – it is not unusual for a few minutes of music to take an hour or two of calculation time.

It was in this environment that John Chowning started his research on FM. His early experiments used only two or three sine wave elements. The Yamaha DX7 used six elements – these were called operators by Yamaha's designers; see Figure 8. On a DX7, the operators can be connected together using one of 32 preset schemes, known as algorithms, and given in Figure 9.

The DX7 was an impressive engineering achievement. Using a custom chip-set it calculated 144 digital sine wave oscillators with 12-bit resolution in real time, together with all their amplitude curves. This was the first affordable machine that could be played as a musical instrument in its own right, because it could produce up to sixteen notes at once, whereas earlier machines had been limited to 5, 6, or (at best) 8, which made them difficult to use in a solo context. And of course, its other

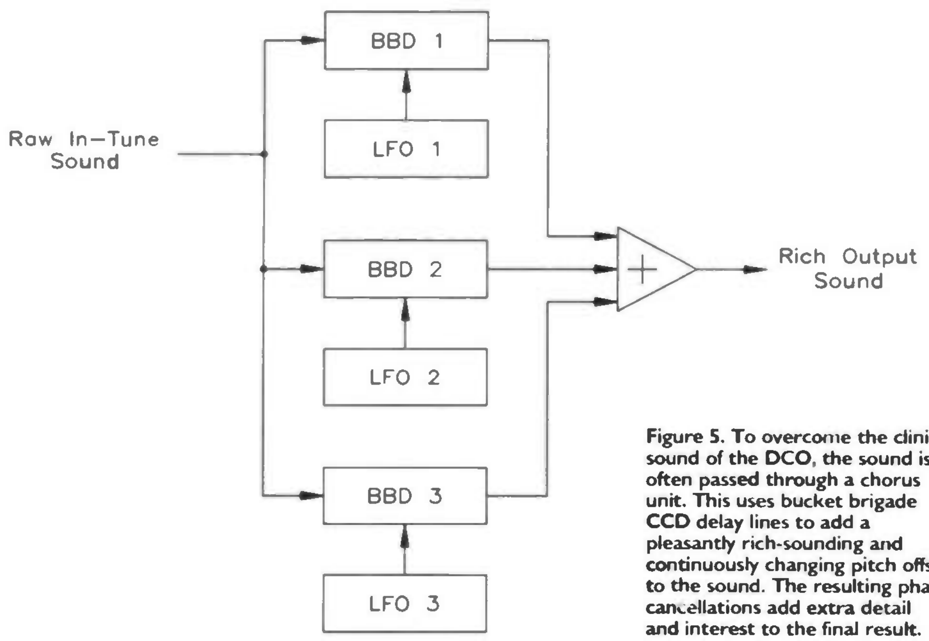


Figure 5. To overcome the clinical sound of the DCO, the sound is often passed through a chorus unit. This uses bucket brigade CCD delay lines to add a pleasantly rich-sounding and continuously changing pitch offset to the sound. The resulting phase cancellations add extra detail and interest to the final result.

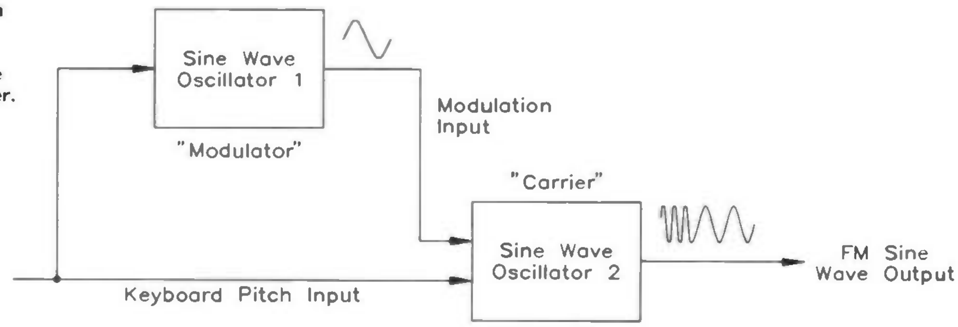


Figure 6. Frequency Modulation (FM) at its simplest. Here, two sine wave oscillators are connected together so that one modulates the pitch of the other.

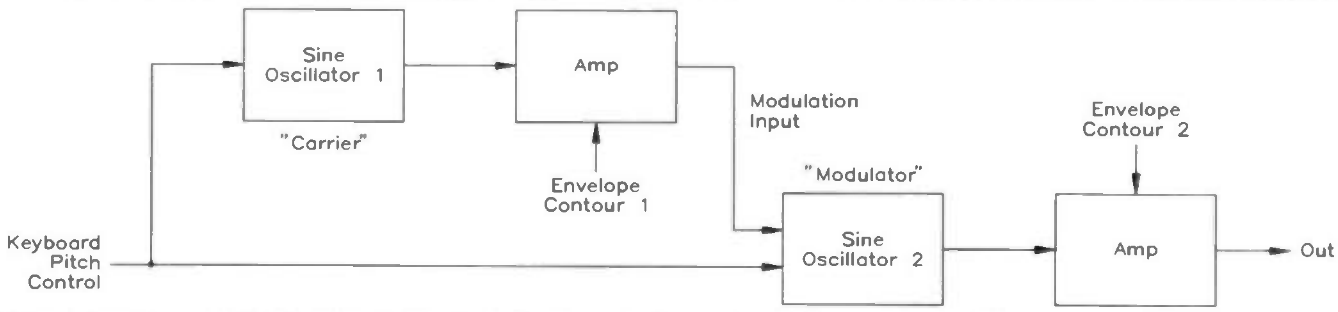


Figure 7. Dynamic depth FM adds extra detail by controlling the amplitude of each oscillator as well as its pitch.

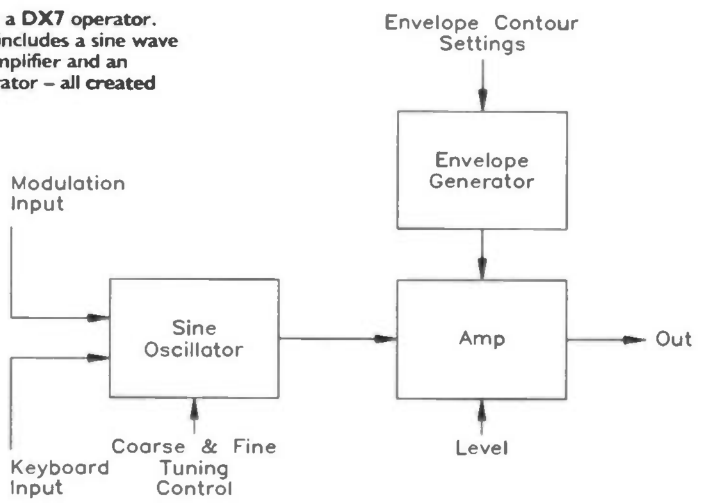


Figure 8. Inside a DX7 operator. Each operator includes a sine wave oscillator, an amplifier and an envelope generator – all created digitally.

innovation was its unique digital sound. Apart from the new approach to sound creation that FM provided, Yamaha also threw out the old ADSR (Attack, Decay, Sustain and Release) envelope system in favour of a new and improved digital envelope design, based on linear rate and level settings, as per Figure 10. This made it possible to create sounds that started almost instantly, with a sharp percussive 'snap', which analogue designs, based on capacitor charge and discharge curves, cannot match.

The other important innovation that first appeared on the DX7 had more to do with ergonomics – it was called the data entry slider. Because each sound was made up of over a hundred different controls and settings, Yamaha's designers decided that dedicating a panel control for each setting was impractical, so they opted instead for a much simpler (and cheaper) approach. The different settings were called up by pushing membrane switches on the panel, and then they could be changed using a single panel slider. An LCD display was used to inform users of where they were within the system; refer to Figure 11.

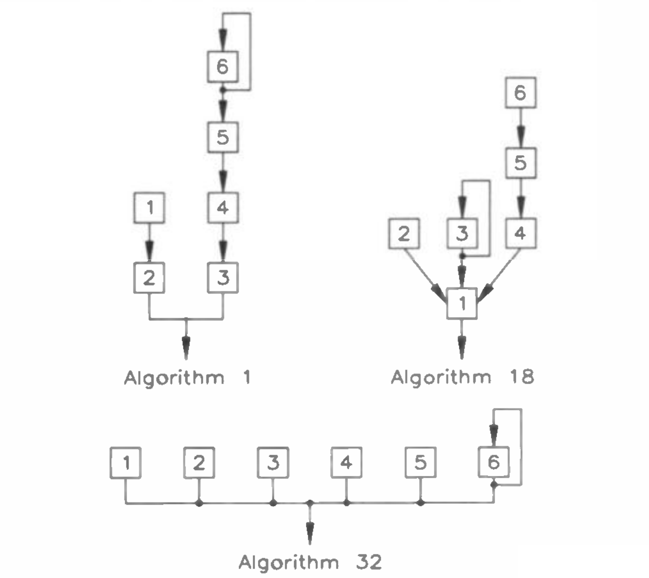


Figure 9. A selection from the 32 connection patterns ('algorithms') available on the DX7. Each box represents an operator. By connecting six operators in these different ways, various musical effects can be produced.

Sounding Off...

Although the system worked, it had its problems. On analogue machines, every control is easily accessible, and changing a setting takes no thought at all. On this new breed of digital machines, changing a setting can take three or four button presses, which is a major headache for new users who are unfamiliar with the machine. Sadly, this system is still with us today, although recently manufacturers have started adding extra panel controls to make programming simpler (as we shall see over the next few months).

The other big problem with the DX7 was simply that it was far too difficult for most people to understand and program. Analogue programming is straightforward in comparison, because there is a simple correspondence between a panel control and the way it affects a sound, whereas FM programming is a much more complicated business, with many of the settings depending on other settings for their effect. And the fact that are so many settings to deal with confuses many users, as does Yamaha's computer-oriented terminology. As a result, many musicians simply ignored carriers, modulators, operators and algorithms and stuck with the DX7's factory presets. Others made a living (for a while) as sound programmers, selling collections of new sounds to busy musicians. In spite of this, the DX7 was a runaway success – worldwide sales were well over 100,000 units. With most synthesizers selling no more than a few thousand, this was a particularly impressive achievement.

However, the search was soon on for an even better way to create sounds. What was needed was something that produced realistic copies of 'real' sounds, was wonderfully easy to use and understand, and could be afforded by almost everyone. As it happened, the technology to do this (which is called *sampling*) had been around since the late 70s in a workable, but very expensive form. I will be back to look at what happened when it became affordable, and also at some its creative variations, next month.

More on MIDI

The MIDI standard was first proposed by Dave Smith of Sequential Circuits, and has proved to be one of the great success stories of the Eighties and Nineties. While it undoubtedly has shortcomings, by and large it is a simple, elegant and successful way of passing information about a musical performance from one machine to another. Because MIDI uses digital codes for this, it also makes it easy to computerise the process. Hence MIDI information can be used live, or

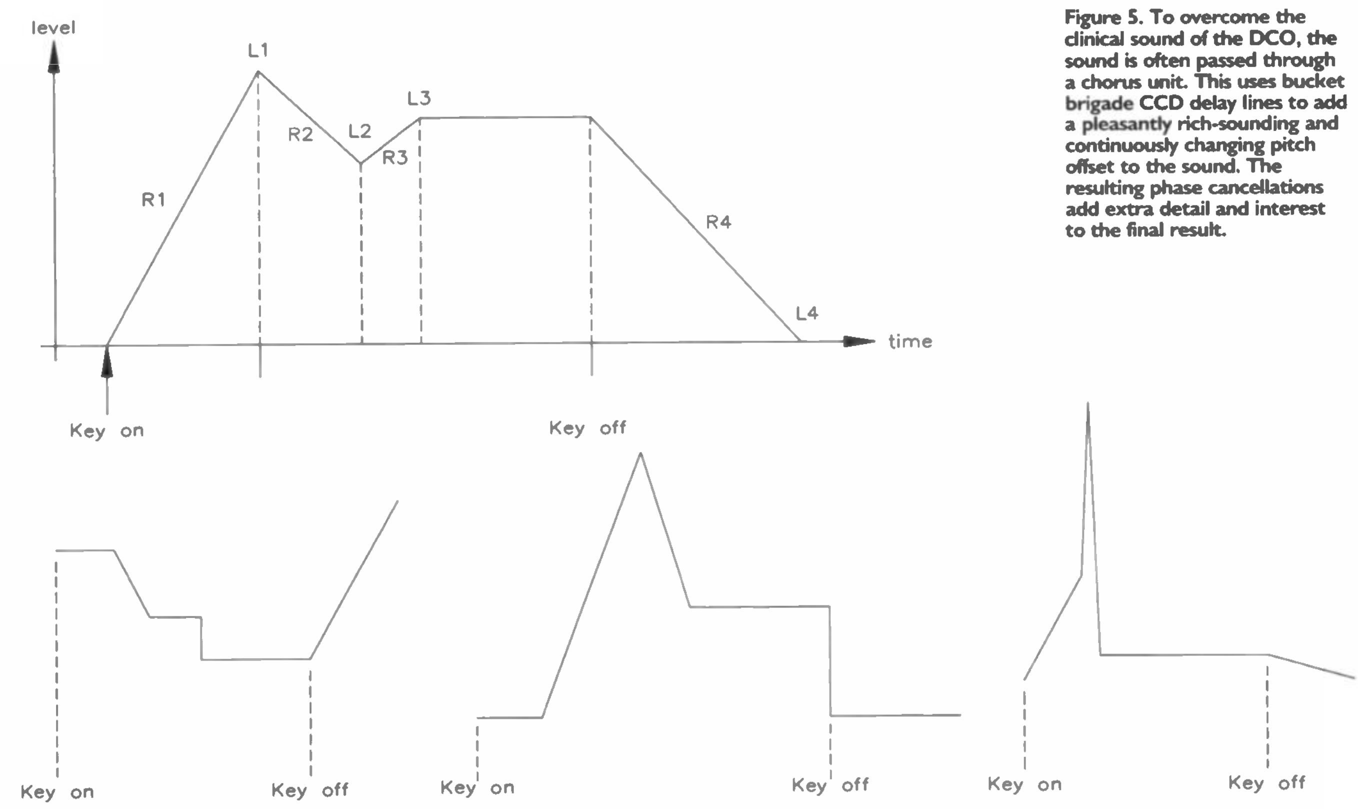


Figure 5. To overcome the clinical sound of the DCO, the sound is often passed through a chorus unit. This uses bucket brigade CCD delay lines to add a pleasantly rich-sounding and continuously changing pitch offset to the sound. The resulting phase cancellations add extra detail and interest to the final result.

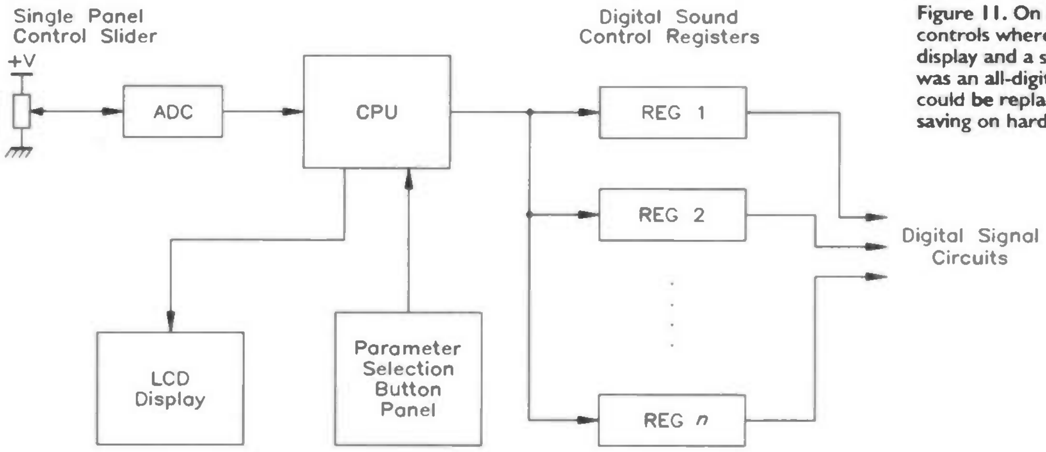


Figure 11. On the DX7, the multiple panel controls where replaced by switches, an LCD display and a single slider. Because the DX7 was an all-digital machine, the S&H circuits could be replaced by digital control registers, saving on hardware and expense.

it can be played into a computer, displayed on screen, edited, and then played back. The multi-channel nature of MIDI, which allows different synthesizers to be 'targeted' with different musical lines, makes it the perfect system for automating a complete performance.

There are three kinds of MIDI messages, outlined below. *System common* messages deal with simple musical events – a key press (known as a 'note on'), a key release ('note off'), a change of sound (program change), and so on. Any synthesizer that supports the MIDI standard must be able to recognise all system common messages – although it may not act on all of them if the hardware does not include some of the more obscure MIDI options. (Drum machines are one example of this – they respond to note-on messages, but ignore note-off messages because the duration of most drum sounds cannot be changed).

As an example, the hex message '90 24 7F' will turn on middle C on a keyboard, with the maximum possible loudness and brightness, whilst sending '80 24 00' will turn it off again. The full details of all the codes are available in the MIDI specification document, see Reference 2.

System real-time messages are used for timing and synchronisation, which make it possible for two drum machines to be run in time, for example. For amateur use, a clocking system is provided, which simply sends a certain hex code down the MIDI line at regular intervals to define the tempo of the music. For more advanced use, *Song Position Pointers* and *MIDI Time Code* are provided. These provide a way of skipping straight to a certain point in a song.

Finally, there are system exclusive (sys-ex) messages, which are unique to every machine. They provide a way of getting at the internal sound memories, and either changing them or saving/loading them in bulk to a computer. Each synthesizer has its own set of sound making parameters, and sys-ex messages are used to manipulate these. Although it is possible to use sys-ex creatively to reprogram sounds on the fly, most users simply use the sys-ex system to upload and download sounds for back-up purposes.

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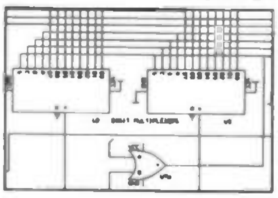
Schematic Design



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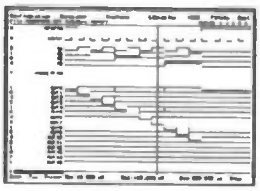
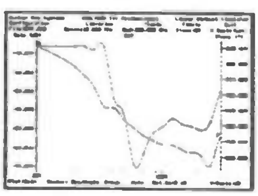
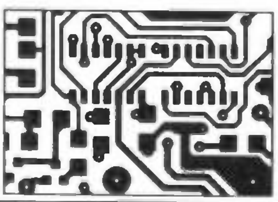
Digital and Analogue Simulation



Modify the configuration and change component values until the required performance is achieved.



PCB Design



The design, complete with connectivity, can then be translated into the PCB. The connectivity and design rules can be checked automatically to ensure that the PCB matches the schematic. And with LAYAN the Parasitic effects of the PCB can be included in the Analogue Simulation

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Stray Signals

by Point Contact

Weak and wracked with pain PC pens these lines, not exactly from his sick bed, but propped up with cushions in his favourite armchair, his recently acquired lap-top computer perched upon his knees. When one falls ill, one generally has no choice as to the ailment, but in the unlikely event that you should find yourself faced with a choice, PC would definitely advise against selecting pleurisy, which in his case has resulted in the loss of weight, a stone in three weeks (*is this a record*?). Although well past the worst stage, further progress towards recovery seems disappointingly slow, but enough of my vicissitudes, you doubtless have enough of your own! However, the enforced idleness gives me an opportunity to browse through my file of interesting snippets for possible inclusion in Stray Signals. This resulted in the weeding out of many news items, interesting in themselves, but which didn't get used at the time, and are now long past their sell-by date. As usual, one or two topical items are included.

Raising the Wind

Readers will be aware how much money the present Conservative government and its predecessors have raised over the years by selling off state-owned enterprises. One-off money raisers, most of them have now gone, leaving ministers wondering how they can raise the wind (financially speaking) in future. Perhaps they will take a leaf out the US governments book on 13th March , it announced that it had made its biggest auction of the nation's frequency spectrum to date, netting some seven billion dollars. The spectrum space was bought by would-be providers of wireless networks for personal communications. The beauty of this scheme is that, due to the limited range of communications at these frequencies, the same spectrum block can be sold over and over again in different cities and states. On the same day, it was announced that New Mexico's Mescalero Apaches had voted in favour of negotiations with the US nuclear industry, to store up to 20,000 tons of spent fuel rods, on their reservation for a period of 40 years, until a Federal disposal plan emerges. In return, the tribe would receive 250 million dollars.

Gallic Generosity

I mentioned some time ago, the efforts being made in California to encourage the adoption of cars powered by electric instead of petrol. France is now following the same course, very logical in a country where Electricite De France (EDF) supplies the majority of the nation's electricity from nuclear sources. The government has announced a plan to subsidise the purchase price of electric vehicles by 5,000Fr, or about £650, each. The subsidy is payable to domestic manufacturers, and in a rare show of Gallic internationalism, also applies to the 'importers' of electric vehicles. Incidentally, this is in addition to a subsidy of 10,000Fr per vehicle already announced by EDF itself.

Nothing New Under the Sun

During the late fifties, young PC worked, in the Solid State Physics laboratories of GEC's Central Research Laboratories in East Lane, Wembley. The place was alive with PhDs and for a while, PC worked for the famous Dr. Jonscher, a real polymath if ever there was one. Developments in semiconductors were proceeding apace, FETs were already well known, though not yet commercially available, and PC was experimenting with whatever semiconductors he could get hold of, though of course at that time, most of my home-brew constructions still used valves.

Arriving at work one day, there was a distinct buzz of excitement in the air – a paper had appeared on an FET tetrode – what we now know as a dual-gate FET. PC's imagination was fired, and he was soon predicting the eventual arrival of semiconductor pentodes, triode hexodes, octodes and even nonodes, rivalling their thermionic counterparts – predictions that in the event, proved wide of the mark.

In his subsequent career as an electronic design engineer, PC worked exclusively with transistors, and when they became available, integrated circuits. In view of the low gain of early transistors, it was common practice to use an emitter follower to drive a following stage, be it a common emitter stage or another emitter follower. So, it was no great surprise when enterprising manufacturers started to put the two stages together in a single package under the name 'Darlington transistor', the interesting point being that the internal first-emitter-to-second-base connection was not brought out to a package pin.

Now here's a conundrum for you; was there ever a 'thermionic Darlington' device (PC certainly never came across one in his days of working with valves), if so, what was it called, and for what was it used?

Yours sincerely,

Point Contact

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

KIT AVAILABLE (90033) PRICE £6.99

FEATURES

* 12 Different Animal Sounds * Low Operating Voltage
* On-board Amplifier * Compact, Snap-off PCB Design
* Very Low Stand-by Current * Alternately Flashing LEDs

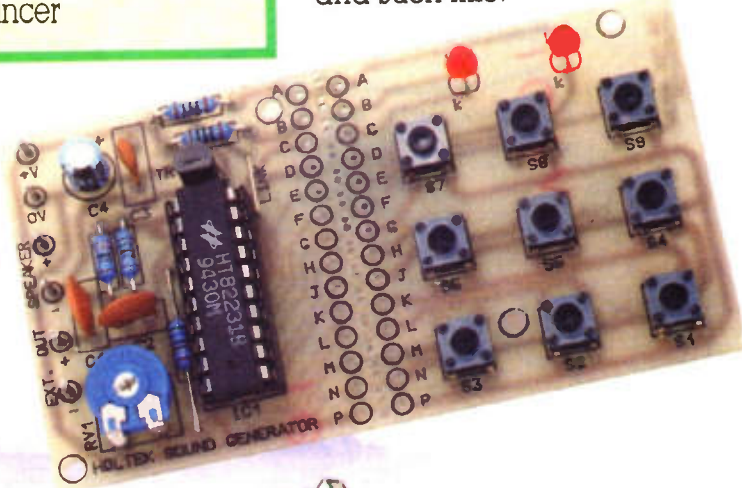
APPLICATIONS

* Ideal for Toys and Games * General Amusement
* Sound Effects for Amateur Dramatics Productions
* Novelty Doorbell/Door Announcer

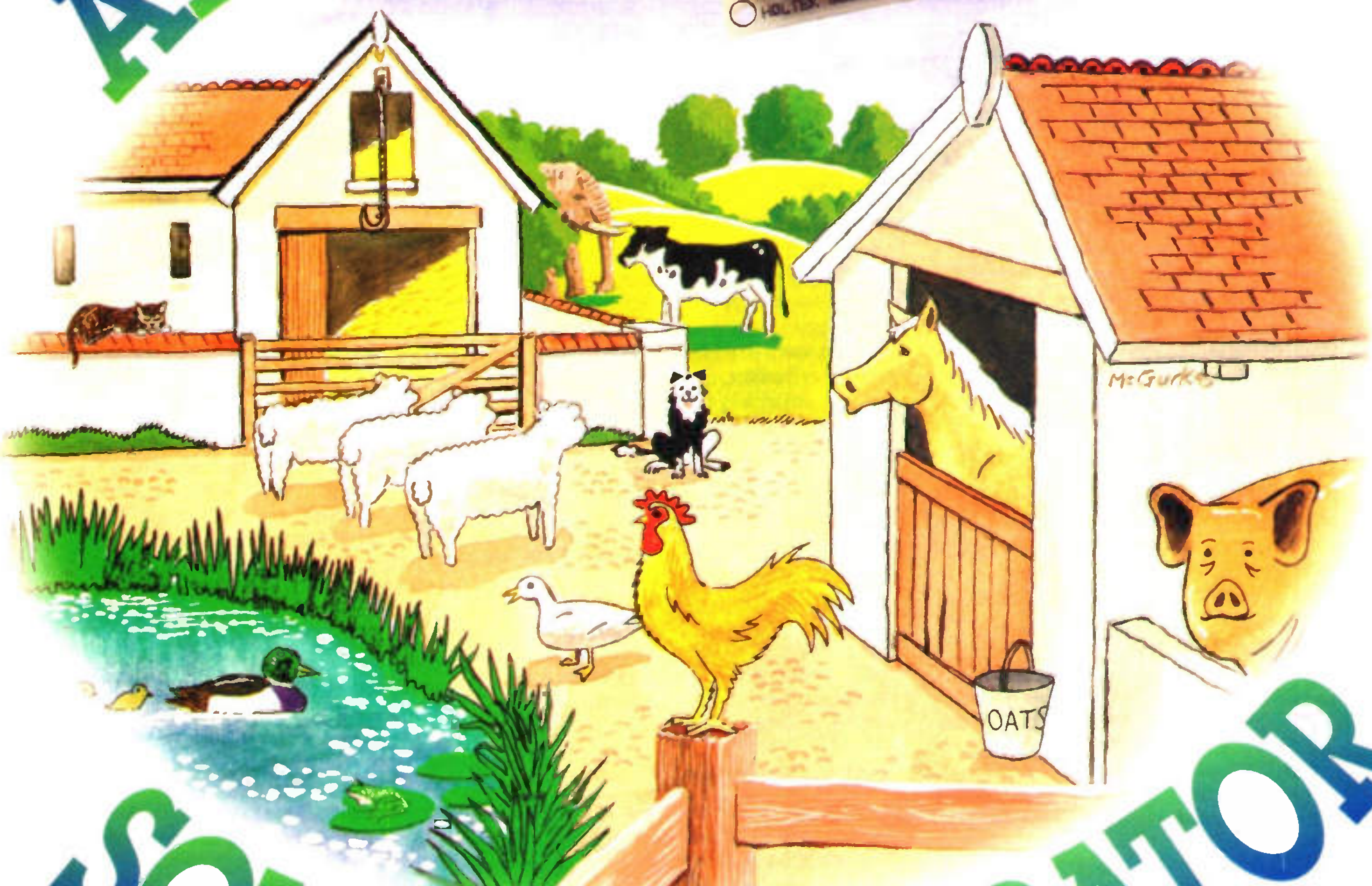
This easy-to-build project captures the realistic sounds of an Elephant, and eleven different farm animals, in one handy unit! Use it to add another dimension to toys and games or theatre productions, films, etc., or simply for fun whenever the mood takes you! Alternatively, the unit could be adapted for use as a novel doorbell or door announcer – great for pet shops, farm produce stores and such like!

Design by Nigel Skeels

Text by Maurice Hunt and Nigel Skeels



ANIMAL SOUND GENERATOR



1 PROJECT RATING

Circuit Description

This is a very simple circuit, the block diagram of which is shown in Figure 1, consisting of two main parts. IC1 is the Holtek HT82231 chip that generates the sound effects, and TR1, a BC337, acts as the output amplifier for powering a speaker of 8Ω impedance. An external amplifier output is available, which is attenuated and decoupled by R4, C2 and C1. R1 and R2 are the current-limiting resistors for the LEDs, LD1 and LD2, whilst potentiometer RV1 sets the speed, duration and pitch of the sound effects. C3 and C4 respectively provide high- and low-frequency power supply decoupling.

There are 12 sounds stored in the on-chip memory, eight of which are directly accessible to the user, the others available by sequencing through the whole set, by repeatedly pressing switch S1 – see Table 1, and the following text. To achieve an output from the sound generator, one of the key pins, 6,7,10,11,12,13,14 or 15, is taken low (via switches S2 to S9), thus enabling the direct access of the sounds, or alternatively, the KX input is taken low (via S1), to page through each of the sounds in turn. Other connections to the chip, include the two LED outputs that flash alternately ('flip-flop'), and the power supply.

The chip's control logic dictates that if two or more buttons are pressed simultaneously, only one sound effect will be emitted, and if a button is held down, the sound effect will be played repeatedly, until the button is released again. Rapidly pressing a button, on the other hand, will cause the sound effect to be restarted each time, resulting in some very odd noises indeed! By doing this, and varying RV1 at the same time, it is even possible to produce tunes (of sorts!) – the theme to *Eastenders*, in cat meowing form, was possible on the prototype, amongst others! This type of abuse (we like to test things properly at Maplin!) is likely to take its toll in terms of potentiometer track/wiper wear if done too often; you have been warned!

S1: Elephant, Dog, Bird, Duck, and the other sounds listed, in sequence.	S4: Cock
	S5: Hen
	S6: Frog
	S7: Sheep
S2: Pig	S8: Cat
S3: Cow	S9: Horse

Table 1. Sounds generated in response to button being pressed.

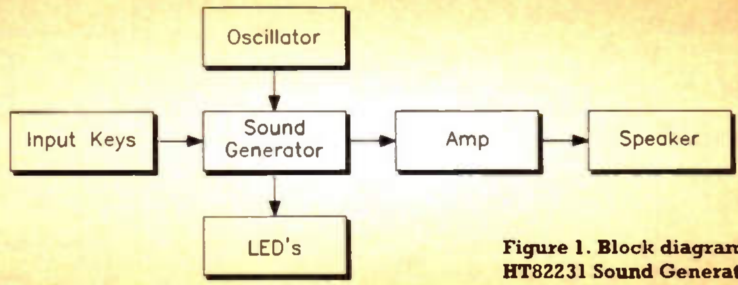


Figure 1. Block diagram of the HT82231 Sound Generator.

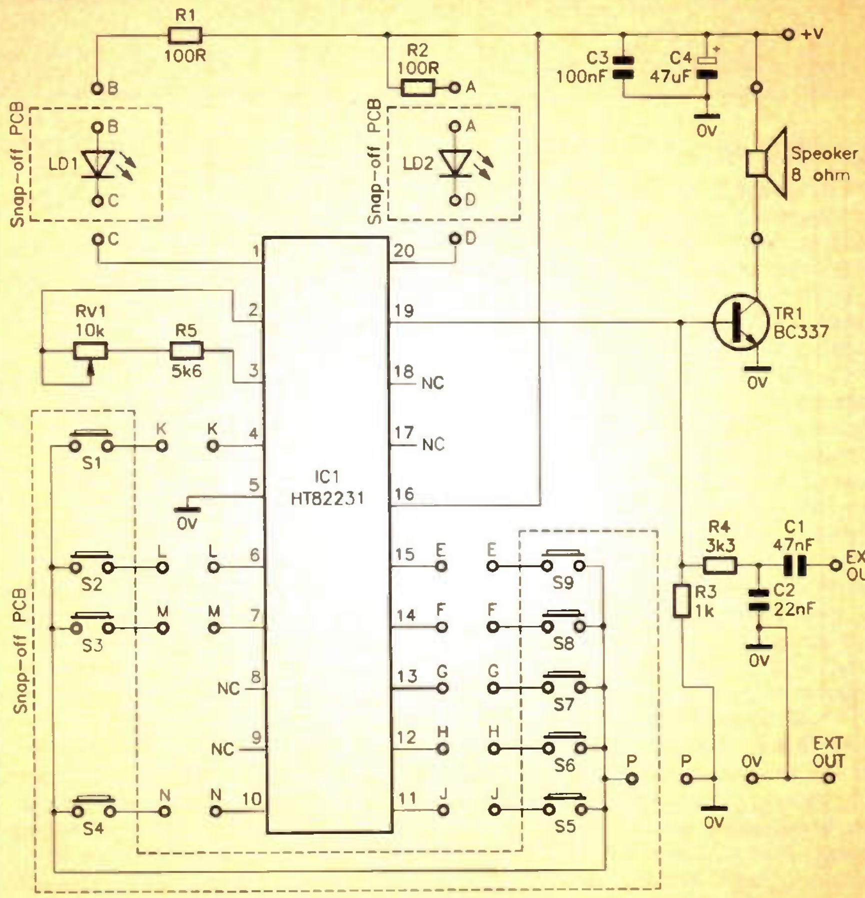
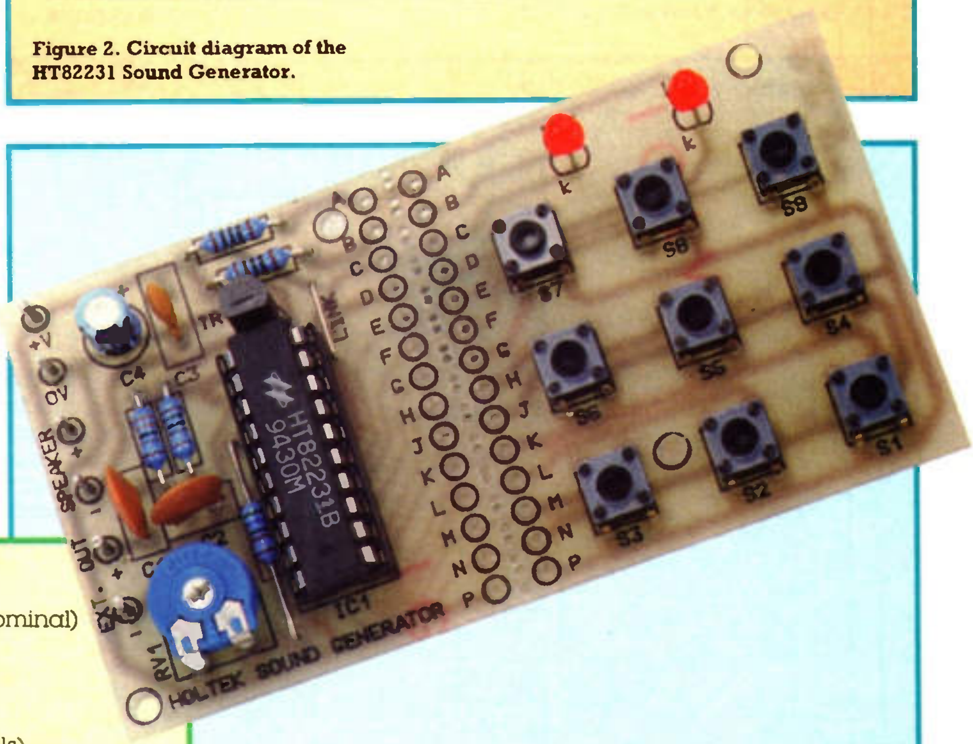


Figure 2. Circuit diagram of the HT82231 Sound Generator.



Assembled PCB with optional switches fitted.

Specification

DC power supply:	2·4 to 5·3V (3V nominal)
DC standby current:	0·03μA
DC maximum current:	200mA
Output impedance:	8Ω
Battery requirement:	2 × 1·5V (AA cells)
PCB dimensions:	45 × 75mm

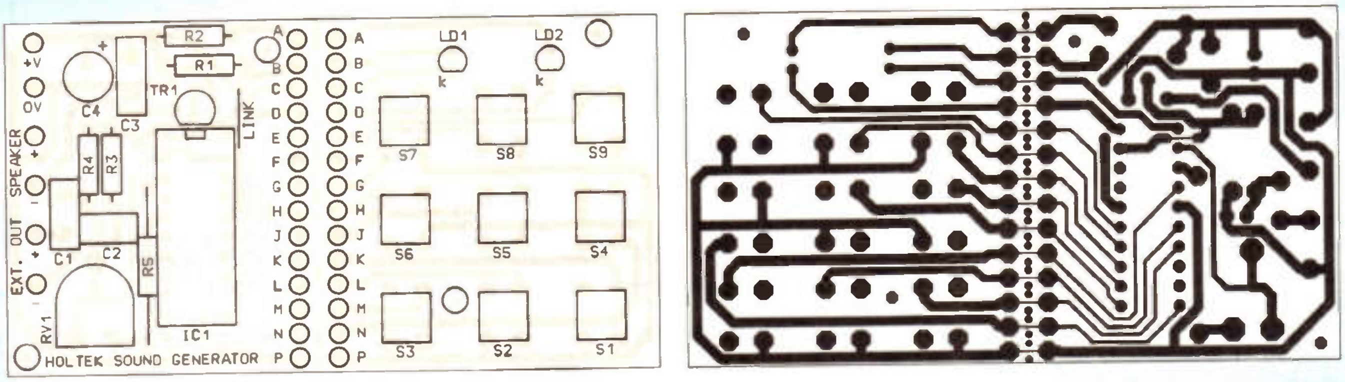


Figure 3. PCB legend and track.

Construction Details

Refer to Figure 2, the circuit diagram, and Figure 3, showing the PCB legend and track, which will assist with the building-up process. If you are a beginner to project construction, consult the Constructors' Guide prior to getting started. The following order is suggested for assembling the PCB, generally installing the components in order of ascending size.

Commence by fitting the six Veropins for the power supply and speaker/external output leads, plus another 28 pins if the two sections of PCB are to be linked remotely, via 14-way ribbon cable. Note, if snapping the PCB, before doing so, score across the PCB tracks between the two sections, or else there is a risk of the rest of the tracks being lifted as the PCB sections are parted.

Next, fit the resistors, disc capacitors C1 to C3, and electrolytic capacitor, C4, observing its correct polarity. Then, install transistor TR1, and trimmer potentiometer, RV1, in addition to the IC holder, taking care to orientate its end notch as per the PCB legend, shown in Figure 3. Fit the wire link and another 14, if the two sections of PCB are going to be at an angle, but next, to each other.

Next, install the two LEDs, LD1 and LD2, (see Figure 4) ensuring they are the correct way round, as printed on the PCB. Finally, install the optional miniature switches, S1 to S9.

Insert the IC into its holder last of all, observing antistatic precautions – this is a CMOS device.

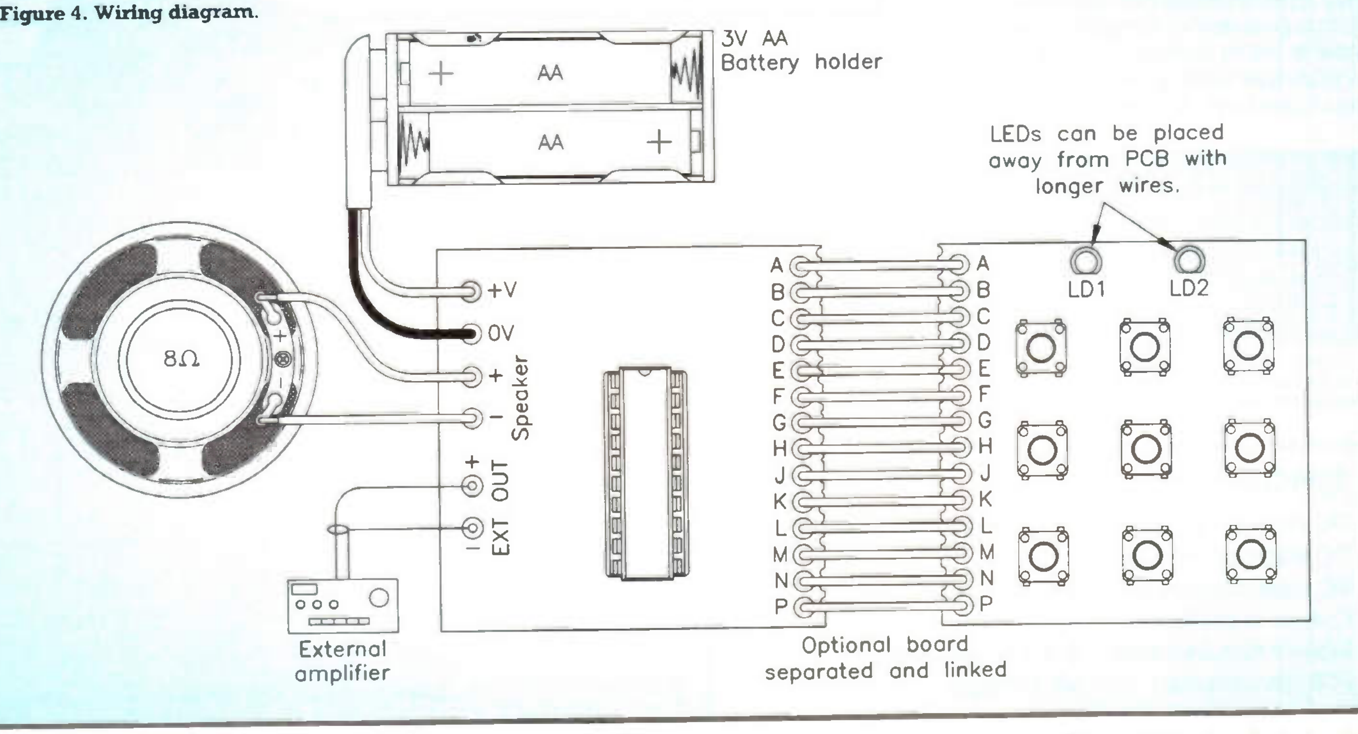
Testing

Make the usual checks for solder bridges, whiskers, and dry joints, misplaced components, and incorrect polarities prior to powering up for the first time. Then, with a suitable 8Ω impedance loudspeaker, or external amplifier, and power supply (3V nominal) connected via the appropriate PCB pins (as shown on the PCB legend), press each button in turn, whereby a different animal sound effect should be heard, along with the LEDs alternately flashing. Note that each sound should be heard twice over, for each press of a button. Each activation of switch S1 should produce a different sound effect each time, running through the unit's repertoire of twelve different animal noises – some of which are only available by means of S1 – see Table 1 for details of which sounds are available in response to the switch being pushed.

Operation

Simply press the appropriate button to activate the circuit into emitting 'farmyard animal'-style sound effects and alternately flashing LEDs. The standby current of the unit is very low, so the batteries could be left permanently connected, without detrimental effect on their lifespan, although a switch could be added into the supply lead if desired. Remember, the circuit has a maximum supply voltage rating of 5·3V, so do not connect a 9V battery to the (optional) PP3 battery clip, otherwise IC1 will be ruined. It is worthwhile putting a warning label in the battery compartment of the unit's housing, particularly if it is a child's toy!

Figure 4. Wiring diagram.



Other Uses

There are many uses for this device – your imagination is the limiting factor! The most obvious is for toys and games, and these days, even some books have built-in sound effects circuitry. Models could also benefit, for example, a train set layout could incorporate mooing cows or croaking frogs to add to the 'soundtrack', every time the train passes over a reed switch hidden in the track. And don't forget that the board can be broken in two, thus enabling remote positioning of the keypad and the LEDs, adding to the project's versatility.

ANIMAL SOUND GENERATOR PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)			
R1,2	100Ω	2	(M100R)
R3	1k	1	(M1K)
R4	3k3	1	(M3K3)
R5	5k6	1	(M5K6)
RV1	10k Horizontal Preset Potentiometer	1	(UH03D)
CAPACITORS			
C1	47nF 16V Ceramic Disc	1	(YR74R)
C2	22nF 50V Ceramic Disc	1	(BX01B)
C3	100nF 16V Ceramic Disc	1	(YR75S)
C4	47µF 16V Radial Electrolytic	1	(YY37S)
SEMICONDUCTORS			
IC1	HT82231	1	(AE12N)
TR1	BC337	1	(QB68Y)
LD1,2	Miniature 3mm Red LED	2	(WL32K)
MISCELLANEOUS			
	Single-ended PCB Pins (1mm)	1 Pkt	(FL24B)
	20-Pin DIL Socket	1	(HQ77J)
	22 SWG TC Wire 0·71mm	1 reel	(BL14Q)
	PCB	1	(90034)
	Instruction Leaflet	1	(XV48C)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)		
8Ω Miniature Loudspeaker, Type 578	1	(WB09K)
Sub-Miniature PCB Switch, Type 105B	9	(KR90X)
2 3 AA-size Battery Box	1	(YR60Q)
PP3 Battery Clip	1	(HF28F)
Duracell AA Alkaline Batteries	2	(JY48C)
Ribbon Cable	1	(XR07H)

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

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

Order As 90033 (Animal Sound Generator) Price £6.99

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

The following new item (which is included in the kit) is also available separately, but is not shown in the 1995 Maplin Catalogue

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SECURE INFORMATION

by Frank Booty

How do you put a value on information? Be it personal or corporate, the value of information is intrinsic. Yet the same information could be worth immeasurable amounts to a competitor, or cause untold damage or distress once in the public domain. Such statements are not new and many organisations have traditionally kept a tight rein on access to sensitive information. But the world is changing. Data is no longer static. It is moved, around companies, around countries. Locking up reams of paper is one thing, but keeping any kind of control over data electronically is causing significant problems.

This situation can only grow. A vast amount of data is still held in a paper based format. But the changing attitude to the use of information technology and the ever developing technology itself is opening up new avenues and uses for data: data is becoming electronic. This is a critical change and a change that must be reflected not only in attitudes to security within the corporate culture but also in international recognition of the implications of information exchange.

Electronic Data

Historically, information technology has been seen as a business cost-saving mechanism, a tool used within a company to streamline internal processes, save manpower costs and increase efficiency. The development of technology, and events such as the deregulation of the Postal, Telegraph and Telephone organisations (PTTs), has created an environment where business is beginning to see ways of exploiting information systems to gain competitive advantage.

These trends, coupled with increases in international trading, are leading to increasing electronic interchange between businesses, and to the exploitation of the information itself as a valuable asset. It is also leading to radically different work patterns for people: home working is becoming *de rigueur*. The economic wealth of a nation is becoming increasingly dependent on the health of its information systems.

Increasingly, companies are trading electronically, not just the traditional activities like funds transfers but more fundamental activities such as just in time (JIT) stock ordering. Many supermarkets now insist that suppliers use electronic data interchange to enable replenishment orders to be placed automatically: machines are controlled remotely and invoices are submitted for payment – all electronically. In addition, electronic mail is widely used to communicate around the world.

One consequence of this trend is an increased awareness of the need to secure these information assets against a wide range of accidental and malicious events. The developing open systems world is creating a whole new set of threats and business risks that must be addressed – otherwise the potential benefit provided by these developments to business could be lost irretrievably.

Legal Aspects

An issue close to every heart is that of personal data and concerns have long been raised about the amount of personal information available to the populace at large. Of course, while data was stored manually, it was difficult to use it for any other than its intended purpose. However, as systems and corporations intercommunicate electronically, the scope for personal data to be distributed, aggregated and used for purposes far removed from that for which it was originally provided rapidly increases. Such data is a valuable asset that can be exploited both for commercial and unscrupulous purposes.

Indeed, while electronic data transfer can provide significant business benefits it raises key legal issues which must be addressed. In the US, the Inland Revenue Service (IRS) is introducing legislation enabling people to submit their tax returns electronically. Their target is to receive half the returns electronically, about 50 million, by the end of the century. But the legal implications are yet to be addressed: the laws still, to a large extent, mirror the manual, paper based processes that have been the cornerstone of business and government for centuries.

Since the introduction of facsimiles, the legality of faxed documents has been questioned. But electronically the questions multiply. Is it possible to be sure that commercially, contractually and personally sensitive information that exists solely in electronic form is legally acceptable? Or is even transmitted or stored correct and unchanged? Are the invoices genuine or the result of some forger's activities? Has the tax return been tampered with? Is the contract the same one as that originally signed? What does signing mean for an electronic document? All of these issues have to be addressed before electronic data interchange becomes a truly viable commercial practice.

Safeguards & Security Matters

Meanwhile the move away from paper to electronic data is growing fast. The European Commission is advocating the use of electronic documentation to reduce the paper mountain and to improve efficiency. Many of the documents involved have legal significance. The current legal and commercial world operates on a well understood paper based system that includes mechanisms to prevent fraud and forgery, for example, and enables people to establish rights years after the creation of the original information. What are the equivalent frameworks and associated processes for electronic information?

These issues demonstrate the need for mechanisms that offer a wide range of technical functions including proof of delivery, integrity of content, non-repudiation of origin, confidentiality, access control and authentication. These technical issues can be and are being resolved as part of the open systems standards process, although current technical offerings do not solve all the problems. What still needs to be addressed are the associated social, commercial and regulatory problems.

There are regulatory problems that are impacting the successful implementation of security techniques. Security procedures have in general stemmed from the defence industries of the world and thus induce a conflict of interest. While security technologies enable corporations to trade internationally without recognising national boundaries and without the fear that the data can be intercepted and manipulated, the same technologies can, of course, also be used by those with a criminal interest to protect their activities from the law enforcement agencies,

Thus those same agencies want, and intend, to keep tight control over the security mechanisms, especially in their use by unfriendly nations. As a result, such technologies and the underlying mechanisms, particularly encryption, are therefore export controlled. In some countries, such as France, there are also controls on the use and even import of these mechanisms and in certain third world countries, the use of these techniques is banned for cross boundary communications.

The current situation prevents vendors from supplying products offering adequate levels of security to customers internationally without significant extra cost. It also prevents legitimate business concerns from using these new security technologies internationally, limiting their ability to exploit the new technologies securely.

In Europe (including the UK) there is a dialogue taking place between the various governments and industry on relaxation of these controls. In the US there is a proposal which has raised serious concerns.

To retain control of the encryption mechanisms, the US proposes a national solution whereby independent government agencies would allow the authorities access to communications secured by an encryption mechanism. US business is understandably concerned at the implications of this proposal on their freedom to operate securely. There is however a danger that this solution could become international through US government pressure on their industry, leading to a situation where non-US industry was dependent on the US security technology that was penetrable by US government. This is not a situation likely to be tolerated in the UK as a business or as a nation.

Data Protection Act & Other Restraints

While the control of security mechanisms still has to be addressed, other moves are under way to address the legal issues raised by electronic trading (which demonstrates a growing understanding at government level of the need to address these issues). One such move is the Data Protection Directive which currently remains under discussion. While in the UK there is the Data Protection Act that insists data use must be registered, other countries have different approaches, some of which are stronger and some non-existent.

With business operations moving globally, it is imperative to have consistent rules for the protection of personal data – and controls to prevent such data going to places where it is not adequately controlled and could be misused. Currently, there is no easy way of ensuring that data sent across a national boundary will be used solely in the way it is intended. The Data Protection Directive will define a harmonised set of rules applying to both manual and electronic data, across the European Community. It is already available for debate.

The concern is that there must be a balance between devising adequate controls and ensuring those controls are affordable to business. If the cost is prohibitive they will either be ignored or, equally damaging, result in European companies becoming less competitive.

Indeed the danger of controls being ignored is very real and will remain so until the attitude towards computer related crime changes. The public reaction to hacking is simply that hacking is not really seen as a crime at all. If a man holds up a bank with a gun and steals £10,000 he will get a long prison sentence. But use a keyboard and 'phone line and the chances are that the criminal will escape unpunished, even if the crime is discovered. Often, even if a company discovers it has been defrauded, it is unwilling to prosecute because of the resultant bad publicity which could dent customer confidence.

Prosecuting the computer criminal is highly complex, of course, especially when the issue of extra territoriality is raised. Typical computer criminals can be based in, say, Germany, stealing money from a UK company's branch in Spain via telephone networks in South America, and lodging the booty (!) in Switzerland. The problems thrown up by extradition between countries have been the bane of many a police force. In this situation, it is worse: who prosecutes this criminal, even assuming he can be identified? What is required is not just consistency of laws but also the means to prosecute that transcends national boundaries.

A legal and regulatory framework is needed which allows for the storage of legally and commercially sensitive documents electronically. Mechanisms have to be agreed to witness and store information that are legally acceptable worldwide. There must be a culture change between thinking of data in hard copy form to an intangible form where it becomes invisible and can be easily manipulated.

While it is possible today for organisations to try to ignore this growing need for international security, it will become more difficult. Auditors are beginning to look not only at the benefits of IT systems to business but also their vulnerability. Further, insurance companies may start offering a varying premium based on the level of security an organisation can put in place. While organisations have traditionally insured their PCs against theft or misuse, the data resident on those PCs has been ignored. This will have to change. The electronic age is gradually forcing everyone to put a value on information. E

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

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

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

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

THE (WIGAN) DOUGLAS VALLEY AMATEUR RADIO SOCIETY still meets on the first and third Thursdays in the month from 8.00pm. The Hesketh Arms, Shevington Moor, Shevington, Wigan. For further details contact D. Snape, G4GWG, QTHR, Tel: (01942) 211397 for further details.

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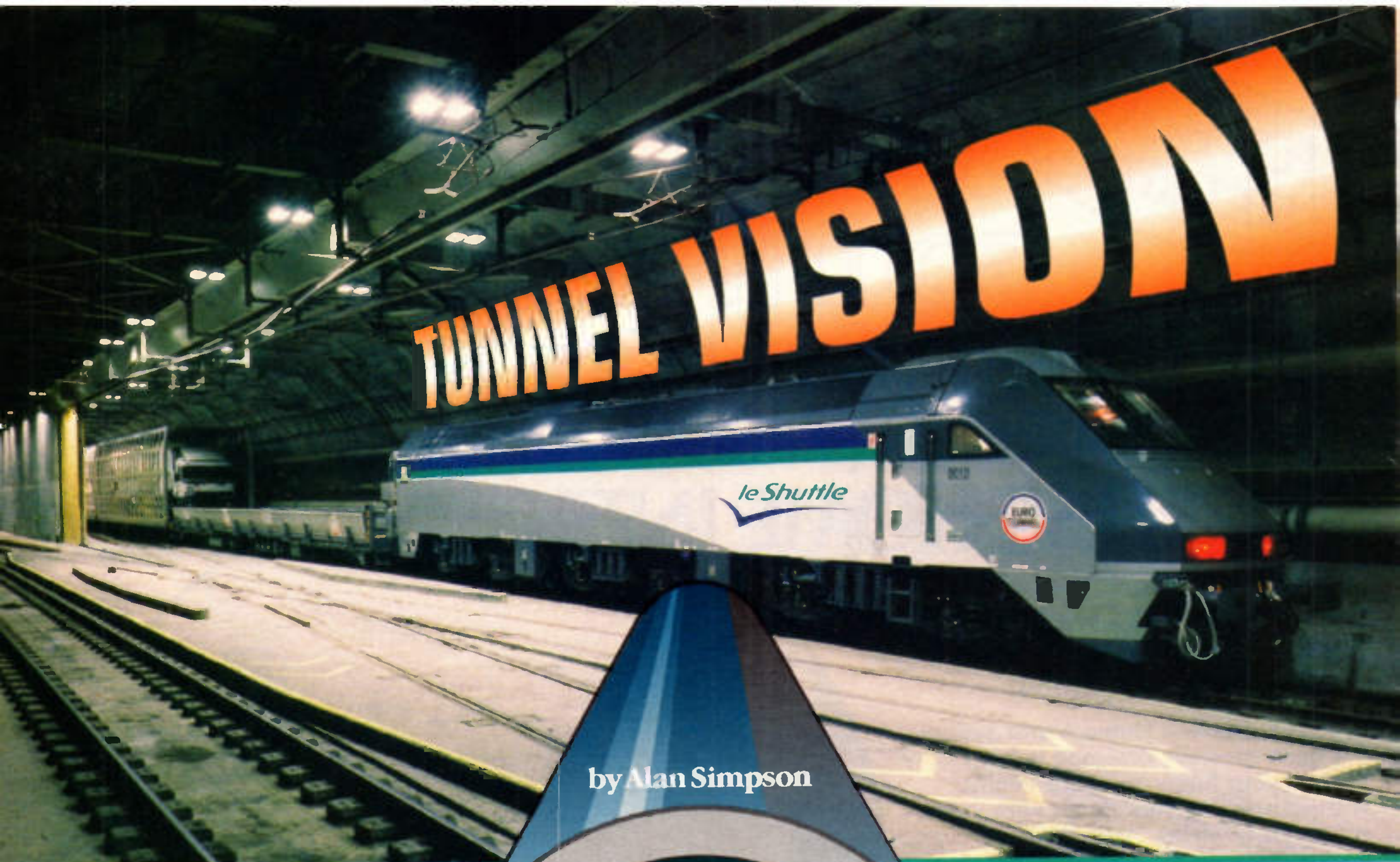

by Alan Simpson

It was back in 1751, when a plan was first produced for a new way to cross the English Channel. This involved horse-drawn traffic being driven through a tunnel, ventilated by iron chimneys standing above the surface of the sea. The first actual attempt to bore a tunnel under the Channel was made in 1880, using a machine designed by a certain Colonel Beaumont. By the time the project was halted two years later, the tunnel, which was 2·4m in diameter, was some 2km long from both sides of the Channel. In 1922, a trial bore was made at Folkestone using a Whitaker machine, which cut a tunnel about 3m in diameter.

In 1974, work began on a much larger tunnel system, similar in size and configuration to today's EuroTunnel. An access tunnel had reached some 400m before the project was abandoned by the Labour Government. But some six years later, under an enthusiastic President of France, François Mitterrand, and The British Prime Minister, Margaret Thatcher, invitations were extended for the financing, construction and operation of a fixed link tunnel. On 1st December 1987, tunnelling began, and had been largely completed in time for the official opening – or inauguration – by Her Majesty The Queen, with assorted dignitaries, in May last year.

The Channel Tunnel, or EuroTunnel as it is now known, has been described as being one of the most ambitious civil engineering projects the world has ever seen. The 31 mile-long tunnel actually consists of three tunnels; two train tunnels, each about 25 feet in diameter, plus a smaller service tunnel in between them, just 15 feet in diameter, linking massive terminals at each end. The undersea section of the tunnel is the world's longest, at 39km. For the record, a total of 7 million metric tonnes of spoil was removed, which could fill Wembley Stadium thirteen times. On the UK side, spoil deposited at Lower Shakespeare Cliff has created an extra 89 acres of land.

Trains of Thought – More Facts & Figures

The organisers expect the system to be the most heavily loaded railway service in the world, with the overall capacity being 20 trains per hour in each direction, regardless of weather conditions. Each tourist Shuttle has the capacity to carry 120 cars and 12 coaches. A full Shuttle will carry around 800 passengers (based on that

Top: The French 'Le Shuttle' train within the tunnel, at the UK crossover, showing an HGV on board.

Left: The British 'Eurostar' train, at the Waterloo International Terminal.

legendary figure of 2·5 passengers per car). In safety terms, EuroTunnel will be one of the safest transport systems anywhere. This is just as well, given that with trains running every four minutes, there could be up to 20,000 people in the tunnel at any one time.

For Le Shuttle traveller, passengers drive through a terminal designed on the lines of Victoria coach station, through passport and customs control, and proceed on to the upper or lower level of a slab-sided Shuttle. For the next thirty minutes, you have the option of sitting in your car or standing outside it. No vending machines, no magazine racks, just a continuous strip screen in each carriage (which would make a space astronaut feel at home) conveying a list of do's and don'ts. There is a special radio channel, which is just as well, as the tunnel does not have the elementary luxury of a relay radio station signal. Even so, there is little doubt that for those in a hurry, Le Shuttle has a considerable time advantage over the ferries.

When it comes to having a glamour edge, the 800-seat Eurostar train wins, hands-down. Even the new Waterloo International Terminal in London has deservedly won an architectural award for design. From the moment passengers step aboard the sleek Eurostar train, they are aware they are in a supertrain. It may not have the panache of the Orient Express, or serve as good a breakfast as the BT Pullman, but it has class and style galore. The multimillion pound train (all quarter-mile of it) gently glides out of Waterloo, proceeding at a sedate pace to Le Tunnel, and then speeding up until France is reached when the brakes are taken off with the train travelling at 180mph. The equally smooth arrival in Paris or Brussels some three hours later, confirms that all that digging was all worthwhile.

Fast Track

Steadily, as rolling stock is delivered, the railway paths are being cleared. Before long, EuroTunnel will be handling all four scheduled services – Le Shuttle tourist and freight service, and the two EuroStar services, the intercapital passenger trains and through-rail freight. Operating seven days a week, 52 weeks a year, EuroTunnel are at long last, fully in business.

The running tunnels each contain a single railway track. At intervals of about 375m, they are linked by cross-passages to a central service tunnel. Frequent ducts between the running tunnels reduce the build-up of air pressure in front of the trains. All three tunnels have immensely strong linings, made from cast iron or reinforced concrete segments. These weigh from 3 to 10 tonnes each, and cement grout was pumped behind the linings to provide a final seal with the rock.

Communications in Tunnels

Racal Datacom, a member of the Racal Electronics Group, was chosen as the company to provide the voice and data communications for the tunnel itself, as well as both British and French terminals. This incorporated system design, project planning and programme management, along with installation and commissioning of the data transmission, telephone, public address and power systems. According to Racal's Andy Picton, "Our overall objective was to install a rock-safe, highly resilient and robust communications system. We have built-in a high degree of redundancy in the transmission systems and connected devices. The aim, which has been successfully achieved, was to be able to sustain a number of communications failures and still keep the trains running safely."

In essence, the transmission networks should be seen as serving as a mini telecommunications network, that is supplying circuits and services on demand. In fact, the tunnel owners, EuroTunnel, own the networks, determine the usage and actually sell bandwidth to the major carriers.

Racal did not see the project as being an opportunity to bring in innovative, state-of-the-art, hightech solutions. Instead, their equipment and systems were very much tried and tested, and above all, dependable. More of an installation problem, was that of gaining access to the tunnel, and that of project management. Racal had to work alongside a multiarray of subcontractors. These close encounters of a subcontractor kind included sharing limited space in one of the 144 rooms in the tunnel, avoiding trial trains (not to mention the high-voltage power lines) plus the various vehicular traffic, ranging from baby tractors to Peugeot 106 diesel cars operating in the service tunnel. It also included having to work on both ends of the tunnel with certain circuits being pressed into use immedi-

Cars unloading from a tourist shuttle.

ately after they were installed. Overall, the challenge was to get the installation up and running in what was a very tight timescale.

The French Connection

The communications facts and figures are as impressive as the tunnel itself. The voice data and transmission system includes three fibre-optic cables with a combined length of 238km, capable of carrying a total of 700M-bit/s of information. Fibre was the chosen cable, thanks to its resilience factor. The fire detection system alone, required the installation of over 2,300 individual items, and 45km of dedicated cable. The signalling system has a massive 1,500km of cable, and there is 550km of piping in the tunnels, all with specialised anticorrosion coating and the ability to withstand high stress conditions. To add to the delight of cable manufacturers, 1,300km of cable has been installed in the tunnels for power supply requirements, which includes serving over 20,000 light fittings. Overall, the total of overhead catenary in the tunnels and terminals is close to 1,000km.

Essentially, Racal has supplied two distinct stand-alone network circuits, one running out of France and the other out of the UK. At all points, equipment connected to the transmission system has dual connections into each network. In case of need, circuits will switch backwards and forwards throughout the tunnel, eliminating any break in connectivity.

The five Racal transmission systems, the backbone of which is a 140M-byte network, supports a wide range of facilities. These include fire detection, pumping stations, emergency telephone circuits, management information and public address systems. There is also a radio track-to-train connection and concession radio, and only the rail signalling itself is not the responsibility of Racal, being a discrete, stand-alone system.

Apart from serving the EuroTunnel management information group requirement, Racal has also installed two separate Public Address systems; one covering tunnels and the other, terminals. Also in the Racal remit, is the special clock network. This is both analogue and digital, and is timed to perfection by the Rugby and France-Inter signals in the UK and France, respectively. As a point of interest, the clocks originally showed Central European Time in the Folkestone terminal. This, however, served to confuse passengers, and the clocks now display basic British time.

Tuning-in

When it comes to radio communications, there are no less than four systems: Concession radio provides general communications for terminals and tunnels; Track-to-train radio, which keeps train drivers in touch with control; Paging provides contact for management and maintenance personnel, and Shuttle internal radio is the VHF link to car FM radios whilst in the tunnel. Supporting the transmission and reception of radio signals, is radiating coaxial cable, which acts as a leaky feeder antenna in the tunnels.

Electromagnetic interference and vibration from the proximity of thundering trains are of major concern to suppliers such as Racal. The solution was to embed communications equipment on soft antivibration mounts, whilst protecting the circuitry by means of membrane screening.

The actual reception of a radio speech channel whilst travelling at speed, is handled by a number of base site receiver cells, rather similar to standard issue, cellular mobile 'phone links. But, just in case passengers are hoping to keep in touch with the world by means of their GSM mobile when in the tunnel, they needn't bother. The EuroStar trains have gold covered windows, which serve to further weaken radio signals. As Andy Picton commented, "You will just have to survive that 35 mile crossing". However, he does admit that for some strange reason, GSM does seem to operate for the first 1·5 miles inside the tunnel. When asked why there were no repeater radio station facilities in the tunnel, I was told that it was not proposed at the outset of the assignment, and that in any case, further cabling space and installation time was at a premium. "But if there was a call for a GSM service, then that could be speedily accommodated."

Power and Safety

No economies, however, were taken where power and safety are involved. Racal has installed 48V DC power back-up supplies, in the form of sealed, leak-proof batteries. As far as safety is concerned, elaborate precautions are in force. EuroTunnel has integrated safety considerations into every stage of planning and design throughout the Channel Tunnel project, and has drawn up a comprehensive safety strategy for the whole system, which involves three main stages:

- Planning-out hazards at the design stage
- Applying operating procedures which avoid hazards
- Devising emergency strategies to contain and deal with an incident

The tunnel authorities have gone to great lengths (and depth) to generate that tunnel 'feel-good factor'. In reality, the tunnel is so far beneath the sea-bed (45m on average) that the sea itself does not present a significant hazard. Indeed, it would take an earthquake unprecedented in this region, to rupture the tunnel lining; even then, pumps are provided to deal with such emergencies. Similar extensive precautions have been devoted to the unlikely threat of fire, with detection and suppression equipment at all stages of the tunnel and in trains.

Earlier this year, following the installation of the entire fixed communications infrastructure, Racal-Datacom was awarded a further contract. Worth approximately £3 million in the first year, this covers the service and support of the Channel Tunnel's Racal-supplied communications systems at both British and French terminals and in the tunnel itself. The contract also defines the provision of maintenance, assistance and training for EuroTunnel personnel. To help maintain and keep the project up and running, Racal have a team of 28 people working with EuroTunnel staff on shifts, 24 hours a day. The last words from Racal's Andy Picton were, "It would be hard to think of any other network that has so much reliability and built-in resilience. It is a network to be proud of."

Have we got news for you – next month, ELECTRONICS launches its most exciting contest ever!

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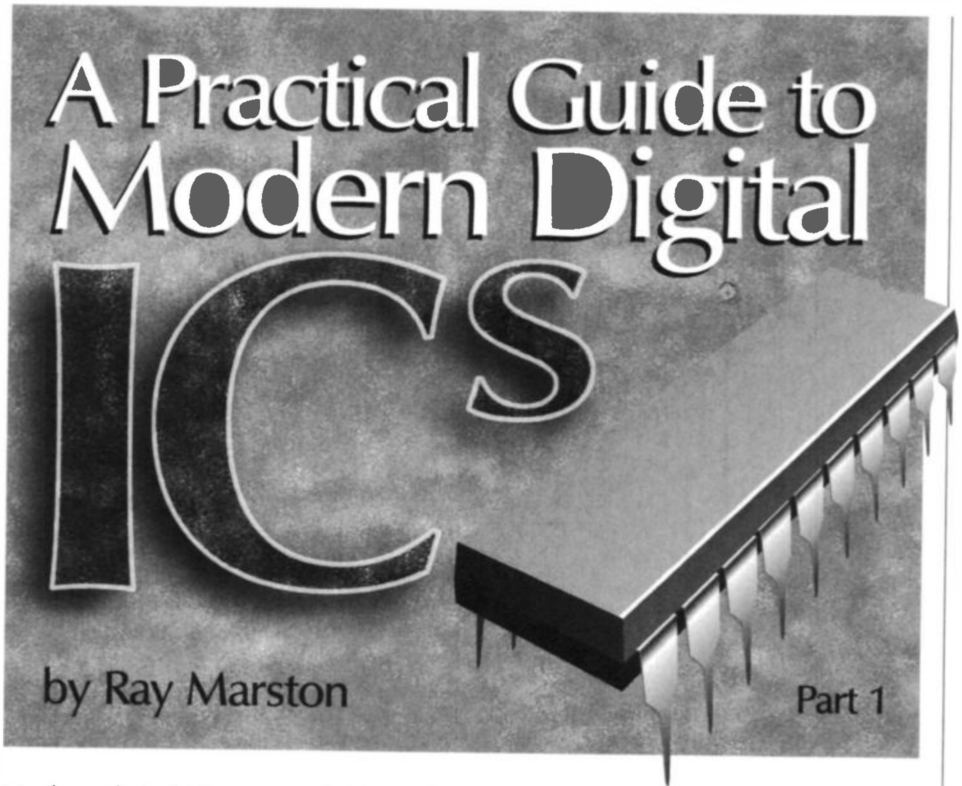
For more details of the show and free tickets, see page 38.



Modern digital ICs are available in three basic types, these being either TTL devices (typified by the 74LS00 logic family, etc.), 'slow' CMOS devices (typified by the '4000' logic family), or 'fast' CMOS devices (typified by the 74HC00 and 74AC00 families of devices). Each of these families has its own particular set of advantages and disadvantages, and its own special set of usage rules. This new series of articles sets out to explain the basic principles and usage rules, etc., of each of these three basic families, and to act as a practical usage guide to the vast range of ICs that are available in each of these families. This first part of the series concentrates on digital IC basics.

Digital IC Basics

An IC is simply an electronic circuit that is integrated within one or more semiconductor slices and encapsulated in a small, multi-pin package, and which can be made fully functional merely by wiring it to a suitable power supply and connecting various pins to appropriate external input, output, and auxiliary networks. ICs come in both 'linear' and 'digital' forms. Linear ICs give a basic output that is directly proportional to the magnitude (analogue value) of the input signal, which itself may have any value between zero and some prescribed maximum limit. Digital ICs, on the other hand, are effectively blind to the precise amplitudes of their input signals, and simply recognise them as being in either a 'low' or a 'high' state (usually known as 'logic 0' and 'logic 1' states, respectively); similarly, their outputs have only two basic states, either 'low' or 'high' (logic 0 or logic 1). If a large sinewave is connected to the input of a digital buffer, it produces an output that (ideally) is of purely digital form.

Digital circuits come in a variety of basic types, and can be built using a variety of types of discrete or integrated technologies. Figures 1 to 6 show a selection of very simple digital buffers and 'gates' that are designed around discrete components, and which can be used in a variety of practical, low- to medium-speed digital applications.

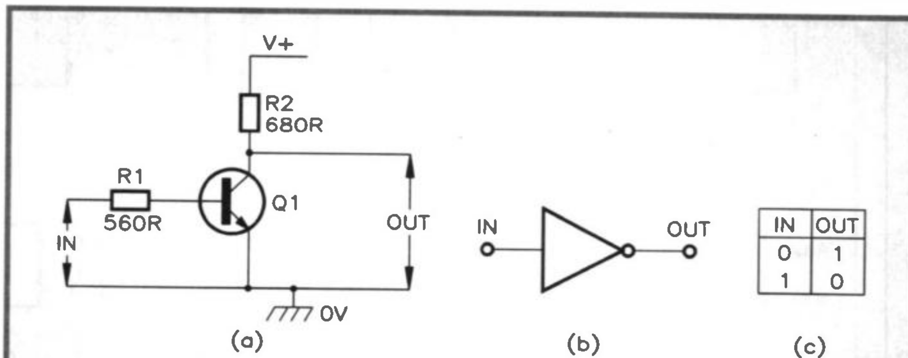
Figure 1a shows a simple inverting digital buffer (also known as a NOT gate), consisting of an unbiased transistor wired in the common-emitter mode, and Figure 1b shows the international symbol that is used to represent it (the arrowhead indicates the direction of signal flow, and the small circle on the symbol's output indicates the 'inverting' action). The circuit action is such that Q1 is cut off (output high) when its input is in the zero state, and is driven fully on (output pulled low) when its input is high; this information is presented in concise form by the Truth Table of Figure 1c, which shows that the output is at logic 1 when the input is at logic 0, and vice-versa.

Figure 2a shows a simple non-inverting digital buffer, consisting of a direct-coupled pair of common-emitter (inverter) transistor stages, and Figure 2b shows the arrow-like international symbol that is used to represent it. Figure 2c shows the Truth Table that describes its action, i.e., the output is at logic 0 when the input is at logic 0, and is at logic 1 when the input is at logic 1.

In digital electronics, a 'gate' is a circuit that 'opens', or gives an output (usually defined as a 'high' or logic 1 state) only under a certain set of input conditions. Figure 3a shows a simple 2-input OR gate, made from two diodes and a resistor, and Figure 3b shows the international symbol that is used to represent it. Figure 3c shows its Truth Table (in which the inputs are referred to as A and B), which shows that the output goes to logic 1 if A OR B (or both A and B) go to logic 1.

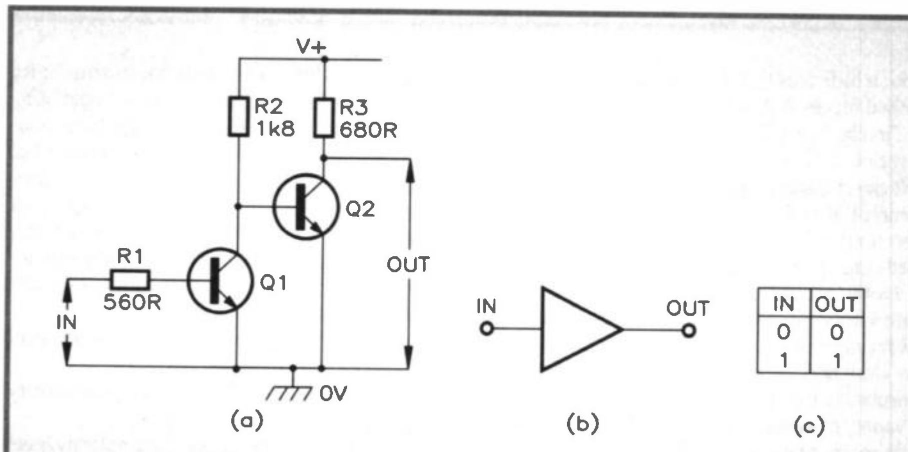
Figures 4a to 4c show the circuit, symbol, and Truth Table of a 2-input NOR (Negated-output OR, or NOT-OR) gate, in which the output is inverted (as indicated by the output circle) and goes to logic 0 if either input (or both inputs) goes high.

Figure 5a shows a simple 2-input AND gate, made from two diodes and a resistor, and Figure 5b shows its standard international symbol. Figure 5c shows the gate's Truth Table,



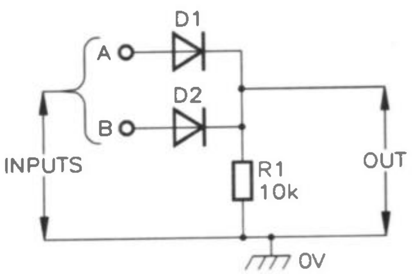
IN	OUT
0	1
1	0

Figure 1a. Circuit of a simple inverting digital buffer. 1b. Symbol of a simple inverting digital buffer. 1c. Truth Table of a simple inverting digital buffer.

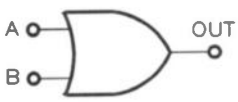


IN	OUT
0	0
1	1

Figure 2a. Circuit of a non-inverting digital buffer. 2b. Symbol of a non-inverting digital buffer. 2c. Truth Table of a non-inverting digital buffer.



(a)

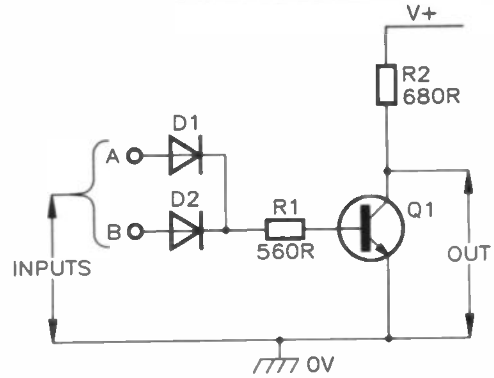


(b)

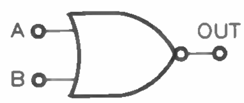
A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

(c)

Figure 3a. Circuit of a simple 2-input OR gate. 3b. Symbol of a simple 2-input OR gate. 3c. Truth of a simple 2-input OR gate.



(a)

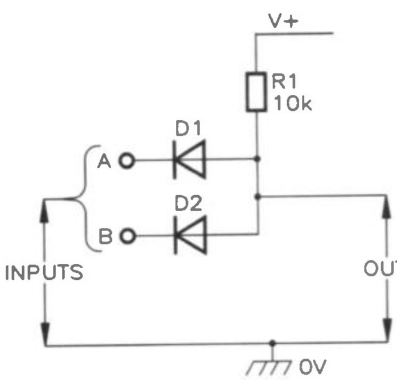


(b)

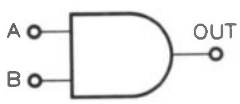
A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	0

(c)

Figure 4a. Circuit of a 2-input NOR gate. 4b Symbol of a 2-input NOR gate. 4c. Truth Table of a 2-input NOR gate.



(a)

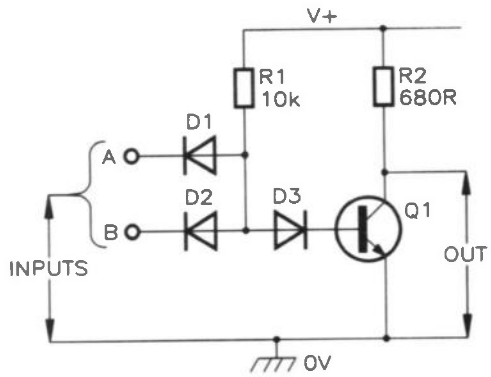


(b)

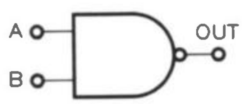
A	B	OUT
0	0	0
0	1	0
1	0	0
1	1	1

(c)

Figure 5a. Circuit of a simple 2-input AND gate. 5b. Symbol of a simple 2-input AND gate. 5c. Truth Table of a simple 2-input AND gate.



(a)



(b)

A	B	OUT
0	0	1
0	1	1
1	0	1
1	1	0

(c)

Figure 6a. Circuit of a 2-input NAND gat. 6b. Symbol of a 2-input NAND gate. 6c. Truth Table of a 2-input NAND gate.

which indicates that the output goes to logic 1 only if inputs A AND B are at logic 1.

Finally, Figures 6a to 6c show the circuit, symbol, and Truth Table of a 2-input NAND (Negated-output AND, or NOT-AND) gate, in which the output is inverted (as indicated by the output circle) and goes to logic 0 only if both inputs are at logic 1.

Note that although the four basic types of gate circuit described above are each shown with only two input terminals, they can in fact be designed or used to accept any desired number of inputs, and can be used to perform a variety of simple 'logic' operations. Also, note that many types of digital buffer and gate are readily available in IC form, as also are many other digital circuits, including flip-flops, latches, shift registers, counters, data selectors, encoders, decoders, and memories, etc. Most digital ICs are also known as 'logic' ICs.

In practice, logic ICs may range from relatively simple devices, housing the equivalent of just a few basic gates or buffers, to incredibly complex devices, housing the equivalent of tens of thousands of interconnected gates, etc. By convention, the following general terms are used to describe the relative density or complexity of integration:

SSI (Small Scale Integration); complexity level between 1 and 10 gates.
MSI (Medium Scale Integration); complexity level between 10 and 100 gates.
LSI (Large Scale Integration); complexity level between 100 and 1,000 gates.
VLSI (Very Large Scale Integration); complexity level between 1,000 and 10,000 gates.
SLSI (Super Large Scale Integration); complexity level between 10,000 and 100,000 gates.

Digital Waveform Basics

Digital ICs are invariably used to process digital waveforms. It is thus pertinent at this point, to remind the reader of some basic facts and terms concerning digital waveforms, which are available in either square or pulse form. Figure 7 illustrates the basic parameters of a square-wave; in each cycle, the wave first switches from zero to some peak voltage value (Vpk) for a fixed period, and then switches low again for a second fixed period, and so on. The time taken for the waveform to rise from 10% to 90% of Vpk is known as its rise time, and that taken for it to drop from 90% to 10% of Vpk is known as its fall time. In each squarewave cycle, the 'high' part is known as its mark and the 'low' part as its space. In a symmetrical squarewave such as that shown, the mark and space periods are equal, and the waveform is said to have a 1:1 Mark-Space (or M-S) ratio, or a 50% duty cycle (since the mark duration forms 50% of the total cycle period. Squarewaves are not necessarily symmetrical, but are always free-running or repetitive, i.e., they cycle repeatedly, with sharply defined mark and space periods.

A pulse waveform can be roughly described as being a bit like a squarewave (complete with rise and fall times, etc.) but with only its mark or its space period sharply defined, the duration of the remaining period being unimportant. Figure 8a shows a basic 'positive-going' pulse waveform, which has a 'rising' or positive-going leading edge, and Figure 8b shows a 'negative-going' pulse waveform, which has a 'falling' or negative-going leading edge. Note that many modern MSI digital ICs such as counter/dividers and shift registers, etc., can be selected or programmed to trigger on either the rising or the falling edge of an input pulse, as desired by the user.

If a near-perfect pulse waveform is fed to the input of a real-life amplifier or gate, etc., the resulting output waveform will be distorted both in form and time, as shown in Figures 9a and 9b. Thus, not only will the output waveform's rise and fall times be increased, but the arrival and termination of the output pulse will be time-delayed, relative to that of the input pulse; the mean value of the delays is called the device's propagation delay. Also, the peaks of the waveform's rising and falling edges may suffer from various forms of 'ringing' or 'overshoot' or 'undershoot', etc.; the magnitudes of all of these distortions vary with the quality or structure of the amplifier or gate, etc.

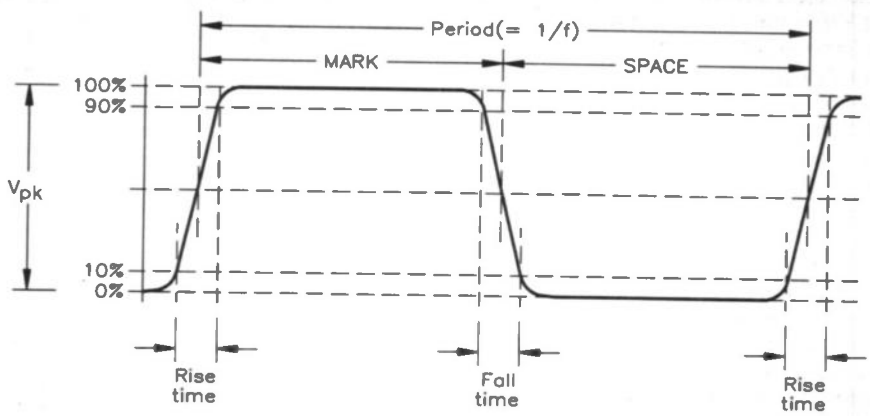


Figure 7. Basic parameters of a squarewave.

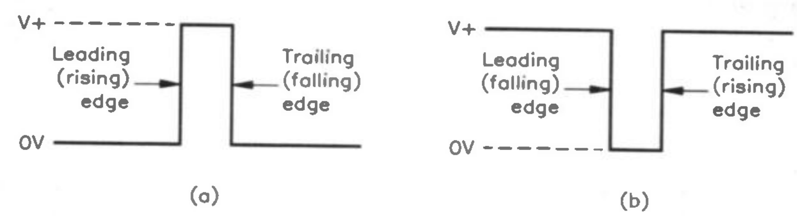


Figure 8a. Basic forms of 'positive-going' pulses. 8b. Basic forms of 'negative-going' pulses.

In practice, pulse input waveforms may sometimes be so imperfect that they may need to be 'conditioned' before they are suitable for use by modern, fast-acting digital ICs. Specifically, they may have such long rise or fall times that they may have to be sharpened up via a Schmitt trigger before they are suitable for use. Again, many mechanically derived 'pulse' waveforms, such as those generated via switches or contact-breakers, etc., may suffer from severe multiple 'contact bounce' problems, such as those shown in Figure 10a, in which case, they will have to be converted to the 'clean' form shown in Figure 10b, for them to be of any use.

Basic Logic-IC Families

Practical digital logic circuits and ICs can be built using various technologies. The first suc-

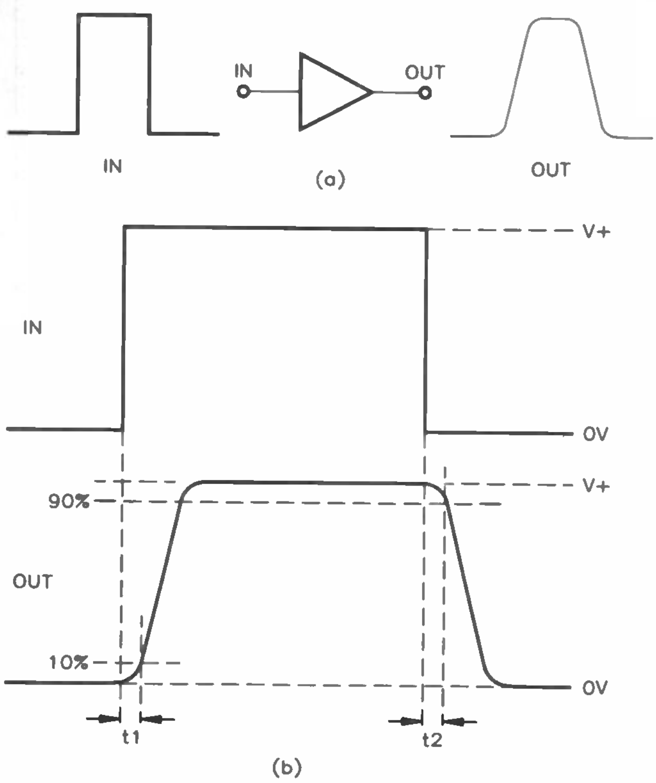


Figure 9a. A perfect pulse, fed to the input of a practical amplifier or gate, produces an output pulse that is distorted both in form and time. 9b. The output pulse's time delay is called its Propagation delay, equal to $(t_1+t_2)/2$

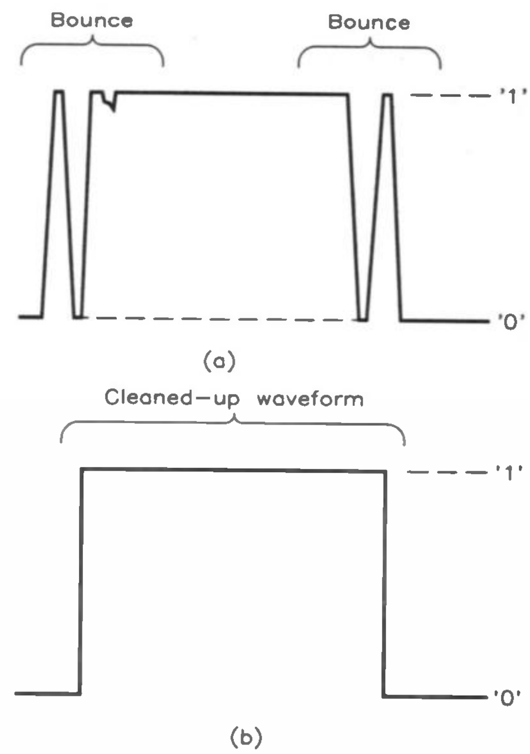
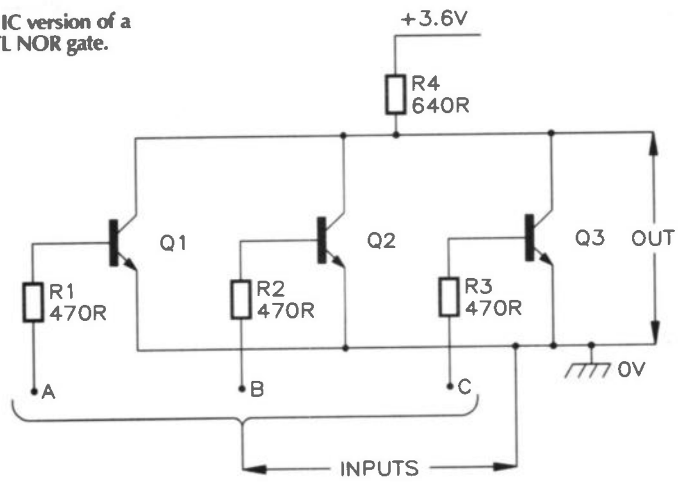


Figure 10a. Mechanically derived pulse waveforms often suffer from 'contact bounce'. 10b Contact bounce must be 'cleaned up' before use.

cessful family of digital ICs appeared in the mid-1960s; these used a 3·6V supply, and employed a simple technology that became known as Resistor-Transistor Logic, or RTL. Figure 11 shows the basic circuit of a 3-input RTL NOR gate. RTL was rather slow in operation, having a typical propagation delay (the time taken for a single pulse edge or transition to travel from input to output) of 40ns in a low-power gate, or 12ns in a medium power gate. RTL is now obsolete.

Another early type of IC logic technology, developed in the late 1960s, was based on simple developments of the discrete types of logic circuit shown in Figures 1a to 6c, and was known as Diode-Transistor Logic, or DTL. Figure 12 shows the basic circuit of a 3-input DTL NAND gate. DTL used a dual 5V power supply, gave a typical propagation delay of 30ns, and gave an output of less than 0·4V in the '0' state and greater than 3·5V in the '1' state. DTL is also now obsolete.

Figure 11. IC version of a 3-input RTL NOR gate.



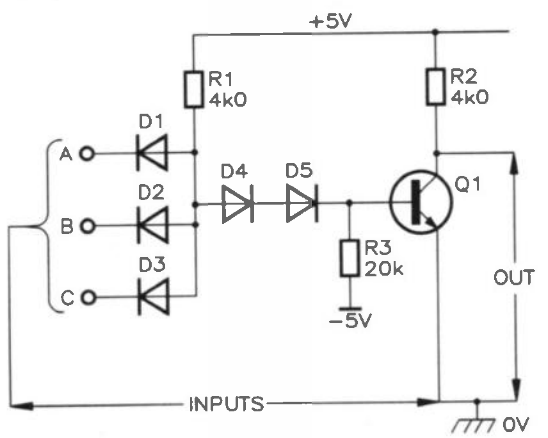


Figure 12. IC version of a 3-input DTL NAND gate.

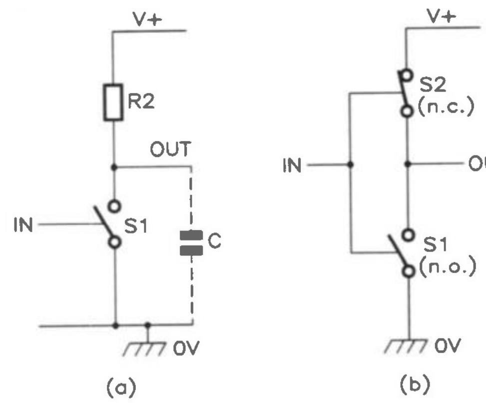
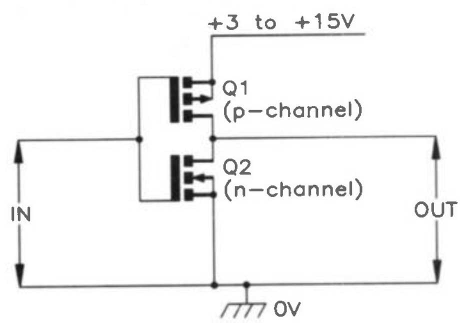


Figure 13a. Simple digital switch. 13b. Basic 'totem-pole' digital switch.

Between the late 1960s and mid-1970s, several other promising IC logic technologies appeared, most of them soon disappearing back into oblivion again. Amongst those that came and either went or receded in importance, were HTL (High Threshold Logic), ECL (Emitter Coupled Logic), and PML (P-type MOSFET Logic). At that time, the basic aim of digital IC designers, was to devise a technology that was simple to use and which gave a good compromise between high operating speed and low power consumption. The problem here, was that conventional transistor-type circuitry, using an output stage of the type shown in Figure 1a (as in RTL and DTL systems, etc.), was simply not capable of meeting the last two of these design needs. The essence of this problem (and its ultimate solution) can be understood with the aid of Figures 13a and 13b.

Figure 13a shows a simplified version of the basic circuit of Figure 1a, with Q1 replaced by a simple mechanical switch. Remember here, that all practical output loads inevitably contain capacitance (typically up to about 30pF in most digital circuits), so it can be seen that this basic circuit will charge (source current into) a capacitive load fairly slowly via R2 when S1 is open, but will discharge it (sink current from it) rapidly via S1, when S1 is closed. Thus, circuits of this type produce digital outputs that tend to have long rise times and short fall times; the only way to reduce the rise time is to reduce the R2 value, and that increases S1's (Q1's) current consumption by a proportionate amount.

Figure 14. Circuit and Truth Table of a basic CMOS inverter



IN	Q1	Q2	OUT
0	ON	OFF	1
1	OFF	ON	0

Note that one good way of describing the deficiency of the Figure 13a logic circuit, is to say that its output gives an active pull-down action (via S1), but a passive pull-up action (via R2). Obviously, a far better digital output stage could be made by replacing R2 and S1 with a ganged pair of changeover switches, connected as shown in Figure 13b, so that S2 gives active pull-up action and S1 gives active pull-down action, but so arranged that only one switch can be closed at a time (thus ensuring that the circuit consumes zero quiescent current). Such a circuit (with one electronic switch placed above the other) is generally known as a 'totem-pole' output stage.

Throughout the late 1960s, digital engineers strove to design a cheap and reliable electronic version of the totem-pole output stage, and then, in the early 1970s, they hit the jackpot, and two such technologies hit the commercial market like a bombshell, and went on to form the basis of todays two dominant digital IC families. The first of these is based on bipolar transistor technology, is known as TTL (Transistor-Transistor Logic), and formed the basis of the so-called '74' family of digital IC that first arrived in 1972. The second is based on FET technology, is known as CMOS (Complementary MOSFET logic), and forms the basis of the rival '4000-series' (and the similar '4500-series') digital IC family that first arrived in about 1975. The TTL and CMOS technologies have vastly different characteristics, but both offer specific technical advantages that make them invaluable in particular applications.

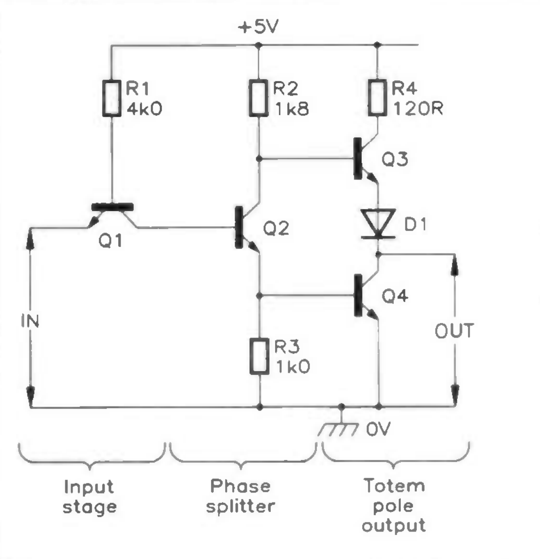
The most significant differences between the technologies of CMOS and TTL ICs can be seen in their basic inverter/buffer networks, which are used (sometimes in slightly modified form) in virtually every IC within the family range of each type of device. Figures 14 and 15 show the two different basic designs.

The CMOS inverter of Figure 14 consists of a complementary pair of MOSFETs, wired in series, with p-channel MOSFET Q1 at the top, and n-channel MOSFET Q2 below, and with both high-impedance gates joined together. The pair can be powered from any supply in the 3 to 15V range. When the circuit's input is at logic 0, the basic action is such that Q1 is driven on and Q2 is cut off, and the output is actively pulled high (to logic 1); note that the output can source (drive) fairly high currents into an external load (via Q1) under this condition, but that the actual inverter stage consumes near-zero current, since Q2 is cut off. When the circuit's input is at logic 1, the reverse of this action occurs, i.e., Q1 is cut off and Q2 is driven on, and the output is actively pulled low (to logic 0); note that the output can sink (absorb) fairly high currents from an external load (via Q2) under this condition, but that the actual inverter stage consumes near-zero current, since Q1 is cut off.

Thus, the basic CMOS inverter can be used with any supply in the 3 to 15V range, has a very high input impedance, consumes near-zero quiescent current, has an output that switches almost fully between the two supply rails, and can source or sink fairly high output load currents. A single basic CMOS stage has a propagation delay of about 12 to 60ns, inversely proportional to the supply voltage.

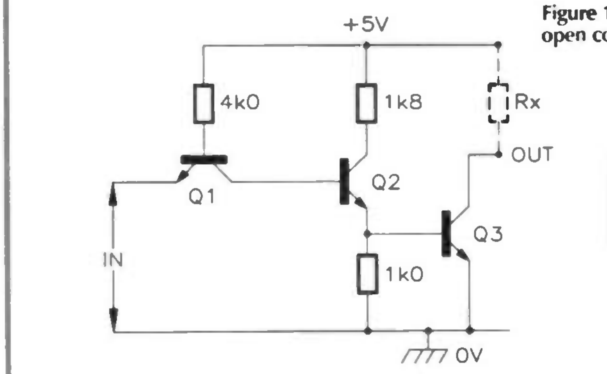
The TTL inverter of Figure 15 is split into three sections, consisting of an emitter-driven input (Q1), a phase-splitter (Q2), and a 'totem-pole' output stage (formed by Q3, D1 and Q4), and must be powered from a 5V supply. When the circuit's input is pulled down to logic 0, the basic action is such that Q1 is saturated, thus depriving Q2 of base current and causing Q2 and Q4 to cut off, and at the same time, causing emitter-follower Q3 to turn on via R2 and give an active pull-up action, in which the output has (because of various volt-

Continued on page 38.



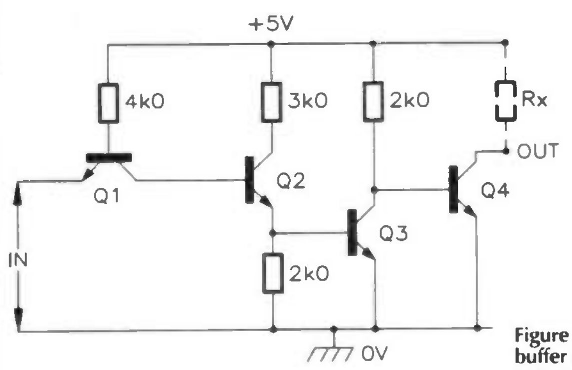
IN	Q1	Q2	Q3	Q4	OUT
0	ON	OFF	ON	OFF	1
1	Disabled	ON	OFF	ON	0

Figure 15. Circuit and Truth Table of a basic TTL inverter.



IN	Q3
0	OFF
1	ON

Figure 16. TTL inverter with open collector output.



IN	Q4
0	ON
1	OFF

Figure 17. TTL non-inverting buffer with open-collector output.

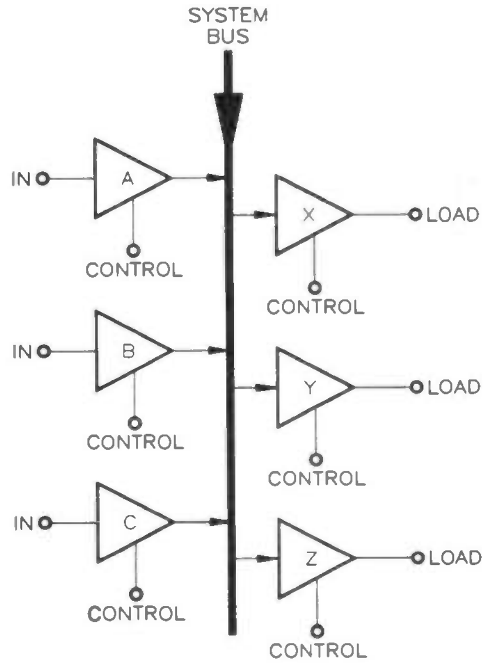
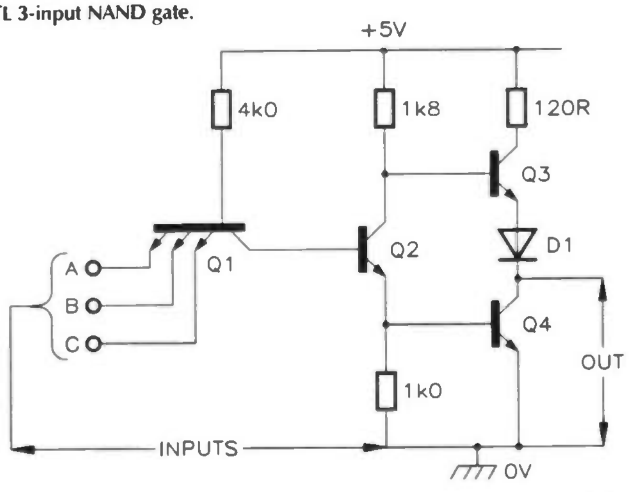
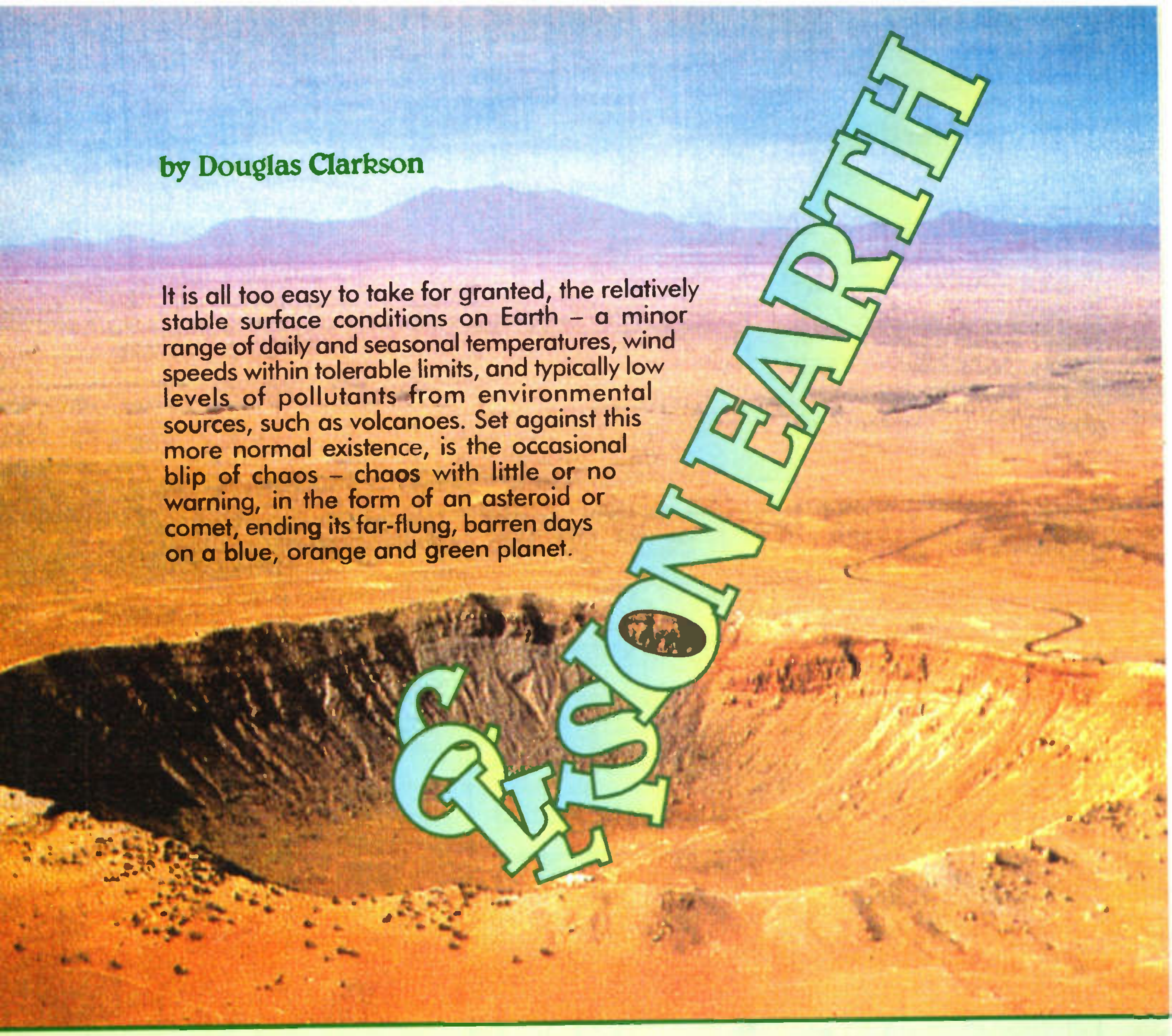


Figure 19. 'Tri-state' logic enables several outputs or inputs to be connected to a common bus; only one output/input must be made active at any given moment.

Figure 18. TTL 3-input NAND gate.





COLLISION EARTH

by Douglas Clarkson

It is all too easy to take for granted, the relatively stable surface conditions on Earth – a minor range of daily and seasonal temperatures, wind speeds within tolerable limits, and typically low levels of pollutants from environmental sources, such as volcanoes. Set against this more normal existence, is the occasional blip of chaos – chaos with little or no warning, in the form of an asteroid or comet, ending its far-flung, barren days on a blue, orange and green planet.

ONE of the most visible signs of such impacts, is the crater near Winslow, Arizona, shown in Photo 1. It is considered that the crater of over 1km wide, was formed by an impacting asteroid of around 50m diameter, some 22,000 years ago. Efforts to recover the original asteroid, by mining down into the ground, have been unsuccessful. The largest meteor crater observable as such today, is considered to be the New Quebec Crater in Canada, which is twice as big as the Arizona impact site, and estimated as being several thousand years old. Asteroids which impact in the sea, however, are more difficult to identify.

The active processes on Earth's surface have acted to 'rework' sites of previous impact. Also, the atmosphere of Earth has acted to absorb some of the energy of impacting objects. Other planets in the solar system have not been so lucky. Photo 2 shows the rugged terrain of Mercury, as photographed by Mariner 10 during 1974. The landscape can be considered to be a 'memory' of impacts that have taken place over the last 3 to 4 billion years, with no surface processes removing the evidence. The diameter of Mercury is 4,878km (0·38 times that of Earth). Some of the craters shown are in excess of 100km in diameter.

In spite of the great developments in space technology in both observation and space flight, observation of 'near miss' incidents is

Above: Photo 1. The meteor crater at Winslow, Arizona: A recent, but relatively modest feature, caused by an asteroid around 50m in diameter.
Right: Photo 2. Battered and still in one piece – the face of Mercury. An example of a planetary system with no protective atmosphere, and no surface processes to rework impact craters.

Photo 3. Pictures from the Hubble telescope. of the impact of fragments of the Levy Shoemaker comet on the surface of Jupiter.

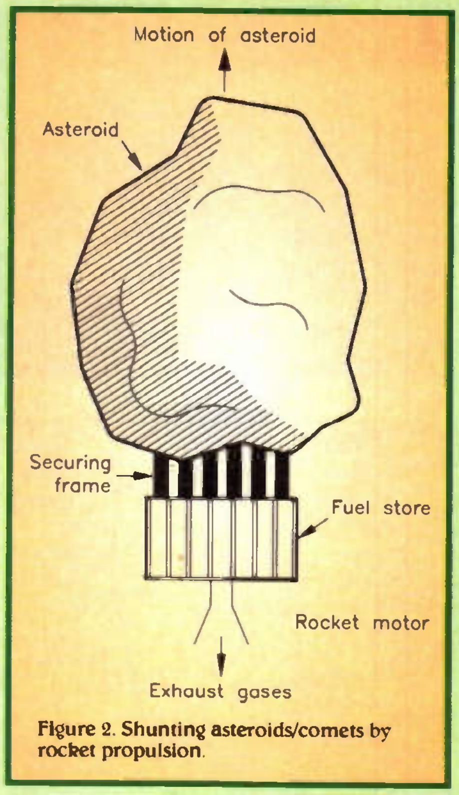


Figure 2. Shunting asteroids/comets by rocket propulsion.

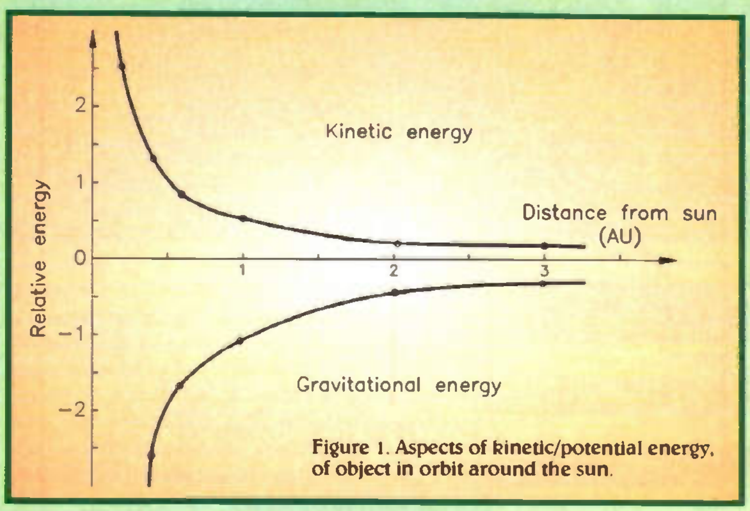


Figure 1. Aspects of kinetic/potential energy, of object in orbit around the sun.

Above: Photo 4. Cratered surface of Phobos, one of the moons of Mars, and considered to be an asteroid captured by the planet.

still not fully developed. Also, the technology is not available at present, to change a direct-hit scenario to a 'near miss' one.

The recent collision of the Levy Shoemaker comet on Jupiter is a lesson in humility. Such an event, rare in its frequency, must be ranked as a major event within the solar system. The regions of turbulence observed on the surface of the vast planet were approximately the size of Earth itself (see Photo 3). The Hubble Space Telescope was able to make some startling observations of the collision.

Asteroids

Asteroids are defined as rocky bodies of less than around 1,000km in diameter. The bulk of these occupy positions in stable orbits between Mars and Jupiter. There are also asteroids which cut across Earth's orbit, and it is these types which are of special interest in potential Earth collision studies. It must be considered, however, that objects in the asteroid belt in orbit between Mars and Jupiter, are still a potential hazard, since incoming objects can perturb previously stable orbits – much like the cue ball breaking the set of reds on the snooker table.

A large number of asteroids have been identified with a unique sequence number and name. As of 1992, over 5,000 had been identified. The Minor Planet Center at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, maintains a database on all such objects. However, more than 99% of asteroids in the solar system have never been observed.

Most asteroids are observed in circular orbits within the orbital fields of Mars and Jupiter. There are, however, some exceptions. One of these, is the object 3200 Phaethon, which was discovered by the Infra Red Astronomical Satellite (IRAS), in 1983. With a near point of 0·14AU (AU = 1 astronomical unit – distance of Earth from sun) from the sun and a far point of 2·4AU, the object behaves more like a defunct or burnt-out comet, which has lost its cover of ice from repeated orbits around the sun.

Distribution in the Asteroid Belts

Approximately 95% of asteroids move in well-defined circular orbits between Mars and Jupiter. Instead of these asteroids being present uniformly within this region, they are found to occupy specific 'resonance' positions, and be excluded from specific zones or gaps, called Kirkwood gaps.

The orbital period of objects in the solar system is proportional to the radius of orbit

Resonance Group	Resonance Orbit (fraction of Jupiter period)	AU Orbit
Trojans	1/1	5·2 (Jupiter)
Thule	3/4	4·4
Hilda	2/3	4·1

Table 1. Specific group resonances of asteroids between Mars and Jupiter.

Photo 5. Picture of the asteroid Gaspara, taken by the Galileo craft while en route to Jupier.

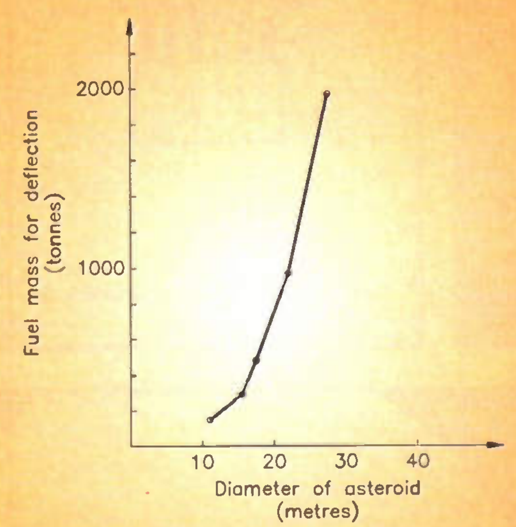


Figure 3. Relative amount of fuel required to move asteroids a distance equivalent to an Earth radius.

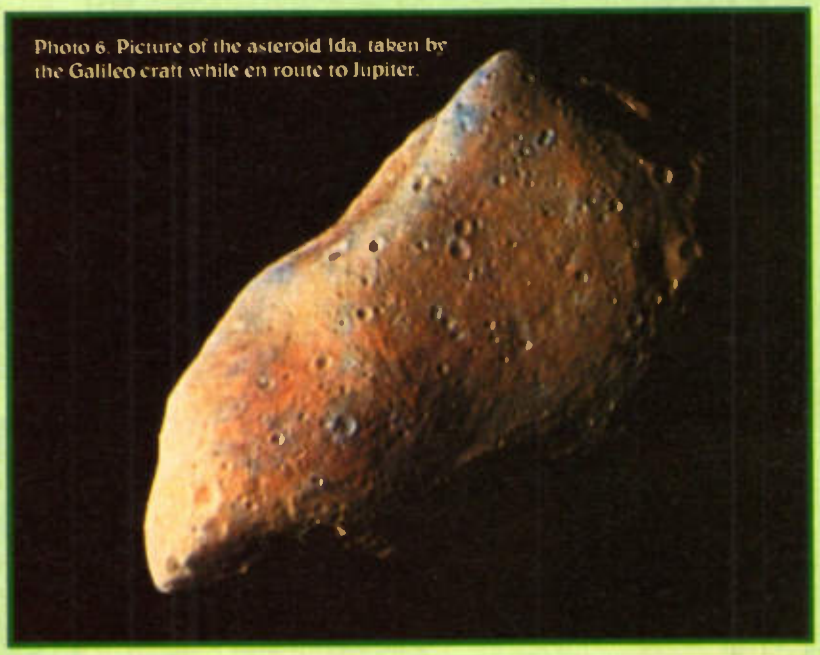


Photo 6. Picture of the asteroid Ida, taken by the Galileo craft while en route to Jupiter.

Gap (fraction of Jupiter period)	AU Orbit
1/4	2·09
2/7	2·29
1/3	2·5
2/5	2·88
3/7	3·02
1/2	3·35

Table 2. Kirkwood gaps in asteroid belt between Mars and Jupiter.

to the power of 1·5. Thus, the ratio of orbits for objects at Mars' orbit (1·5AU) to that at Jupiter's (5·2AU), is approximately 6·5. If asteroids were initially uniformly distributed between Mars and Jupiter, they would experience gravitational 'tugs' on them from the two planets. Through time, this has acted to concentrate asteroids into specific resonance zones – and exclude them from others, although the workings of this mechanism are not yet fully appreciated. Table 1 indicates the zones of concentration and associated nomenclature of groups of asteroids between Mars and Jupiter.

Table 2 indicates the relative positions of the so-called Kirkwood gaps – discovered by US astronomer Daniel Kirkwood, in 1866.

Asteroids Observed

The moons of Mars – Phobos and Deimos, are considered to be captured asteroids. The Viking mission of the late 1970s, sent back the first close-ups of asteroid bodies – revealing objects with numerous craters, indicating a turbulent and eventful history. The surface of the highly cratered Phobos is shown in Photo 4.

The Galileo craft, while in transit to Jupiter, has sent back pictures of Gaspara, shown in Photo 5, and Ida, see Photo 6. There was considerable surprise when a small moon – only a few metres in diameter, was observed to be in orbit around Ida. This posed a new problem for those that name asteroid bodies.

It is considered that the orbit of Phobos is unstable in Mars' orbit, and that at sometime in the not too distant future, it will impact on the Martian surface. Future scientific missions which venture to Mars, will no doubt seek for evidence of asteroid impacts on the planet surface over the life of the planet. If such impacts were too numerous, this could have thrown a spanner in the works of evolution of life forms on Mars.

The Near-Earth Asteroids

Asteroids which can pass inside the orbit of Mars are said to be near-Earth asteroids. The Amor asteroids occupy orbits between 1·017AU and 1·3AU. While this definition would exclude any objects from this group crossing Earth's orbit, gravitational interaction with Earth can significantly perturb orbits of individual members, and bring them temporarily inside Earth's orbit. While the Amor asteroids are on the edge, as it were, of Earth contact, the Apollo and Atens asteroids deeply cross Earth's orbit.

Density of asteroid material	3,000kg/m^3
Exhaust velocity of rocket	4·5km/s
Mass of Earth	5·983 × 10^{24}kg
Mass of sun	329,390 × Earth
Distance of Earth from sun	149·1 × 10^{6}km
Radius of Earth	6,378km
Gravitational constant	6·673 × 10^{-11}

Table 3. Data for calculation of asteroid deflection data.

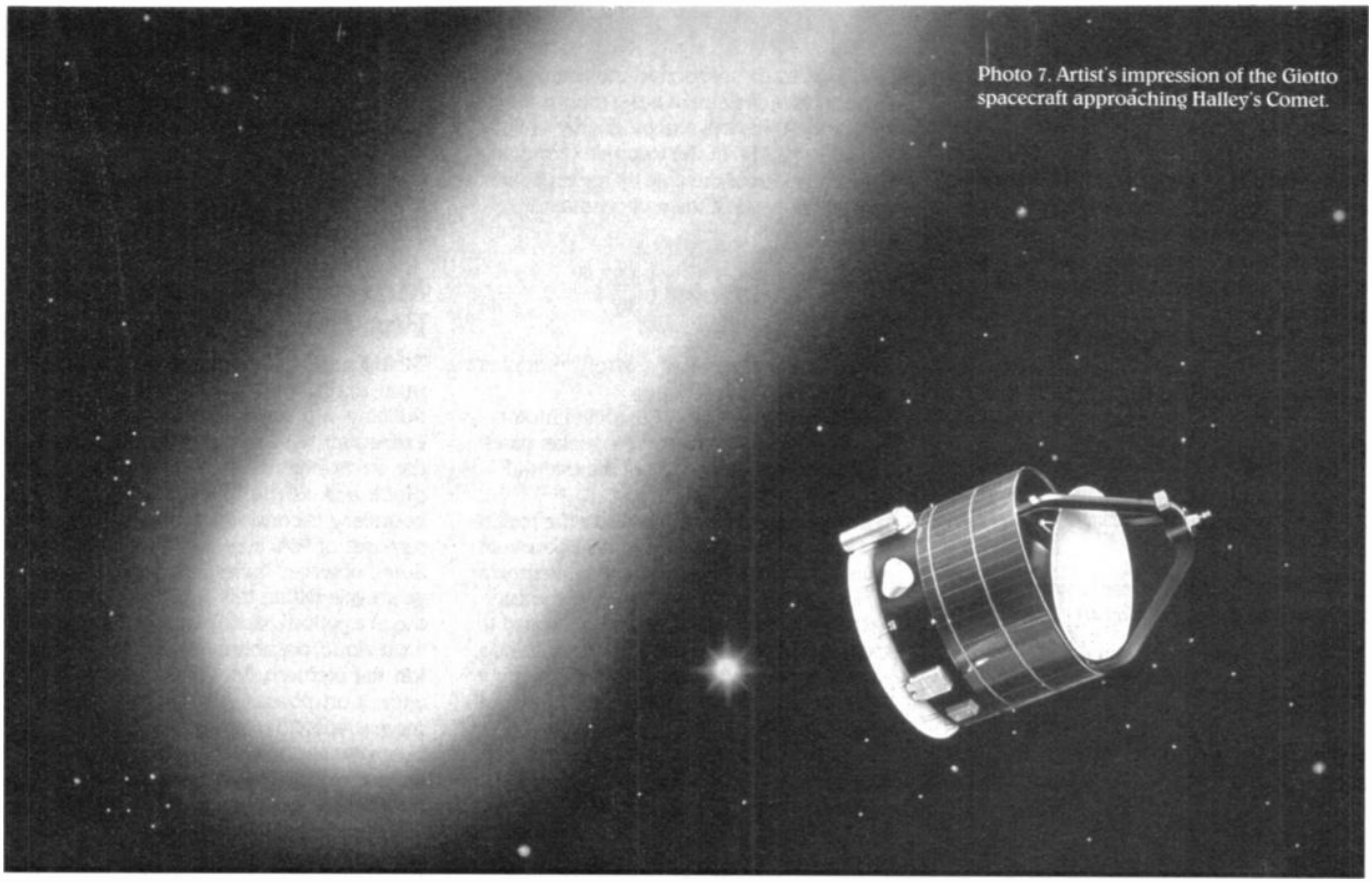


Photo 7. Artist's impression of the Giotto spacecraft approaching Halley's Comet.

The Apollo group, whose first member is 1882 Apollo, was discovered in 1932, by the German astronomer, Karl Wilhelm Reinmuth. It is perhaps not very reassuring to know that 1882 Apollo was 'lost' shortly after its discovery, and not 'rediscovered' until 1978 – during which time, it must have made numerous orbits around the sun. So far, over 40 members of the Apollo group have been identified, although it is estimated that over 700 Apollo asteroids exist with diameters in excess of 1km.

The first member of the Atens group was 'discovered' in 1976, by E. F. Helin of the USA, and named 2062 Atens. The Atens group has a smaller number of estimated members – around a hundred with diameters in excess of 1km. Of the Atens group, only six have been identified.

In many ways, it is quite a surprise that an asteroid group as significant as the Atens group was discovered only as recently as 1976. It is not inconceivable that other groups have yet to be identified. Part of the problem of identification of asteroids, however, is the low levels of light reflected from such relatively small objects, and the large volume of space which they may occupy. For many amateur observational groups, this, however, adds to the excitement of discovering a previously unknown asteroid.

Earth Watch Programmes

Two specific programmes are in place to detect near-Earth orbit asteroids. One programme is based at the Kitt Peak National Observatory in Arizona, and is operated by the University of Arizona. Another is based at the Siding Spring Observatory in Australia.

On 18 January 1991, two astronomers at Kitt Peak, observed a faint streak on a CCD camera image. By observing the image for 4·5 hours, it was possible to determine that the object was a small asteroid of probably 10m diameter, whose orbit had carried it to within 170,000km of Earth – less than half the distance between the moon and Earth. Had the object hit Earth, it would have released energy equivalent to 40kilotons of TNT being exploded.

It has also been possible to use Earth-based radio telescopes to obtain images of Earth-approaching asteroids. An interesting set of images has been obtained, by the NASA radar telescope facility, of the asteroid Toutatis. This object is one of the most irregular-shaped objects in the solar system, and is considered to consist of two large pieces of rock, held together by gravity. The fragments are estimated to be roughly 5km across, and 2·6km across.

In 1989, the object 1989FC passed within 700,000km of Earth – around twice the distance between the moon and Earth. The object was estimated to be around 1km in diameter, so a collision would have been highly undesirable. If it had struck Earth, it is estimated that it would have left a crater of some 10km diameter on land. The object 1989FC, was only observed after it had made its close encounter. This was largely because it approached from the sunward direction, which made observation difficult.

Comets

Comets are considered to be 'space snowballs' – typically, a rocky core covered with layers of ice and dust.

From the point of unpredictability, it is possible that perturbations of comet objects in the Oort cloud could send a comet in the direction of the sun and the planets of the solar system. As seen from the destructive power of the Levy Shoemaker comet, such apparently 'soft' objects can wield awesome destructive potential when they impact at high velocity onto a planet surface.

The best-known comet, is Halley's Comet. The successful Giotto mission mounted by the European Space Agency, was able to fly within 600km of the comet on 14 March, 1986. An artist's impression of the Giotto craft is shown in Photo 7. Details of Halley's very dark, peanut-shaped nucleus with sunlit streams or vents, is shown in Photo 8. It is likely that comets contain an exotic collection of molecules, scoured from vast distances of travel around the sun.

Asteroid and Comet Deflection

The appearance of objects such as 1989FC, has revived interest in devising the capability to destroy or remove asteroids from threatening orbits, or which were on a collision course with Earth. Even some very basic observations, however, indicate that this approach is unlikely to be very useful with available propulsion systems. Table 3 (see previous page) indicates some various parameters and constants used.

An object in orbit around the sun, has an absolute energy based on its kinetic (motion) energy, and its gravitational potential energy relative to the sun. For an object in circular orbit, this is expressed by:

$$E = \frac{1}{2} mv^2 - \frac{GmM}{r}$$

Where:
m is the mass of the object in orbit around the sun.
v is the velocity of the object.
r is the distance of the object from the sun.
M is the mass of the sun.
G is the universal gravitational constant.
E is energy of mass m, in orbit around the sun.

Figure 1 indicates the two aspects of energy, kinetic and potential, as a function of distance r from the sun, and as a function of r of unit kg mass. The total net energy of a kg mass at Earth orbit with respect to the sun, is of the order of $-4{\cdot}4 \times 10^8$J/kg. The net contribution from the kinetic energy of unit mass, based on an orbital velocity around the sun at Earth orbit of 29,770m/s, is $4{\cdot}4 \times 10^8$J, and that from the gravitational energy is $-8{\cdot}8 \times 10^8$J. As r becomes larger and larger, then the energy of objects approaches zero. Objects with net positive energy which enter the solar system, e.g., comets, can orbit around the sun, and eventually leave the system. Assuming the object is in a stable circular orbit, then where the centrifugal force in orbit is balanced by the gravitational attraction, is given by:

$$\frac{mv^2}{2} = \frac{GmM}{r^2}$$

Using this result in the previous equation,

$$E = -\frac{GmM}{2r}$$

If an object is given more energy, dE, to increase the value of r by dr, then this is given by:

$$dE = \frac{GmM\ dr}{2r^2}$$

Evaluating the term at Earth's orbit for a 1kg mass:

$$dE = 0{\cdot}00296dr$$

Thus, for an object at a distance of *1AU* from the sun (i.e., at Earth distance), to increase its distance from the sun by 1m, this will require *0·00296j*. In comparison to the energy field at the surface of Earth, if a 1kg mass is raised by 1m, then this will require energy of 9·81J – a ratio of 3,314. In the example of moving an asteroid out of the way by rocket power, use can be made of the rocket equation:

Where:

$$v = v_e \,.\, Log\left(\frac{Mi}{Mf}\right)$$

Mi is the initial mass of asteroid + rocket motor + fuel.
Mf is the mass of asteroid + rocket motor.
v_e is the exhaust velocity of the rocket gases.
v is the change in velocity of the asteroid.

In this example, it is assumed that the rocket and fuel can propel the asteroid like a train shunting a wagon out of the way, as shown in Figure 2. No matter how massive the asteroid chosen, it is always going to be moved to some extent. In terms of moving asteroids a 'useful' distance, it is appropriate to select a value of the radius of Earth, a distance of some 6,378km.

In order to move a 1kg object this distance, an energy of approximately 20kJ will be required. Figure 3 shows the amount of fuel that will be required to move asteroids of specific diameters this distance. It would require a vast store of fuel, some 5,000 tonnes, to shift even an object of 40m diameter a useful distance – assuming that it could be intercepted on its orbital path to allow attachment of the rocket drive system. This should be seen against the great difficulty at present, to shift objects of 100 tonnes into space. It is abundantly clear that the technology is not available to 'nudge' even small objects out of threatening other objects' way.

Mass Extinctions in the Fossil Record

Table 4 summarises the episodes of probable mass extinction, as accepted by current thinking. It is considered that most of these extinctions have followed from a cooling of the environment. The extinction that took place across the Triassic/Permian time boundary, is considered to have caused the removal of 96% across all types of species. Some observers have identified a 26 million year cycle within this data, and have linked this to a periodic disturbance of comets in the Oort cloud, possibly caused by the companion star Nemesis. Modern thinking of such extinction phases, however, is becoming more subtle. After a major extinction, whole new species rapidly evolve and establish themselves, and become better adapted to the environment.

Most work has been undertaken trying to determine aspects of the relatively recent Palaeocene/Cretaceous extinction event, which apparently removed the dinosaurs from their dominant reign. It is considered

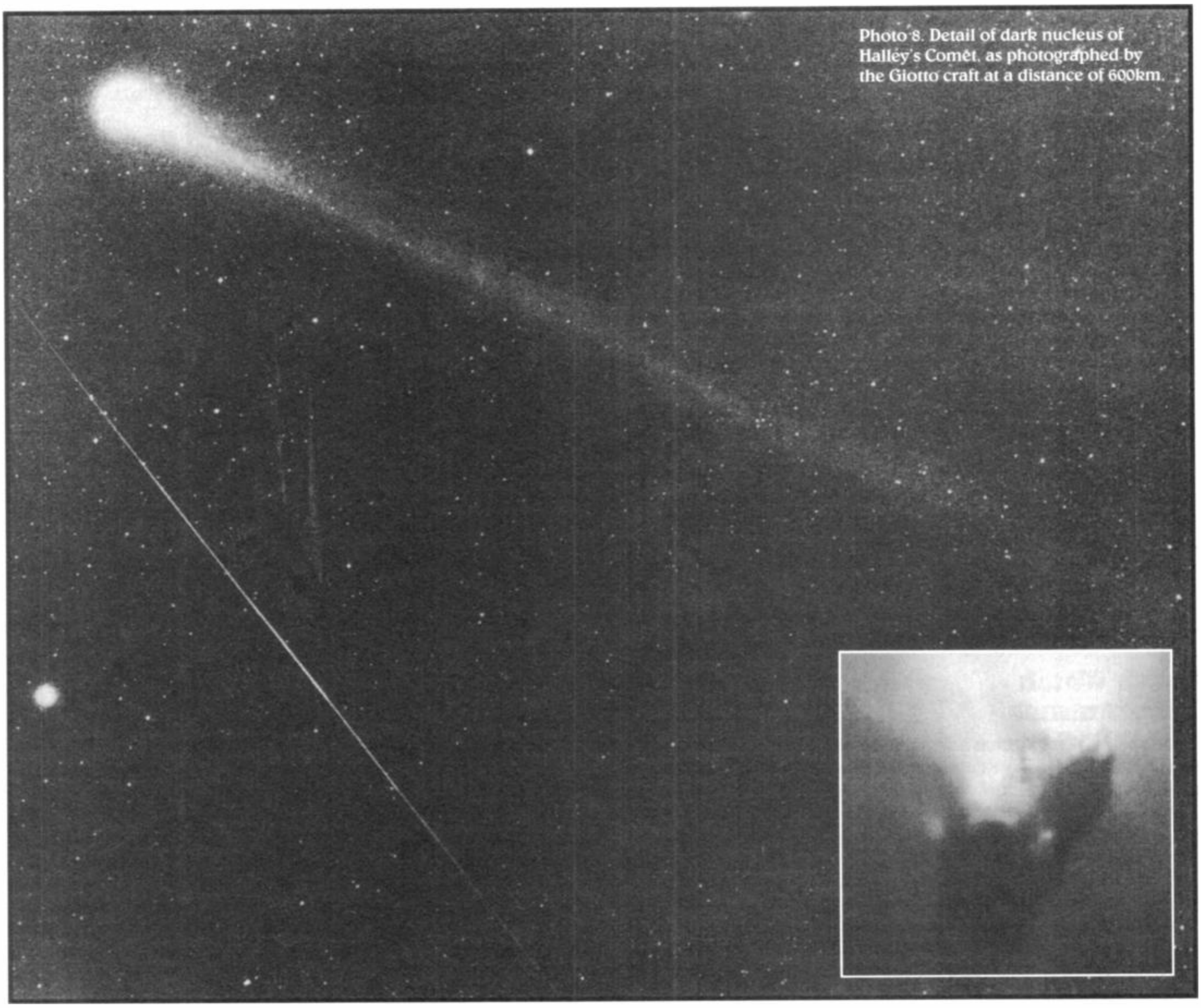


Photo 8. Detail of dark nucleus of Halley's Comet, as photographed by the Giotto craft at a distance of 600km.

Geological Transition	Millions of Years
Palaeocene/Cretaceous (KT Event)	65
Jurassic/Triassic	208
Triassic/Permian	245
Mississippian/Devonian	362
Silurian/Ordovician	510

Table 4. Summary of probable episodes of mass extinction.

that this extinction was probably caused by an asteroid which crashed into the Yucatan peninsula in central America.

Finding the KT Crater

The term, KT crater, has been adopted to refer to the asteroid/comet crater, which is considered to be responsible for the mass extinction episode some 65 million years ago. The ocean floors are subject to a process of continual subduction into deeper layers of the mantle. It has been estimated that if the KT crater was formed on the ocean floor, there is a 20% chance that traces of it no longer exist, due to its remelting in the depths of the earth.

Numerous teams of researchers have been 'looking' for the crater, and a team led by Professor Walter Alvarez at the University of California at Berkeley, claim to have pinpointed its precise location, at around longitude 89·5° East and latitude 21° North, close to the town of Merida due south of New Orleans, across the Gulf of Mexico.

If the fossil record is examined at all points round the world where it can be still identified, there is a consistent Iridium anomaly – a sharp increase in the concentration of the element – suggesting an extraterrestrial impact. In sites progressively closer to the Yucatan, such as in North West Mexico, the KT boundary layer contains shock-metamorphosed quartz, impact spherules and fused silica, in the form of ragged glass nodules. All these suggest asteroid/comet impact.

The size of the KT crater is estimated to be some 150km in size. In colliding with Earth, the KT object, estimated to be 10km in size and travelling at between 11 and 80km/s, would penetrate up to 10km below the earth, releasing vast amounts of heat energy in the process, and ejecting large amounts of material into the atmosphere. It is considered that the object struck in fairly deep ocean waters, and sent out waves of water kilometres high to surrounding lands, disturbing even deep water layers, and totally wiping out large surface life-forms on any adjacent land surfaces. For an impact of this type, the crater formed would always tend to be circular, irrespective of the angle of incidence of the object to the surface. This is consistent, with observations of the surfaces of the moon and Mercury.

Summary

In being aware of the cataclysms of the past, it is useful to think of practical ways of minimising the risk of intruders from the skies. There would be a very high price to pay for any impact on such a highly developed world as we now live in. It is clear, that the space technology is not yet available to do much more than track trajectories very carefully, and evacuate centres of population. In the modern global village in which we now live, however, there is the potential for mass hysteria and panic. Also, in looking at previous data, much depends on the closing velocity and impact of colliding objects. Impact craters less than 100km in size do not appear to be associated with mass extinction events. E

Further Reading

Target Earth: Asteroid Collisions, Past and Future, Jon Erickson, Tab Books.

The Miner's Canary: Unravelling the Mysteries of Extinction, Niles Eldredge, Virgin Books.

The Search for the KT Crater, Walter Alvarez, Science and the Future, Britannia Year Book 1993.

The Nemesis Affair, Davis M. Raup, W. W. Norton, New York.

Mass Extinctions, Processes and Evidence, Stephen K. Donovan, Columbia University Presses.

Credits

Photographs 1, 2, 3, 4, 5, 6 & 8, courtesy of NASA. Photograph 7, courtesy of The European Space Agency.

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Establishing a new University

A PRACTICAL GUIDE TO MODERN DIGITAL ICs – *Continued from page 31.*

drops) a typical loaded value of about 3·5V and can source fairly high currents into an external load.

Conversely, when the circuit's input is at logic 1, Q1 is disabled, allowing Q2 to be driven on via R1 and the forward-biased base-collector junction of Q1, thus driving Q4 to saturation, and simultaneously cutting off Q3; under this condition, Q4 gives an active pull-down action, hence can sink fairly high currents, and the output takes up a typical loaded value of 400mV. Note that (ignoring external load currents) the circuit consumes a quiescent current of about 1mA in the logic 1 output state, and 3mA in the logic 0 output state.

Thus, the basic TTL inverter can only be used with a 5V supply, has a very low input impedance, consumes up to 3mA of quiescent current, has an output that does not switch fully between the two supply rails, and can source or sink fairly high load currents. Typically, a single basic TTL stage has a propagation delay of about 12ns.

Basic TTL Circuit Variations

There are five very important variations of the basic TTL 'inverter' circuit of Figure 15. The simplest of these is the so-called 'open collector' TTL circuit, which is shown in basic form in Figure 16. Here, output transistor Q3 is cut off when the input is at logic 0, and is driven on when the input is at logic 1. Thus, by wiring an external load resistor between the 'OUT' and '+5V' pins, the circuit can be used as a 'passive pull-up' voltage inverter, that has an output which (when lightly loaded) switches almost fully between zero and the positive supply rail value. Alternatively, it can be used to drive an external load (such as an LED or relay, etc.) that is connected between 'OUT' and a positive supply rail, in which case, the load activates when a logic 1 input is applied.

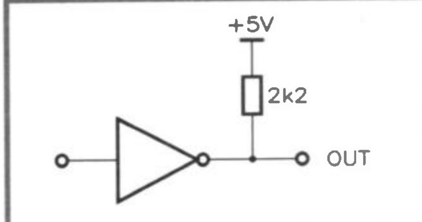

Figure 20. An external 2k2 pull-up resistor connected to the output of a totem-pole stage pulls the output to almost +5V in the logic-1 state.

The second variation is the non-inverting amplifier or buffer. This is made by simply wiring an additional direct-coupled inverter stage between the phase-splitter and output stages of the standard inverter. Figure 17 shows an 'open collector' version of such a circuit, which can be used with an external resistor or load; in this example, Q4 turns on when a logic 0 input is applied.

Figure 18 shows a major TTL design variation. Here, the basic inverter circuit is used with a triple-emitter input transistor to make a 3-input NAND gate, in which the output goes low (to logic 0) only when all three inputs are high (in the logic 1 state). In practice, multiple-emitter transistors are widely used within TTL ICs; some TTL gates use an input transistor with as many as a dozen emitters, to make a 12-input gate.

A further variation concerns the use of a 'tri-state' or 'three-state' type of output, which incorporates additional networks, plus an external ENABLE control terminal, which in one state, allows the totem-pole output stage to operate in its normal 'logic 0 or logic 1' mode, but in the other state, disables (turns off) both totem-pole transistors, and thus gives an open-circuit (high impedance) output. This facility is useful in allowing several outputs or inputs to be shorted to a common bus or line, as shown in Figure 19, and to communicate along that line by ENABLING only one output and one input device at a time.

The final circuit variation is an 'application' one, and concerns the use of an external 2k2 'pull up' resistor on a totem-pole output stage, as shown in Figure 20. This resistor pulls the output (when lightly loaded) up to virtually the full +5V supply value when the output is in the logic 1 state, rather than to only +3·5 volts; this is sometimes useful when interfacing the output of a TTL IC to the input of a CMOS IC, etc.

The '74' Series of Digital ICs

TTL IC technology first hit the electronics engineering scene in a big way in about 1972, when it suddenly arrived in the form of an entire range of versatile and cleverly conceived digital ICs, that were each designed to operate from a single-ended 5V supply, and to directly and easily interconnect with each other without hassle (each output was capable of directly driving several inputs), thus making it relatively easy for any moderately competent engineer to design and develop fairly complex digital logic circuits. It was an instant and brilliant international success, and almost immediately became the world's leading IC logic system. Its ICs were produced in both commercial and military grades, and carried prefixes of '74' and '54', respectively; the commercial product range rapidly became known simply as the '74-series' of ICs.

Over the years, the '74' series of ICs has progressively expanded its range of devices and advanced its production technology, so that today, the '74-series' is as popular and versatile as ever, and is available in a wide variety of TTL and CMOS sub-families. The next instalment of this new 'Practical Guide' series will take a deeper look at the '74' sub-families of ICs, and explain their basic usage rules, etc. E

Following the success of LIVE '94, Britain's most exciting consumer electronics event will be held this year at Earls Court, for six days. LIVE '95, will take place between Tuesday 19th and Sunday 24th September 1995.

The show will embrace the whole spectrum of entertainment, and in excess of 200,000 visitors will be allowed to gain a hands-on, fully interactive preview of the very latest consumer electronics. There will be a Multimedia Village to cater for the huge interest in this market, with Apple, BT, Compaq, Mercury, Microsoft, and Nintendo among the big names scheduled to appear. Audiophiles, meanwhile, will find their seventh heaven amongst the manufacturers of top-flight stereo systems, in-car entertainment (ICE) from makers such as Alpine, Clarion, Pioneer and Sony, and during the weekend, there will be demonstrations of the latest in in-car audio and security, plus the ground-shaking National Sound-Off Challenge!

For those who prefer to make their own music, instruments from companies like Korg, Roland, and Yamaha will be available to try out. Each weekday evening, the contenders for the National Battle of the Bands will be strumming their stuff, with the winner being declared on Saturday afternoon.

Television and radio will be well-represented, with live broadcasts from Carlton Television, Capital 95·8FM, and Kiss 100FM will be there as the ICE radio station, with a road show. All the major manufacturers will be demonstrating satellite receivers and TV sets in all shapes and sizes. Video, home cinema, photography and those latest buzzwords (multimedia and the Internet) will also be making a strong presence, with a BT Internet Cafe for you to surf across the World Wide Web whilst supping your cappuccino coffee, and the public will be able to gain hands-on experience of the latest computers, television, video and Hi-Fi equipment, CD-i, camcorders, sophisticated cameras and accessories.

And, of course, Maplin will be there too, on stand 7535. Copies of *Electronics* and the bumper new 1996 Maplin Catalogue will be available, together with a varied selection of the many new product lines that are on offer in the new catalogue, plus a wide range of projects for the electronics enthusiast, as featured in our publications. We are looking forward to meeting you there at stand 7535!

LIVE '95 tickets are available with an adult ticket costing £8, with a discount after 5.00pm on weekdays (£2 off for adults, £1 off for children). Tickets for children (under 16) are £4. All children up to the age of 16 must be accompanied by an adult.

For booking information, First Call has set up a hot line on (0171) 396 4545 (open 24 hours). Tickets will also be available on the door, and at all 252 stations on the London Underground system in the month prior to the event, and also from the Earls Court Box Office. Earls Court is easily accessible by tube, via the District and Piccadilly Lines.

Twelve lucky *Electronics* readers need not pay a penny for admission, and can bring a friend along for free! The first twelve coupons to be drawn from the Editor's top hat(!) on 15th August will receive a double ticket by post, but will be notified by 'phone first. *Please note that all coupons received outside the stated period will be disqualified.* Good luck!

Just fill in the coupon below and send it to **'LIVE '95 Competition', P.O. Box 3, Rayleigh, Essex SS6 8LR, *to arrive between the 7th and 14th August.***

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If you do not wish to cut your copy of *Electronics* photocopies or post-cards are acceptable.

A readers' forum for your views and comments. If you would like to contribute, please address your replies to: **The Editor, Electronics – The Maplin Magazine P.O. Box 3, Rayleigh, Essex SS6 8LR, or send an e-mail to: AYV@maplin.demon.co.uk**

Dear Editor

AIR YOUR VIEWS

S·T·A·R L·E·T·T·E·R

In this issue, D. Becker, from St. Albans in Hertfordshire, wins the Star Letter Award of a Maplin £5 Gift Token, for his 'imageinative' letter.

Dear Editor,
In your June issue, the first item on the Stray Signals page equates 'image' with 'second channel' in superhet receiver operation, but I think that this is incorrect. The image effect means that the same station can be received at two different points on the set's tuning scale – hence the title. It requires the set to be retuned so that its oscillator frequency is reduced by 2×IF – often possible on SW bands, with an IF of 465kHz. Second-channel interference, on the other hand, occurs when the set, already tuned to a desired signal of frequency f_{in}, responds to a second aerial signal (i.e., the 2nd channel) that has a frequency approximately equal to f_{in}+(2×IF). Each carrier (modulation is not necessary) beats with the set's oscillator to produce a CW signal within the IF pass-band, and these two IF signals mix in the IF output demodulator to produce an audio signal – the familiar whistle. If f_{osc} is changed a little, by slightly retuning the set, one IF signal frequency reduces and the other increases by the same amount, thus altering the whistle pitch. When measuring image rejection with a signal generator, the requirement to retune the set usually alters the set's aerial sensitivity, so there could be several dB difference between the measured image and 2nd channel rejection figures. (For the 2nd channel measurement, the set tuning is unaltered, and the sig. gen. frequency is increased by 2×IF). In the example quoted in the article, with a 5MHz aerial input signal and an IF of only 30kHz, in the absence of any other aerial signal, there could be no 2nd channel interference, but I'm sure that the one 5MHz signal could be tuned in at two points on the set's tuning scale (i.e., the image effect). It is umpteen years since I was involved in radio set design and testing (back in the days of valves!), but I think I've remembered the facts correctly.
D. Becker, St. Albans, Herts.

The Stray Signals in question is referring to a pre-war (from a 1925 book!) description of image frequency, when it was also known as the 'second channel'. Of course, you are correct in pointing out that, post-war at least, image effect and second-channel interference are terms used to describe two separate phenomena in radio operation. Terminologies change over the years, and the circuit shown in the article was in fact, an 'autodyne', a term that has passed into distant memory! Other examples of this sort of thing exist, for instance, it was once assumed that current flow was from positive to negative, which we now refer to as being 'conventional current flow', whereas we have realised that it actually flows the opposite way around, i.e. from negative to positive. And of course, the Earth used to be though of as being flat!

Take Your PIC . . .

Dear Sir,
In Air Your Views in the July edition, the Star Letter from Paul Tuff was about PIC microcontrollers. As you are aware, he wanted a cheap way to program them. Well, you must have seen the serial method of programming the PIC 16C84, and the freely available software to do it. The hardware can be built for about £5, and a super programmer complete with box, for under £20. The author of the software and hardware diagrams is David Tait, e-mail **david.tait@man.ac.uk.** It is really good! I notice that your RS232 Serial Line Tester uses a 16C84, so how did you program that?
Steve, sma2@student.open.ac.uk

PICture This . . .

Dear Editor,
Your reply to the sender of the Star Letter in the July issue of the Maplin magazine surprised me. A couple of low-cost PIC programmers are available on the Internet, on Andy Errington's PIC page. The URL of Andy's page is: **http://www.lancs.ac.uk/people/cpaame/pic/pic.htm** I made the programmer designed by David Tait.
Peter Morton, Ryton, Tyne and Wear.

Thank you both for sharing the source of the details on the low-cost PIC programmers, which will probably be very useful to those readers with access to the Internet. The RS232 Serial Line Tester concept originated from an 'outside' designer, Robin Downs, who also devised the program for the PIC that this project is based on. Our in-house project developer for this piece of test gear, Dennis Butcher, was allocated the job of 'breathing on' the project in order to optimise its design for kit production.

Off the Wall!

Dear Sir,
I would like to blend my satellite dish in with the colour of my brick wall. The dish is black, and although it is mostly for cosmetic reasons, it would help to camouflage the dish seen from outside of my garden, namely, the road, from would-be thieves. Will spraying the dish with a spray paint impair the reflective properties of the dish, and reduce the picture quality?
R. E. Howes, Bromley, Kent.

Assuming your satellite dish is for the reception of satellite TV broadcasts, then there is no need to be too concerned about its reflective properties, as it is only taking in a (microwave) signal rather than bouncing one back over a large distance. A thin coating of aerosol-type spray paint would not have any detrimental effect on the reflection of the signal to the focal point of the dish, and there would be no undue effect on the picture quality; the dish manufacturers painted it, after all. However, before you rush out to the paint supplier, there are/soon will be special fabric covers available (recently featured on TV), in various brick-effect patterns/colours, and even hanging-basket floral effects(!), specifically for the camouflage of dish aerials, and which are claimed to be very easy to fit. Alternatively, you could mount the dish high up on the wall, out of the reach of thieves without ladders/stilts, or paint the entire wall black to match the dish!

Mounting Difficulties

Dear Editor,
I would like to congratulate you on a brilliant magazine, as it has helped me along on many a project. I would like to ask you why your catalogue does not sell any Hi-Fi sized boxes. I have made quite a few audio projects that would look much better in a proper box that would fit in with the rest of my Hi-Fi system. I realise that you do sell the 19in. rack system, but they are very expensive, and you really do need to buy one of the rack cabinets to put them in, which puts the price up a lot. My latest project involves one of your 10-segment LED bargraph arrays (YH76H). All was going well, until I tried mounting it! I found that it was almost impossible to mount nicely. In the end, I found that if you drilled off the three plastic lugs at the back, you can then take off the front piece. This allows you to make a 4×60mm rectangular hole (in the project casing – Ed.), then you can put the back of the front piece through it, and superglue the back PCB part of the bargraph on, sandwiching the box in between. It would be an idea to paint the edge of the front piece black, so it all looks the same. If the box is metal, then you should cover up the solder terminals with a bit of electrical tape, otherwise the box will short them together. Why doesn't the manufacturer supply them with proper fixings? Everything else you get, from single LEDs to switches, has proper fixings that you can buy, so why don't these? My last point involves your technical enquiries line – please could you extend the hours that it is open?
Dan Benton, Guildford, Surrey.

Thank you for your comments and suggestions. The problem is that there are so many different makes of Hi-Fi equipment, all with their own casing styles, textures, colours, and sizes, that trying to stock matching housings would be unfeasible. However, a cost-effective way of obtaining a Hi-Fi sized case would be to purchase a cheap, damaged stock unit and relieve it of its innards, or to purchase a (possibly defunct, but with a good case) second-hand one from a car boot sale or similar. Alternatively, if you are good at carpentry/metalwork, you could fabricate your own case from plywood/metal, and cover it in a suitable vinyl coating (e.g., XR95D/96E, or XS05F/06G), or paint, varnish, etc., allowing you to custom-design it to exactly the right size and appearance. Look out for the new Maplin Catalogue, due out in September, for new types of cases being offered, amongst many other new lines. Regarding the LED bargraph array, both its bezel and PCB have holes drilled for mounting screws, which could be of the black anodised type to match the bezel/case colouring, or you could use black plastic 'rivets' to secure it. Alternatively, you could hide the bargraph array behind a display filter (such as FR34M) incorporated into the casing, so that you would only see the segments when they were lit, and any mountings would be 'out of sight, out of mind'. In this case, the array could be supported by the main circuit board, and positioned at the appropriate location within the casing to align with the display filter window. Obviously, each application will dictate different mounting methods, so in fairness to the component manufacturers, it is impossible to provide mountings that will please everyone! However, thank you for sharing your solution to this problem, which may well be of interest to other readers facing the same dilemma.

RIAA in Australia

Dear Editor,
I have just read Mike Meechan's article on the Audiophile preamp, 'RIAA-CD Versus Vinyl' in the May 1995 issue, and enjoyed it very much. I've been looking for an affordable, high quality M.M., M.C. phono stage for some time, and feel this design may be the answer. Is a Maplin kit and PCB available, or in the pipeline? If not, I'm sure I would not be alone in suggesting it would be a great idea. If so, what are the ordering details, code, cost, etc.? I look forward to your reply.
John O'Malley, Camperdown, Sydney, Australia

G'day, Sport! Thanks for your letter from 'down under'! Good to hear that you appreciated the RIAA article. Unfortunately, no Maplin kit is available of the amplifier you mention, although the component values are provided for you to duplicate your own. Another design of an RIAA (stereo) preamp is given in the final instalment of Mike Meechan's series, in the June 1995 issue, together with corresponding PCB legend and track diagrams, and component list including the order codes. For prices, please see the latest Maplin Catalogue. Maplin do however, stock a Velleman kit for a stereo RIAA Correction preamp, also described in the June 1995 issue, Stock Code 90014, price UK £7.99. Ordering information is provided at the front of each issue of Electronics.

NEWS Report

ISDN Set to Kill V.34 Modems

V.34 modems have been around long enough for industry commentators to begin predicting their demise. Racal has just launched a range of ISDN adaptors, which it plans to target aggressively against the V.34 market. Racal's new generation of ISDN terminal adaptors maximise data throughput, by supporting up to 64K-bit/s synchronous and 57·6K-bit/s asynchronous data formats. The DAP 6200 series offers significant advantages over high-speed and V.34 analogue modems, being one of the first ISDN terminal adaptor ranges with V120 ITU rate adaption, allowing compressed and uncompressed data transfer at speeds of up to 57·6K-bit/s.

Contact: Racal, Tel: (01734) 669969.

PC Card at the Desktop to Treble

According to figures from IDC, the number of desktop PCs incorporating PC Card sockets will treble over the next two years. Total units with PC Card drives are projected to rise by over 350%, from 1·4 million in 1995, to 6·5 million in 1997. Signs that the PC Card market is becoming commoditised come from US Robotics, who this month slashed the price of their flagship V.34 modem from £399 to £199.

Contact: US Robotics, Tel: (01734) 228 200.

BT Price Per Second

BT introduced split-second billing at the end of June. Instead of billing customers per unit, BT is now using the same cost structure as Mercury, charging in discrete 1 second intervals. BT claim this will reduced the average bill by 5%. The minimum charge remains at 5p per call.

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

How Mobile is Mobile? – Survey Results

A survey conducted by independent research firm BIS Strategic Decisions, indicates that while many of us think of mobile computing as using a laptop computer in remote locations, it is more likely to mean sitting in a meeting, in a building away from your office. BIS said a survey of 300 mobile computer users showed that nearly half use notebook computers for travelling between meetings. 43% of those surveyed travel mostly within a single city, while only 8% use a notebook computer when travelling between cities.

NEC Merge Portable with Cellular Phone

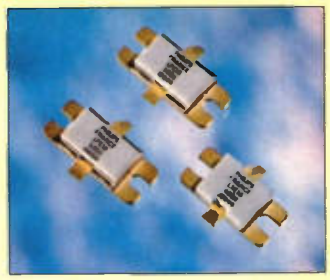
News hot off the wires from Japan, tells of the NEC Corporation which has developed a relatively inexpensive pocket-size computer equipped with an internal cellular phone, scheduled to hit store shelves sometime early next year. The new product, the first of its kind in this country, will sell for under approximately £750, and enable users to send and receive computer data virtually anywhere they go. According to NEC officials, the unit will contain word processing, telecommunications and other software programs.

Conventional portable computers and PDAs do not include phone functions. Users must connect the units to cellular phones when sending or receiving data on the road. Sharp currently holds approximately 80% of the domestic pocket computer market. However, industry analysts predict that the introduction of NEC's new product will increase its market share considerably.

Cellular Networks Catalyst for Chipset

The growth of mobile networks in the USA and throughout Europe is being limited by the spread of cellular base stations. Designers are faced with two options – either increase the number of base stations across the country, or make existing stations more powerful, enabling greater geographic coverage. The latter option is the most sound. Fewer base stations with greater power per station limits infrastructure costs, and is the preferred environmental option. The problem is that until now, the technology has not been available to produce adequate power at cellular frequencies to enable a wide geographic spread of workstations.

However, this could change. Philips Semiconductors has extended its range of silicon bipolar microwave power transistors, to include devices with the high- frequency and high power capabilities required by new digital cellular telephony. The new LXE18400X and LFE18500X microwave transistors, which are designed for common-emitter class-AB operation in the 1·7 to 2·0GHz band, deliver load powers of 40 and 50W, respectively, from a 24V supply. They both provide low-level power gains in excess of 7·5dB, and achieve typical collector efficiencies of 42%. No other manufacturer currently offers such high output power at frequencies above 1·5GHz.



Contact: Philips Semiconductors, Tel: (+31) 40 72 2091.

Parallel Computer Systems: the Key to Business Advantage

Parallel processing has the potential to revolutionise operational systems, decision support systems and multimedia applications. This is the main message from the new report just published by Ovum, *Beyond the Data Warehouse: New Markets for Parallel Computing.* According to lead author Philip Camelly, Parallel processing can bring real business advantage. For example, database queries that took hours to process can now be satisfied in minutes.

Contact: Ovum, Tel: (0171) 255 1995.

Video Police Station

Robocop may be a futuristic vision, but Videocop is here now. When officers are unable to staff the local police station in Byfleet, Surrey, the public are put in touch with the divisional headquarters in nearby Woking, via an experimental video-conference link-up. When Byfleet Police station is not open, visitors secure access using a TelGuard entry-phone telephone link to Woking, which is staffed round-the-clock. Officers at Woking check the caller using a discreet video camera mounted above the entry-phone, before allowing entry to the building via a remote lock-switch.

Once allowed inside the Byfleet police station, visitors are able to speak directly to officers at Wokingham using a video-conferencing suite provided by BT. Forces throughout the country are watching this trial with interest. Officers at Wokingham are concerned that this is a cost-cutting exercise. "A video-screen is no substitute for real people. If someone is in need of urgent help, a video-screen is of little help", a senior officer from the Surrey Police Federation told *Electronics*.

IBM Expands Research

The IBM Research Division has announced that it will establish a third US research laboratory in early summer, in Austin, Texas. The focus of this new laboratory will initially be on advanced circuit design, and new design techniques and tools for very high-performance microprocessors.

Contact: IBM, Tel: (01705) 561780.

Apple Signs Two Major Deals to Enable Videoconferencing

Apple Computer has announced two major deals (with AT&T and the Nippon Telegraph and Telephone Corporation (NTT) of Japan) to bring videoconferencing and desktop collaboration products to market, based on Apple's QuickTime Conferencing technology.

AT&T and Apple have announced an agreement to combine QuickTime and AT&T's WorldWorx Network Services to provide Macintosh users with access to other H.320 standards-based videoconferencing products over AT&T's global wide area network. WorldWorx is designed to support a wide variety of videoconferencing devices, including room-based and desktop systems. The two companies are working together to provide voice, video and data conferencing and collaboration, both point-to-point and multipoint, to more than 27 countries worldwide, over LANs and via dial-up services.

NTT and Apple are to introduce Japan's first Apple desktop videoconferencing product, based on QuickTime and NTT's ISDN networking technology. NTT has positioned the product, the FM-A71, as an important addition to its FaceMate line of videoconferencing and collaboration solutions. It will allow users throughout Japan to collaborate from their desktops, by sharing the same screen images, using high-speed 64K-bit/s lines. Based on Apple's Power Macintosh, the product is designed to include QuickTime Conferencing software, an H.320 ISDN adaptor card and a colour video camera. The FM-A71 is expected to be available at the end of July 1995.

Apple's QuickTime Conferencing technology, announced in February this year, allows personal computer users to communicate in real time via audio, video and data. Users can also share documents, images and movies across a digital network connection. Since QuickTime Conferencing is a software-based architecture, application developers, communications providers and hardware vendors can easily develop QuickTime Conferencing-compatible solutions.

Contact: Apple, Tel: (0181) 730 2480.

New ICE Power Amplifier Minimises Power Dissipation

To reduce the size of the heatsinks required in car radios, Philips Semiconductors has introduced the TDA1561Q, a unique dual 23W audio power amplifier. It has the unique ability to automatically switch between single-ended and bridge-tied load (BTL) configurations, in response to the required output voltage swing. For typical music signals, which only require the high output powers available from a BTL amplifier for short periods of time, the efficiency advantages of operating in single-ended mode at low power level result in an overall power dissipation up to 30% lower than for a fixed BLT amplifier.

Contact: Philips Semiconductors, Tel: (+31) 40 72 2091.

Motorola Commits to PCI Mezzanine Card (PMC) Architecture

The PCI Mezzanine Card (PMC) architecture has been strongly endorsed by Motorola with the announcement of a range of new products based on the standard. Aimed at high-performance applications, the new I/0 adaptor modules bring the performance and interoperability of PCI to integrators of embedded board-level systems. Supporting high-performance networking, communications and mass storage applications, the first PMC products in the range are an ATM adaptor, a 100VG AnyLAN adaptor, an FDDI adaptor, and a high-end fast and wide SCSI-2 mass storage controller.

The PMC specification combines the electrical and logical layers of PCI with the secure mechanical mounting and high-reliability of a two-part connector necessary for reliable operation in an industrial/embedded environment. When used in conjunction with Motorola's family of PowerPC-based VME boards, the new range of PMC adaptors enables OEMs to configure systems incorporating the latest communications, networking and mass storage technology – quickly and cost-effectively. The PMC modules are supported on Motorola PowerPC boards, with software drivers for AIX 4.1, Windows NT and VMEexec.

Contact: Motorola, Tel: (01628) 29121.

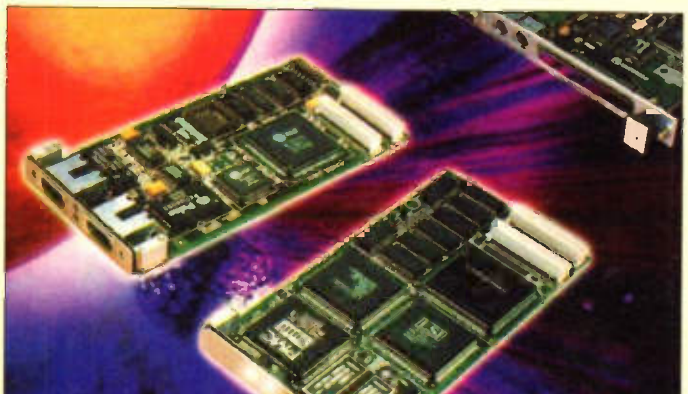
German Electronics Expects Growth

The German electronics industry federation (ZVEI) has announced that the recession in the German computer and electronics industry is over. Officers expect sales in the industry to increase 15% during the current year, and sales will continue to increase at least until the end of the century. In a statement released to the business press this week, ZVEI notes that the projected market for electronic components for the current calendar year will top the DM20 billion mark for the first time. This projection, ZVEI officials claim, is a conservative one, and the recorded 1995 figures could be even higher. The main impetus behind the sales surge is a massive increase in PC component requirements over the last 18 months.

Carrera First with P133

Carrera Technology is the first UK PC manufacturer to announce shipment of PCs based on the Pentium P133 processor. With increasing demands for high-end data processing and enhanced graphics programs, Carrera predicts strongest demand for its new PC to come from the corporate and CAD/CAM markets.

Contact: Carrera Technology, Tel: (0171) 8300 586.



Mercury Opts for Frame Relay Ahead of ATM

Mercury Communications is in the early stages of Asynchronous Transfer Mode (ATM) application trials with a limited number of major UK customers, as part of the Cable and Wireless ATM trial. Mercury announced the start of its transatlantic ATM trials in December last year, the objective of which is to fully understand the implications and benefits of ATM and the options for ATM service delivery. However, for today's applications, Mercury remain committed to frame relay as the most suitable method of implementing a virtual private data networking capability.

Contrary to the common perception, frame relay is not a low speed technology, Clive Curtis, product manager for Mercury's Managed Data Services told *Electronics*. "Mercury are currently implementing a 2M-bps access capability on MediaLink, our national Frame Relay service, and we are already planning to extend this to provide higher speed access to Frame Relay at up to 8M-bps.

"As a connection orientated service, Frame Relay delivers permanent virtual connections, offering the most elegant migration path to ATM Wide Area Services. Not only have frame relay standards gained widespread international acceptance from both Public Telecommunications Operators (PTOs) and leading Customer Premises Equipment (CPE) vendors, but frame relay services have become the de facto global service offering for high speed data networking. One of the major benefits of ATM to Mercury is that, by implementing it as a backbone technology, it will allow us to improve the performance and quality of services such as frame relay."

Contact: Mercury, Tel: (0171) 528 2547.

BT Interactive Recruits for Trial

BT today announced that it has started recruiting customers for BT Interactive TV, its trial of interactive multimedia services. The trial, which starts this summer, will involve about 2,500 customers in Colchester and Ipswich. All customers will be recruited by market research, to allow BT to achieve a representative demographic sample of the UK population, and a wide range of data will be collected about them before the service is connected.

BT Interactive TV will consist of nine main services: movies on demand, television programming on demand, children's TV, education, music videos, local life, and high street, which incorporates home shopping and home banking. In addition, there will be two services, games on demand and Adland (an interactive advertising service) introduced progressively during the course of the trial. Services are ordered and controlled via a standard remote control, and delivered to a normal television over copper telephone lines for the majority of homes, and over fibre to the remainder.

BT Interactive TV will have more than 100 service and content providers. In order to provide the movie service, the company is working with European and Hollywood studios, including Columbia/Tristar, Handmade Films, Lumiere, MCA, MGM/UA, PolyGram, Rank, 20th Century Fox, Walt Disney, and Warner Bros. BT is also working with Nintendo to finalise the games service. The local life service will be supplied by more than 50 charities and local organisations, while more than 20 advertisers have already committed to participating in Adland with interactive advertisements.

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

Radio Authority Publishes Annual Report

The Radio Authority has published its Annual Report and Financial Statement for 1994. The report gives details of the Authority's licensing and regulatory activities, and operating costs for 1994. During the year, the Authority awarded ten new local radio licences, and as part of its readvertisement programme, it awarded 33 existing licences – all but two of these were returned to incumbents. The Authority received 444 complaints about programming and advertising, compared with 391 in 1993. Of these, 44 programming complaints and 36 advertising complaints were upheld.

Contact: Radio Authority, Tel: (0171) 430 27424.

Gigabyte of Data for Mobile Users

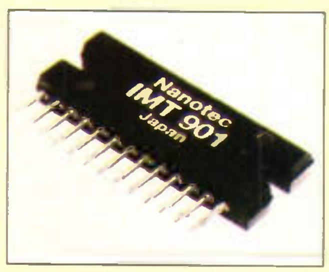
Quantum have crammed 1G-byte of data onto a 2·5in. drive. The new drive, which is expected to be positioned in the mobile PC market, incorporates two new technologies to achieve a record level of data density within the commercial market. Magneto-resistive heads and a partial response maximum likelihood (PRML) read channel enables greater density per track than existing technologies. The drive, which is expected to become commercially available in October, will hit the streets at around the £375 mark. The drive will also be available in 540, and 810M-byte formats.

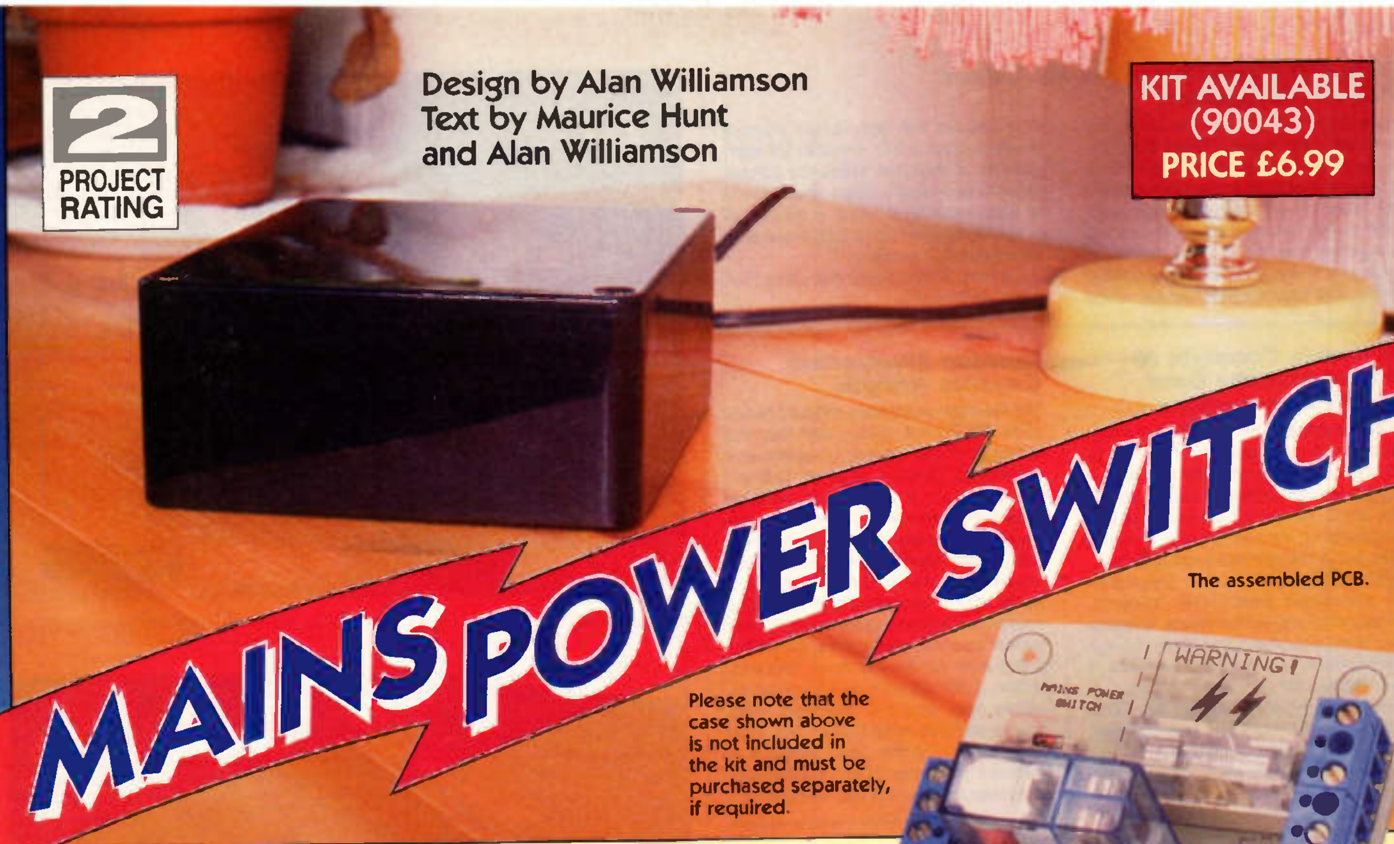
Contact: Quantum, Tel: (0171) 835 1001.

Innovative Stepping

A new stepper motor driver from Nanotec is the first discrete device to enable full, half, and quarter stepping of eight stepping modes. Previously, engineers have had to resort to software control using an 8- or 16-bit microcontroller, if they needed to drive a stepper motor at stepping angles of less than a single step.

Contact: Nanotec, Tel: (+49) 8121 79992.





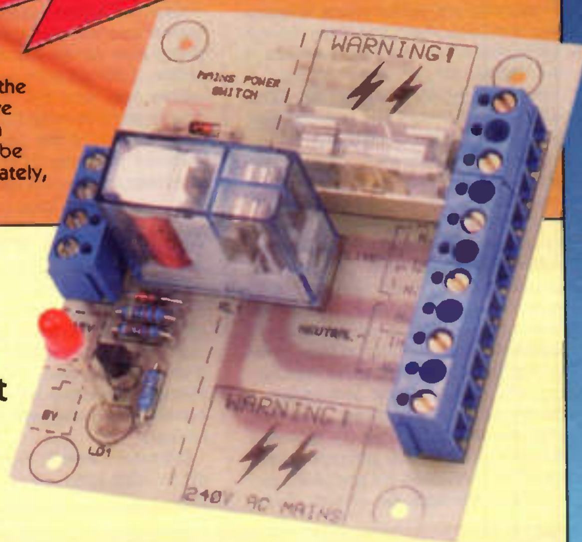
2
PROJECT RATING

Design by Alan Williamson
Text by Maurice Hunt
and Alan Williamson

KIT AVAILABLE (90043)
PRICE £6.99

MAINS POWER SWITCH

Please note that the case shown above is not included in the kit and must be purchased separately, if required.



The assembled PCB.

FEATURES

* Switched ground and switched supply inputs
* LED relay activated indicator
* Low trigger current
* Compact, versatile design
* Fuse protected output
* Reverse supply protection
* Zero standby current
* Switching of DC and AC resistive loads

APPLICATIONS

* Add-on unit for existing low-voltage projects
* Safety switching of mains via low voltage switch
* Radio/remote control receiver outputs
* Security floodlight controller – alarm or PIR sensor input

THIS project has been designed in response to the demand for a general-purpose unit that is capable of switching high current resistive loads at mains supply potential (or lower voltage DC), and which can be easily added to other low-voltage controller circuits, to provide convenient switching of resistive output loads.

Circuit Description

The block and circuit diagrams of the Mains Power Switch are shown in Figures 1 and 2, respectively, and perusal of these will assist in understanding the following description of how the circuit operates. The relay RY1, is switched 'on and off' by means of transistor TR2, which is protected from the back emf generated by the relay coil, by reverse biased diode, D4.

Transistor TR1 provides an inverter stage, allowing a ground switching input to complement the supply switching input into TR2. R5 is the current limiting resistor for the LED, LD1, which, wired in parallel with the relay coil, serves as an 'on' indicator (relay activated). The relay itself, is a double-pole, double-throw (DPDT, or 'changeover') type, specifically designed to switch the mains supply (230V AC), at currents of up to 5A (resistive), 120V AC at 5A (inductive), or a maximum of 30V DC, at 5A (resistive).

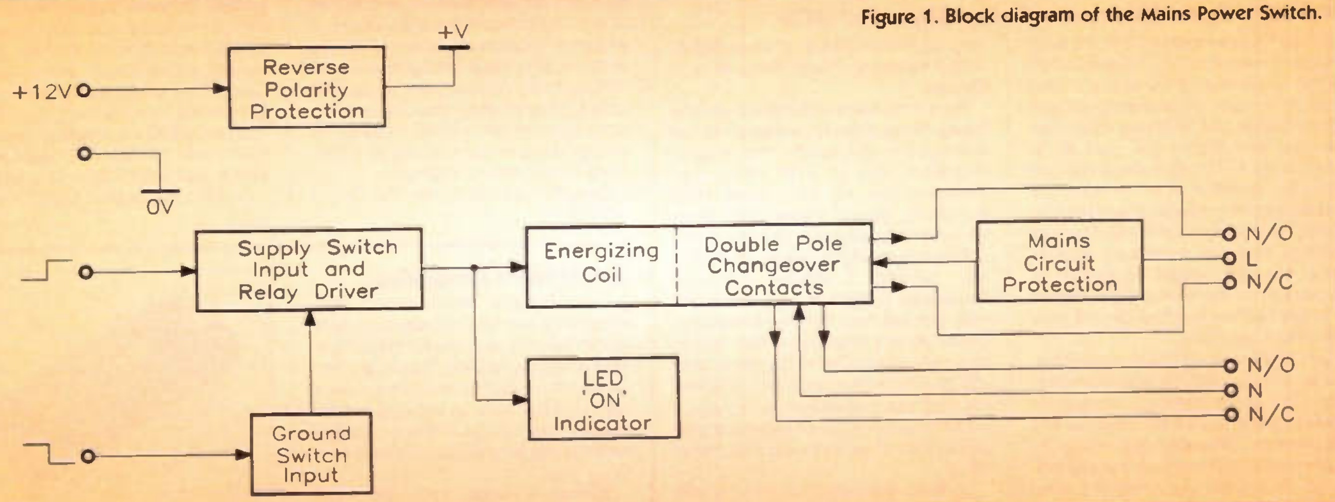


Figure 1. Block diagram of the Mains Power Switch.

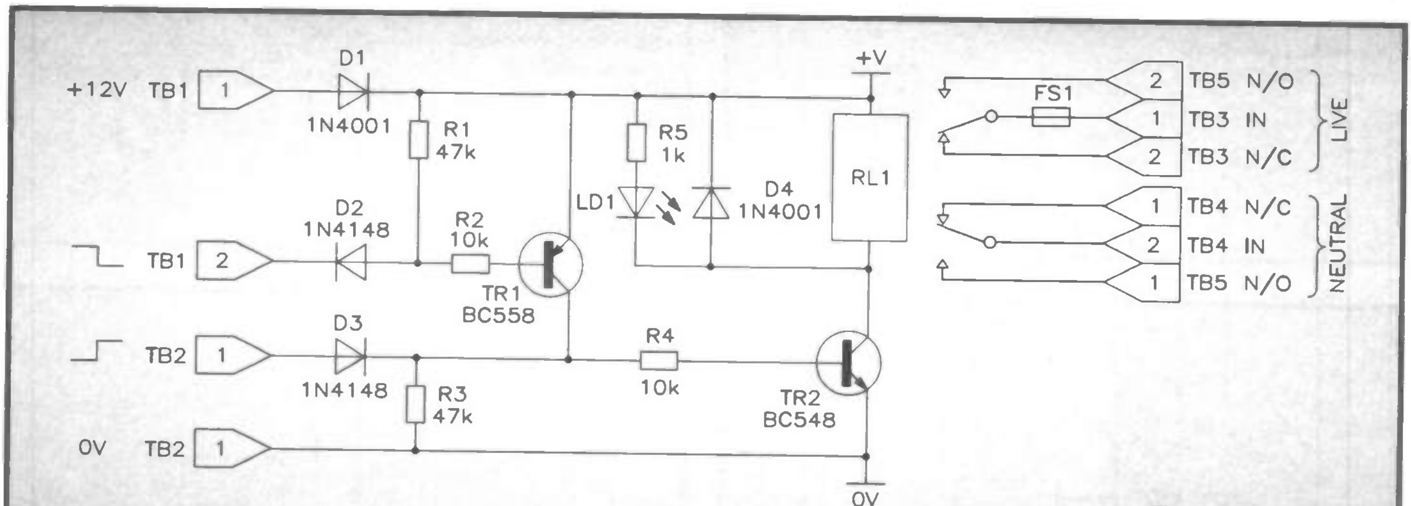


Figure 2. Circuit diagram.

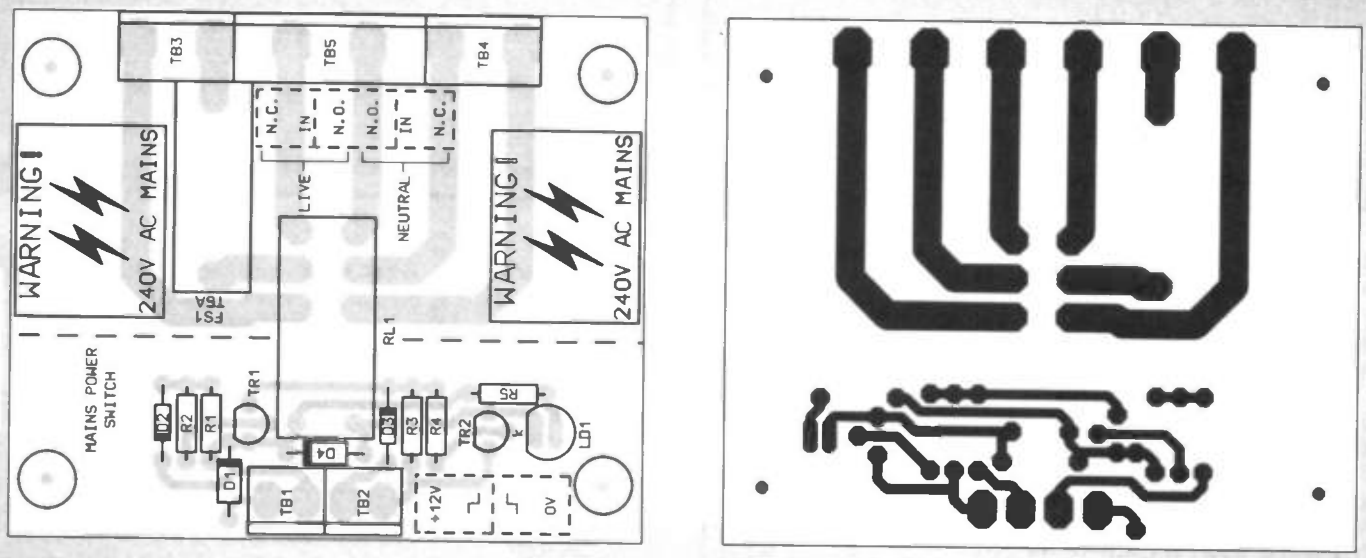


Figure 3. PCB legend and track.

Specification

Operating voltage range:	9 to 15V DC
Current consumption@9V:	40mA
@12V:	58mA (nominal)
@15V:	70mA
Trigger current:	1·3mA
Relay operating time:	15ms (release time, 7ms)
Maximum switching loads:	230V AC mains, 5A maximum (resistive)
	120V AC, 5A maximum (inductive)
	30V DC, 5A max. (resistive)
Visual indicators:	LED to show relay activation

Important Safety Note:
It is important to note that mains voltage is potentially lethal. Full details of mains wiring connections are shown in this article, and every possible precaution must be taken to avoid the risk of electric shock during maintenance and use of the final unit. Safe construction of the unit is entirely dependent on the skill of the constructor, and adherence to the instructions given in this article. If you are in any doubt as to the correct way to proceed, consult a suitably qualified engineer.

Diode D1 prevents any possible damage to the circuit that may result from accidental reversed supply polarity. The mains side of the relay is protected by the on-board 5A time-delay fuse. **UNDER NO CIRCUMSTANCES should the fuse be replaced by one with a higher current rating.**

Construction

Construction of this project is reasonably straightforward, all components being mounted on one side of the PCB, the legend and track of which are shown in Figure 3. Begin with the smallest components first, and progress through to the largest. Ensure that the diodes, D1 to D4, are installed in their correct positions, with the right polarity; this

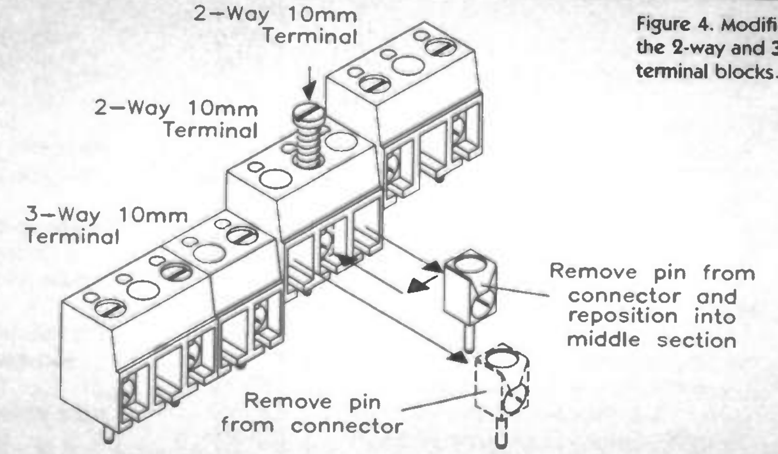


Figure 4. Modifications to the 2-way and 3-way terminal blocks.

Figure 5a. Low-voltage (supply switching) wiring.

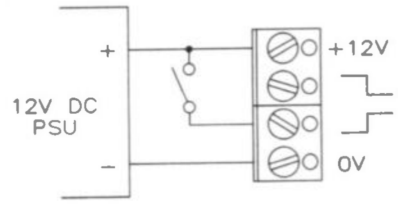
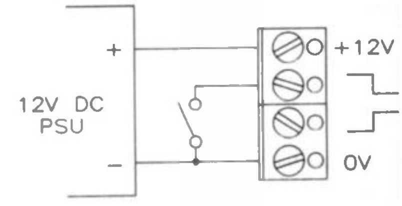


Figure 5b. Low-voltage (ground switching) wiring.



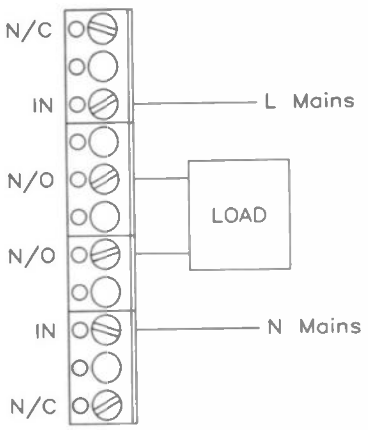


Figure 5c. Normally open output mains wiring.

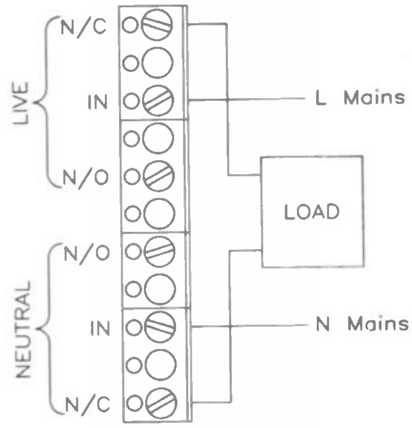


Figure 5d. Normally closed output mains wiring.

also applies to transistors TR1 and TR2. Clip the 2-way terminal blocks together prior to fitting them to the PCB, and modify one of the 2- and 3-way terminal blocks as per Figure 4.

If the 'ground switching' input is not required, the following components can be omitted from the build-up: R1, R2, D2, and TR1. The fitting of the LED (LD1) is also optional.

Thoroughly check your work for misplaced components, solder whiskers, bridges, and dry joints. Next, clean all the flux residue off the PCB using a suitable solvent, and finally, seal the PCB with conformal coating.

Testing

Apply a 9 to 15V DC (12V nominal) supply to the two outer terminals of the (now) 4-way terminal block, and on connecting a short fly lead between the +V terminal and the supply switching terminal (marked (_|¯) on the PCB), the LED should illuminate, and the relay energise. Remove the fly lead, whereupon the LED should extinguish, and the relay drop out. Reconnect the fly lead, this time, between the 0V and the ground switching input (marked (¯|_) on the PCB), and again, the LED and relay should activate. If the unit works as above, then it is tested and ready for use, once it has been installed in a suitable housing, details of which are described below.

Using the Mains Power Switch

The unit should be fitted into a suitable casing BEFORE any attempt is made to connect it to the mains supply. Any robust plastic casing will be sufficient, and the PCB must be supported on plastic mounting pillars (which may be moulded into the box) or insulating spacers. Ensure that strain relief grommets are used where cables pass through holes in the housing, to avoid the risk of them chafing through and shorting out.

Figures 5a to 5d show the various wiring configurations possible with this unit. Figures 5a and 5b provide the low voltage supply- and ground-switching wiring, respectively, whilst Figures 5c and 5d give the relay output mains wiring, for normally open and normally closed operation, respectively. Take care to ensure that mains wiring to the unit is carried out in accordance with these diagrams, to avoid the risk of shorting out of the mains as the relay switches over. Use only the correctly rated, insulated mains cable for the output wiring, if switching at mains potential, and take care to clamp the stripped ends of cables securely into the terminal blocks, with no extraneous strands of wire protruding. The maximum load that can be switched is stated in the Specification table; if this is exceeded, the fuse, FS1, will blow. Do not use the unit outdoors, or anywhere else where there is a risk of the circuitry getting damp, such as bathrooms, kitchens, etc., unless it is fitted into a totally sealed, waterproof enclosure.

MAINS POWER SWITCH PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1,3	47k	2	(M47K)
R2,4	10k	2	(M10K)
R5	1k	1	(M1K)
SEMICONDUCTORS			
LD1	Red LED	1	(WL27E)
D1,4	1N4001	2	(QL73Q)
D2,3	1N4148	2	(QL80B)
TR1	BC558	1	(QQ17T)
TR2	BC548	1	(QB73Q)
MISCELLANEOUS			
RL1	5A Miniature DPDT Mains Relay	1	(YX98G)
FS1	5A Time-delay Fuse	1	(RA12N)
TB1,2	2-way PCB Terminal Block 5mm Pitch	2	(JY92A)
TB3,5	2-way PCB Terminal Block 10mm Pitch	2	(JY93B)
TB4	3-way PCB Terminal Block 10mm Pitch	1	(JY95D)

PCB Fuseholder with Cover	1	(KU29G)
PCB	1	(90044)
Instruction Leaflet	1	(XV66W)
Constructors' Guide	1	(XH79L)

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

The above items are available as a kit, which offers a saving over buying the parts separately.
Order As 90043 (Mains Power Switch) Price £6.99

The following new item (which is included in the kit) is also available separately, but is not shown in the 1995 Maplin Catalogue
Mains Power Switch PCB **Order As 90044 Price £2.99**

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What's On?

When the Chips are Down

The co-ordination of Europe's biggest electronic reclamation scheme was explained to delegates at a Waste Watch seminar hosted by the Corporation of the City of London, at the Guildhall on July 4. According to principal speaker, Wolfgang Wurz of the cleansing department of Greater Berlin, six million items of electronic waste will be discarded this year in the UK, with numbers rising year by year. Taking the lead in electronics recycling, Wurz is responsible for a number of pioneering recycling schemes operating throughout Germany. At the seminar 'When the Chips are Down – The Future of Electronic Waste', representatives from industry, local authorities and the community sector, came together to explore a range of practical solutions to the recovery of electronic products.

Contact: Waste Watch, Tel: (0171) 245 9998.

A Summer Full of Science

We said it last month, and we'll say it again this month, if you're stuck for something to do this summer, head down to the Science Museum. But, if you're planning a trip into the depths of South Kensington, London, make sure you have a full day to spare. With over 200,000 different exhibits to look at, covering almost every imaginable sector of science, technology, industry and medicine, the Science Museum has something to appeal to everyone.

Special events organised for the summer holidays, include a programme of workshops, demonstrations and drama performances celebrating a century of cinematography. There will be almost 30 different events each day, targeted at special age and interest levels. Shadow puppets, pioneering film makers, special effects, and model making are just some of the topics explored, which demonstrate the huge advances in film technology over the last century.

Over 1,000 of the Museum's exhibits are interactive, so visitors can learn first hand how various scientific principles work. Launch Pad, for example, the hands-on gallery designed especially for children, is the most popular gallery of its type in Europe. Other highly popular areas include Health Matters, which allows visitors to get an instant health check; Exploration of Space, where you can find out what the surface of Mars looks like, and how astronauts live in space; Flight Lab, which interactively introduces the basic principles of flight; Food for Thought, where you can find out much more about the different foods you eat; and Information Superhighway, which looks at the future of global communications and even offers you the chance to surf the Internet.

Particularly interesting exhibits, include some of the oldest cars, planes and locomotives in Britain, some of the very earliest veterinary and medical instruments, clocks and time measurement devices throughout the ages, and a special radio room, which demonstrates various forms of radio communication. You can even see an exact replica of George Washington's false teeth, or the very first types of oral contraceptives. Entrance to all of these exhibits, including the special summer events programme, is included in the standard admission price to the Museum of £5.00 for adults and £2.60 for children and concessions.

Contact: The Science Museum, Tel: (0171) 938 8000.

X-ray to CT Scanner – IEE Archives Exhibition

A New Kind of Vision is the title of the 1995 Archives Summer Exhibition, which opens at the Institution of Electrical Engineers on Wednesday, 16 August. The Exhibition celebrates the 100th Anniversary of Röntgen's discovery of X-rays, traces their development for medical use, and looks at the public perception of the new kind of vision. It will also embrace later developments, ranging from the EMI body scanner of the 1970s, to present CT scanning techniques.

The IEE material on the X-rays, which form the Exhibition, was gathered by Sylvanus Thompson, the 19th century physicist, educator, writer, biographer and collector of early printed books and manuscripts on electricity and magnetism. Thompson replicated Röntgen's experiments with X-rays early in 1896, and did much to popularise them with the medical profession and the early public. The exhibition will be open from 10.00am to 5.00pm each weekday from Wednesday, 16 August to Thursday, 28 September. Admission is free.

Contact: IEE, Tel: (0171) 240 1871.

Southend Radio Rally

To celebrate its 75th Anniversary, the Southend & District Radio Society is holding a mammoth rally with over 8,000sq.ft. of exhibitors and traders. The society, which has a membership of around 60 individuals, will play host to organisations such as Waters & Stanton, and the Radio Society of Great Britain. Also, watch out for Maplin Electronics. Indeed, the editorial team from *Electronics* is set to make an appearance. The Essex police will also be on hand, to demonstrate their collection of historic radio sets and crime prevention. The event will take place on Sunday, 10 September, commencing at 10.00am at the Cliffs Pavilion, Westcliff-on-Sea, Essex. Admission is £1.50, or £1.00 for concessions.

Contact: Southend & District Radio Society, Tel: (01702) 353676.

DIARY DATES

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

24 July. Construction Competition, Stratford-upon-Avon and District Radio Society, Stratford-upon-Avon. Tel: (01789) 740073.

24 July to 24 December. Through the Looking Glass, Jodrell Bank & Arboretum. Tel: (01477) 571339.

16 August to 28 September. X-ray to CT Scanner – IEE Archives Exhibition, Institute of Electrical Engineers, London. Tel: (0171) 240 1871.

19 to 20 August. A Miniature Steam Up, Jodrell Bank & Arboretum. Tel: (01477) 571339.

20 August. Evening on Air, Crystal Palace & District Radio Club, London SE19. Tel: (0181) 699 5732.

27 August. East Coast Amateur Radio and Computer Rally, Clacton Leisure Centre. Tel: (01473) 272002.

2 September. Wight Wireless Rally, Arreton Manor Wireless Museum, Newport, IOW. Tel: (01983) 567665.

2 to 3 September. HF SSB Field Contest Weekend, Crystal Palace & District Radio Club, London SE19. Tel: (0181) 699 5732.

5 to 7 September. International Conference on 100 Years of Radio, Savoy Place, London, WC2. Tel: (0171) 240 1871.

10 September. Southend & District Radio Society, 75th Anniversary Radio & Computer Rally, The Cliffs Pavillion, Southend. Tel: (01702) 353676.

10 September. Lincoln Short Radio Hamfest, Lincoln Showground, Lincoln. Tel: (01522) 525760.

10 to 12 September. European Computer Trade Show, Olympia, London. Tel: (0181) 742 2828.

10 to 13 September. PLASA – Light & Sound Trade Show, Earls Court, London. Tel: (0171) 244 6433.

12 September. Opening Night and Dayton 95 by Herb Asmussen and George Beasley, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

12 to 14 September. First IEE/IEEIE International Conference on Generic Algorithms in Engineering Systems – Innovations and Applications, Sheffield. Tel: (0171) 240 1871.

13 to 14 September. European Optical Communications Show, Olympia. Tel: (01425) 473535.

19 to 24 September. LIVE '95 – The Consumer Electronics Show, Earls Court, London. Opening times: 12 noon to 9.00pm weekdays, 10.00am to 6.00pm weekends. Tel: First Call Ticket Agency (0171) 396 4545.

20 to 21 September. Electrical Engineering Show, Hinckley Island Hotel, Hinckley. Tel: (01732) 359990.

26 September. Top Band DF Construction, by Geoff Foster, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

3 to 5 October. Electronics Data Exhibition, NEC, Birmingham. Tel: (0181) 742 2828.

4 to 6 October. Electronic Data Exhibition, ICC, Birmingham. Tel: (0181) 742 2828.

10 October. Inside Your PC, by Martin Rhodes, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

12 to 13 October. Electrical Engineering Show, Forte Post House Hotel, Basildon. Tel: (01732) 359990.

24 October. QRP by Norman Field, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

25 October. Junk Sale, Lincoln Short Wave Club, Lincoln. Tel: (01427) 788356.

27 to 29 October. Acorn Road Computer Show, Wembley Centre, London. Tel: (01295) 788386.

7 to 9 November. Software Development Exhibition, NEC, Birmingham. Tel: (0181) 742 2828.

8 to 11 November. Apple Expo, Olympia, London. Tel: (0171) 388 2430.

10 to 12 November. Design & Technology Education Exhibition, NEC, Birmingham. Tel: (01425) 272711.

11 November. Bingley Hall, Staffordshire Showground, Stafford. Tel: (01473) 272002.

14 November. Operation Raleigh, by John Leyton, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

22 November. Construction Contest, Lincoln Short Wave Club, Lincoln. Tel: (01427) 788356.

28 November. Microphones by Jack Cluley, Stratford-upon-Avon & District Radio Society. Tel: (01789) 773286.

28 to 30 November. Computer Graphics Expo, Wembley Centre, London. Tel: (0181) 995 3632.

7 to 11 December. Computer Shopper Show, Wembley Centre, London. Tel: (0181) 742 2828.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex SS6 8LR.

@Internet

Popping up all over the Internet, are examples of the latest revolution in digital documentation and publishing. So-called portable documents are being used by Internet servers around the world, to ensure that documents can be displayed and printed exactly as they were produced. Adobe's Acrobat is the application they are produced on, and the files have the PDF extension (*portable document format*) identifying them.

They beat ASCII coded text files hands-down in their ability, simply because the documents contain within them all the necessary information needed at the readers' computer to display them on screen, and print them for hard copy. All styles, formats, images and even hypertextual links are displayed exactly as they were published, and the printer doesn't need to know which fonts were used in the writing stage. In fact, all the remote computer needs is a copy of the Acrobat Reader, which allows anyone, anywhere, to see and print any PDF document. Acrobat reader is a small utility application package which is distributed by Adobe and other outlets. It is freeware, and can be distributed to anyone without license restrictions.

Portable documents downloaded in this way become independent of whatever computing platform they were originated on, as all the information needed to display on any computer is held within them. If you've got Acrobat resident on your computer, you can look at and print anyone's portable documents.

Ten or fifteen years ago, when personal computing was just a twinkle in the mainframe daddy's eye, the concept of the paperless office was dreamed up. If all documents could be stored on disk, and viewed on screen, people thought that there would be no need to have a paper copy. It has been a long time coming, but Adobe's portable document format could be just that. Remember – any computer, any portable document. And it has taken the Internet to create the answer.

In truth, of course, we cannot exist without paper. Reading a document on-screen isn't quite the same as holding it. You cannot really enjoy a good book unless you can turn the pages over yourself. You cannot scribble comments in the margins of a report if it's on your computer screen. So there's no fear that paper will ever disappear, but it's an interesting concept nevertheless. Computers, divided by hardware and software, are now joined together by the Internet and portable documents.

Vis-a-visa

Shopping on the Internet looks set to catch on over the coming period. Barclaysquare is an electronic shopping mall recently launched by Barclays Merchant Services – yes, that's the same Barclays which currently processes credit card transactions for more than 125,000 retail outlets. Two big names, J. Sainsbury and Toys 'R' Us, are already on the service, so many more are likely to follow. You electronically wander through Barclaysquare, look at and purchase your goods, which are despatched post haste to arrive at your door. Barclaysquare is at: **http://www.itl.net/barclaysquare/**

Another service set up specifically for business users, is Infobank, which calls the service the *Business Superstore at your desktop*. Products such as Microsoft software, IBM hardware, and Orange mobile telephones can be bought. Infobank is at: **http://www.atlas.co.uk/infobank**

If you are worried about credit card security, encryption methods are built-in to both systems. In fact, a spokesperson for Barclaysquare operators Interactive Telephony, has said that they are "confident that it is secure and expect it to stay like that". Sounds like a hackers dream come true to me.

Novell's Netware WWW Site

Novell has announced a NetWare World Wide Web site. The site offers customers a single point of access for information about the reliable, secure and high-performance database solutions provided by Novell and its 14 NetWare database partners. Customers with an Internet connection and a World Wide Web browser, can access Novell's NetWare web site at: **http://www.netware.com/**.

Biscuits on Order

One from the pages of the Sunday Times. As the paper's technology editor recently pointed out, it can be a hungry business surfing the Web. Fear not, the Elizabeth Botham family bakery in Whitby, North Yorkshire, allows Internet users to order and pay for plum bread, gingerbread and biscuits using a Web service. Unfortunately for hungry Web cruisers, biscuits are packaged and despatched by snail mail.

Contact: http://www.octacon.co.uk/bothams/.

Netting Sales

Surrey based Interactive Media Communications (IMC) has some of the first proof that the Internet offers marketing opportunities for the business community. IMC creates electronic brochures on its Route One WWW space. To date, both Scotlens of Linlithgow, Scotland and Knight Rider, based in London, both report sales secured through the Internet.

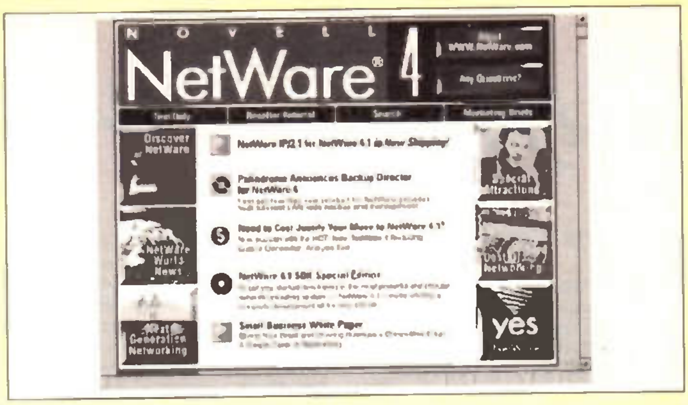
Scotlens, a contact lens manufacturing company, provides optical practitioners with a simple method for prescribing complex lens configurations. It is not possible for Scotlens to deal direct with patients, since contact lenses must be supplied and fitted by a qualified practitioner. That said, proprietor Jack Brown reports professional enquiries coming in daily, as a result of contact lens wearers downloading Scotlens information and passing it on to their practitioners.

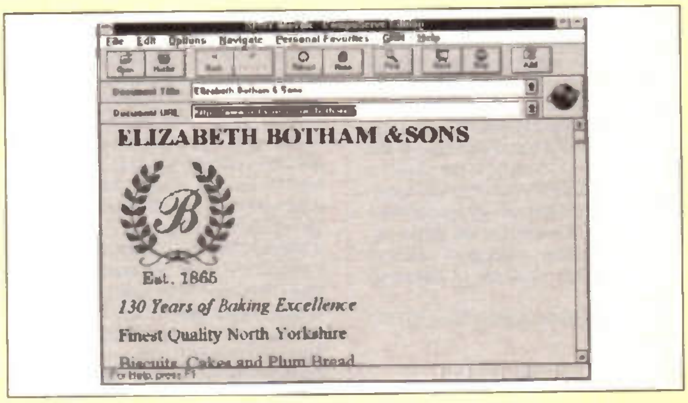
Success in a totally different industry, is reported by global newspaper and information provider, Knight Rider. The London based UK arm of the company commissioned IMC to create a WWW brochure, outlining the companies services. Within the first two months of advertising on the Internet, Knight Rider reports over 250 responses from around the world. IMC's Route-One WWW pages can be accessed at: **http://www.route-one.co.uk/route-one/**.

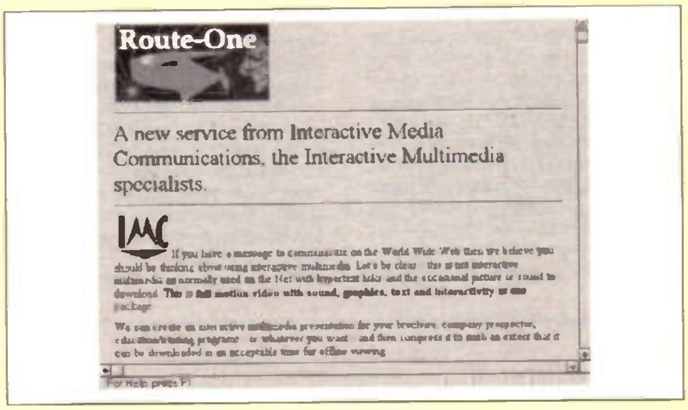
BCS Goes Online

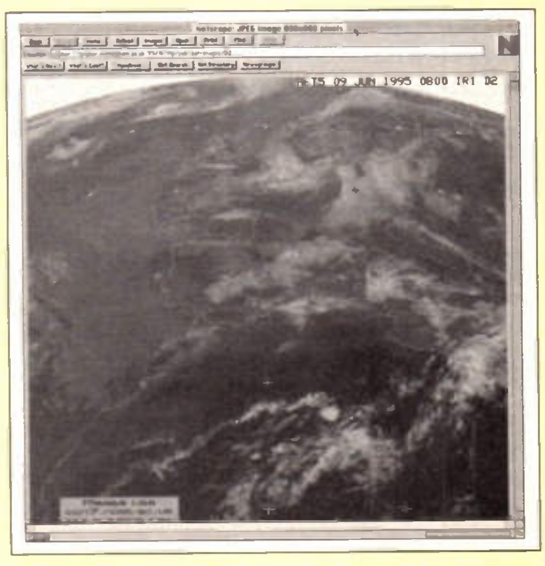
The British Computer Society is preparing to offer an Internet service, BCSNet. The service will be run through the internet provider, Cityscape. Members will be offered a two-tier service. Tier one, called Lite, will offer a basic e-mail service for a one-off payment of £10. Tier two users who sign up to the Gold service, will pay a £25 sign-up fee, and then £12.95 per month subscription. This will allow unlimited access to Internet e-mail, telnet, World Wide Web access and most SLIP services.

Contact: British Computer Society, Tel: (01793) 417 417.









Publishing Revolution

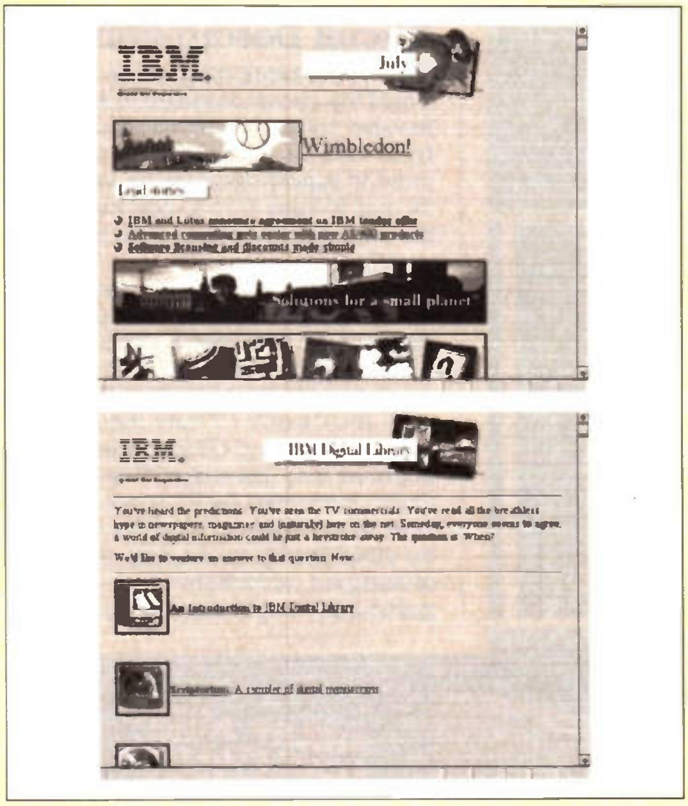
The Internet is set to revolutionise the publishing industry, through services such as interactive television, digital radio and the personalised newspaper. According to publishing consultant Paul Youlton, in this new world, there will be no place for editorial control or advertising executives. What is really scary, is that Youlton's claims are far from science fiction. The technology exists today to support his arguments. This morning for instance, instead of picking up a newspaper, I dialled into the Executive News Service, available through CompuServe.

ENS takes feeds from 25 news wires around the world, from the German Press Agency to The Washington Post. The service continually scans each wire service for keywords or phrases which the subscriber selects and is able to update at any occasion. Any wire story which contains the selected keyword or phrase is downloaded and stored in a folder for the subscriber to access.

For instance, I am keen to track any material on video-on-demand, tele-working, green issues and rugby, so these are all included as keywords. I am my own editor, I edit my own newspaper with contributions from a rich stock of journalists around the world. Having selected the stories I want to read, I print them on a laser printer, disconnect from CompuServe and read them at my leisure, as I would any newspaper.

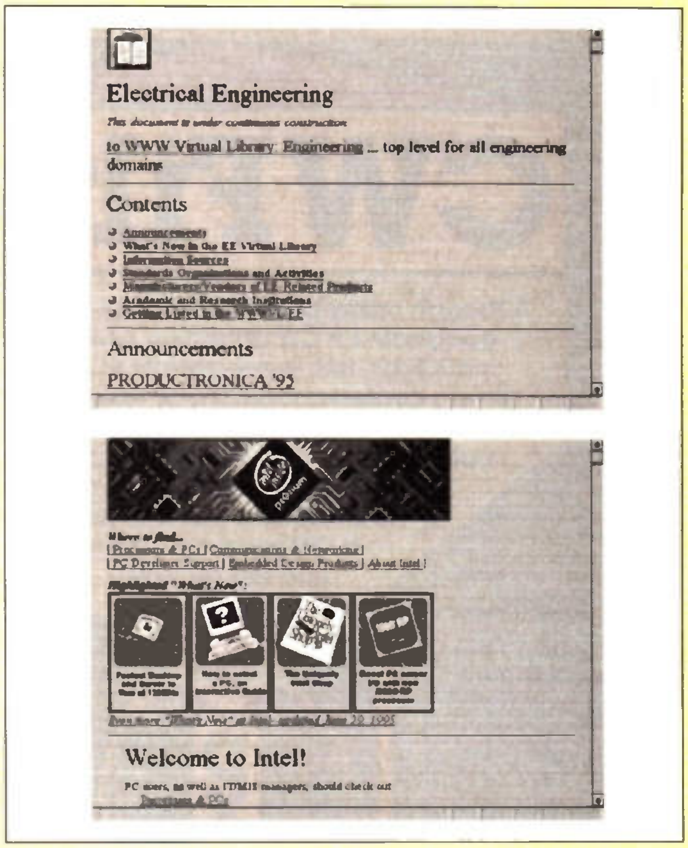
And if you're concerned the electronic newspaper doesn't allow access to material outside the subscribers range, think again. For material outside the sphere of my keywords, I dip into the Reuters Newsclips Wire. Here, I can gain access to news stories as they break from around the world. For instance, the day John Major resigned as leader of the conservative party, I had access to his resignation speech at home before full details were available in the House of Commons.

Interactive Television and digital radio are extensions of ENS. In both instances, the subscriber is the editor, using an agent or electronic search mechanism to select material of specific interest. The journalist in this new world is secure – wire services require stories. The editor is on dodgy ground, although stories will always have to be audited for quality. As for the advertising executive, I think he or she should look to retire within the next decade. Who is ever likely to select to view an advertisement through choice?



IBM in Music Link-up with EMI

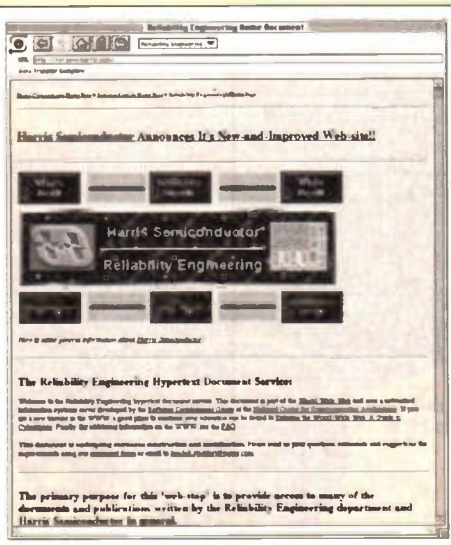
IBM is working with its British development partner, Multimedia Archive and Retrieval Systems (MARS), and EMI Music Publishing, to enable EMI's library music to be distributed online through IBM Digital Library technology. The IBM Digital Library is a solution that allows owners of information content in all its forms (including film, music, text, art and manuscripts) to maximise their assets and make them available through networks around the world. The IBM Home Page can be found on the Internet at **http://www.ibm.com**. The IBM Digital Library page can be found at: **http://www.ibm.com/features/library/**.

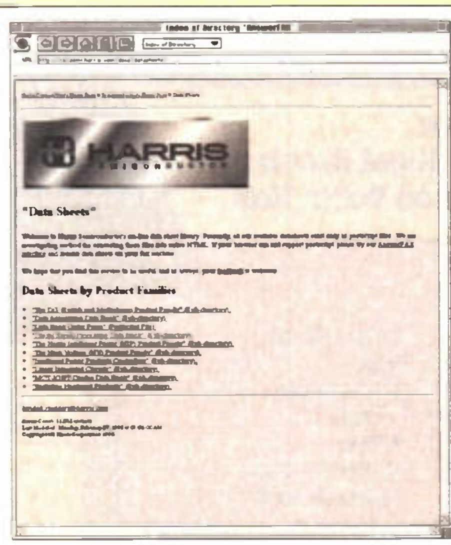


Electronic Travel

Browsing the World Wide Web is like travelling abroad. There are thousands of possible destinations, two sites are never the same, and for the real hardy trekker, there is plenty of opportunity to head off the beaten track. The great thing is that there is something of interest for everyone, available without even leaving a PC. WWW has plenty to offer the Electronics enthusiast. Readers can plan their journeys at: **http://epims1.gsfc.nasa.gov/engineering/**, which lists Web sites of the major Electronics companies. For example, some of the big guys, such as IBM, Intel, and Apple, can be found at: **http://www.ibm.com/,http://www.intel.com/** and **http://www.apple.com/**, respectively.

But, this is all pretty superficial stuff. Glossy home pages are about as much use as corporate brochures to the electronics enthusiasts. There is some really useful technical stuff out there if you are prepared to look. For instance, Harris Semiconductors provide all their datasheets in postscript format, at: http://rel.semi.harris.com:80/docs/datasheets/. Roam around, and if you find something really neat, drop us an e-mail at: AYV@maplin.demon.co.uk, so that we can pass your discoveries on to fellow readers.





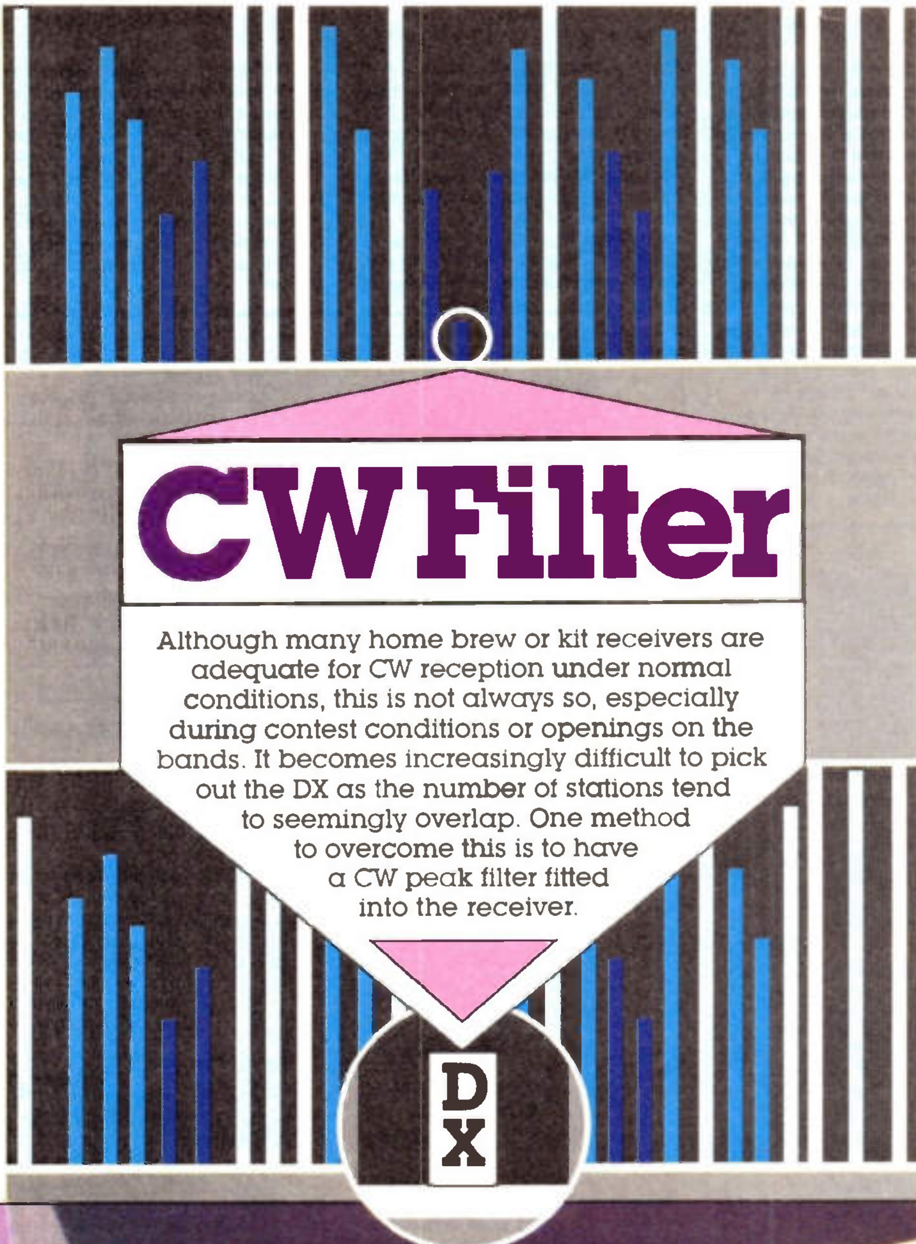
Site Survey – the month's destinations

A couple of interesting sites for you this month. First is a peep at Harris Semiconductor's World Wide Web server, whose URL is: **http://rel.semi.harris.com/**

From here, you can take a trip through all Harris' library of data sheets in PostScript format, at: **http://re.semi.harris.com/docs/datasheets/**

You can even take a look at some aerial photographs of Harris' manufacturing plant located near Cape Canaveral – check out the home page.

Talking of aerial views, our other site worth a look, is located a little closer to home in relative terms: the University of Nottingham, which keeps a few satellite images on its server for downloading. Try:**gopher://gopher.nottingham.ac.uk:70.19/ftp/pub/sat-images** to see what's available. The one shown is a view from a meteorological satellite of Europe and the UK. If you look closely, you'll see me waving. Hello, Mum.



CW Filter

Although many home brew or kit receivers are adequate for CW reception under normal conditions, this is not always so, especially during contest conditions or openings on the bands. It becomes increasingly difficult to pick out the DX as the number of stations tend to seemingly overlap. One method to overcome this is to have a CW peak filter fitted into the receiver.

A notch filter can be made with three resistors and three capacitors arranged in a dual T configuration. The basic circuit and response are shown in Figures 1 and 2.

The upper T, (created by the two resistors and one capacitor), is a low-pass filter (LPF). The lower T, (created by two capacitors and one resistor), is a high-pass filter (HPF). The notch frequency is determined by $f=1/(2\pi RC)$ where f,R and C are in Hertz, Ohms and Farads respectively.

Placing the notch filter in the negative feedback path of an op amp (Figure 3) inverts the overall response into a peak filter shown in Figure 4.

Circuit Description

Refer to the block diagram in Figure 5 and the circuit diagram in Figure 6. Reverse polarity protection is provided by R1 and D1. Capacitors C1 and C3 provide supply decoupling. Resistors R4 and R5 bias IC1a to half rail, and the output of IC1 biases IC1b directly via R11.

The AF signal input is DC decoupled by C2 and passes to AC attenuator R2, R3 and C4, all frequencies above 1·5Hz are attenuated by 25dB. This compensates for the gain of IC1a.

R6, R10,C6 and C7 form the LPF and C5,R7,R8 and C8 form the HPF. Together they are a dual T notch filter which is inverted by IC1a into a peak filter. Many narrow CW filters produce an effect known as 'ringing', (a form of damped oscillation) which sounds particularly unpleasant to the user.

A typical short wave receiver (not included in kit).

FEATURES
- SHARP AUDIO PEAK FILTER
- LOW POWER CONSUMPTION
- REVERSE POLARITY PROTECTION
- IDEAL NOVICE PROJECT

1 PROJECT RATING

Design by Ben Spencer
Technical support by Nigel Skeels
Text by Ben Spencer and Robin Hall

Assembled CW Filter PCB.

KIT AVAILABLE (90045) PRICE £4.99

Specification

DC power supply voltage:	11 to 15V DC
Overall gain:	0dB
Input level:	8V Pk-to-pk
Input impedance:	>1kΩ
Centre frequency:	775Hz
Bandwidth:	100Hz @ –3dB, 150Hz @ –6dB

Resistor R9 reduces the gain of the filter to about 25dB and prevents any ringing.

The 25dB attenuation provided by R2,R3 and C4 has been made up for by the 25dB gain IC1a, the net effect is 0dB gain as required.

The output from IC1a is fed via attenuator (R11,R12 & C9) to another peak filter (IC1b, C10 to C13 and R13 to R17). The output from the second filter is taken from IC1b to the CW output pin where it can be fed via a switch to the receiver gain control.

Construction

Construction is fairly straightforward, refer to the Parts List and to Figure 7 PCB legend and track. Begin with the smallest components (i.e. PCB pins, resistors and capacitors) working up in size to the largest. If you are new to project construction, refer also to the Constructors' Guide (XH79L) for hints and tips on soldering and assembly techniques.

Be careful to orientate correctly the polarised devices, i.e. electrolytic capacitors, diode and IC. The IC should be inserted into the socket last of all.

Thoroughly check your work for misplaced components, solder whiskers, bridges and dry joints. When the PCB has been fully built up, clean off all flux using a suitable solvent.

Fitting the CW Filter

The board operates on 11 to 15V DC and in the majority of receivers this supply should not be a problem. The positive supply is connected to (+12V), and to ground (0V). The low level audio input is connected between (IN) and ground (0V). The audio output is taken from (CW OUT) and (0V).

There are generally two options in fitting the CW Filter. One is to insert the CW Filter in line between the receiver low level audio stage and the audio gain control. If this method is approached then the AF signal path, must be interrupted just before the AF power amplifiers gain (volume) control. The CW Filter is inserted at this point. Figure 8 shows the positioning of the CW Filter in a typical receiver. The breaking of the AF path will depend upon your receiver. Some form of switching arrangement may be incorporated to enable the CW Filter to be switched in or out as required.

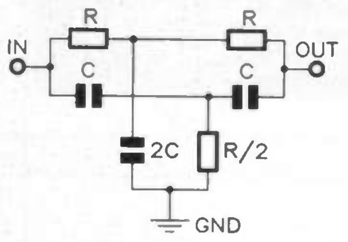


Figure 1. Dual T configuration notch filter.

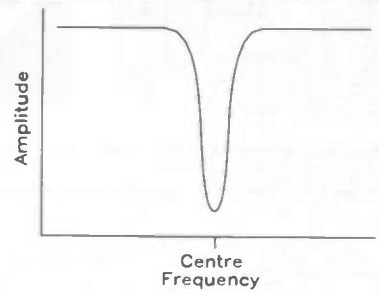


Figure 2. CW Filter frequency response curve.

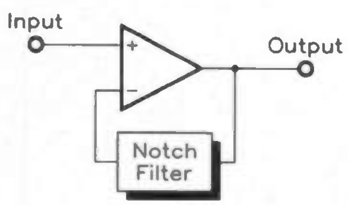


Figure 3. Notch Filter in negative feedback path of op amp.

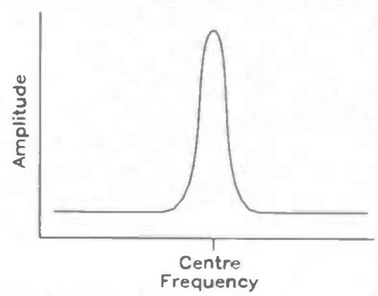


Figure 4. Inverted frequency response curve.

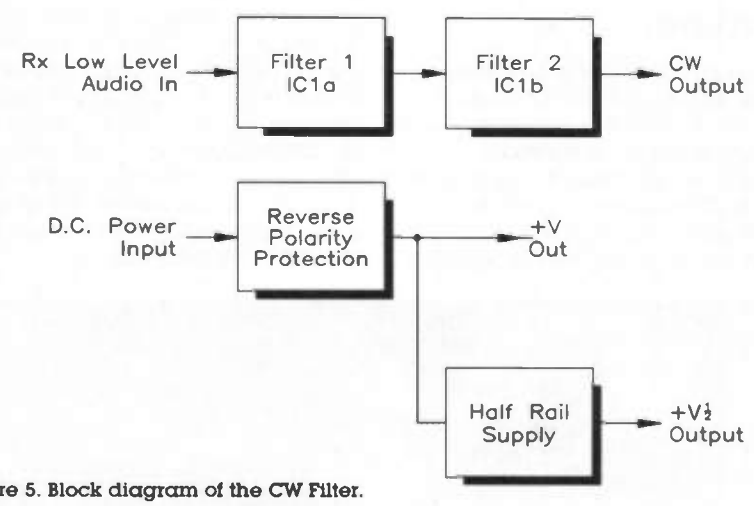


Figure 5. Block diagram of the CW Filter.

Figure 6. Circuit diagram of the CW Filter.

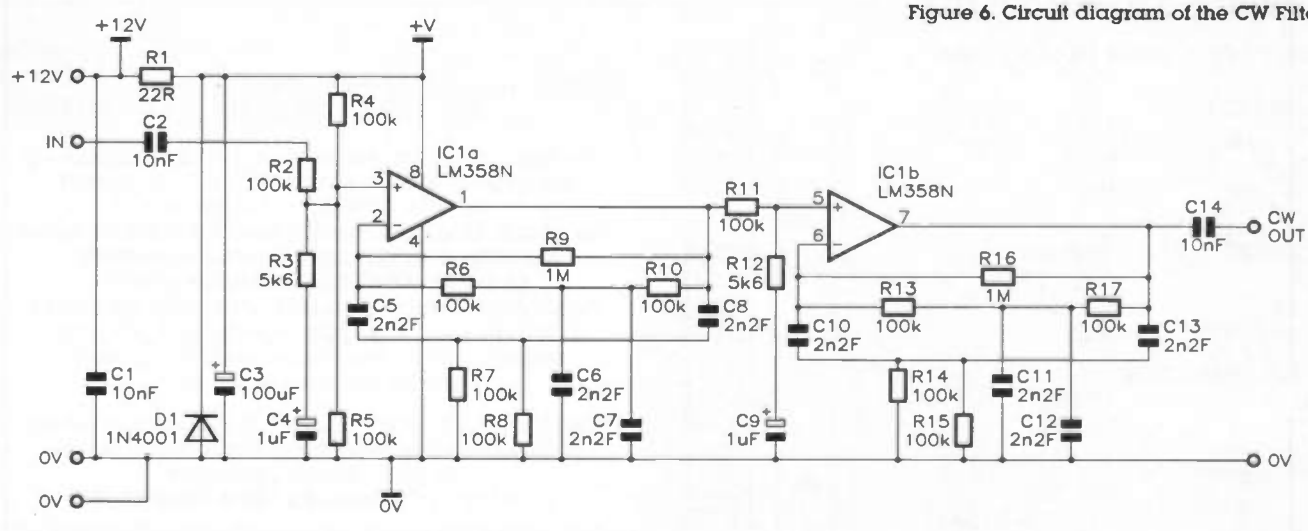
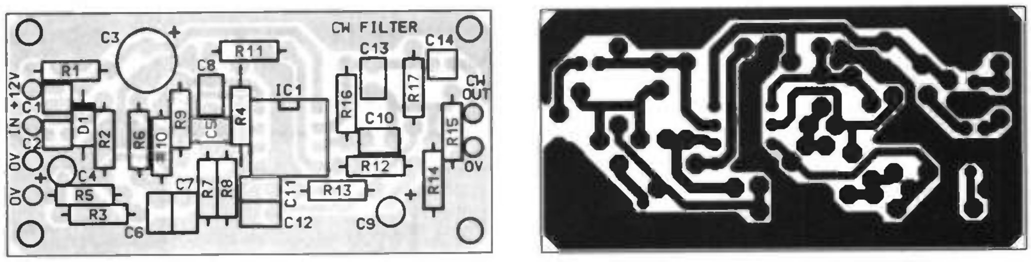


Figure 7. CW Filter PCB legend and track.



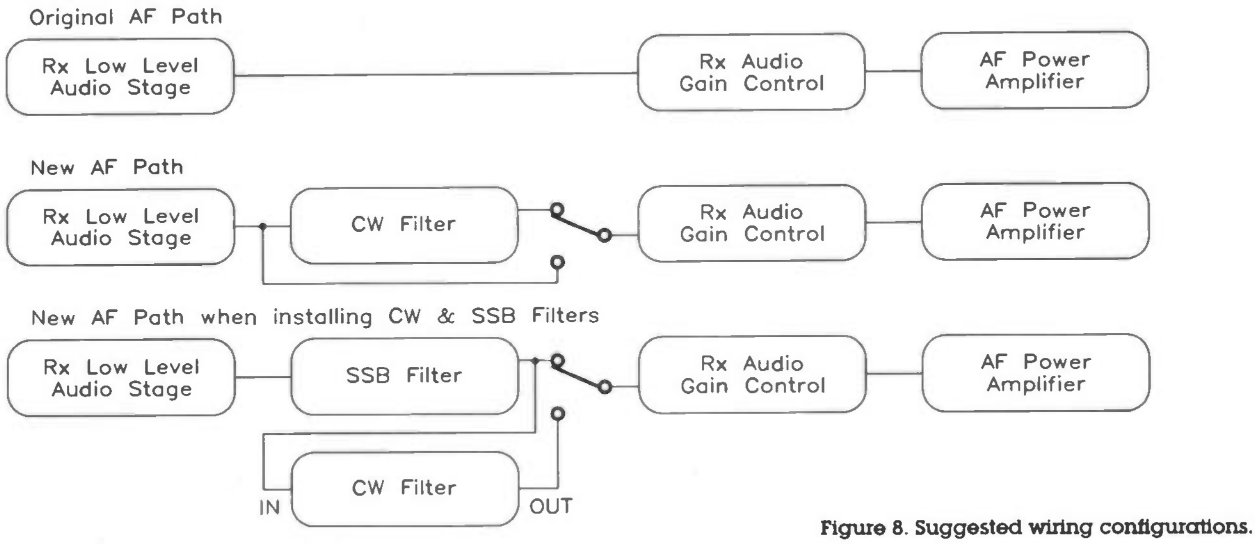


Figure 8. Suggested wiring configurations.

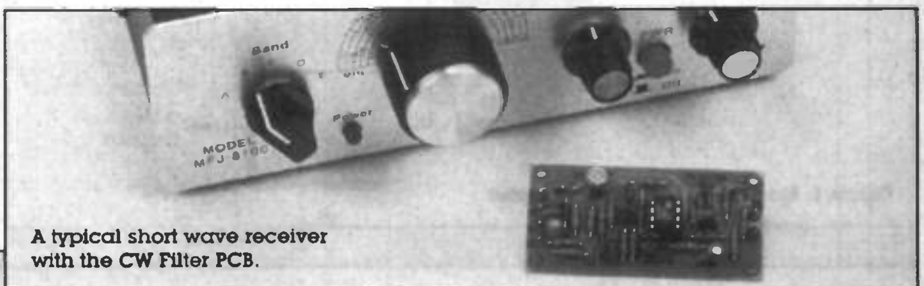
Another option is to incorporate the CW filter with another filter such as an SSB Filter.

If the receiver is home brew or of kit origin then fitting this module is less likely to be a problem, but it is not advisable to fit it into a professional receiver, especially if it is still under guarantee.

It is possible to have the CW filter attached externally to the receiver audio output, as there are generally audio connections available. The CW Filter can accept up to 8V Pk-to-Pk audio input, and its input impedance is greater than 1kΩ. The audio output from the filter can then be fed via an audio amplifier and then to a loudspeaker.

Operation

Operating the CW Filter is very easy. Switch on the receiver and find a suitable Morse (CW) transmission, preferably on an amateur radio band. If the band is busy more than one signal should be heard. Switch in the CW Filter, and slightly adjust the tuning of the receiver. The CW signal should then peak up in level, cutting out the other CW signals. There will be a characteristic slight hollow sound noticed to the signal, this is normal. The CW Filter is tuned to a centre frequency of 775Hz, and with practice tuning to this frequency will become second nature. It is generally best to tune around the band without the CW Filter in circuit.



A typical short wave receiver with the CW Filter PCB.

CW FILTER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1	22Ω	1	(M22R)
R2,4-8,10,11, 13-15,17	100k	12	(M100K)
R3,12	5k6	2	(M5K6)
R9,16	1M	2	(M1M)
CAPACITORS			
C1,2,14	10nF 50V	3	(BX00A)
C3	100µF 16V	1	(RA55K)
C4,9	1µF 63V	2	(YY31J)
C5-8,10-13	2nF2	8	(WW16S)
SEMICONDUCTORS			
D1	1N4001	1	(QL73Q)
IC1	LM358N	1	(UJ34M)
MISCELLANEOUS			
	PCB Pins	1 Pkt	(FL24B)
	8-pin DIL Socket	1	(BL17T)
PCB		1	(90046)
Instruction Leaflet		1	(XV67X)
Constructors' Guide		1	(XH79L)

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

The above items are available as a kit, which offers a saving over buying the parts separately.
Order As 90045 (CW Filter) Price £4.99

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

The following new item (which is included in the kit) is also available separately, but is not shown in the 1995 Maplin Catalogue
CW Filter PCB **Order As 90046 Price £1.99**

What is it, and Why?

PART THREE
Noise in Circuits

by J. M. Woodgate B.Sc.(Eng.), C.Eng., M.I.E.E., M.A.E.S., F.Inst.S.C.E.

In Part 1, we looked at the fundamentals of noise theory, and in Part 2, we covered noise in transistors and valves (tubes). Now, we can go on to look at how active and passive components interact to affect the noise performance of actual circuits. This is not going to be a particularly easy ride, even if you skip the mathematics that allows circuit performance to be calculated. Just keeping track of what is actually going on in the circuit requires concentration. Still, the endless search for clarity is one of the fascinations of technical writing, or so it is alleged!

Generalised Circuits

The two circuits shown in Figures 6 and 7 represent the vast majority of circuits whose noise performance is of interest. The generator *V(f)* and source impedance *Z(f)* may be in the form of a transducer, such as a tape playback head, or may be a previous stage in the circuit. Equally, the amplifier A may be a unity-gain buffer, or it could have more than 60dB of gain. The resistor R2 provides negative feedback, and we can represent a circuit without feedback by letting the value of R2 become very high indeed, and short-circuiting R3 if we have the type of circuit shown in Figure 6, or R1 if we have the circuit depicted in Figure 7.

These two circuits differ in the way that feedback is applied. In Figure 6, the feedback signal appears across R3, in series with the input signal, and this is, therefore, a series feedback circuit. In Figure 7, the feedback is in the form of a current through R2, and appears in parallel, or shunt, with the input current, so this is a shunt feedback circuit. In fact, if A is a high-gain amplifier, all of the input current is shunted away through R2, and virtually none flows into the inverting input of the amplifier. This input is called a 'virtual earth', because the high gain of A means that only a very tiny change in the voltage at this point is required in order to produce the output voltage, and the impedance at this point, as seen by an external signal, is very low indeed. The tiny change of input voltage produces a large output voltage of opposite polarity, and thus, a large current through R2.

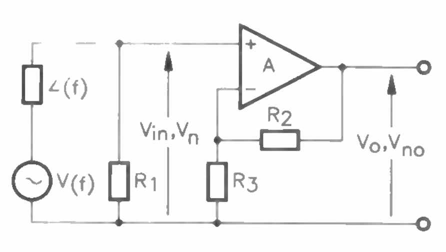


Figure 6. General input circuit with series-feedback (if any).

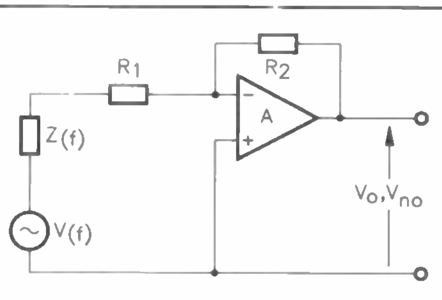


Figure 7. General input circuit with shunt-feedback (if any).

Signal-to-Noise Ratio

We could clearly make the noise voltage at the output of either circuit low, by making A a low-gain amplifier, or by applying lots of feedback, so as to reduce the closed-loop gain to a low value. However, it is easy to show from the standard negative feedback equation:

$$A_c = \frac{A}{1 - A\beta}$$

Where A_c is the closed-loop gain, A is the open-loop gain and β is the feedback factor), that *the application of negative feedback decreases the noise and signal outputs in the same ratio.*

This is not helpful, because what we need is a circuit whose output consists of as much signal as possible, and as little noise as possible, i.e., the signal-to-noise ratio (SNR) must be as high as possible (or as high as necessary, anyway). We have just shown that negative feedback does not help us to achieve that.

There are, actually, a few cases where the SNR is not the correct measure of circuit performance, and we may as well dispose of them now. Consider, for example, the noise performance of an audio amplifier, with the volume control set at minimum. Early transistor amplifiers were often rather noisy in this condition, but we cannot talk about the SNR, because with the volume control at minimum, there is no signal (or only an ill-defined leakage signal). In this case, we should talk about, and the manufacturer should specify, the *noise output voltage* (or power), so that we can use the loudspeaker sensitivity specification to calculate the resulting acoustic noise level. Another example occurs in digital audio technology, where the noise output in the complete absence of signal may be lower than that obtained with a very small input signal. In this case, we talk about 'idle channel noise', for the case where there is no input signal at all.

As an alternative to the SNR, the term 'equivalent input noise' is used; you can often see it in microphone amplifier specifications. This is the input signal which produces an output equal to the noise at the output, i.e. it produces an SNR, at the output, of 0dB. However, this value cannot be measured, because we cannot measure the signal without the noise – we cannot turn the noise off. The only things we can measure are the noise, and the signal and noise together. So, we would actually measure a (signal-plus-noise)-to-noise ratio of 3dB (not 6dB, because the noise and signal add, 'rms-wise').

The Series-Feedback Circuit

The first thing to notice about this circuit (shown by Figure 6) is that, unless R1 is much higher in value than *Z(f)*, the signal is attenuated before it even reaches the amplifier. Clearly, that does absolutely no good to the SNR. But, the resistive and reactive components of *Z(f)* have different effects. The resistive part, *R(f)*, produces attenuation which is the same at all frequencies, but the reactive part, *X(f)*, in conjunction with R1, alters the frequency response of the circuit. We shall see how to take this effect into account later, but first of all, we should minimise the constant attenuation due to $R(f)$. This is an important general principle in low-noise design – *no resistive attenuation before amplification*. R1 must be much higher (at least three times as much) than the highest value of $R(f)$ within the working frequency range. We have to consider, also, that $V(f)$, as well as $Z(f)$, is likely to be frequency-dependent, which means that our circuit may be required to introduce frequency-response correction, i.e., to be an equaliser. This can be achieved, for example, by replacing R2 (or R3 in Figure 6) by a network including inductors and/or capacitors.

The SNR for this circuit, at frequency f, is derived in Annex A, and is given by:

$$\left|\frac{V_0}{V_n}\right| = \frac{V(f)}{\sqrt{4kTB(\frac{|Z(f)^2|}{R1} + R(f))}}$$

Where:

k is Boltzmann's constant, $1{\cdot}38 \times 10^{-23}$ J/K (Joules per Kelvin)

T is the absolute temperature, in Kelvin

B is the bandwidth of the circuit, in Hertz

$R(f)$ is the equivalent series resistive part of the impedance $Z(f)$ (i.e., $Z(f) = R(f) + jX(f)$)

This assumes that R2 is small enough, compared with R1, for its noise voltage contribution to be neglected. Since the noise voltages add, rms-wise, this is true within 10%, if R1 is rather more than three times the value of R2. Because $Z(f)$ represents the impedance of what may be quite a complicated source circuit, we cannot assume that the equivalent series resistive part, $R(f)$, is independent of frequency. This is not true, even for a simple parallel resistor and capacitor.

There is a conceptual problem with 'SNR at frequency f'. Measuring at a specific frequency implies zero bandwidth, and, according to the Nyquist equation, there is zero noise if the bandwidth is truly zero. Of course, in practice we can never achieve zero bandwidth, but this problem lurks in all sorts of unexpected places when thinking about noise, and can cause much confusion. What we really mean is that we are measuring within a bandwidth narrow enough for $Z(f)$ and $R(f)$ to be taken as constant over that bandwidth, and our signal frequency, f, sits within that bandwidth. In particular, if we measure within a bandwidth of 1Hz, centred on the frequency f, and allow f to vary, we can obtain a graph of the *spectral density* of the noise (this is not a measure of the lack of intelligence of ghosts!) It is very necessary to distinguish between the *voltage/current* spectral density and the *power* spectral density, which may be expressed in terms of the square of the rms voltage or current, rather than explicitly as power. Quite often, in text-books and technical articles, it is not made clear which is being discussed, and this has to be deduced from the context or any equations that may be included.

The Shunt-Feedback Circuit

The SNR ratio for this circuit is derived in Annex B, and is given by:

$$\left|\frac{V_0}{V_n}\right| = \frac{V(f)}{\sqrt{4kTB[R1 + R(f)]}}$$

It can be seen that the ratio of the two SNRs is independent of $V(f)$, which is very plausible, since the circuits do not 'know' how the source voltage varies with frequency. This ratio is calculated from the equation:

$$\frac{\text{shunt S/N}}{\text{series S/N}} = \sqrt{\frac{\frac{|Z(f)^2|}{R1} + R(f)}{R1 + R(f)}}$$

This assumes that R1 is the same value in both circuits, which is quite likely, especially if the source is a transducer, because the manufacturer or a standard probably specifies the optimum load resistance (e.g., 47kΩ for magnetic pick-ups for analogue disc records, see British Standard BS 6840-15).

Choosing the Better Circuit

If this ratio is greater than 1, the shunt feedback circuit gives the better SNR, while if it is less than 1, the series circuit is preferable. Applying the 'no resistive attenuation' rule, R1 should be much larger than $R(f)$, but this does not necessarily mean that R1 is much greater than $|Z(f)|$. However, the 'no resistive attenuation' rule does allow us to simplify the equation to:

$$\frac{\text{shunt S/N}}{\text{series S/N}} = \sqrt{\frac{|Z(f)^2|}{R1}}$$

If this ratio is greater than 1, $|Z(f)|$ must be greater than R1. We must not forget, however, that these equations apply at a specific frequency, f. Over a range of frequencies, the series circuit may be preferable if $|Z(f)|$ is greater than R1 over only a small part of the range. It is important to consider this point in terms of a *linear* frequency scale, so that, for example, the part of the audio frequency range between 10 and 20kHz is *half* the total range, and not 'just the top octave'.

Noise Performance of Equalisers

This is where the subject gets really exciting! By definition, an equaliser has a frequency response which is not flat, and is intended to correct the spectrum of the input signal or to modify it for later correction (this is usually called 'pre-emphasis'). The calculation of the effects of the uneven frequency response on the noise output requires a clear head and some mathematics, which is rather more than elementary. However, it is not really too difficult, especially if you take the results of the integrations on trust. Just a hint of what is coming!

Probably the most complex equaliser that most people will come across, is that required for magnetic pick-ups for analogue disc records. Strictly speaking, the standard equaliser response has four distinct regions, as shown in Figure 8, but the region at the lowest frequencies has almost no effect on circuit noise, although it has a major effect on the reproduction of rumble from the turntable. In order to calculate the noise performance of a *circuit* which produces this response, we consider each region separately, and then add their noise contributions, rms-wise.

In considering the relative importance of the noise contributions of the regions, we must recall that the usual logarithmic frequency scale is helpful in relating graphs to what we hear, but the noise power contributions are related to a *linear* frequency scale, as shown in Figure 9. This emphasises that regions 3 and 4 are the more important.

Magnetic Pick-up Equaliser

A circuit with a non-flat frequency response modifies the *power* spectral density, Sin, of the input signal or noise, by multiplying it by the *square* of the modulus of the (voltage) frequency response or 'transfer function' T, given by:

$$S_{out} = S_{in}|T|^2$$

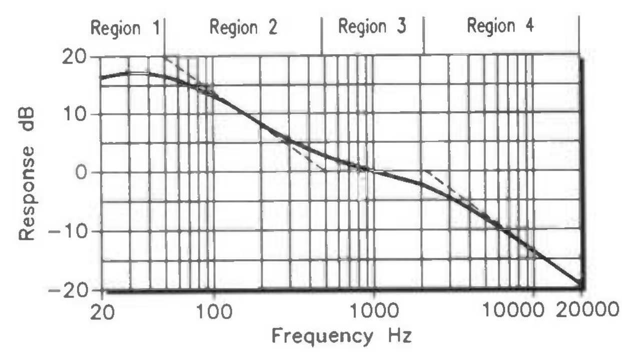


Figure 8. Magnetic pick-up equaliser response, showing four regions and straight-line approximations used for calculations.

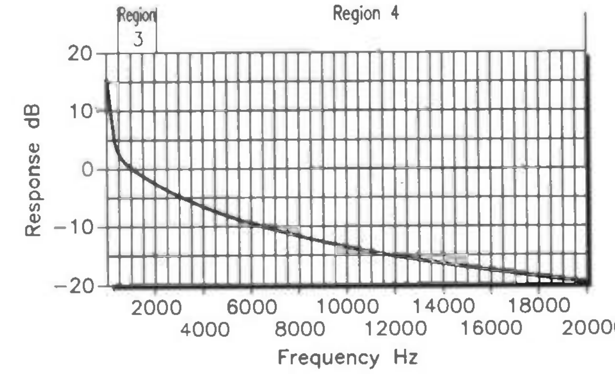


Figure 9. The equaliser response plotted on a linear frequency axis, showing the importance of Regions 3 and 4.

'Modulus' simply means the numerical value, without taking the phase angle into account, and is what we normally see presented as frequency response graphs. The squaring of the transfer function is quite logical, because the output power is proportional to the square of the output voltage.

To simplify the calculations, we replace the actual transfer functions by the straight-line approximations shown in Figure 3. For this particular equaliser, the errors introduced in this way, at the boundaries of the regions, can be shown to be small, but that is not always so, and it may be necessary to use the actual functions in some cases. The approximated transfer functions are:

Region 1 – (neglected, as having little effect – see above)
Region 2 – $T_2 = (f_2/f_1)^2$ between f_1 and f_2
Region 3 – $T_3 = 1$
Region 4 – $T_4 = (f_4/f_3)^2$ between f_3 and f_4

Noise in the Series-Feedback Circuit

The source impedance of the magnetic pick-up can be quite accurately represented by an inductance of about 0·5H in series with a resistance *R(f)* of about 600Ω, which is negligible. From Annex A, the noise voltage across R1 in the series-feedback circuit is:

$$V_n^2 = \frac{1}{|1 + jF|^2} \times 4kTB\cdot R1\cdot F^2$$

$$= 4kTB\cdot R1\left(\frac{F^2}{1 + F^2}\right)$$

Where F is a normalized frequency, f/f_s, and $f_s = R1/2\pi fL$. We can then find the mean square noise output voltage, by multiplying by the appropriate value of T for each region, but the equations are only valid if B is a small bandwidth, whereas each region (except perhaps Region 1, which we are going to neglect anyway) is by no means, a small bandwidth. Hence, we have to substitute B by the function $f_s dF$, of the differential dF, and then integrate with respect to F over the bandwidth of the region. For Region 2, we get:

$$V_n^2 = 4kT\cdot R1\cdot f_s\int_{F_1}^{F_2}\frac{F^2}{1 + F^2}\left(\frac{F_1}{F}\right)^2 dF$$

$$= 4kT\cdot R1\cdot f_s F_1^2\int_{F_1}^{F_2}\frac{dF}{1 + F^2}$$

This integral can be evaluated by the substitution $F = \tan x$, leading to:

$$V_n^2 = 4kTf_1F_1(\arctan F_2 - \arctan F_1)$$

The evaluation for Region 4 follows in the same way as for Region 2, but for Region 3 we get:

$$V_n^2 = 4kT\cdot R1\cdot f_s\int_{F_2}^{F_3}\frac{F^2 dF}{1 + F^2}$$

This integral can be evaluated by the substitution $F = \tan x$ as well, leading to:

$$V_n^2 = 4kTf_s(F_3 - \arctan F_3 - F_2 + \arctan F_2)$$

Noise in the Shunt-Feedback Circuit

Using the equation for V_{no}^2 from Annex B, we proceed in exactly the same way as for the series circuit, and if you carry the calculations right through to the actual numerical noise voltages, the shunt circuit turns out to be substantially noisier, in this case, than the series circuit. This is because the source impedance is lower than R1 over almost all of the frequency range.

Operating Conditions of Active Devices

In the above analysis, we have only been considering the noise generated in the source and the passive components, and we have seen how to choose the circuit configuration (series or parallel feedback) for minimum noise. But, we can easily throw away the advantage of the better configuration by not operating the active device(s) in the input stage under the optimum DC conditions for lowest noise. We covered this, at least for bipolar transistors, in Part 2. The optimum mutual conductance, g_m, is $\sqrt{\beta}/R_s$, where R_s is the source impedance, and $g_m = 39I_c$, if I_c is in mA, so that the optimum collector current is $\sqrt{\beta}/39R_s$. What we have now found, is the way to determine the source impedance which the transistor sees, and which determines the optimum DC collector current.

Annex A – SNR of the Series-Feedback Circuit

The signal voltage across R1 in Figure 1 is:

$$|V_{in}| = \frac{V(f)R1}{|R1 + Z(f)|}$$

The noise voltage across R_1 is given by:

$$V_n^2 = 4kTB\left[R1\cdot\left|\frac{Z(f)}{R1 + Z(f)}\right|^2 + R(f)\cdot\left|\frac{R1}{R1 + Z(f)}\right|^2\right]$$

Where the first term in the square brackets is due to R1, and the second term is due to the resistive part *R(f)* of *Z(f)*.

So, the r ms noise voltage is:

$$V_n = \frac{R1}{|R1 + Z(f)|}\sqrt{4kTB\left(\frac{|Z(f)|^2}{R1} + R(f)\right)}$$

Thus, the SNR at frequency f, is given by:

$$\left|\frac{V_{in}}{V_n}\right| = \frac{V(f)}{\sqrt{4kTB\left(\frac{|Z(f)|^2}{R1 + R(f)}\right)}}$$

Annex B – SNR of the Shunt-Feedback Circuit

For the circuit shown in Figure 7, we have to consider the currents at the inverting input – the virtual earth point if the gain *A* is large. In this case, for signal currents, we get:

$$\frac{V(f)}{|Z(f) + R1|} = -\frac{V_0}{R2}$$

And for noise currents, if R2 is high enough for its noise current to be negligible compared to those of R1 and *R(f)*:

$$\frac{4kTB[R1 + R(f)]}{|R1 + Z(f)|} = -\frac{-V_{no}^2}{R2^2}$$

So, the SNR ratio is:

$$\left|\frac{V_0}{V_{no}}\right| = \frac{V(f)}{\sqrt{4kTB[R1 + R(f)]}}$$

Next Time

The concluding part of this series will include methods of measuring noise, what A-weighting, CCIR weighting and CCIR-ARM mean, and some actual measurements on real circuits.

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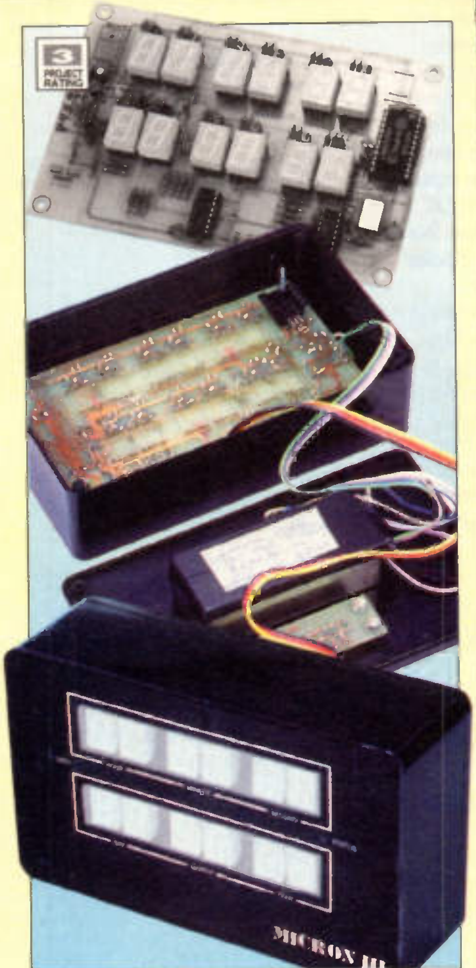

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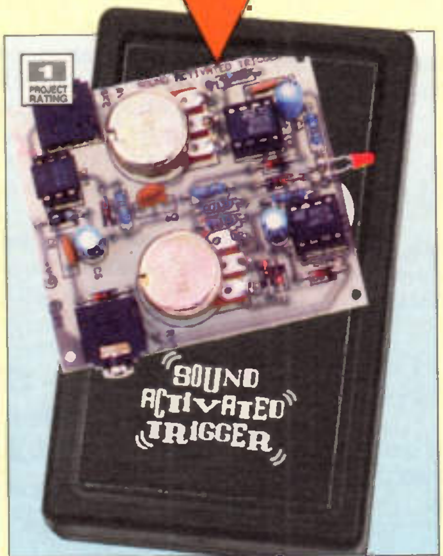

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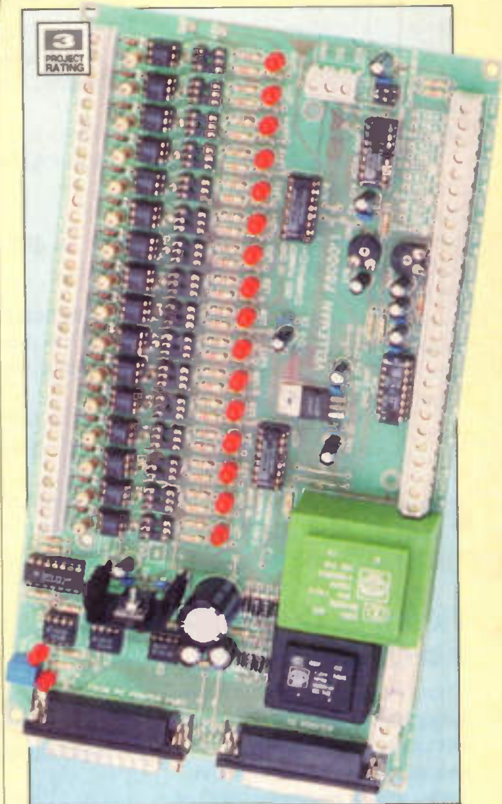

COMPUTER INTERFACE BOARD

Unleash your computer's power by allowing it to communicate with the outside world. This fully optoisolated interface is suitable for IBM compatibles and simply connects to the printer port, while still allowing the printer to be used. Features include: sixteen inputs/outputs; eight 6-bit analogue outputs; one 8-bit precision analogue output and four 8-bit analogue inputs.
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Improve your scanner's reception with this active, broadband aerial. The aerial supplied with most scanners is perfectly adequate for local reception, but a significant improvement can be made in the reception of long distance (DX) and weaker stations by using a fixed, active aerial like the Super Scan. (Plastic aerial housing and PSU box not included in kit.)
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VOICE VANDAL

Create your own distortion effects and 'alien' voices with this entertaining audio project. Both music and voices can be 'vandalised' by pitch changing, clipping and echo effects. Ideal for plays, amateur dramatics or just for fun. Dad's Max Bygraves collection will never sound the same again! (Case not included in kit.)
Order as: LT82D, **£29.99**. Details in *Electronics* No. 89, May 1995 (XA89W).

RS232 SERIAL LINE TESTER

Troubleshoot RS232 equipment quickly and conveniently with this battery powered, hand-held tester. The tester produces a short RS232 message and is ideal for checking terminals, printers, and other serial equipment, as well as their interconnecting data cables.
Order as: LT83E, **£32.99** A1. Details in *Electronics* No. 89, May 1995 (XA89W).

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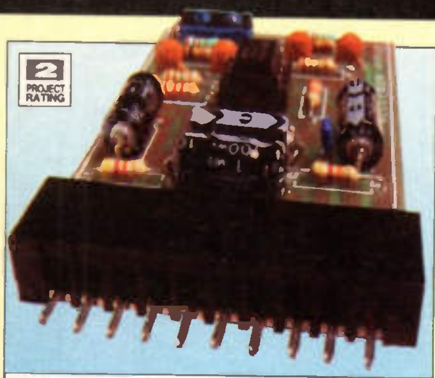

STEREO RIAA CORRECTION PREAMP

Many modern power amplifiers no longer have RIAA corrected inputs suitable for moving-magnet or moving-coil cartridges. If you, like many others, have a substantial vinyl record collection, but want to update your amp, then this project is a must.
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INTERACTIVE DOORBELL

Ring the changes with this novel doorbell project! Up to 16 seconds of sounds or speech can be recorded, for playback when the door bell is pressed. Greet your friends with a warm welcome, or your mother-in-law with a suitable insult! (Case not included in kit.)
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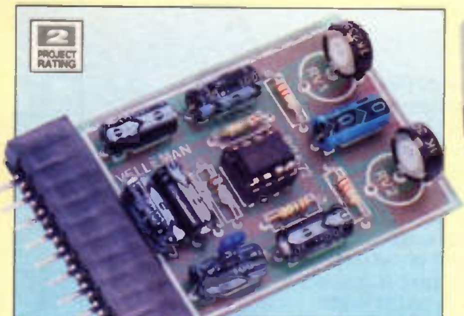

UNIVERSAL STEREO PREAMPLIFIER

This inexpensive stereo preamplifier is suitable for all sorts of applications where input signals are too small or too large for direct connection to a power amplifier. The unit requires a power supply of between 10 to 30V DC and is compatible with other featured modules enabling you to build a complete stereo preamplifier system.
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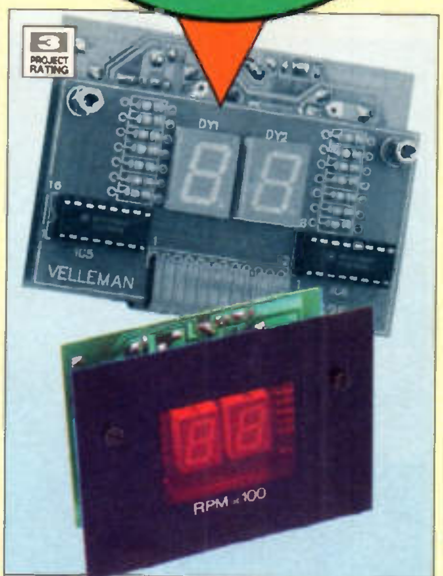

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This digital 'rev-counter' is a very practical 'bolt-on-goody' for older or base specification, negative earth cars. The Digital Tachometer can allow you to set up idling speeds accurately, and drive your car at its optimum engine speeds for maximum acceleration, power or economy.
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No, it won't make piles of towels all soft and fluffy, but it will help to remove spikes, transients and noise from the mains supply, which could otherwise upset sensitive equipment like computers, TVs, Hi-Fis, test gear and communications equipment.
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ULTRASONIC DETECTOR

Bats in the belfry? Noisy mechanical bearings? Not sure if your dog-whistle works? This novel project converts ultrasonic sounds into audible sounds enabling them to be heard by the human ear. Other applications include testing of ultrasonic remote control units and ultrasonic alarm detectors.
Order as: 90008, **£39.99** A1. Details in *Electronics* No. 90, June 1995 (XA90X).

SIREN SOUND GENERATOR

Generate up to six different siren sounds for models, toys, plays, alarms, etc., with this easy-to-build project. Features include variable sound pitch, cascade mode, auto power-off, and outputs for an LED and a speaker or piezo sounder. Please note that the Maplin 'Get-You-Working' Service is not available for this project.
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CMOS ELECTRONIC CW KEYER

If Morse Code is driving you dotty, make a dash for this project! Designed for use with a paddle key, the unit produces a continuous stream of dots or dashes, depending on whether the key is pushed to the left or to the right, saving all that frantic hammering on a conventional key. (Case not included in kit.)
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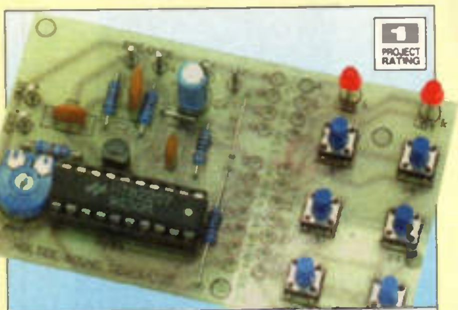

WESTERN SOUND GENERATOR

Mosey on down to the workshop and build this super 'audio six-shooter'. The easy-to-build unit produces 6 'Wild West' sounds like horses, guns, etc., for plays, toys, novelty doorbells, or simply just for fun.
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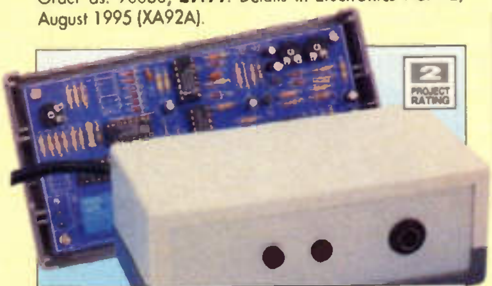

CALL CODE SWITCH

Don't just 'phone home, 'phone the microwave and start your dinner cooking! This telephone activated switch and timer can be used for a host of remote control functions like turning lights on and off while you're on holiday. What is more, there are no huge 'phone bills or direct connections, as the unit is controlled by the sound of the 'phone ringing.
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SHORTWAVE REGENERATIVE RECEIVER

Listen to the world and recapture some of the look and feel of the early days of short wave radio reception. The receiver covers frequencies from 3·5 to 22MHz in 5 bands, using a regenerative technique, and is therefore easy to build and set up.
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The flashiest strobe in town! This stand-alone strobe unit can also be 'daisy-chained' with more units to produce stunning multiple strobe effects, controlled via the built-in RS232 input. Features include built-in variable speed controller and optional remote-control oscillator.
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IEEE-488 explained

by Ian Poole

The IEEE-488 bus is one of the most used and versatile interface standards available today. It enables a wide variety of pieces of equipment to be linked together, and for data to be transferred along the bus. In fact, today, a wide variety of instruments have IEEE-488 bus capabilities. Virtually all types of test equipment are available with IEEE-488 bus options, ranging from oscilloscopes to digital voltmeters, and counter timers to spectrum analysers. Although it was mainly intended for the remote operation of test equipment, a number of printers use it, and it can be utilised in many other applications.

ORIGINALLY named the HP-IB (Hewlett Packard Instrument Bus) when it was first introduced, it has gained a number of other names over the years, including GP-IB (General Purpose Interface Bus). The bus has been adopted by a number of major institutions who have given it their own numbers. As a result, it is now almost universally called the IEEE-488 bus, because it has been adopted by the Institute of Electrical and Electronic Engineers in the USA, who have given it their specification number, 488.

Other organisations have also adopted it, for example, the American National Standards Institute and the European IEC. Despite the proliferation of names and numbers for it, the specifications are all virtually the same and can be used interchangeably.

Basic Concept

The IEEE-488 bus is a very flexible bus system, allowing data to flow between any of the instruments on the bus, at a speed suitable for the two instruments which are communicating. The bus allows up to a total of fifteen instruments to be connected together. The overall maximum length of the bus must not exceed 20m, and there must be no more than 2m between any two instruments.

The connector is standardised, and is an Amphenol 57 series 24-way type. The connections to it are shown in Figure 1. As it can be seen, this is very similar to the Centronics or parallel interface connector used for printers and PCs these days, although it has the advantage that several connectors can be 'piggybacked'. This helps the physical setting up of the bus, and prevents complications with special connection boxes or star points.

The equipment on the bus is organised into three different types. There are controllers, talkers and listeners, although any piece of equipment may be able to fulfil more than one function. For example, a voltmeter which is controlled over the bus, will act as a listener when it is being set up, and then when it is returning the data, it will act as a talker. However, a printer will only be able to listen, as it will only need to accept data to print out on the paper.

The controller has the most crucial role on the bus. It is usually a computer, and signals which instruments are to perform the various functions. It also ensures that no conflicts occur on the bus. If two talkers tried to talk at the same time, then data would become corrupted, and the operation of the whole system would be seriously impaired.

Basic Operation

The bus uses basic TTL signal levels, and it consists of a total of sixteen active lines. The logic levels are quoted in the specification, and after its initial release in 1975, it was updated three years later to incorporate the Schottky TTL levels. In view of the slightly different characteristics of Schottky TTL, it was found necessary to increase the logic low level, from 0·4 to 0·5V.

The sixteen lines on the bus can be organised into three categories, as shown in Figure 2. A summary of IEEE-488 bus connections is given in Table 1. Eight are used for data transfer, and use ordinary ASCII data. Three lines are used for a very comprehensive form of handshaking. This ensures that the data has been properly transmitted and accepted, whatever the speed of the talker and listener. The five remaining lines are used for general bus management functions, and they carry status and control information.

The key to the whole operation and flexibility of the bus is the handshaking system. The three lines named DAV (DAta Valid), NDAC (Not Data ACcepted), and NRFD (Not Ready For Data), are used to control this, as shown in Figure 3.

All the listeners on the bus use the NRFD line to indicate their state of readiness to accept data. It only requires one listener to hold the line low, to prevent data transfer being initiated. In other words, only when all the relevant instruments are ready can any data be transferred. Once all the instruments have released the NRFD line and it is in the high state, the next stage can be initiated. Data is placed onto the data lines by the talker, and once this has settled, the DAV line is pulled low. This signals to all the listeners that they are able to read the data which is present.

During this operation, the NDAC line will be held low by all the active listeners, i.e., those which have been instructed to receive the data. Only when they have read the data will each device stop trying to hold this

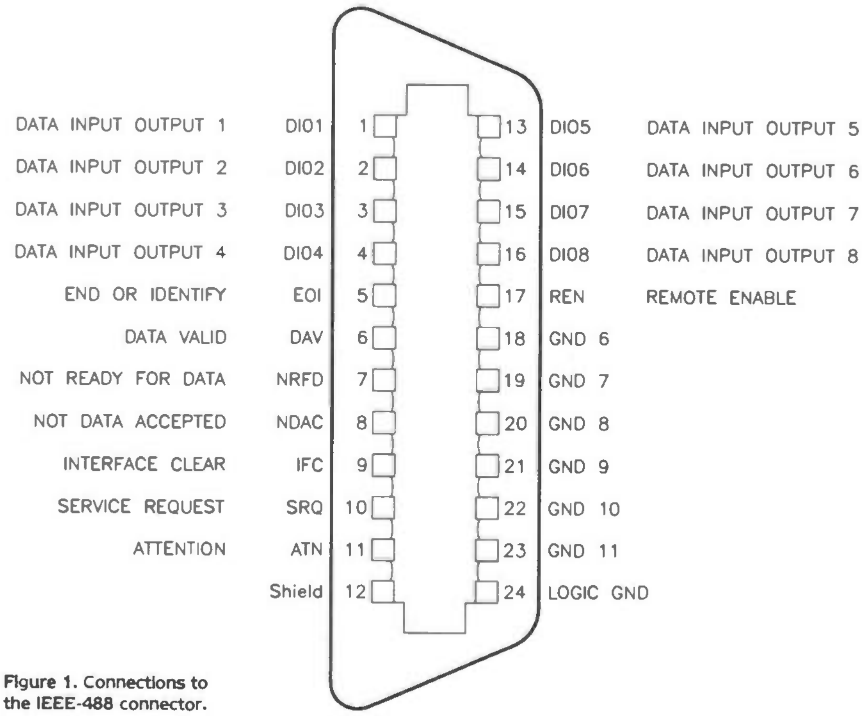


Figure 1. Connections to the IEEE-488 connector.

line low. When the last device removes its hold, the level of the line will rise, and the talker will know that all the data has been accepted and the next byte of data can be transferred.

By transferring data in this way, the data is placed onto the bus at a rate which is suitable for the talker, and it is received at a rate which is suitable for the slowest listener. Thus, the optimum data transfer rate is always used, and there are no specifications and interface problems associated with the speeds at which data must be transferred.

Bus Management

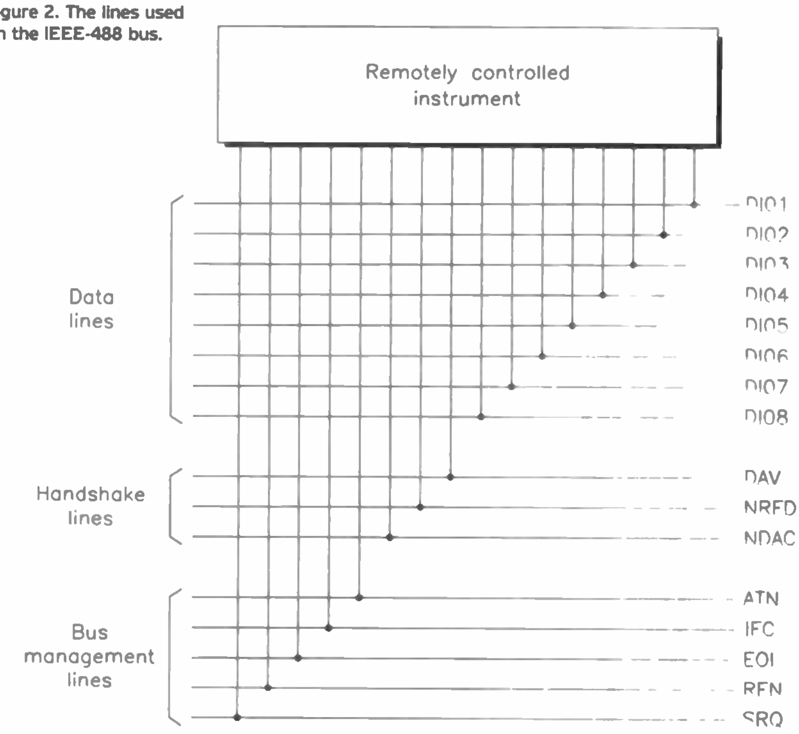
Apart from a very comprehensive handshaking system, the IEEE-488 bus employs a sophisticated form of bus management. This enables the variety of instruments on the bus to be controlled in a very flexible manner, and provides the facilities which are required. Each instrument has its own address, which allows the controller or talker to talk to a specific piece of equipment. It is obviously imperative that each piece of equipment has its own unique address on the bus, otherwise bus conflicts will occur, and the operation of the system will crash.

Often, different types of instruments have their own default values set in at the factory during manufacture. However, in all cases, it must be possible to change the address, either by changing switches on the outside or on the inside of the equipment. Even though only fifteen units are allowed on the bus at any one time, addresses for up to 31 are allowed. This enables a standard to be devised for an organisation, with different addresses allocated to different types of equipment. In this way, the address on a piece of equipment need only be changed to the standard for the organisation and then left on that address, even though it may be used in a number of different test set-ups within the organisation.

One of the most important lines is the ATN (ATtentioN) line. Using this, the controller is able to signal whether the data to be placed onto the data lines is control information or data. When the line is pulled low, the bus is said to be in command mode, and bus commands may be placed onto the bus. These commands are the same for all bus systems, and each device is programmed to respond to any commands which have a useful or applicable meaning. One of the most common bus commands is to give the address of an instrument to which data is about to be sent. In addition to this, when the line is pulled low, it causes any talker to relinquish its control of the DAV line and cease its data transmission. Another result is that all listeners, whether active or not, will listen to the control data being transmitted.

When the ATN line is high, the bus is said to be in data mode, whence data transfers between the instruments can take place. In command mode, not all the data lines are used. Bit seven is ignored, whilst bits five and six indicate the type of information to be transmitted. It may be a bus command, a talk address, or a listen address.

Figure 2. The lines used on the IEEE-488 bus.



Pin Number	Line Name	Abbreviation
1	Data I/O 1	DIO1
2	Data I/O 2	DIO2
3	Data I/O 3	DIO3
4	Data I/O 4	DIO4
5	End or identify	EOI
6	Data Valid	DAV
7	Not ready for data	NRFD
8	Not data accepted	NDAC
9	Interface clear	IFC
10	Service request	SRQ
11	Attention	ATN
12	Shield (connected to earth)	
13	Data I/O 5	DIO5
14	Data I/O 6	DIO6
15	Data I/O 7	DIO7
16	Data I/O 8	DIO8
17	Remote enable	REN
18	Twisted pair with pin 6	
19	Twisted pair with pin 7	
20	Twisted pair with pin 8	
21	Twisted pair with pin 9	
22	Twisted pair with pin 10	
23	Twisted pair with pin 11	
24	Signal ground	

Table 1. Bus Connections.

Other Controls

Apart from the ATN line, there are four further lines which can be used. The lines are the IFC (InterFace Clear), SRQ (Service ReQuest), REN (Remote ENable), and EOI (End Or Identify) lines.

The IFC line is used by the controller to reset the bus and place it into its quiescent state. Any talker or listener which is active is stopped, and control is returned to the controller. This is not used in the course of normal operation. However, it can be used when the system needs resetting or at initial power-up, when the bus may be in a random state.

Remote enable (REN) is a function which is used by the controller to set instruments on the bus to local, i.e., front panel control, or to bus control. Bus-controlled instruments may be returned to their local state by a 'go to local' message sent in conjunction with the ATN line set to low.

End or Identify (EOI) is an optional function, used to signify the end of a multiple byte data transfer. As an alternative, talkers can use a carriage return or carriage return line feed, to terminate the message. This can then be interpreted by the controller, dependent upon how its software is configured.

The next control line is the SRQ line. Any

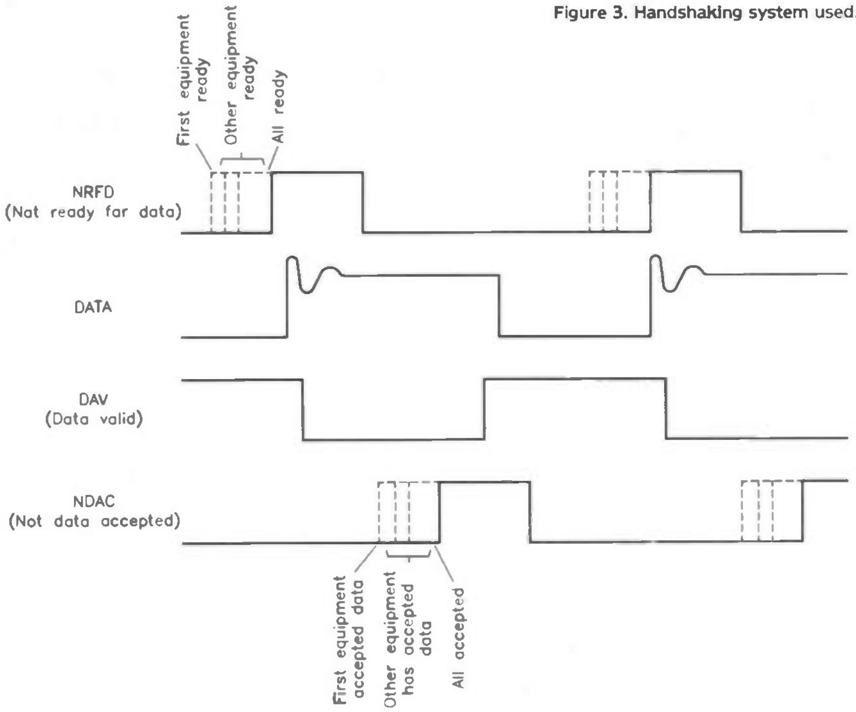


Figure 3. Handshaking system used.

device fitted with the Service Request function can pull the service request line low. When this happens, it indicates that it wants to interrupt the current activities so that attention can be given to a particular event. One instance where this facility is needed, is when a printer runs out of paper, or in another instance, when an instrument may be overloaded or overranged.

Once the SRQ line has been pulled low, the controller then has to identify which instrument has caused the interrupt. This is accomplished by a process called polling. Essentially, the controller requests status information from the devices on the bus.

Polling

There are two ways in which instruments on the bus can be polled. One is called parallel polling, and the other is serial polling.

Parallel polling can only operate with up to eight instruments. This is because each of the devices will return a status bit on one of the eight data lines. To assert a parallel poll, the controller pulls the ATN and EOI lines low. When this occurs, each instrument responds by transmitting a one bit status report.

A serial poll is more flexible, but takes longer to accomplish. Here, the controller sends each instrument in turn, a serial poll enable command. This is one of the bus commands which can be sent when the ATN line is held low. When an instrument receives a serial poll enable, it responds by returning eight bits of status information. When the status data has been received by the controller, it sends a serial poll disable command and returns the bus and instruments on it to the normal data mode.

As mentioned above, the advantage of a serial poll is that it is far more flexible, and enables eight bits of data to be returned. However, it is much slower, because each instrument has to be polled in turn, to find out which one polled the SRQ line in the first place.

Operating on the Bus

In practice, the bus is very easy to use. Ready-made cables are widely available, even if they appear to be a little expensive. However, they are fully screened and have the correct lines, made up of twisted pairs, as shown in Figure 4. This considerably reduces the susceptibility of the bus to data corruptions. Manufacture of full specification cables can be difficult, in view of the complexity of the cable and having to ensure the integrity of the screening.

A cheap and convenient alternative is available, in the form of a cable based on insulation displacement connectors. Whilst cables made in this way are much cheaper, they are not screened, and do not con-

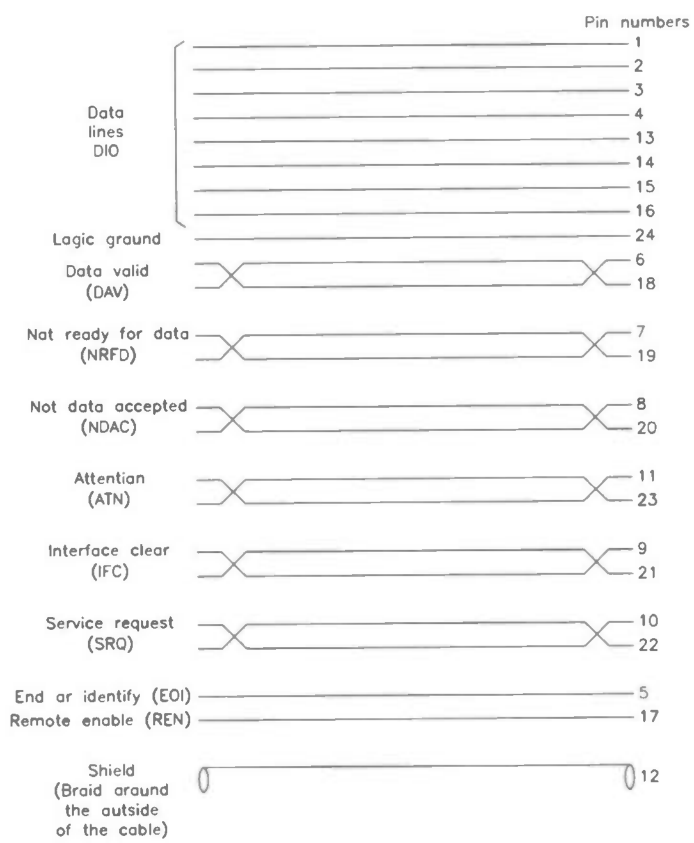


Figure 4. Wiring in a connection cable.

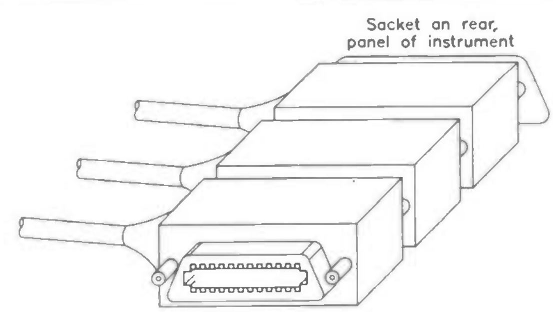


Figure 5. 'Piggybacking' of connectors.

A typical IEEE-488 interconnection cable.

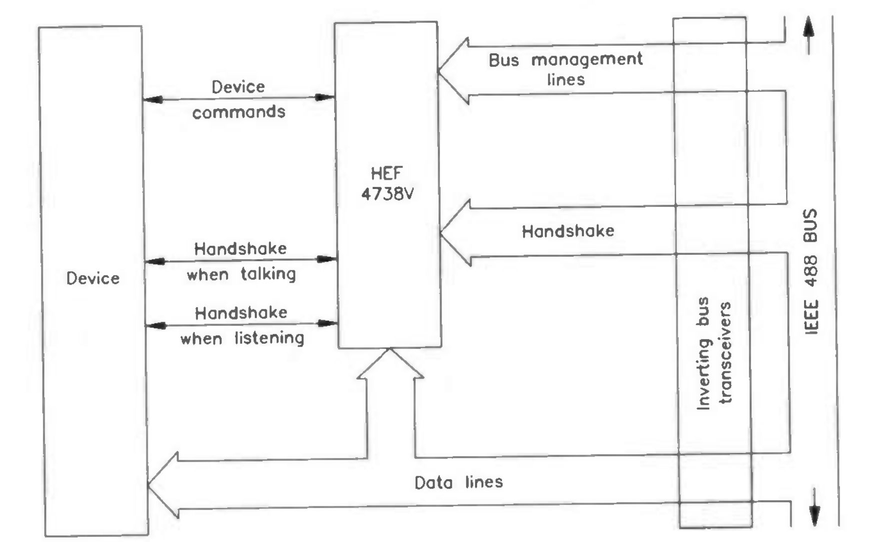


Figure 6. Details of the HEF4738V IC.

form to the correct specifications. In view of this, they should only be used where there are a very limited number of instruments, where data rates are likely to be low, for long runs, and where electrical noise is not likely to be a problem. If a cable of this nature is used, then it is worth being aware that it could be the cause of random errors when the system is operating.

When setting up a system linked by the bus, few rules need to be observed. The cables can generally be routed as required, linking the instruments as is most convenient. As the connectors can be 'piggy-backed' as shown in Figure 5, this makes linking the instruments very easy. However, a little common sense is required, and not too many connectors should be linked to one point.

Before firing up the set-up, all the instrument addresses must be checked to ensure that they are correct. Unfortunately, this can sometimes be a time-consuming operation, because not all the instruments will have switches that are easily available. To overcome this, it is best to have standard addresses for different types of instruments within a factory. This will eliminate the need for any swapping and changing as test stacks are taken down and erected.

Although the bus normally works very well, occasionally some problems inevitably arise. Sometimes it has been known for the bus to hang up, even though all the instruments are operating correctly on their own. Some instruments can be sensitive to their physical position on the bus, particularly if they are at a remote end. In instances like this, the topology of the cable routing can be changed to bring the offending instrument closer to the controller.

ICs

A large number of today's test instruments use microprocessors to control their many functions. Therefore, it makes sense to use their functionality to control the interface to the IEEE-488 bus. As a result, there are comparatively few ICs on the market which are designed specifically to act as an interface to the bus. Even then, those which are designed for this purpose, are themselves, processor based.

Processor based ICs are ideal for ambitious projects, where maximum flexibility and efficiency are of paramount importance. However, there are still a large number of instances where a non-processor based chip is ideal. There are still many designs for instruments and devices which do not include a processor. Here, a specialised IEEE-488 chip comes into its own, since it allows the device to interface to the bus with the minimum of additional work.

One chip which fits this bill, is Philips Components' HEF4738V, the pinout of which is shown in Figure 6. This chip performs the bus management functions for a talker and listener, and even some controller facilities. Whilst the HEF4738V performs all the management functions, a number of other chips are needed around it. Inverting bus drivers are needed to interface to the bus itself, and these should have the correct terminating resistors in the circuit, to ensure that the correct terminating match is given. These can be made up out of discrete resistors, or they can be bought as special resistor packs. In addition to the bus drivers, latches are needed for the incoming data. Whilst additional chips are needed, the HEF4738V provides an ideal solution to anyone wanting an easy way to get onto the bus.

Summary

The IEEE-488 bus has been available for in excess of 20 years. In some areas of technology, this would mean that it would be outdated now. However, this is far from the case. The bus is still finding widespread use in many new areas of control and instrumentation. A wide variety of test instruments are fitted with this facility as standard. In view of these factors, it is certain that the bus will be widely used in automated test and instrumentation applications for many years to come.

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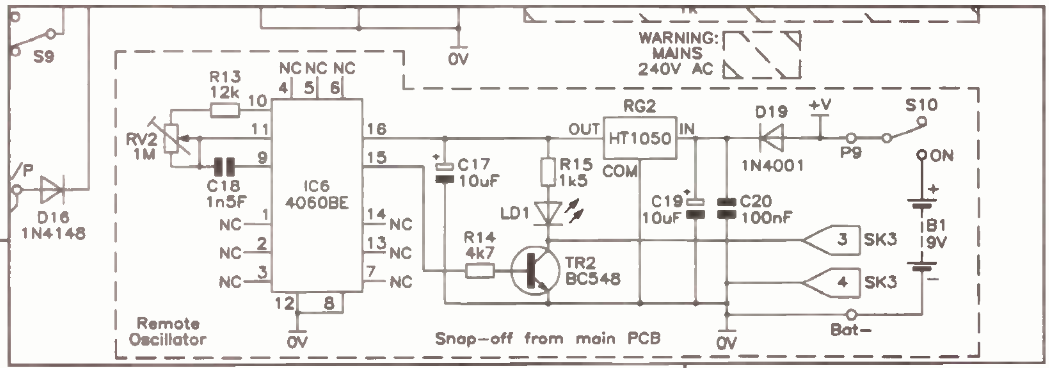
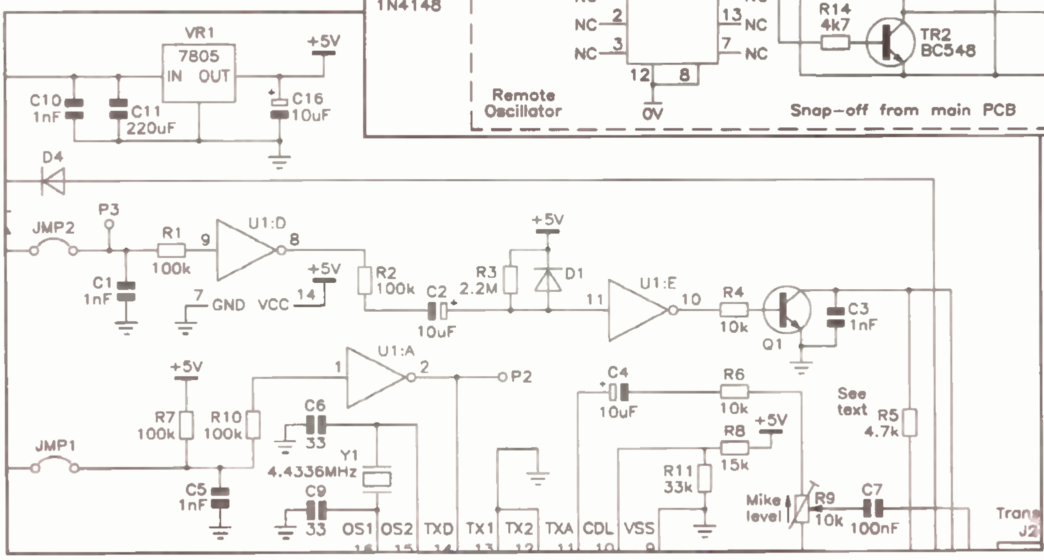
ISSUE 78/JUNE 1994

Packet Radio Modem, page 50, the circuit diagram shows C2 10µF fitted wrong way round, should be placed with positive towards R3 and D1, see drawing below.





ISSUE 79/JULY 1994

Model Train Chuffer, page 8, Parts List, transpose TR1 and TR2 components, to read TR1 BC558 and TR2 BC548.

ISSUE 92/AUGUST 1995

Multistrobe, page 49, Parts List, triac changed, should read: TI1 T410-800T 1 (AH68Y). On page 38, the circuit diagram shows two RG1, the HT1050 should be shown as RG2, see drawing Remote Oscillator above. Page 49, Parts List, number of 16-pin DIL Sockets should read 4.

NEXT issue

There are more terrific projects and features heading your way in next month's super issue of *Electronics – The Maplin Magazine*, including:

PROJECTS

In the October issue (No. 94) of *Electronics*, there are some splendid projects heading your way, comprising of the exciting PC Teletext Decoder system, which consists of an Interface Card to slot into your PC's expansion port, a separate TV Tuner Module (which has other applications), and Windows™ 3.1-based software, to enable your PC to display and control pages of Teletext information, and also store pages and print them out, if you wish. The SSB Filter project is designed to give enhanced reception of short wave radio signals, by filtering over a limited bandwidth within a crowded frequency band, particularly useful for DX-ing. Then, there is the Mains Failure Alarm, a useful gadget that gives you a clear warning that there is, or has been, a failure in the supply of mains power, so that you can take necessary action to avoid a freezer-full of prematurely thawed food, or other nasties in equipment dependent on a continuous supply. In addition to these, there is the UHF Prescaler, a handy circuit that will increase the upper-frequency measuring range of your digital frequency meter (DFM) by a factor of ten, and which is formed from an intriguing combination of conventional and surface-mount devices, giving an insight into the world of ultra high-frequency circuit design.

FEATURES

Features in this issue, will include the continuing parts of Richard Wentk's The Art of Electronic Music, and Ray Marston's Practical Guide to Modern Digital ICs, plus the final instalment of John Woodgate's thorough investigation into Noise. Eurostar, by Alan Simson, describes the sensory and technological delights provided on the new eurostar train, in the aim of whetting your appetite for a fabulous competition to win a return ticket for two between London and Paris, details of which will be given in this issue. Meanwhile, Plug Into PCMCIA Versatility, by Martin Pipe, details the convenient and robust alternative to floppy disk memory storage that is provided by personal computer memory cards, Stephen Waddington investigates mains safety devices in his article, Circuit Breakers – Standby for Action! Finally, we have RS-232 Explained, from Ian Poole, which describes the ins and outs of this widely used and ever-popular data cable connector standard.

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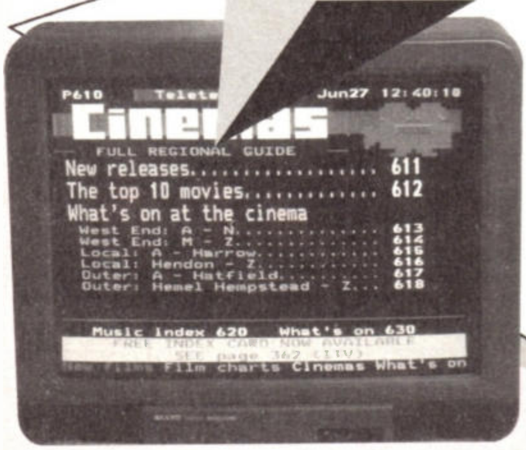

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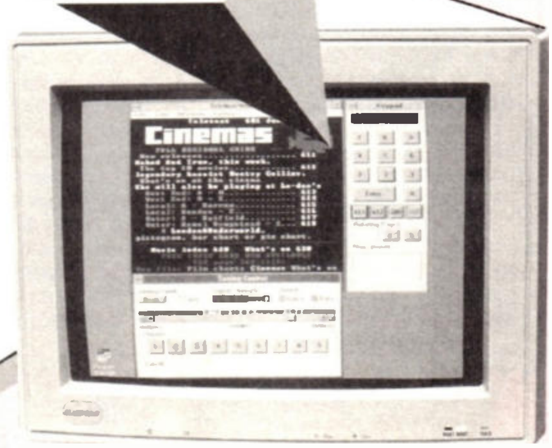

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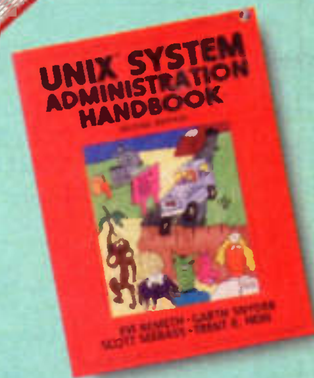

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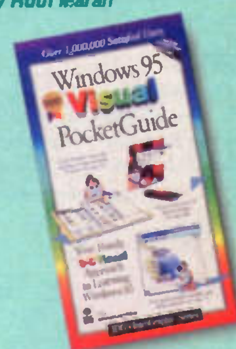

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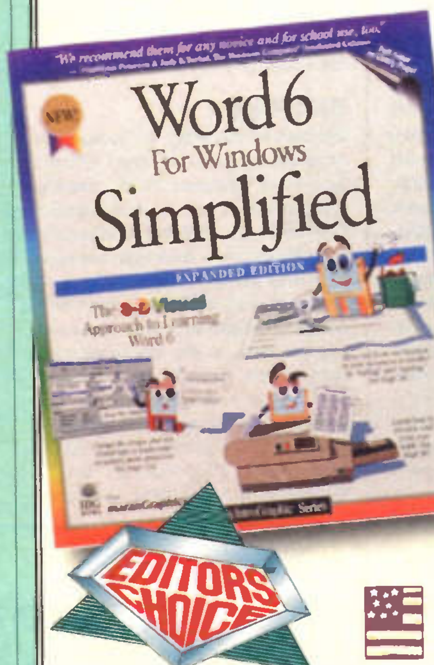

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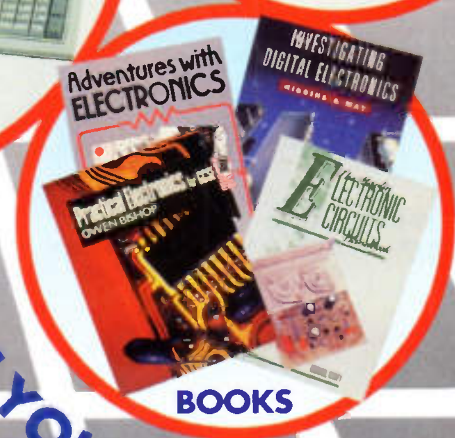

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