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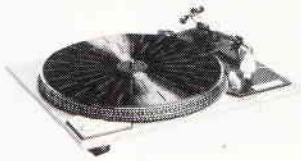

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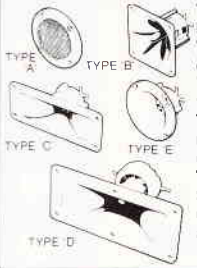

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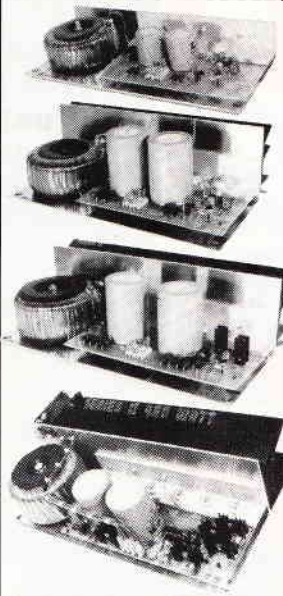

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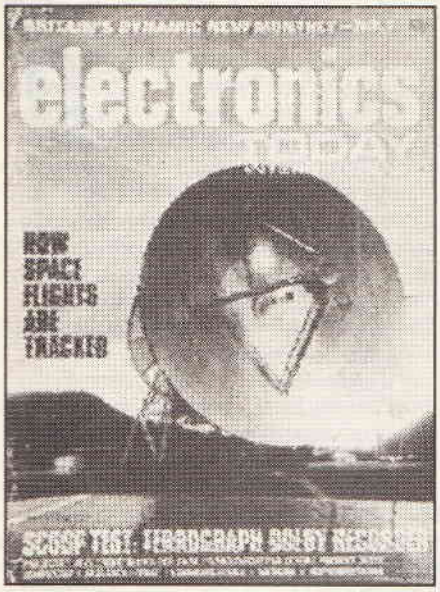
It was 20 years ago today . . .



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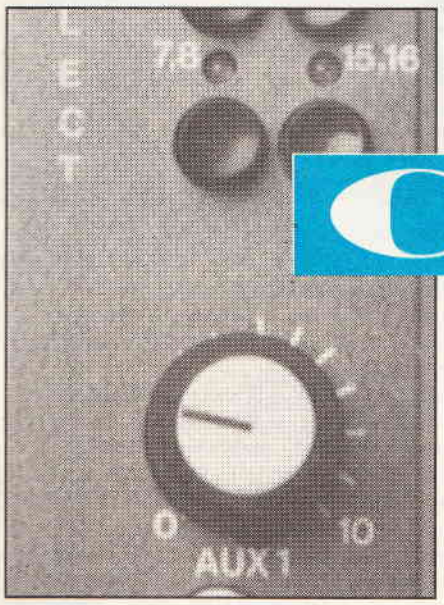
April 1992



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Editorial

By Paul Freeman

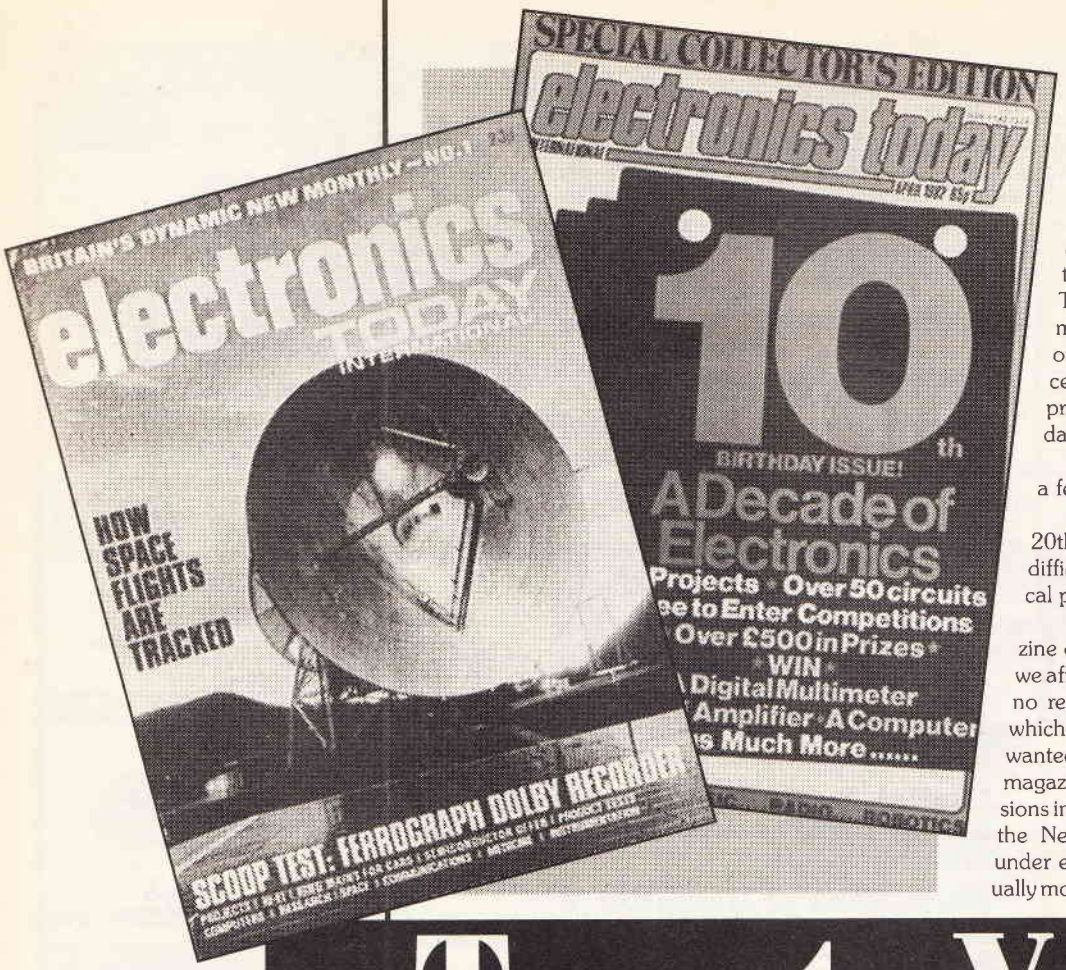
Twenty years and ETI is still going strong. In this issue we take a brief look back at our history and we also present the beginning of our 20 Year Index to show you the variety of projects covered throughout that period. As will be seen, by far the most popular projects have been in the Audio and Test-gear sections. Judging by your letters, the great Audio debate will remain for some time to come.

But ETI is very much a forward looking magazine always providing new ideas and creations for you to develop and build. We will also continue to bring you the wider aspects of technology even to the point of what such a cumulative effect of mass electronic products has on society and whether such products are desirable as they become 'semi-intelligent'. So stay with us.

Showtime

As you see from within these pages, ETI will be at the Radio and Electronics Show at Sandown Park over the weekend of 28-29th March. It's a new exhibition covering Ham and CB radio, hobby electronics and home computing. We do hope you can spare the time to pop down and see us.

Finally, I would like to thank all the advertisers and contributors for supporting us over the years and to you the reader for all your good wishes for the future. Happy Birthday ETI.



Twenty Years

Paul Freeman and Keith Brindley take a brief nostalgic look at your favourite mag

Well here we are still after twenty years. The revolution in technology has been unrelenting in its progress and ETI has reflected the trends irrespective of the varying economic climate.

But let us take a brief nostalgic look at what appeared in the first UK edition of ETI.

The issue contained 88 pages of features, projects, news, reviews and product tests, the features taking front position over constructional articles. The diversity of reported technology certainly made it a magazine to stand above the rest and it has been argued that it is still the case.

Hi-fi was there at the very begining with outlines on how to put loudspeaker cabinets together including a bass reflex design, tests on Dolby noise reduction, room acoustics and a product test on a Ferrograph tape recorder, to say nothing of LP music reviews.

Projects included an oscilloscope callibrator, wide range voltmeter and a power supply. Tech Tips also appeared in this first issue.

Astronomy and cosmology has been featured very much so in the early days and the first mag cover led us into the subject with an article on space tracking stations.

The most striking change over the years must surely be the way we see women portrayed in what still appears to be a male dominated subject. Beautiful girls appeared to sell products or presented themselves to brighten up a very dull picture. Could we get away with it these days without a tirade of abuse? I wonder what Halvor Moorshead and Ron Harris, past editors of ETI would think about it now!

Some advertisers have maintained a loyalty to ETI. J & N Bull and Electrovalue appeared in the first edition and a little later Maplin Electronics appeared. Do you remember a company by the name of Sinclair Radionics? Products like the Z30 & Z50 amplifiers and not forgetting the ZX80 & 81 and Spectrum computers appeared in the magazine. They have come and gone at a speed which made us all well aware of the pitfalls of development, marketing and entrepreneurial success. It taught us all about the risks invovled in producing a product with a 'built- in' redundancy time. Anyway enough of this!

It's time to hand over to Keith Brindley for a few historical words.

Thanks Paul. Now, a few words for ETI's 20th Birthday issue. There's so much to say, it's difficult to know where to start. Perhaps the logical place is right at the beginning.

ETI was an offshoot of the Australian magazine of the same name. ETI Australia, or 'Oz' as we affectionately knew it in the UK office (bearing no relationship to that other Australian import which raised more than few eyebrows at the time), wanted to branch out by opening editions of the magazine worldwide. These editions included versions in the UK (our own ETI), Canada, France and the Netherlands. Originally, these exports were under editorial direction from Australia, but eventually most became free-standing. ETI UK was originally owned by Modern Magazine Holdings, later to become Modmags, from there being bought by the Argus Press Group and forming the figurehead magazine published by Argus Specialist Publications. All that's historical fact — but what of the underlying personality of ETI?

In the UK at least, ETI was a new type of electronics magazine altogether. It eschewed the boring, textual styles of the already established magazines such as Practical Electronics and the like, instead offering readers a whole new insight into modern methods and practices of electronics. As a schoolboy when ETI appeared, I was immediately attracted to its openness and clarity. Now I didn't have to read what stuffy old magazines gave me — at last I was getting what I really wanted. Projects I could use (with no valves!) integrated circuits I could experiment with, features which were up-to-date, and a style and format pleasing to the eye.

Most projects and features in the first issues were simple reprints of Oz issues. As such, ETI worked from a strong base, with only a small financial outlay. Much more could be packed into a single issue of ETI than in the rest of the competition's offerings put together. As I write this I'm looking at issue number one of ETI — I had to delve deep into my archives up in the attic to find it, but it was worth the time and proves my point. There are a dozen features on all sorts of topics, four projects, two product tests, reviews and news, together with lots of other information. Issue number one's cover, featuring a photograph of a space flight tracking station's dish antenna, is a sight to behold - even after all this time. All those other electronics magazines of the day must have rued that day back in April 1972, when ETI first hit the news-stands. I don't think they've really ever recovered.

From there, ETI simply got even better. After a number of editors had their turn, Halvor Moorshead took the helm and from there things began to rocket. Halvor realised that the competition was beginning to include the same sorts of things ETI had pioneered. He knew that to forge ahead and keep its position as the best, ETI's projects had to be manifold and varying, and its features had to be even more dynamic and topical. He set up a four-man project team to design, build and test most of the projects ETI published – a fact which allowed ETI to present projects of a consistent quality every month. He trained up a youthful editorial team to research and write exceptionally readable features – just the features readers wanted. These were brilliant and progressive ideas which soon made ETI the nation's number one electronics magazine.

It was at this time I first became associated with ETI. I joined the project team as the fourth man, early in 1979. The team, under the lead of Ray Marston, had the brief to fill ETI's pages with excellent projects, as well as those of two sister magazines Hobby Electronics and Computing Today. It was hard work, but great fun. I consider myself most fortunate to have been involved with ETI at this stage. Things I learned then have stood me well in my freelance days since.

At the height of ETI's popularity back in 1980 Halvor left to run Canada's ETI, and he's there still I think. I know that magazines are occasionally swapped between international offices, so if you're reading this Halvor – thanks! Thanks for knowing what would make ETI the best electronics magazine, thanks for making ETI the best, and thanks for being the best boss I've ever had.

After Halvor, ETI has had a succession of editors: Ron Harris, Dave Bradshaw, Gary Herman, Geoff Bains, Jez Ford and now Paul Freeman. I don't think I've missed any out, if I have I'm sorry. Each editor has given to ETI his bit of personal style, adding many excellent new ideas, but the legacy of Halvor's original purpose has run throughout – it's an electronics magazine which the rest strive hard (but fail) to follow. ETI has the best projects, the best features, the best electronics information, the best contributors and the best style of any.

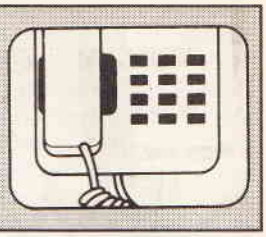
As for the future, Paul has smashing ideas for ETI. He has maintained the ETI standard throughout the newstrade recession and knows what ETI has to do to keep its position in the marketplace when the recession ends. ETI's still in the best of hands, and looks destined to set new records and break even more new ground. There's no let-up for the competition, yet!

So – Happy 20th Birthday ETI – I'm proud to be associated with you. May you lead the field for (at least) the next 20 years, too.

Thank you Keith. Now, back to the future, Ron Harris asked in the tenth birthday issue what ETI would include at the grand old age of 21. Although a year away, I would say ETI will very much reflect the digital world, presenting features on the latest developments in digital disc recording of data, video and audio, the combined interactive media experience, forming standards for digital television and the decline of the cathode ray tube. I am sure we will also be reporting further on the communication revolution and the reduction in the need for business travel. We have not reported yet on man-made growth of computer memory, but I'm sure we will – All in good time.

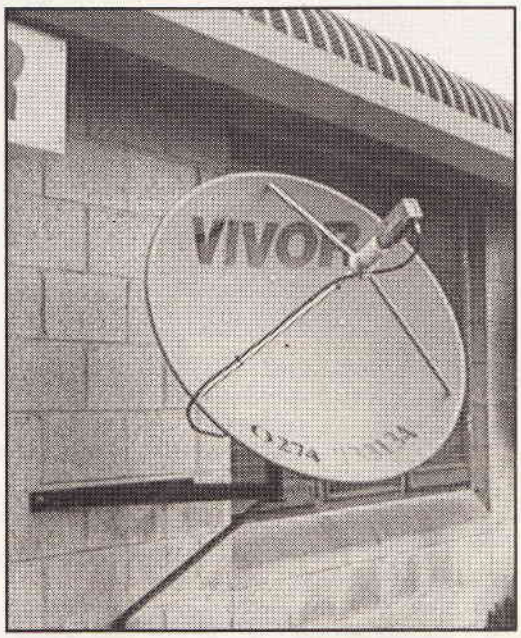
So to end, I am pleased to be associated with this aniversary of the magazine. Although ETI has many plans for the future, one thing is certain, the spirit of the magazine's initial concept will remain, that of technological diversity.

OPEN CHANNEL



ETSI is an acronym we'd all better be learning. It stands for European Telecommunications Standards Institute. Note the wording here: telecommunications standards, not television standards, not consumer electronics standards. But plain and simple telecommunications standards! This is pretty important, which is why I've stressed it and laboured the point.

Now let me explain. ETSI wants to make a standard which defines satellite television dish size as a minimum of 80 cm. Hmm, think about it. If ETSI gets its way new services will have to be designed around an 80 cm dish. Old services like Astra, naturally, won't have to force its users to have 80 cm dishes, so on the face of it there's no concern to the millions of viewers watching Sky TV and the rest of the Astra programmes.



But, when you look deeper, what the 80 cm standard will mean is that more directional dishes are being used. An 80 cm dish has a beamwidth of about 20, while a 60 cm dish beamwidth is around 30. So, if a more directional dish is used, satellites can be more closely spaced around the geostationary orbit. Currently, they're about 30 apart, but future satellites could (and most certainly will) be placed a lot closer. Result is potential interference between satellites if a dish with too high a beamwidth is in use.

So, all these millions of Astra viewers may very well end up with interference on their systems, and so be forced to install a larger dish! Can you just imagine this. Within a year there's probably going to be over 4 million Astra watchers — most with 60 cm dishes. In two years there's likely to be double this, if current rates of sales keep going. What are we going to tell all those viewers when satellites positioned too close to Astra start transmitting and causing chaos to current picture quality? We're sorry, but this daft French organization said 80 cm dishes have to be used?

The whole problem is getting out of hand. ETSI is a pressure group on the European telecommunications scene. It's standards are by no means legally binding on any manufacturer, broadcaster or user. But ETSI aims to get this standard incorporated into national laws throughout Europe.

ETSI, however, is just a telecommunications institute. As I pointed out earlier, it is neither a consumer electronics institute nor a television institute. So what it seems ETSI is trying to do is get a standard which affects all satellite users made into law effectively by a backdoor route.So what are Socit Europene des Satellites (SES — the owners of Astra satellites) and broadcasters such as BSkyB doing about trying to stop ETSI? Well, there's nothing they can do. Because ETSI is a telecommunications institute, and they're television and consumer electronics companies, they have no say over what ETSI decides about telecommunications issues. Apart from being a little strange, this is downright underhand. ETSI is an organization which has proved itself to be obviously either unaware of television and consumer electronics issues, or maybe wanting to do something specifically for one type of satellite owner and not for another.

You see, the problem is really only a problem because Eutelsat (the European telecommunications satellite organization) wants to setup a network of satellites spaced around the geostationary obital arc. The problem has been recently highlighted by Eutelsat's positioning of a high-powered satellite at 16 East of South. Astra is positioned at 19.2 East of South, so there should be little problem for dishes of even 30 beamwidth (ie, 60cm). Actually, six of Astra's transponders are affected, but as they're not currently used don't create many headlines — Astra just can't use them!

But Eutelsat wants to position a high-powered satellite at 21.5 East of South, too — which will definitely cause interference problems. Now we're beginning to get the picture - ETSI's desire for an 80cm standard seems to fall neatly into Eutelsat's requirements, doesn't it?

There is a far better method of using satellites, which SES itself has pioneered — that of co-locating satellites at the same orbital position. SES already has two satellites located at 19.2 East of South, and plans at least another two. Why, oh why, oh why then does Eutelsat need to go gallumping around the sky, putting up satellites in different orbital slots, using up valuable airspace and interfering with existing satellite transmissions?

If Eutelsat was judicious and fair about the process it could co-locate as many satellites as it wants at, say, 160 East of South or (better still) 130 East of South. Alternatively it could use transmission frequencies which did not interfere with Astra transmissions. There'd then be no interference problem.

If ETSI was judicious and fair about television and consumer electronics' use of satellites (and remember they do not have a voice in the ETSI institute!) there'd also then be no problem.

ETSI is to have decided on the proposed standard by the time you read this. Let's hope it sees sense. Let's hope its decision does not appear to give an unfair advantage to Eutelsat. Let's hope we don't all have to strip out our 60 cm dishes and replace them with larger ones.

I'll keep you posted. **Keith Brindley**

ETI NEWS

WORLD'S FIRST 16.5-INCH WIDE VISION AND MULTIMEDIA COLOUR LCD

Sharp Corporation, the major Japanese electronics manufacturer, has developed the world's first wide-vision and multimedia compatible 16.5" colour TFT liquid crystal display. This new big-screen LCD is also compatible with VGA computer software.

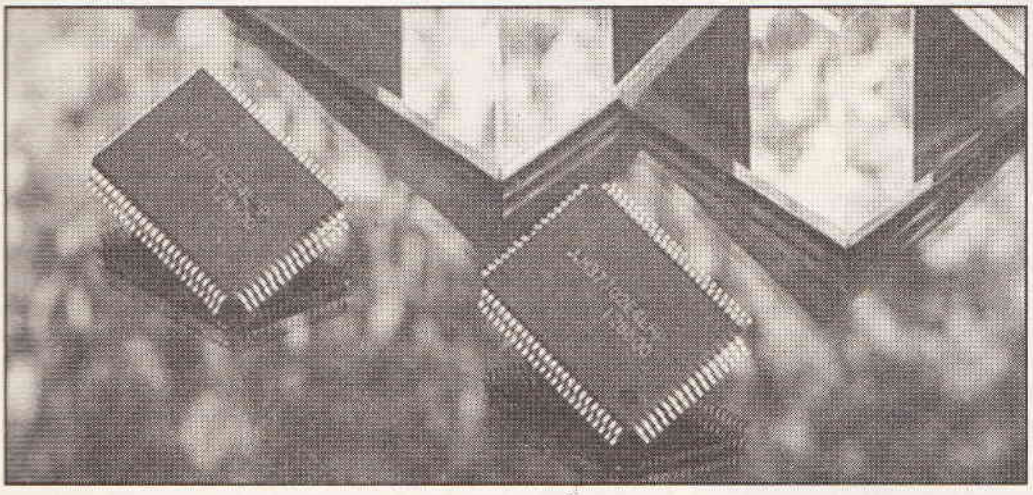
The display offers crisp, clear imaging on a high-density, high—resolution screen incorporating more than 1,228,000 pixels. Colour reproduction is exceptional across a range of 16.7 million tones. The new LCD provides the substantial advantage of muiti-media compatibility, an important technological advance. The first in the world to offer this capability, it can reproduce not only clear colour computerised graphics, but the animation and natural colours of A/V images. This achievement is due in part to the development of:

- a new high-speed digital driver
- high-speed digital processing technology for video images and computer signals
- new thin-film construction technology for even reproduction over a large area
- lower resistance source and gate-bus lines

As the world's leading manufacturer of LCDs, Sharp continues to develop and commercialise advanced LCD products. The company produced the world's first 14" TFT LCD in 1988 and has since led the field in large-scale LCD imaging, including such innovations as an HDTV LCD projection system and true wall-mount 8.6" televisions. From the first mass production of LCDs 19 years ago, the Sharp LCD business has now grown to annual sales of over £500 million.

Basic Specifications: Screen size 16.5", wide aspect; Pixel structure 853 x R,G,B x 480; Number of pixels 1,228,320; Pixel configuration RGB stripe; Display mode Normally white

16-BIT MICROCONTROLLERS FOR PORTABLES



Mitsubishi Electric is announcing the launch of a new series of 16-bit, 7700 single chip microcontrollers which provide processing solutions with low battery requirements for portable applications. Included particularly are telecomms, such as CT2 and GSM, as well as portable computing and office automation equipment such as palm top, laptop and notebook PCs.

The high performance CMOS devices operate over a wide temperature range of −40 to 85°C as standard, from power supplies ranging from 2.7 to 5.5V. Typical consumption is just 12mW at 3V and 30mW at 5V. Instruction execution time is a fast 500ns and the chip operates at 8MHz.

The low power microcontrollers come in 80 pin quad flat packaging with 68 programmable I/Os. Features include 16Mbytes of addressable memory together with three instruction queue buffers and two data buffers for high speed operation. The 16-bit central processor is easily switched for 8bit processing to provide speed optimisation and memory savings.

A basic instruction set of 103 is provided with 19 interrupts at seven levels. Also on-board are a multiple function 16-bit timer and two UARTs which can operate either synchronously or asynchronously.

An 8bit analogue to digital converter provides eight channel inputs and up to 68 I/Os are user programmable. A 12-bit watchdog time is also provided.

For further information, please contact either Christine Warren or Chris Marnoch at Mitsubishi Electric UK Ltd, Tel: 0707-276 100.

CAMCORDERS RECORD IMPRESSIVE GROWTH

Although the market for electronic goods may be depressed at present, one product which seems to have escaped the worst effects of the recession is the Camcorder.

A recent report shows how demand for camcorders has grown. In 1985 the market was worth just £64 million. 1991 saw this figure grow to £378 million and it is predicted that just under £600 million of camcorders will be sold in 1995.

Because of its restricted consumer base, (65% of owners are ABC1 social groupings), the camcorder market has escaped the worst effects of the recession.

Product developments, price reductions, and the user friendly feel of the camcorder are all helping to expand ownership. And with household penetration standing at only 5% there is plenty of scope for expansion, the report states.

Innovations such as the 'palm' corder and the new compact 8mm format not only attract new buyers but also mean that existing owners trade up. It is thought that 20% of all purchases are now replacements.

Elsewhere in the electronics market new developments are helping to pull the sector out of the doldrums. Radio sales have been boosted by the BBC's change in programme frequencies.

HARD COPIES FROM VIDEO

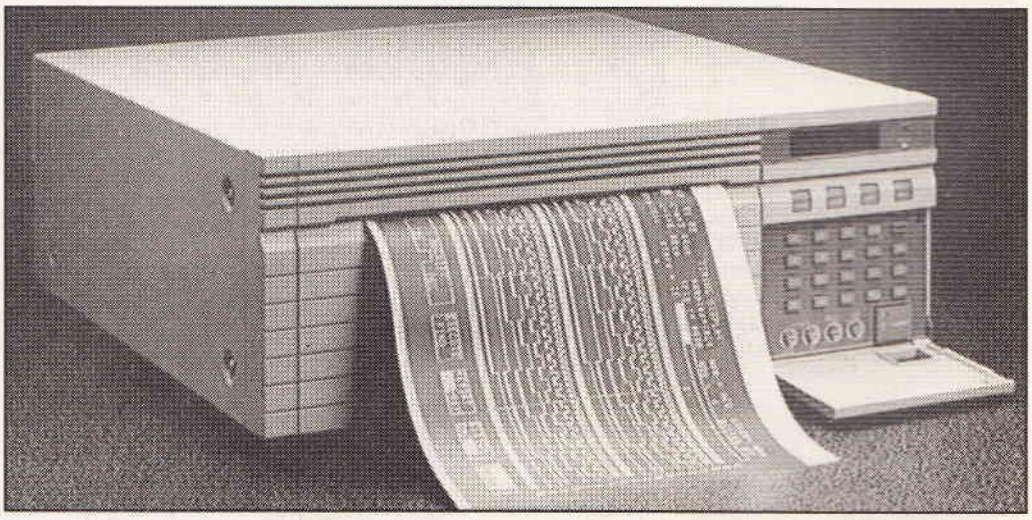
The TP6490 Video Printer from Thurlby Thandar offers 64 tone gray scale printing and has a built in frame buffer which allows multiple copies to be printed.

It incorporates a programmable control panel with a 32 character LCD readout making selection of the printer facilities easy.

The TP6490 includes a Universal Video Interface which will accept most video signals including PAL, SECAM, CCIR, NTSC and RS170.

Unlike most dot matrix printers the TP6490 will print exactly what is showing on the CRT without the need for complex interfaces or special software. The print time is very fast.

One of the major advantages of the printer is that it can be connected with high frequency dot clocks up to 90MHz as used on computer workstations.



Applications for the product are broad and include medical, military, computer and video industries. In fact wherever there is a need to take hard copies from a display or at video level.

For further information please contact: Thurlby-Thandar Ltd, Tel: 0480 412451

POCKET-SIZED TONE DIALLER PAD

A universal key tone pad which emits audible Dual-Tone Multi-Frequency (DTMF) encoded signals has been added to the Maplin Electronics fast expanding range of communication products. The pad serves a growing number of products and services which are steadily coming on-stream in the UK, and which require the use of tone signalling over the telephone line. These items include answering machines, home banking facilities, home shopping and computer based services.

The pocket sized key tone pad allows the user to enter the DTMF tone codes required by many such services. Having accessed the service by dialling a line in the conventional manner, the speaker of the tone pad is placed over the microphone of the telephone handset and then the DTMF encoded numbers are transmitted to the receiving device. The unit is powered by two AG13 type button cells supplied. The tone dialler pad (order code ZB19V) costs £8.95 (to incl vat).

ELECTRONIC WATCH-DOG

The Maplin Electronics new Velleman Kit, electronic watchdog is designed to scare away intruders from your household and the surrounding area. The circuit unit generates a realistic barking sound, with a sensitive ear to what's happening around. The sentinel never sleeps, and doesn't ask for much: only a 2 x 8V transformer or an (unstabilised) 9-12V DC power supply.

One may disagree about the best deterrent against burglars, but one fact is true; a frightfully barking dog brings most villains to their senses. However the kit doesn't need walking, feeding or even a licence.

It features a choice out of two different dogs with realistic sound using a random generator. It has an adjustable sensitivity control for noisy environments.

The Velleman Kit (K2655) costs £29.95. (including VAT)

DATA DISCMAN 'ELECTRONIC BOOK' FROM SONY

This spring sees the appearance in UK high streets of the first in a new generation of multi-media communications products. Thanks to the Sony Data Discman, both the British business community and the public at large will be able to equip themselves with a revolutionary means of accessing and presenting information, while the publishing world will gain a powerful new 'paperless' communications medium.

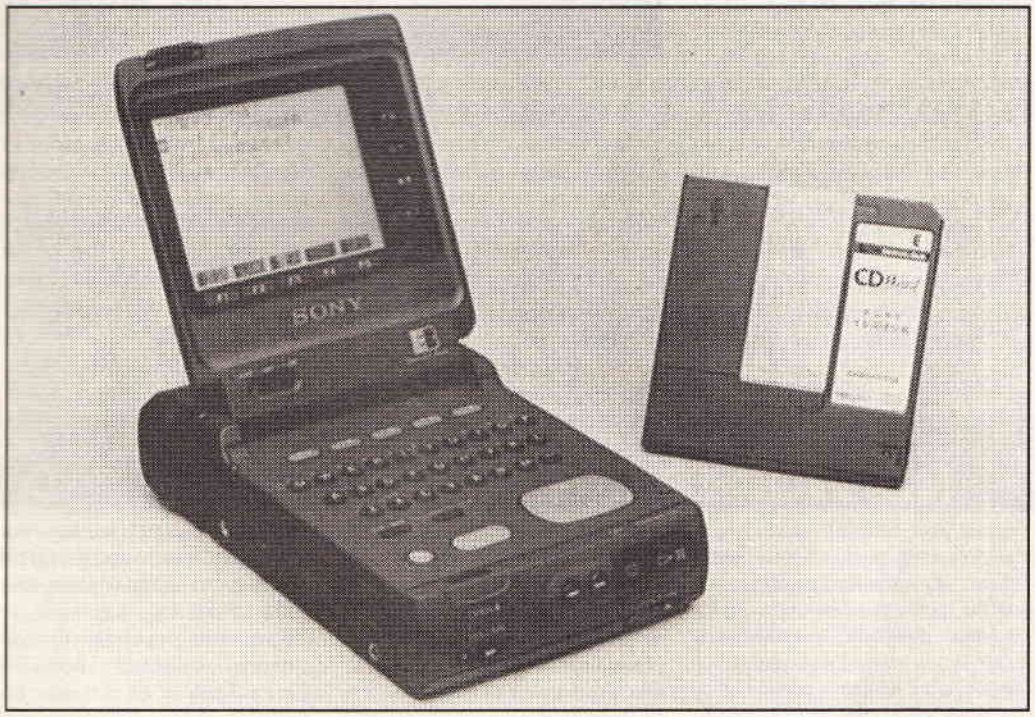
A hand-held electronic 'book' (weighing just 705 grams) capable of displaying text, graphics and replaying audio, the Sony DD-1EX Data Discman offers rapid access to the right information whenever and wherever it is needed — and with over 100,000 systems (plus more than 200,000 software discs) in daily use in Japan, Data Discman has already captured the imagination of both consumer and business professional alike.

EB (Electronic Book) software titles are many and varied and they include maps, business directories, reports on the world's top companies and even the complete works of Shakespeare. In April, over a dozen UK titles will be available, three of which will be 'bundled' with each Data Discman sold. However, given the international compatibility of the software, early British purchasers can be confident that their Data Discman can accommodate the additional 85 plus EB titles available from the US, Japan and mainland Europe. Such is the enthusiasm of the publishing community, Sony is confident that around fifty discs sourced from Britain will be on the market within twelve months of the launch.

Data Discman reads CD-ROM discs adhering to the globally—recognized Electronic Book (EB) Standard. With an impressive 200 Mb data capacity, it provides the equivalent of 100,000 pages of A4 text or 32,000 visual images (or any combination of the two). A single 8cm CD-ROM can accommodate the same amount of information that on the printed page would occupy around two hundred telephone books. For extra versatility, the DD1-EX Data Discman can also play standard 8cm audio CD singles.

While the capabilities of its new baby are already remarkable, Sony is quick to underline that, the £350 DD-1EX represents just the first stage in the emergence of a new generation of Data Discman products. Well before the end of the decade, the Electronic Book standard will be just one strand within an interactive personal communications network incorporating advanced multi-media systems, CD-I (Compact Disc Interactive) the recording Mini-Disc and even satellite-based 'GPS' Geo— Positioning Systems. For both publishers and those buying the new EB standard software, one thing is certain — EB titles available for first generation Data Discman products are set to be compatible with all of the exciting future hardware developments that Sony and other hardware signatories may have in the pipeline.

Data Discman's 'human interface' consists of a QWERTY keyboard, cursor and function keys, while information is displayed as 10 lines of 30 characters or graphics via a 3.4" diagonal backlit LCD screen. Information can be accessed in any of seven ways via either individual words, keywords or word parts — or via a choice of other simple menu-based, cross-referencing and graphic search techniques.



The format's international compatibility is an important aspect of Data Discman: not only will EB software sourced from all over the world perform in any unit, but a multi-standard composite video output enables the device to be connected directly to a monitor or video projector of any television standard for large screen presentation. A multi-lingual capability is central to Data Discman's true international portability, and the command functions of the DD-1EX can be selected in any one of twelve languages.

Data Discman's prodigious information capacity lends it to a wide spectrum of business and professional users who need access to either 'off-the-shelf' information (such as dictionaries, maps and business directories) or their own customized data-bases. While Data Discman's UK launch is bolstered by a large international catalogue, Sony is particularly keen to assist corporate users who wish to create their own tailor-made 'books'. Typical custom packages might include stock inventories, price lists, corporate profiles or reports as well as 'expert systems' for legal, engineering and medical practitioners.

Sony's Data Discman product specialists were joined at the Design Museum press launch of Data Discman by Haydn Abbott, Managing Director of Sony UK. He said: "While the Sony name is intimately associated with the concept of personal products such as Walkman and Watchman, the significance of our 1992 Data Discman introduction in the UK is two-fold. As well as representing a breakthrough in personal information technology, it also heralds a radical challenge to the British publishing industry."

"The printed word's role in society is more potent than ever before, and it is now augmented by a complementary medium that unites text, graphics and audio in situations where words on paper alone can not suffice. As we all face the implications of a truly multi-media based future, publishers now have control over another dimension in the presentation and marketing of information. I look forward to the industry's response to this new and exciting opportunity for the Nineties."

The Sony DD-1EX Data Discman comes supplied with three EB titles as standard, plus a NiCad rechargeable battery pack, dry cell battery pack, AC adaptor and video cable. The unit is expected to retail at around £350 from April 1992. UK software prices are as yet unfinalised.

FIRST EUROPEAN MINI DISC PRODUCTION WILL START IN AUTUMN 1992

Sony have announced that production of pre-recorded Mini Discs (MD) will start at their Austrian plant, in Autumn 1992.

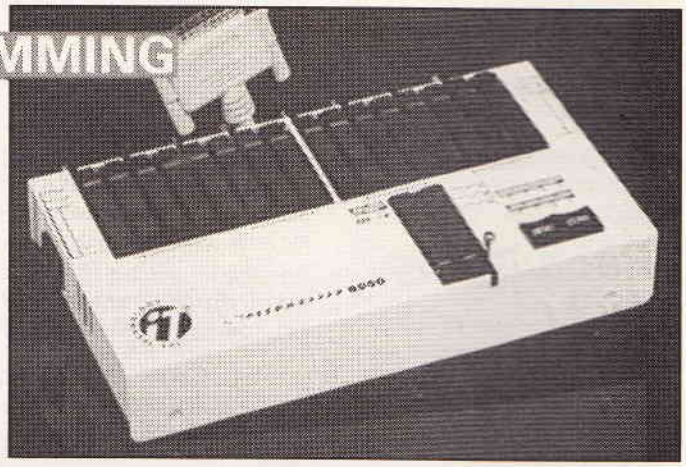
29 years after the launch of analogue compact cassette tape and 10 years after the market introduction of the Compact Disc, the Mini Disc is a revolutionary record/playback audio system that combines the portability and shock-resistance of analogue, compact cassettes with the sound quality, quick random access and easy operation of CD.

The Mini Disc system offers more than one hour of digital audio playback and recording on a 64-millimetre (diameter) disc.

Sony believes that the Mini Disc will meet the consumers demand for portability, recordability, quick random access and high quality digital sound, thereby creating a new portable, personal stereo market for both hardware and record industries.

Sony will start to manufacture pre-recorded Mini Discs worldwide in facilities in Japan, America and Europe with a starting capacity of approximately 1.5 million units per month in the second half of 1992.

FLEXIBLE EPROM PROGRAMMING



UK programmer manufacturers Ice Technology are able to offer very flexible solutions to many different gang programming requirements. Their systems are based around the Speedmaster 8000 programmer, which can operate either linked to a PC or in stand-alone mode. The base unit can programme EPROMS up to 32 pins, while systems can be built around this unit to programme Micro-controllers, Programmable Logic Devices and PLCC devices.

The Speedmaster 8000 is one of the fastest, if not the fastest gang programmer around. Using manufacturers approved algorithms, it can programme eight 27C256 Eproms in around 5 seconds. Set programming is also a feature.

For more details contact Ice Technology Ltd on 0226 767404.

MORE HI-TECH IN THE HOME

Personal fax machines will soon be seen in homes and cars across Europe — and they will be manufactured in the North of England.

The Korean giant Samsung Electronics has set up the first manufacturing plant in the North to produce personal fax machines for the European market. The £4.5 million investment is being made at Samsung's Billingham factory in Cleveland, which was set up in 1987 to manufacture microwave ovens and video recorders. It is the third investment at the Cleveland site to be made by the company.

Samsung's UK Managing Director, Mr Chan Bae said: "The home fax machine will help improve communications for the businessman or woman, ensuring that no opportunities are missed in the competitive business world of the nineties. Samsung are ensuring that they are leaders in the field."

Support in bringing the investment to the North of England was given by Northern Development Company — both in England and Korea - and by Cleveland County Council who provided financial assistance towards the project. Regional Selective Assistance has been approved for the project by the Department of Trade and Industry.

ACCELERATOR CARD FOR WINDOWS 3 NEURAL NETWORK PROGRAMS

Neural Computer Sciences has released a plug-in accelerator card for PC AT-compatible computers which provides a more than 100-times increase in performance of its Windows 3 neural network package, Neural Desk. The card provides the means to speed dramatically the 'training' of neural network artificial intelligence programs. It will also improve the performance and response time of installed programs dealing with particularly complex problems. Neural Computer Sciences believes that the £1500 card — working with the Neural Desk provides industry and commerce with one of the most cost-effective approaches to artificial intelligence in the world today.

Based on a 32-bit digital signal processor, the 25Mflop accelerator card implements the algorithms required for Neural Desk to make over 300,000 neural connections/second; this is more than 100 times the performance of the package when running on a typical 386/387- or i486-based PC. The board plugs into any ISA/PC AT-compatible expansion slot.

This means that the training of a neural network — the process whereby the package learns the correct responses to input data by running real-life examples and optimizing its responses — can be accomplished very rapidly. Training time can be significant when a network is developed to deal with a large number of input variables. Examples of applications involving many inputs include intelligent process control systems and speech recognition; both training and the response times of the program in use would benefit from the installation of the accelerator card — as would defence-oriented applications such as pattern recognition. Another key application area is where a neural network needs to be regularly re-trained in a short space of time - for example, the accelerator card could allow a network used to predict stock exchange movements to be re-trained overnight using large volumes of the latest trading data.

Until now, neural networks have largely been the preserve of scientists, because of the substantial programming effort and computer power required to implement and run them. Neural Computer Sciences realised that modern PCs, such as those with 386 processors and the new graphical user interfaces, provided the basis for making the technology available to non-specialist users, and developed Neural Desk. This provides artificial intelligence support in the form of a Windows 3-based package for PCs.

The software's unprecedentedly simple graphical user interface allows it to be applied quickly and easily to assist with many daily tasks, providing fast, intelligent help for complex and problematic situations. Released in late 1991, Neural Desk is the first complete neural network package for Windows 3, and offers everything required to develop, train, and run applications, including the availability of a low-cost run-time module for embedded applications. The result is a highly powerful neural network tool which can be applied to problems without conventional programming skills. The new accelerator card substantially extends the application range for Neural Desk, taking it into the topmost layers of artificial intelligence applications.

For further details please contact Brian Kett, Neural Computer Sciences, Tel: (0703) 667775.

ETI NEWS

stateside

Preheated catclytic converter

A catalytic converter for cars that is electrically preheated using power from the vehicle's 12V battery has been developed. In tests, conventionally converted cars equipped with the supplemental electrically heated converter have met California's projected ultralow-emission vehicle standards for hydrocarbons, benzene, and formaldehyde.

The converter is designed to reduce emissions during the cold-start portion of the driving cycle, during which 50-70% of vehicle emissions are produced. Key to its operation is a coated and catalyzed honeycomb substrate made of Alfa-IV, a ferritic stainless steel (Type 445) developed by Allegheny Ludlum Steel, Div. of Allegheny Ludlum Corp. The stainless-foil substrate doubles as the unit's heating element. The time required to preheat the substrate to the catalyst's reaction, or 'light-off', temperature of 345°C ranges from 7 to 15 seconds, depending on exhaustpipe size and whether it is a single- or dual-exhaust system. Power usage is 4.8kW for single exhaust or 2.8 kW/unit for dual exhaust with two units required. Conventional ceramic-substrate converters are relatively ineffective under cold-start conditions because they require several minutes of engine operation to reach light-off temperature. Preheating is not practical for ceramic substrates due to the large drain that would be imposed on the battery.

Alfa-IV was developed specifically for catalyst substrates, where oxidation resistance is important to minimize spalling of precious-metal catalyst coatings. Its typical composition by weight percentage is 0.01 C, 20 Cr, 5 Al, 0.02 Ce, La = Ce/2. Typical mechanical properties of annealed, 0.635mm thick material include a yield strength of 72 x 10^3psi, tensile strength of 94 x 10^3psi, elongation of 23% and hardness of 75.5 R30T.

According to Allegheny Ludlum, the oxidation- and corrosion-resistant stainless also is a candidate for furnace parts, heat exchangers, recuperators, kiln linings and refractory-reinforcing fibres. The EKC's honeycomb substrate is made of 0.05-mm (0.002-in) thick Alfa-IV foil.

Recharging nickel cadmium batteries

A US company is now marketing a battery-controller IC for recharging nickel-cadmium batteries in as little as 20 minutes.

The ICS1700 CMOS circuit incorporates the patented Reflex principle of charging. It combines a high-charge current with regularly spaced negative-current pulses.

Unlike other controllers that terminate the charge when the battery is in a state of overcharge, the ICS1700 controller employs inflection-point cutoff, which terminates the charge when overcharge has just begun. This terminates the charge before internal presure has significantly risen, and reduces the likelihood of premature battery failure due to venting.

Among the features of the chip is the detection of a fully charged state, detection of defective batteries and of open-or short-circuit charger condition. There is an internal timer and no external clock is required.

The chip operates from 0°C to 70°C using a 5V supply. The device is housed in either a 16-pin plastic DIP or a 16-pin small-outline surface-mount package.

The device is available now in small sampling quantities. An evaluation board and an evaluation schematic are also available.

Integrated Circuit Systems Inc., Valley Forge, Pennsylvania.

New optical intercommunication technique

In a new technology for optical processing, engineers have developed a bare printed-circuit board that houses an embedded fibre-optic cable.

The technology, disclosed in a paper at the International Electronic Packaging Conference in San Diego, uses optical fibre to carry high-speed signals without crosstalk, reflections and other problems that plague board designers working on high-density, high-speed boards. Data can be moved at 150 Mbits/second. The board was co-developed by Alcatel Bell Telephone, Advanced Interconnection Technology and the University of Ghent.

The optical-interconnection technique is being studied by various telecommunications companies, which have found that speed and density are limited by packaging and interconnection problems: differential delays in buses and reflections caused by discontinuities between bond wires, via holes, crossovers and device packages.

The Alcatel project addresses a wide range of optical processing, including transmissions through a single rigid board and to other boards linked via flex circuits. Researchers are also working on a backplane that has optical interconnects.

Components have to be placed almost perfectly to ensure good signal integrity.

The fine positioning is necessary to avoid loss when data is sent into the optical cable and retrieved from it. In the Alcatel programme, the fibre core is only 100 microns in diameter, making tight positioning necessary. Researchers at the University of Ghent are currently using manual alignment to position the optical transmitters and receivers.

To try to overcome that problem, engineers at GEC-Marconi are using flip-chip solder bump bonding, which has self-alignment characteristics. The firm has developed integrated optical circuits that are aligned to silicon substrates, which have up to six fibre-optic cables.

Researchers at GTE also are using flip-chip bonding, linking a laser chip to a silicon wafer board that houses optical fibres. The wafer board is an extension of thin-film multichip-module technology.

BLUEPRINT

Blueprint is a column intended to provide suggested answers to readers' electronics design problems. Designs are only carried out for items to be published, and will not be prototyped by the columnist. Circuits published in Blueprint are believed to work, but may need minor alteration by the reader after prototype. Individual correspondence will not be entered into, save as necessary to prepare items for publication.

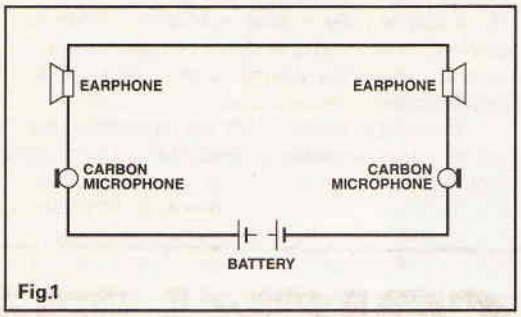


Fig.1

Dear Blueprint,

I have been trying to design a cheap intercom for use in concert situations between the sound desk and a stage assistant. It is difficult because only three cores are available to connect the two stations. My amplifier design uses a 9-0-9 power supply, so that at first glance five cores appear necessary.

One idea I have is to modulate the −9V supply with one signal, and the +9V with the other. Would this work, and is there a better way to do it.

Jamie Ogden
Hemel Hempstead
Herts.

This is a problem which was addressed in the early days of the telephone. Figure. 1 shows a simple telephone type intercom which will work effectively. Unfortunately it suffers from the problem that when you speak into the microphone your voice is very loud in your own earphone. This gives rise to a tendency to speak too quietly for the person the other end to hear properly.

The design of the old style of telephone, in use for a long time, incorporated a circuit of the type shown in Figure. 2. This uses the primary winding of the transformer to balance out most of the signal passing from local microphone to earphone, without reducing the signal from the other end. The correct amount of sidetone, as it is called, balances the tendencies to shout because one cannot hear ones own voice in the earphone, or to whisper because the sound in the earphone is too loud.

The way this works may not be immediately obvious, so consider what would happen if the centre tap of the transformer were connected directly to ground. In this case, V2 would be of the same amplitude as V1, but inverted. If the centre tap were not connected at all, then V2 would be in phase with V1. At a particular value of R, the two effects balance and no signal is passed from V1 to V2. In practice the circuit is not balanced exactly because a little sidetone is beneficial.

Active Cancelling

Modern telephones achieve the same effect by using low power active circuitry. We can do the same to make an intercom.

To minimise the complexity, I have not attempted to make this work with only two cores in the way that telephones function; I have used the three cores stated to be available. The connections between the two intercom stations are then: positive power supply, 0V, and bi-directional signal.

Figure 3 shows the signal splitting circuitry. Considering the case of a signal travelling from left to right,

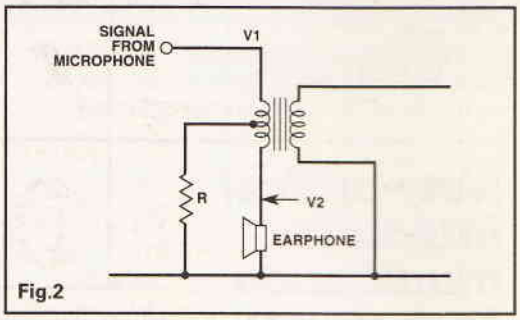


Fig.2

what happens is as follows: the signal from the microphone is amplified by IC1a. The gain of this stage may need to be varied to match whatever microphone is in use. To increase the gain, increase the value of R4; to reduce the gain, reduce the value of R4.

The signal from IC1a is fed to the bi-directional signal line via R5. The signal on the line is half the amplitude of the signal on pin 1 of IC1, because it is potted down by R9 and R5. This is true whether or not a completely separate signal is travelling in the other direction.

The half-amplitude signal on the bi-directional line is fed to IC1b, where a proportion of the output from IC1a is subtracted from it. If the values of R6 and

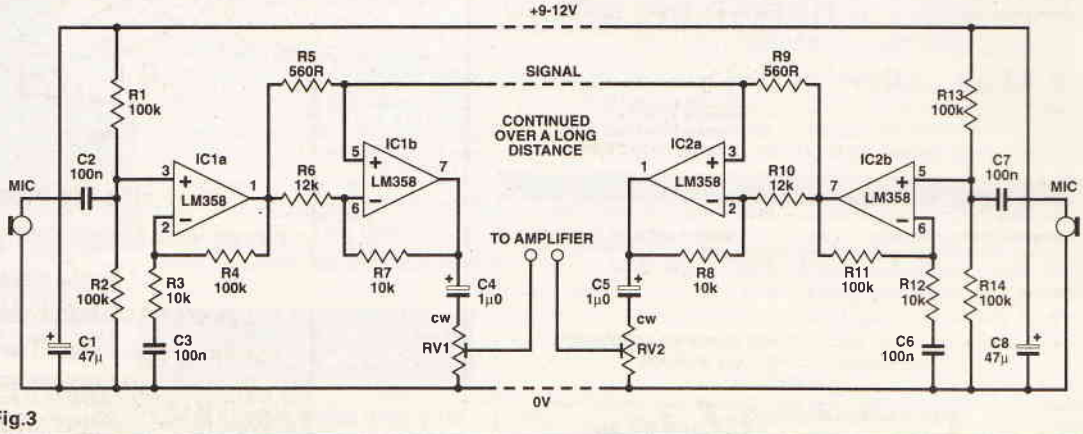


Fig.3

R7 were the same, then cancellation of the signal would be almost complete (with leakage only due to imperfections in the components). As it is, the output from IC1b consists of a small signal in phase with the output of IC1a, plus a much larger replica of any signal travelling in the opposite direction.

Exactly the same reasoning applies to signals travelling in the opposite direction, so that at each intercom station the dominant sound in the earphones is the signal from the other station. Just enough of the station's own signal is fed to the headphones, so you can hear what you are saying in a noisy environment. If extra sidetone is required, then the value of R6 should be increased.

The audio amplifier itself is not relevant to the understanding of how the unwanted signal cancellation takes place. For this reason, the amplifier circuit is shown separately in Figure 4. The LM386 connected as shown in Figure 4 has a gain of 20dB which should be more than enough to amplify the signal sufficiently for even the noisiest environments. It is likely that, in practice, the volume controls will need to be turned well down.

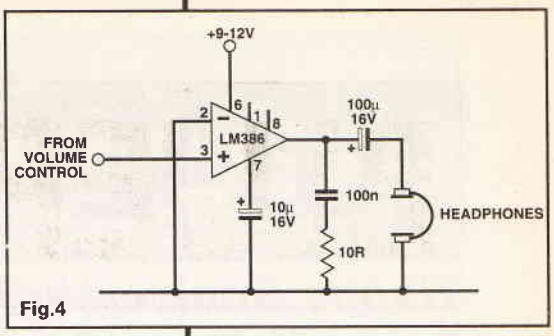


Fig.4

Because the microphone signal is amplified before being fed into the cable, some extra immunity to the effects of noise is built in. However, if the cable carrying the intercom signal is to be run anywhere near to phase controlled lighting cables, then screen lead may be found to be necessary.

In common with all Blueprint designs, this is believed to be workable as drawn, but it has not been prototyped.

Andrew Armstrong

READ\WRITE

ETI LETTERS

Happy Anniversary

In response to your Editorial in the January issue I send my greetings in readiness for the 20th anniversary, and best wishes for another twenty years of your excellent magazine.

As author of the Digital Scoreboard and the ETI Digibaro (and numerous Tech Tips of course — keep them coming everyone!), I have played but a small part in the history of this illustrious publication, surely the best of its kind. (To think that I nearly published in another magazine when ETI turned me down first time - smack hand!). I'm afraid I cannot claim to have every issue, I started around year 5, and I have had to consign them to the basement of my local electronics shop for reasons of space.

On the subject of the Digibaro, I had a letter quite recently requesting the program for the EPROM, so I know ETI projects get made, even some years after publication. Technology moves on a pace, of course, as does the public perception of what it should be able to do. A revised Digibaro, maybe battery powered LCD and easier to calibrate, might be of interest if ever I can find the time to design it.

To look into the future, the trend in semiconductors, and hence projects, is greater sophistication for little increase in price. We might expect to see some dramatic changes in the level of technology available to the amateur in the next 20 years, just as we have in the last 20 (or even the last 15 — check out the 5th anniversary issue if you have it!).

There are going to be problems, though. More powerful ICs require special handling — you should see the lengths I go to to get heat off their mainframe PCBs. On a more basic level, more and more devices will only be available in surface mount packages, which are terribly difficult to deal with even for small to medium sized companies, let alone the amateur. One thing I am sure about is that the enthusiasts won't give up, and somebody somewhere will come up with a solution.

Finally, a word in reply to Mr Henning (Read/Write, January issue). I too have considered the problem of detecting whether a door is secure, not just closed, and it seems remarkable to me that nobody I am aware of has implemented a solution. The idea I came up with is to embed a microswitch in the door frame, so that when the door is locked (or just latched), the bolt actuates the switch. This would detect doors that are not locked, or could be made to sound the alarm if someone even tries the handle.

So,Happy Birthday ETI, and long may you live.

Ken Wood,
Ipswich.

Many thanks for your kind words Ken — Ed.

MIDI Origins

Regarding the article by Mike Meechan, on Digital audio mixing consoles.

So MIDI is proprietary to Yamaha, is it? This will come as a bit of a shock to the hundred or so other manufacturers who have merrily been building it into their products for the last nine years. Yamaha should clean up on royalties if they decide to apply them retrospectively.

Runs at 19.2kBaud does it? Yet another blow for the design boffins who have unanimously been running it at 31.25kBaud.

One wonders where Mr. Meechan has been hiding since October 1982 (the date the MIDI specification was made public), that these basic facts have eluded him.

Well yes, it is similar to RS232 but then so is almost every other serial data protocol run through cable. This is as useful as saying a car is a box with a wheel at each comer, (so is a shopping trolley) it's a factual statement that conveys very little information.

To be frank, I am surprised this stuff survived the editorial knife, but it does rather cast doubt on the veracity of other statements in this apparently informative article.

More vigilance, more fact checking, less misinformation please, (I educate people in Technology of Music and my job is easier if I don't have to 'deprogram' those students who believe everything they read in a magazine).

G Wilkie, London.

Mike Meechan replies:
Taking your points in the order they were made.

After I received your letter, I contacted Yamaha (K) Research and Development in London. The Japanese chap to whom I spoke explained to me that Yamaha had indeed pioneered the original MIDI interface code back in the early eighties. Subsequently, there was a meeting of other major musical instrument manufacturers— Oberheim and Roland among them — and the first MIDI specification was created., Each manufacturer present then developed different parts of the specification. The MIDI 1.0 spec is formulated by joint agreement of the different manufacturers involved and ratified by the International Association and the Japanese MIDI Association (JMSc).

With regards to the 19.2kBaud statement, meâ culpâ, although it was more of an old truth than an untruth. Not being of a musical instrument-playing disposition, my only contact with the word and concept of MIDI apart from when I was researching and designing the AutoMate mixer for the anniversary issue of the ETI was in music equipment manufacturers' literature. The 19.2kBaud figure mentioned was part of the original and quickly superceded specification. I later found that the up-to-date spec showed 31.25kBaud and informed the Editor of this fact but it was unfortunately past the copy deadline for the issue in which this erroneous statement was issued and it had to remain. Finally, on the point of associating the MIDI protocol with that of RS232, I have to say that I beg to differ. I maintain that the statement referred to is only of very little significance to someone who would most probably find the whole article very simplistic and of little relevance when compared to their own breadth of knowledge in the subject. I should like to point out that the series was entitled Introduction to Audio Mixers, with great emphasis on the elemental and rudimentary nature of the text. It was not pitched at Music Technology lecturer level. If I had said the that MIDI was similar to the Racal SCORE method for machine interface (Serial Control Of Racal Equipment) which is also an asynchronous, serial but little-known data protocal, I think that the criticism might have been justified.

However, many people who know little of musical instruments or MIDI but who are interested in mixing consoles and audio in general and who know that RS232 is a medium speed, serial, and asynchronous protocol (like myself) and may have heard of MIDI mentioned in a music context would, I hope, have been able to easily associate with this statement.

I could have proven the verasity of other statements in the article by including some complicated Fourier Analysis, transforms and convolutions. I refrain from doing so in the interests of keeping the text in a manner that I thought would be interesting and available to a much wider section of the readership of ETI. The Automate Mixer project which I have developed for ETI and which is featured in this issue goes into this sort of depth. In any case, I am sure that you would have been more that willing to highlight any further gaffes on my part. It is a sad fact of life that all of the magazine contributors are human and therefore fallible and prone to the odd mistake.

Hiding? For nine years, Mr Wilkie? Indeed not. I have been busy formulating a fiendishly cunning ten-year plan for world domination. It entails programming individuals with the word "MIDI — 19.2kBaud" whereupon they become mindless zombies completely under my control . . . Now, Paul, pass the dark glasses and false beard so that I can slip quietly away . . . click . . . slip quietly away . . . click . . . slip quietly away.

ETI Provides Circuits For Development

I have been a reader of ETI since I went to University to study electronics in the mid 1970s. I found ETI a valuable counterbalance to lecturers whose idea of electronics was sheets of complex maths ending with the throwaway remark that "if the first function had represented the input signal and the second the transfer function of the circuit, then the answer would represent the output".

I rarely built ETI projects as published, but took pieces of circuitry or sometimes just ideas to help design gadgets tailored to my own needs. So did my friends. It was the assumption that others might like to do the same thing which gave me the idea for the Blueprint column.

In the early days of ETI electronics was a younger and more widespread hobby, and there was more scope to build for oneself things which were not available commercially, or which were much more expensive to buy than to build.

Nowadays that is less true, with many imported Japanese products costing less than the price the amateur would pay for the parts. However, there still are, and will be for the forseeable future, areas in which personal construction scores: in audiophile equipment, in interesting gadgets which are not commercial, and in areas too specific for a commercial product to fit the bill.

I hope that ETI will continue to provide interesting projects and technology articles for the next twenty years.

Andrew Armstrong
Leighton Buzzard

24V Power Supply For Generator

In the Republic of Ireland, the Electricity Supply Board is a government monopoly. Nevertheless, the workers are permitted to go on strike, which usually leads to five days or more of IPS (Interruptible Power Supply). The management of our little software firm has forethoughtedly outfitted us with a 4kW diesel generator. It has two 12V starting batteries in series. At the moment we charge the batteries one by one from a 12V automotive- type charger, which means a lot of clipping and unclipping giving general irritation. The generator supplier has quoted us a ridiculous price for a 24V charger (can you believe £953.85 plus VAT, installed?).

My question is: is there any reason why we can't use two identical 12V automotive chargers with their outputs connected in series to charge the two series-connected batteries simultaneously? I think that the answer to this might be of interest to a number of readers, but if you can consider putting us out of our misery with a yes/no answer, we would be very appreciative. Alternatively, a charger design for 12/24 volts that can be left on lead-acid cells full time and built for less than £953.85?

Frank Chambers,
Co. Mayo, Ireland.

I see no reason why not. On the other hand, you could modify our battery chargers that ETI has featured over the years to give +24V out by changing the transformer and checking the voltage ratings of other components. — Ed.

Wizard of Oz

From one of the old-timers, best wishes to ETI and all who sail in her as she heads off into her third decade. It just goes to show that not everything washed up on these shores from Australia is duff, despite Paul Hogan, Neighbours, Barry Humphries, Home and Away, XXXX lager, and Kylie Minogue.

All the best.

Dave Bradshaw, London.

20 YEARS OF PHOTOCOPIES

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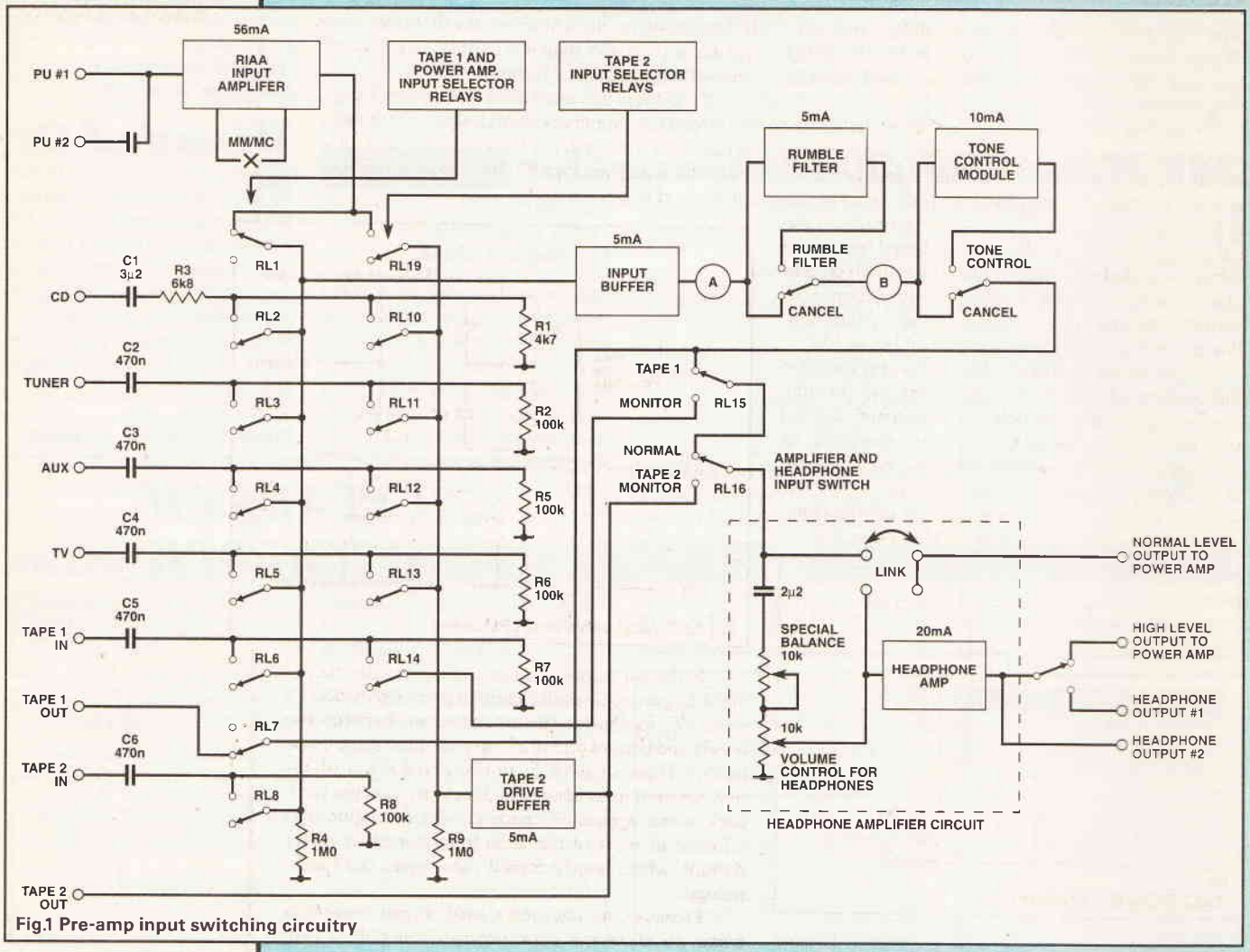

Fig.1 Pre-amp input switching circuitry

John Linsley Hood presents the first part of this audio project to complement the 80 watt power amp featured in ETI.

PROJECT

Basic philosophy

An intentional feature of the 'Audio Design' 80 watt amplifier was that the two separate halves of this system — the preamp. and the power amp. - should be usable, on their own, as separate, self-contained units. The preamp. as a unit which could be used with any existing power amp., or as a very high quality headphone amplifier, with a good range of input facilities, and the power amp., with its input gain and balance controls, capable of use as a flat frequency response system for those whose normal input is from radio, tape or compact disc.

An oversight in the power amp. layout was my failure to provide a separate input selector switch, and I have now remedied this omission.

Preamp Organisation

In order to allow as much flexibility as possible in construction and use, I have based the preamp. design on a series of functional modules which operate from a ±15V DC power supply. All of these modules have a high input impedance and a low output impedance, so that they can be joined together without any difficulty, and the 'tone control' and 'rumble filter' stages can be switched completely out of circuit when the quality of the input programme material makes their presence unnecessary. Similarly, at the discretion of the constructor, unwanted modules could be omitted entirely, without problems.

The circuit interconnection layout of the complete preamp. system is shown in schematic form in Figure 1. This is similar to the layout of the design described in 'ETI' in June/September 1980, except that — at the suggestion of Hart Electronic Kits, who have put together a kit of parts for this design — I have allowed for more signal channel inputs, and have made the layout of the tape monitoring facilities more feedback-proof.

I have also organised the layout, at Hart's suggestion, to provide two entirely separate and isolated signal channels within the preamp., together with an additional pair of output sockets, ('Tape 2'), which makes it possible to record some programme other than that to which one is currently listening, and to simplify tape-to-

ular Pre-Amplifier

tape recording. It would also be possible, if one were wealthy enough to own two tape recorders, to record two separate signals at the same time, and monitor these at will!

Hart Electronics were also keen to use relays for switching the various signal channels, because this would simplify their PCB and front panel layout. It would also avoid the need to route input signal wiring to the front panel, allowing shorter and more direct signal paths. The type of relay they preferred was of the miniature sealed and vacuum 'filled' type, in which gold plated contacts and an inherent freedom from dust, contact contamination or corrosion, will ensure both low contact resistance and a long trouble free life.

To eliminate switching 'clicks', by greatly reducing the amount of current flowing across the preamp. 'mother' board and through the front panel channel selector switch, the relay coils are energised as demanded by a low-powered transistor switching circuit, shown in Figure 2. This also reduces the rise and fall times of the turn-on current pulse. In use this channel selector switching system is entirely noise free.

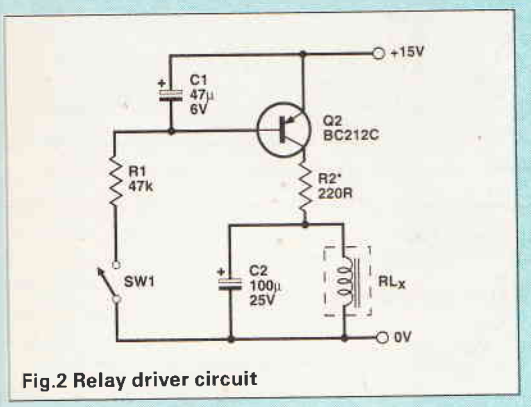

Fig.2 Relay driver circuit

If this preamp is used with the 'Audio Design' power amplifier, which has a high input sensitivity, and also has gain and channel balance controls on its input, it will not be necessary to duplicate these controls in the preamp., except on the input to the headphone amp.

However, the headphone amp. is an extremely high quality 'class A' design, and makes an excellent output driver to more conventional direct input power amps., where its low output impedance and its ability to drive capacitative loads will allow long connecting cables, (up to 50 metres of standard low-loss 'TV' type coaxial cable, or 20 metres of normal twin screened audio cable), to be used without any loss of quality in wiring between the preamp. and any following power amp., as for example, in a 'tri-amped' LS system.

The RIAA stage.

By and large, the design of high quality preamplifiers is easier than comparable quality power amplifiers because they will usually only be required to drive a resistive load, typically 10k or so, in parallel with, perhaps, a few hundred picofarad. The normal output voltage requirement will only be 1-2V RMS, at the most.

On the other hand, preamps will be required in 'tone controls' or 'RIAA type' input frequency response correction stages, to introduce deliberate modifications to the overall frequency response of the system, is less easy to do either of these in an entirely satisfactory manner than it is to devise a circuit with a ruler-straight frequency response.

It is in these two areas that I have made changes to my original preamplifier circuit design, (ETI June/September 1980), though the basic circuit layout remains much the same, and I would like to explain my reasons for these changes.

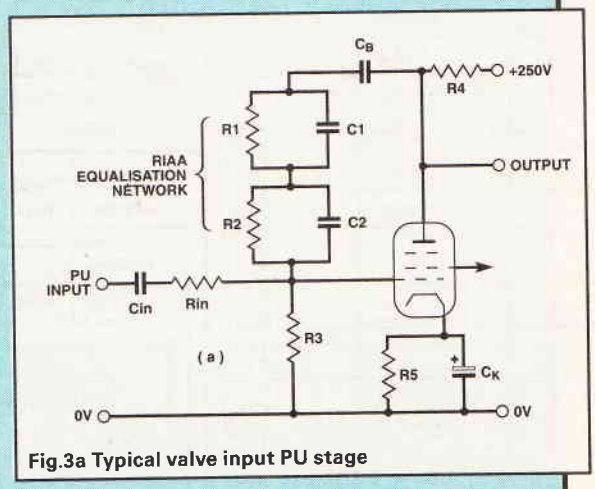

Fig.3a Typical valve input PU stage

In the early days of valve 'hi-fi', gramophone PU input frequency response correction was provided by some RC feedback network connected between the anode and control grid of a high gain input stage in the manner I have shown in Figure 3a, and this type of system; referred to as 'shunt' feedback because the feedback signal appears in parallel with the input; was adopted in most of the early transistor preamplifier designs, which largely copied valve type circuit technology.

However, as low noise small signal transistors began to allow the construction of amplifiers with exceedingly quiet noise and hum backgrounds, designers began to realise that such 'shunt feedback'

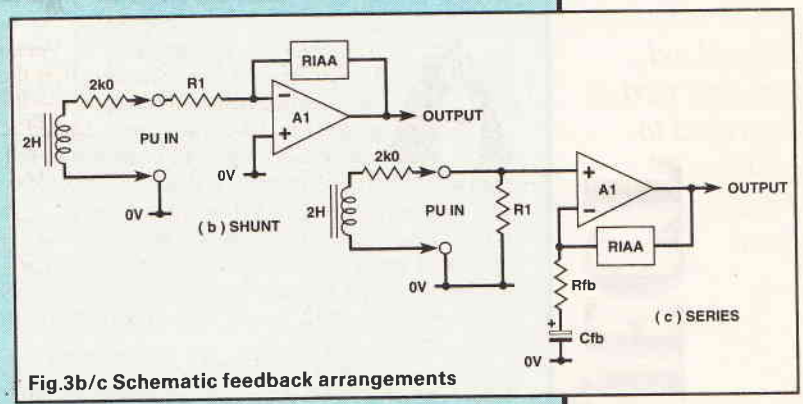

Fig.3b/c Schematic feedback arrangements

systems, shown schematically in Figure 3b, had a higher intrinsic noise level, because of the thermal noise generated in the input (PU load) resistor R1, than the equivalent 'series feedback' system, shown in Figure 3c, in which this resistor was shunted by the DC resistance of the PU coil itself, which might be only 1-2k ohms in value.

In consequence, nearly all designers of commer-

cial hi-fi equipment changed over to series f/b systems, to avoid adverse comment in the 'Hi-Fi' press about their PU input S/N ratios - usually measured at 1kHz with the PU inputs short-circuited.

Shunt vs Series Feedback

As ever, input 'noise figure' is only part of the problem, and there is a host of other ways in which the types of circuit shown in Figure 3 differ in their characteristics. Of these, the most immediately obvious is that when the impedance of the RIAA feedback network falls to zero – as it will do at very high frequencies – the gain of the 'shunt' f/b layout will also fall to zero, (required by the RIAA equalisation specification, shown for reference in Figure 4), whereas the 'series' f/b system simply becomes a unity gain voltage follower.

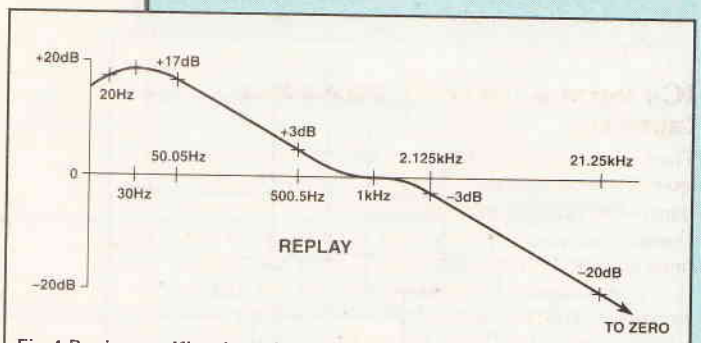

Fig.4 Basic specification of RIAA equalisation curve

There is a 'Catch 22' type of problem hidden in this effect, in that if the designer tries to improve the distortion characteristics of the stage by having a lot of negative f/b, (a feedback network which has a low impedance in relation to Rfb), a flattening-off in the frequency response will occur at a lower frequency. This is closer to the top of the audio band and makes this frequency response error more prominent. On the other hand, having a higher impedance feedback network, that pushes the gain error up towards a higher frequency, may cause the stage to run out of gain at the LF end, resulting in poorer distortion and bass response.

The ear may not notice one or two dBs of error at the top end of the audio band owing to incorrect RIAA equalisation, because of this failure of the series f/b system, but I am sure that most people can hear the phase error associated with this, and in the days when I used to do a lot of 'Hi-Fi' talks, I would frequently invite the audience to do an 'A' vs. 'B' comparison between these systems in the reproduction of a gramophone record.

This would be done by means of a pair of anonymous 'black boxes', simply labelled 'A' and 'B'. These contained RIAA equalising stages based on either shunt or series f/b systems, and, to allay any doubts, I would demonstrate – before the test - that the gain and frequency response given by both of these units was identical, to 0.5dB or so, within the audio band.

Typically about three quarters of the audience – and this would be far from ideal listening conditions – believed that they could hear a difference between 'A' and 'B', and a similar proportion of those who thought that the sound was different, would express a preference for reproduction via the box which contained the 'shunt' f/b arrangement.

I am not surprised at this outcome since, as can be seen from the respective gain/phase curves vs. frequency, for 'passive', 'shunt f/b' and 'series f/b' equalisation systems, shown in Figure 5, the passive and the shunt f/b systems are identical in their characteristics – apart from differences in gain – whereas the series f/b system is the odd man out.

Distortion, 'clicks', and background noise, in RIAA stages

A further difference in performance for the shunt f/b system is due to the fact that, the signal from the (PU) input is applied to the same point as the feedback, whereas it is applied to a different input in the series f/b circuit. So a sudden transient input signal, such as might arise from a dust particle or a nick in the groove of a vinyl disc, can more easily cause a sudden brief input overload in the series f/b system, as both inputs try simultaneously to follow the input signal voltage transient.

Certainly in my experience, shunt f/b systems seem to be less plagued by record surface 'clicks' than the equivalent series f/b ones, which makes for more restful listening.

Another difference between the two systems comes about from the actuality of the input circuit impedance. A typical moving magnet or variable reluctance PU coil may have a DC resistance of 1k5 ohms, coupled with an inductance which can be as high as 2H, (though, in fairness, some of the better modern units have achieved an adequate output voltage with a somewhat lower value of coil inductance). At the bottom end of the audio band, say 100Hz, this will provide a total PU input impedance of about 2k.

However at 15kHz, this has increased, because of the inductance of the PU coil, perhaps to some 180k, with a much higher input noise figure.

Assuming an input load resistance of 47k, a typical value, the two systems described will have the same spot frequency noise figure at about 3.8kHz, with the series f/b system being worse than the shunt one above this frequency. This gives rise to a clear difference in the sound of the background noise too, with the series f/b system having a high pitched background 'hiss', while the shunt f/b one is more of a 'rustle'.

As a matter of personal preference I do not like the sound given by simple series f/b RIAA equalisation stages, which was why, in designing equipment which was mainly for my own use, I persisted in the use of shunt f/b designs long after they had been abandoned by my peers, and I am not at all contrite over my obstinacy.

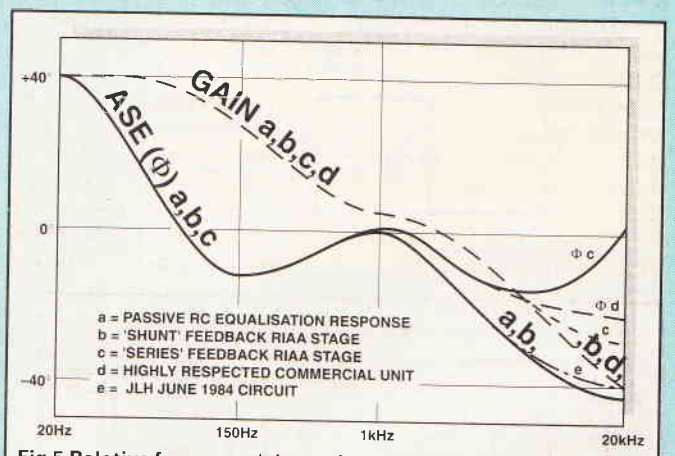

Fig.5 Relative frequency/phase characteristics of various RIAA equalisation stages

Alternative RIAA equalisation systems

The main circuit options which are available to the

PROJECT

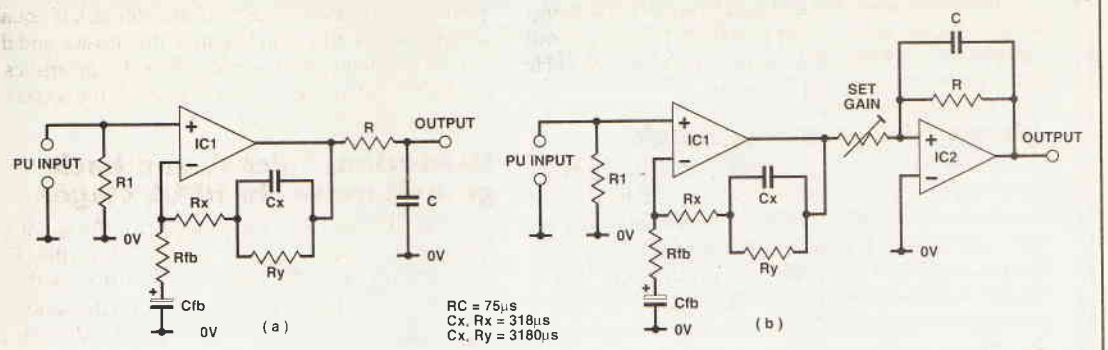

Fig.6 two stage RIAA equalisation circuits

designer of input RIAA equalisation circuitry are; passive networks, much beloved by the purists: shunt or series f/b layouts, or combinations of all three. Moreover, since the RIAA curve can be divided into two separate parts; that from 20Hz – 1kHz, and that between 1kHz – 20kHz; one can use one type of equalisation for one half and another for the other, giving six possible combinations.

In the circuit I described in ETI in June 1984, I used a series f/b system for the lower part of this frequency band, and a passive RC network to deal with the upper, as shown in Figure 6a. This requires an output buffer stage to prevent the load impedance of any succeeding circuitry from altering the time constant of the output RC network, which should be as close as possible to 75µs.

Having decided to use a two-stage equalisation circuit, I chose this particular layout because it did not introduce any phase inversion in the input signal path, which would have been the case if I had used the electronically equivalent active stage shown in Figure 6b.

The penalty is that the input gain stage must be able to deliver a ten times greater output swing, at 20kHz, in the case of Figure 6a, than would be required for the circuit of Figure 6b, because it must compensate for the signal attenuation introduced by the output network. Unfortunately, the phase characteristics of this circuit, shown in Figure 5e, still differ slightly from the ideal.

This need for high output voltage swing capability, (and consequently more limited 'headroom'), in the line amplifiers, is the principal drawback with all purely passive RIAA equalisation systems of the kind shown in Figure 7.

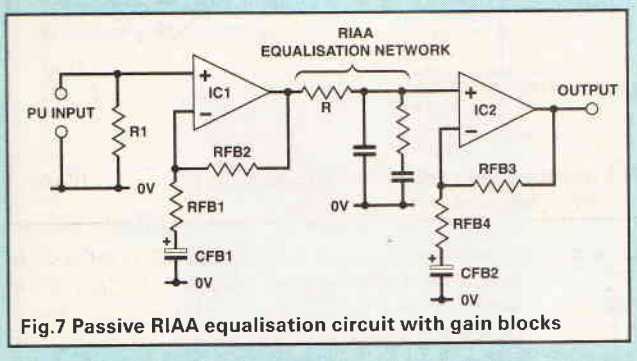

Fig.7 Passive RIAA equalisation circuit with gain blocks

An idea which has been around for a long time, and has recently begun to be regarded with greater favour, is the layout shown schematically in Figure 8, in which a straightforward gain stage, (IC1), is used as a buffer stage between the PU input and a shunt f/b equalisation stage, and this is the arrangement which I have now chosen.

This allows a simple gain switching facility to cope with pick-up cartridges of greatly different output levels, e.g., moving magnet or moving coil, and also allows a low impedance drive to the shunt f/b circuit, so that its impedances (and consequent thermal noise level) can be kept low.

ICs versus discrete transistor layouts.

There are some very good low-distortion, low noise level, ICs around, and the question of how these compare in their audible performance to one another, and to equivalent discrete component circuits, is one which must engage the minds of all audio circuit designers.

I must declare, at this point, that I do not accept, because I cannot hear, the bulk of the audible phenomena claimed by the 'golden eared' fraternity for component types or constructional niceties – like super grade non-polar capacitors or 'single crystal copper' printed circuit boards, whatever that may be.

However, I do believe there can be some small audible differences between different design approaches, and it is up to the designer, if he is conscientious, to try to establish through the verdict of his own ears and of many friends as he can prevail upon to listen, whether these differences are real, noticeable, and closest to the original.

On the subject of linear ('op-amp' type) ICs, I think there are some small differences in sound from similarly specified devices of different types. These only become noticeable when the ICs are caused to give gains in excess of 5×, or when they are asked to drive awkward load impedances.

At unity gain levels, and modest drive voltages into resistive loads in excess of 2k, I confess that my own ears are not good enough to distinguish between a good quality op-amp. IC, used as a voltage follower, and a direct wire connection, on switching trials between one and the other.

I think there are also some small differences in sound between discrete component voltage amplifier designs and op. amp. ICs, especially at higher gain levels, even though they may have impeccable performance specifications. Where low cost and circuit simplicity are not major requirements, I prefer to use discrete component circuits where gains in excess of 2× are required.

The MM/MC input stage.

As shown in Figure 8, the input signal from the PU cartridge is taken directly to a switched gain stage, shown in simplified form in Figure 9a. This is a fully symmetrical layout of two 'push-pull' two-transistor amplifiers connected in parallel, which halves the input noise impedance presented by Q1 and Q2. These are a pair of TO126-type small power transistors, and makes for a very quiet background noise, even on low output M-C Pins.

This circuit has an input noise impedance of about 15R, and a flat frequency response from less than 20Hz up to the MHz range, coupled with a clean square wave response, and a very low harmonic distortion. I also like the sound of this layout better than any of the others which I have tried.

Because the base bias currents of the two input transistors blow from one to the other, the DC input resistance is high, while the use of negative feedback to the input transistor emitter circuits also ensures a high dynamic input impedance, so it will also work well with a higher input impedance moving magnet or variable reluctance PU cartridge.

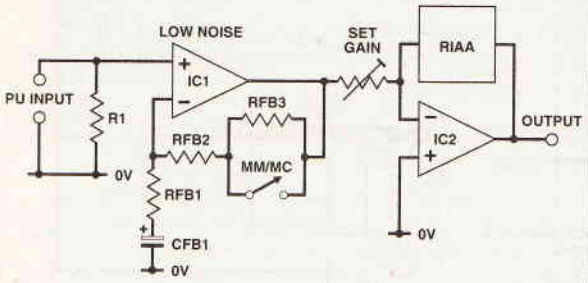

Fig.8 Shunt feedback RIAA equalisation circuit preceeded by impedance converting gain block

The gain options chosen are 14.6× for high input signal level cartridges, and 150× for the low output (moving coil) types.

The second, shunt feedback, equalisation stage, shown in schematic form in Figure 9b, is a very high gain, (around the 100,000× mark), symmetrical two-stage amplifier circuit with a closed loop gain, at 1kHz, of 18×. Because the RIAA equalisation network presents a capacitative load to the output stage, it is essential that the output drive capability should be symmetrical - with the output transistor, (Q8), load provided by the current mirror CM1 — and that its output impedance, with feedback applied, should be very low, to prevent any slew-rate limiting.

The complete circuit of the combined input and RIAA stages is shown in Figure 10. The DC supply to the input stage is provided by a pair of on-board 5V DC voltage regulators, and the whole unit should be well screened, and situated away from AC 'hum' fields.

The output voltage swing capability of the complete stage is 10V RMS, over the range 20-20kHz, and its distortion is below 0.005% at 1V RMS output, at 1kHz. The output impedance, at the collectors of Q13 and Q14, is less than 25R, so the effective output impedance is determined largely by the 120R output resistor, R25.

This should allow the unit to drive up to 50 metres of standard low-noise screened connector cable without HF loss, if the user prefers to mount this module, as a separate unit, on the gramophone turntable housing, where this is situated at some distance from the amplifier.

Although I think the sound quality given by CDs is already very good, and likely to improve still further as developments take place in player systems and the disks themselves; nevertheless there are still a lot of vinyl disks around, and a lot of money has been invested in turntables and cartridges for the reproduction of these, so there is clearly a continuing need for good vinyl disc reproduction systems.

Speaking for myself, I have accumulated, over the years, some 2000 LPs, and I wish to be able to enjoy these for a long time to come, so I am very pleased to find that the performance given by this new RIAA stage offers a small but noticeable step forward, in terms of clarity and transparency, by comparison with some earlier designs of my own, which I had, indeed, thought to be quite good when I did them.

In the next part of this article, I will describe the remainder of the preamp. circuit, and explain my changed intentions with respect to the 'tone control' stage.

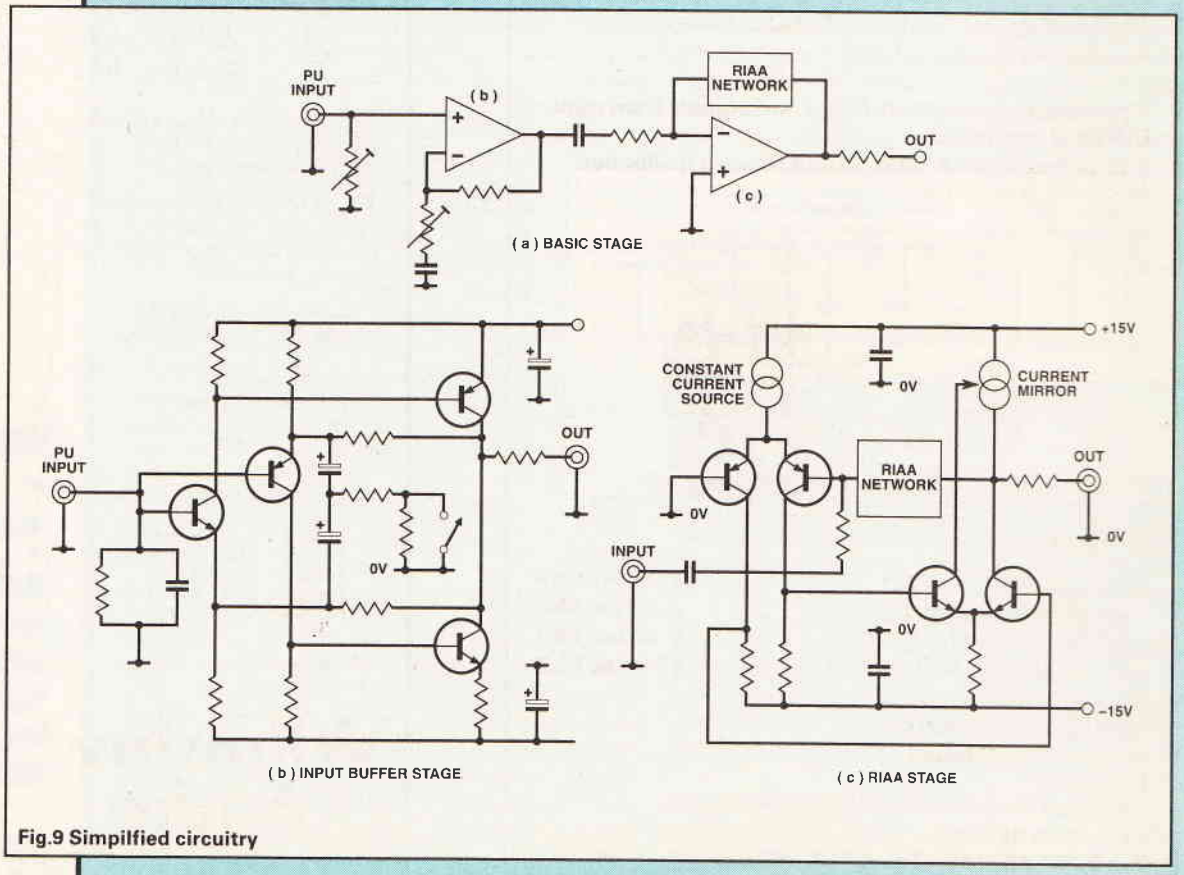

Fig.9 Simpilfied circuitry

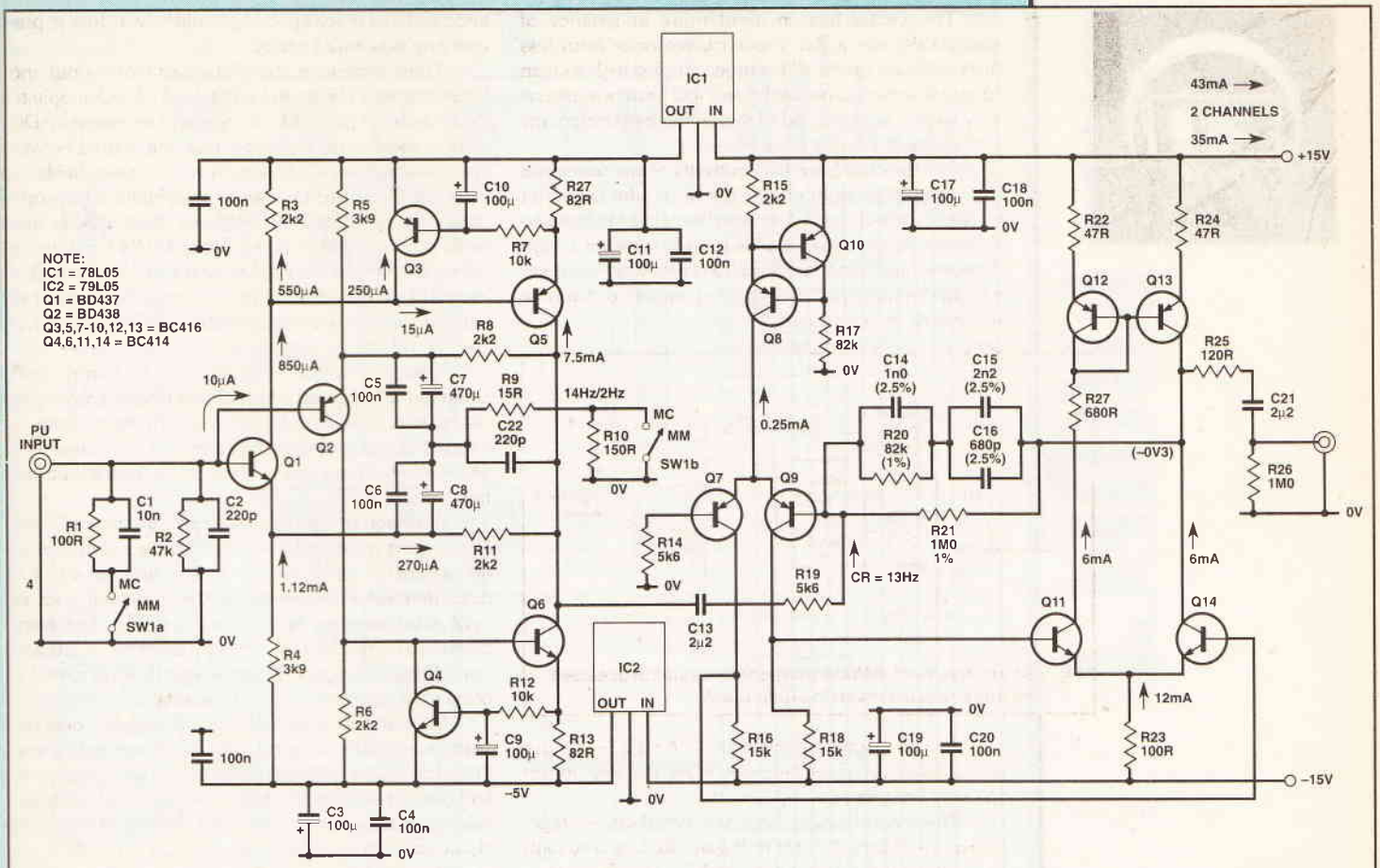

Fig.10 Buffered shunt-feedback RIAA equalisation stage

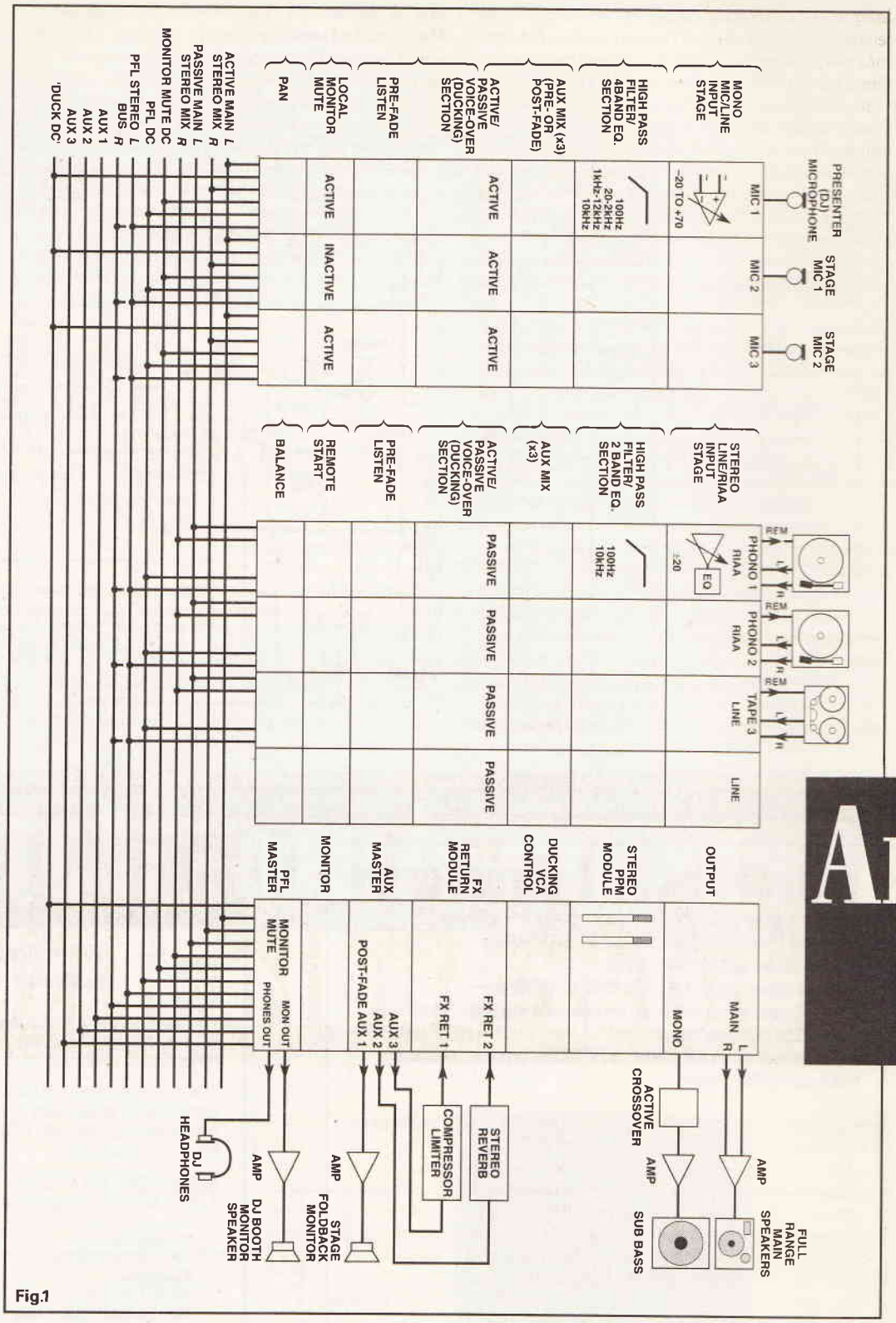

Fig.1

Mike Meechan begins a major series on ETI's biggest project ever for our Anniversary.

If the reader has been following the recently published two part introductory feature on the 'why's and wherefore's' of mixing desks, and wondering just why the magazine doesn't produce something tangible to put all of the high falluting theories into practise, well, fret no more. By burning the candle at both ends, and exhausting extensive stocks of the old midnight oil, I've managed to create a mixer project which will do for your ears what the Nightfighter Lighting Control System did for your eyes and all in time for the magazine's 20th anniversary, hence the name. I have been given strict orders to cease and desist from my usual awful puns so there shall be no mention whatsoever of waltzing through the many features of the mixer or maintaining the status quo, and contrary to unsubstantiated rumours, my next series of articles will not feature projects for the nose and throat and neither is this an April fool! We hope to follow up this series with a series of projects of studio-quality effects units, starting with a 1/3rd octave, tamper-proof equaliser.

The Mixing Console articles mentioned covered some of the problems which have to be surmounted in the design of a mixing console, and we discussed some of the aspects and problems which the design engineer has to contend with. In this series of constructional articles, we shall delve slightly more deeply and at a more mathematical level into how the circuitry can be

designed to minimise noise, crosstalk, distortion and general signal degradation. Having said this, the equations will be kept to an absolute minimum here (well almost) and used only to illustate why certain components, component values or circuit topologies were chosen in this design in preference to others — the author is always open to critisms and suggestions (but only of the constructors sort). Let me know if the featured circuits could be made to work either with less components or with higher performance. With due deference to the excellent series of articles by my compatriot, Mike Barwise, I hope that the series interests both the technically trained and the scientifically educated! What I wanted — and what I hoped that the readership of ETI would want — was a console which ostensibly could be configured in one of three ways:

As a Disco Mixing Console (albeit with many more inputs and with much greater facilities and flexibility than the usual consoles of this genre). The ability to be used in circumstances such as hospital radio would be an asset. Obviously some sort of voice-over facility would be desirable in this situation.

As a live music mixer for use at small concerts. A good range of auxiliary sends for use in foldback or monitoring purposes was a major prerequisite in this instance.

As a mixing console for use in a multitrack recording situation. This would require a flexible group routing system, in addition to other facilities already mentioned. Also, some sort of console automation — memory retention of group routing switch settings, fader levels and perhaps an option of motorised pots — might be a possibility here. Also, with the present-day prerequisite needed for MIDI on anything remotely to do with music, the possible inclusion of the MIDI interface for controlling channel mutes and the like. This would use the continuous controller, note on/note off or system exclusive messages within MIDI to implement these functions. There could also be another Expansion port to allow connection to a PC or external disk drive which would mean that complete mixes and all automated switch settings would be able to be downloaded from the console and then replayed at a later date or perhaps even modified in software.

Figures 1 to 4 show four possible configurations for this console.

Mixing consoles in the commercial market place are generally designed for one of these categories although some can be configured in different ways, such examples marketed as being able to handle two of the three tasks listed.

The major shortcoming is in commercially-produced mixers falling into the budget price range, 'budget' being relative in this instance and meaning that the unit may retail in a region up to about four or five thousand pounds. Although all but the lowest priced use one PCB assembly per Channel, possibly one or two for the Auxiliaries and another for the Master, joined umbilically by a wiring bus system, the mixer is generally constructed as one complete unit, each individual PCB being bolted to and sharing a single front panel. This makes tailoring the console to individual needs a very difficult task to implement, the mixer either having to be bought in a size where there is inbuilt redundancy of unused modules or facilities, or conversely, continually upgraded or superceded if used in an environment where needs are constantly changing. This is not necessarily a bad state of affairs nor is it intended as a criticism or indictment of manufacturer's of these type of consoles, Soundcraft, Soundtech etc — indeed it makes good performance and reasonable facilities affordable and available to a much wider range of musicians and to those within the music industry, particularly struggling, poverty-stricken young bands waiting for their first break.

The afore-mentioned is good news to us as it is in this region that the electronics magazines such as ETI can score, since all of the reasons which make this philosophy of easy upgrade and individual packaging undesirable to the commercial fraternity — cost, intensity of labour and the like — actually make it very attractive to the hobbyist constructor. He or she can spend such time on the project as is necessary to tailor it exactly to one's personal requirements, time which in a commercial environment would spell financial disaster.

Money Matters

Alas, one aspect of mixing console construction in which we are unable to successfully compete with the big boys is in the bulk buying component stakes. If a given console manufacturer orders 10,000 control knobs from the component supplier, a corresponding bulk order discount is applied. This saving in material costs — in a smaller form otherwise the mixing console retailing business would be a profitless one — is then passed on to the consumer. If, on the face of it, this sounds somewhat off-tangent, I should explain why I have mentioned it.

It has to be said that there are available some excellent and competively-priced mixers. To build these same consoles at home using the component supply channels available to the home constructor would, in material costs alone, probably be priced at least as much as the ready-built version, and most probably more.

This project faces identical problems in that the component cost is high and a similar-looking, commercially produced (though non-modular) example might cost in the same order of magnitude.

All is not lost, though, since an increase in the size of the mixer above about 8 channels or so brings increased savings, as does the fitting of any of the bolt-on extras, owing to development costs to you the

PROJECT

niversary Auto-Mate 20 Modular Audio Mixer

1

reader being negligible – the cover cost of the magazine, in fact. I shall mention a guide cost for each module as and when these are featured.

All Mod Cons

Now, back to the matter in hand. What we were talking about before being so rudely interrupted by the vulgar topic of money is, of course, a modular design philosophy wherein each module is able to be configured in a variety of ways (using sub-modules). The overall size and shape, in a metaphoric sense, is dictated by the operator and the use to which the console will be put, NOT as is often the case in commercially-produced consumer durables, of the supplier deciding what is average and ideal for the customer.

This modular philosophy also means that the whole desk could be re-configured and completely different from when first constructed, simply by retro-fitting some of the specialised add-on modules.

Now that we have a very rough design brief of the requirements of the console, the question now is, how best to implement the design? Why not imitate the better features of the more upmarket desks whilst

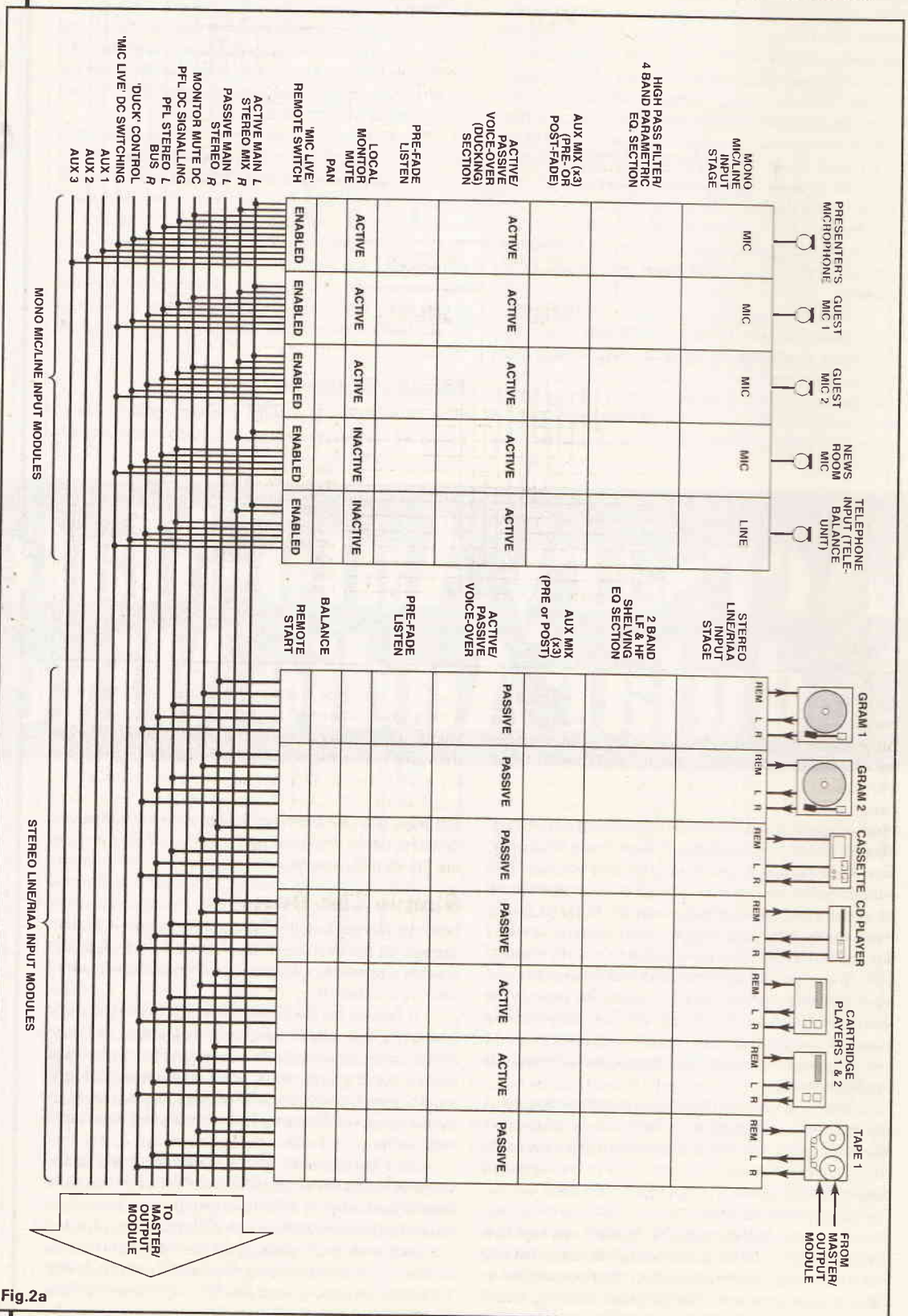

Fig.2a

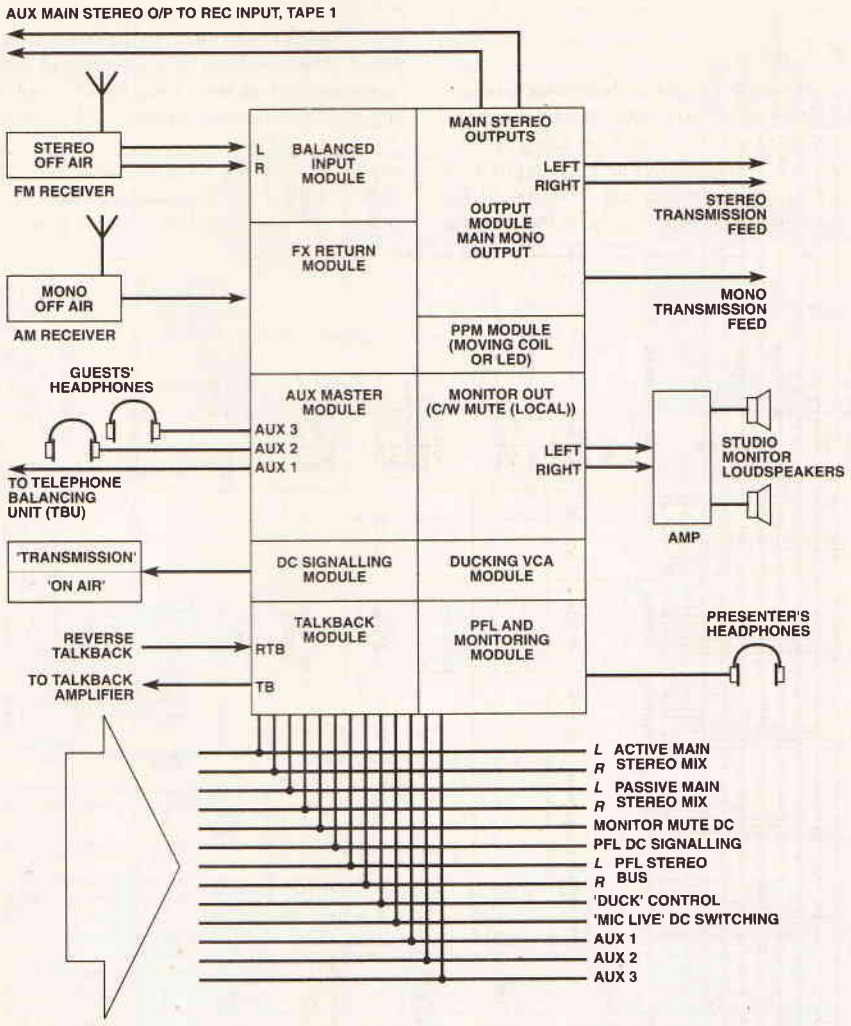

Fig.2b

minimising cost by utilising the commodites which we have in abundance, namely time and energy? The Anniversary AutoMate Mixer uses separate modules for each Channel, Monitor/Group and Output 'card' with each module having its own metalwork. The only component common to all of the modules is the Motherboard 'frame' which houses all of the modules. This can be as small or as large as required, up to certain practical limits which we will discuss later. It is entirely passive and serves only to support and house all of the modules which are inter-connected using a daisy-chained ribbon wire/IDC connector bus system. I did not entertain the idea of using a motherboard/edge connector system for a variety of reasons. The primary one was that the idea of a motherboard system would have somewhat ruled out any infinitely variable modular philosophy, since motherboard PCB's could only be manufactured in a very finite number of sizes. It would also have meant that the PCB for this board on a 36 input desk, say, would have been rather large and expensive, a real mother, in fact. edge connector/mother board systems can also prove to be unreliable unless gold-plating is used on the edge connectors and expensive and good quality sockets are used on the motherboard frame.

The number of different PCB's has been kept to a minimum so that facilities can be supplemented at any time after initial construction. This is important if any future re-configuration of the console is envisaged and since a complicated PCB costs no more to produce than one which is sparsely populated with tracks, it makes good financial sense to create one standard layout which encompasses all eventualities. We are then able to use this as a standard module. Capital outlay in the first instance is thus minimised as much as possible. Each module has a number of corresponding sub-modules which can be used to alter the configuration of it, either when it is first built or at a later stage in the life of the console.

Simply The Best

I should also say that throughout the design and development of the circuitry, I tried always (and quite successfully, I think to use those techniques which would not be considered amiss in the very best, ultra-fi preamplifiers. It is sadly true that many mixer manufacturers' take what best can be described as liberties in circuit design, with configurations guaranteed to cause weeping and wailing and gnashing of teeth amongst hardened audiophiles, and all seemingly justified as cost-saving exercises. Many such sonic blunders have been avoided here, and with no increase in cost to the constructor. One example of this is in the scaling of the resistors in the Parametric EQ section (yet to be published) such that polystyrene capacitors, which are more aurally-friendly than polycarbonate or polyester, but much bulkier at values more than about 15n, could be used . . . I also went to great pains to return to first principles and design a low-noise, high current power supply to run the whole thing.

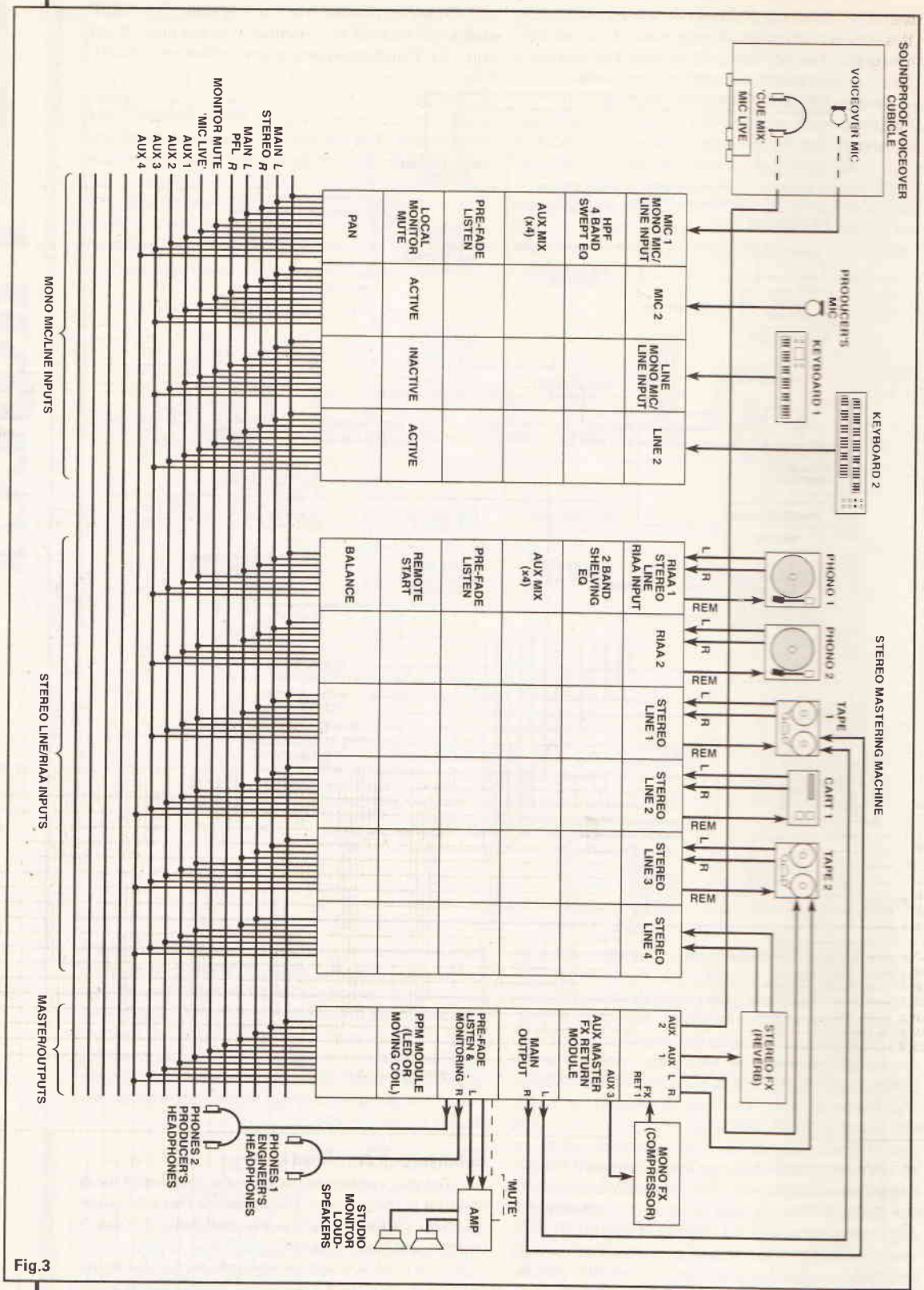

Fig.3

The 'sub-modules' include :

Mic/Balanced Line Input. 48V Phantom powering for the Mic input and electronic unbalancing of both.

Stereo Line Input/Stereo RIAA Input. Both unbalanced and unbalanced.

Module for the Electronic Muting of inputs — 'ducking' — for use in a DJ or presentation situation.

Presentation module with voice-over masters and enhanced monitoring system more suited to a DJ style console

Remote Start module for use with turntable, cartridge or tape machines.

Electronic Group Routing Matrix module using FET switching — for use in a multi-track recording situation.

Clean-feed module for the generation of PA, foldback, monitor and cue mixes.

Central Digital Control Module with battery-backed up RAM for memorising of Group Selection and Fader setting.

MIDI and External interface module to be used with all of the automation facilities.

It should be said at this early stage that with a constructional project of this scope and magnitude, it is prudent, and in fact should be considered imperative,

to wait until all parts of the series have been published. In this way, a comprehensive overview of the system can be gained before the idea of any major capital outlay is entertained.

As we said earlier, with the great repetition of components such as jack, XLR and multipole connectors, pots, switches and pushbuttons, op-amps and control knobs, LED's etc, serious financial savings can be made if all components are bought at one time and in bulk packs. The final prototype – which we'll show in its entirety at the earliest possible date – used some 325 pushbuttons, 333 control knobs, 320 pots, 600 LED's, 52 XLR's, 30 faders, 60 jack sockets and 350 odd switches. Finally, and most importantly for the home constructor, the prototype shown on the front cover was built using tools available to those with a reasonably equipped workshop, the only power tools utilised being an orbital sander (for the woodwork) and a pillar drill for all of the holes. I say this only to demonstrate that it is possible to build it at home using everyday tools, although had I been able to use a milling machine at the local technical college (useful for fader slots and in-line holes), I would have.

All of the modules feature PCB-mounted input and output connectors, switches and pots where at all possible, so minimising the opportunity for hum loops or instability to be introduced because of pickup in the wiring.

Construction-wise, or more specifically, metalwork-wise, each of the modules is constructed from strips of 1.5" angle aluminium (or its metric equivalent). If we refer to the colour shot on the front cover, we can see that these are finished in a rather nice, in-vogue metallic grey colour although who cares about fashion – personally, I'm waiting for the return to haute couture of drip-dry polyester shirts, crimpolene slacks and champagne-coloured hi-fi separates. Yes indeedy!

A wise investment before any metalworking is undertaken might be a set of needle files and some Q-MAX punches, in view of the multitude of holes in the panels of each module.

The modules will be featured in the following order:

Power Supply Unit
Input Channel Modules (and associated plug-in daughter boards)
Group/Monitor Module (and associated Electronic Switching Matrix)
Auxiliary and Communication Module
Output Module
Meter Pod and optional Digital Group Routing Module
Fader Automation, Digital Control and MIDI/External Control Module
Motherboard, Wiring Harness, Casing design and Final Construction

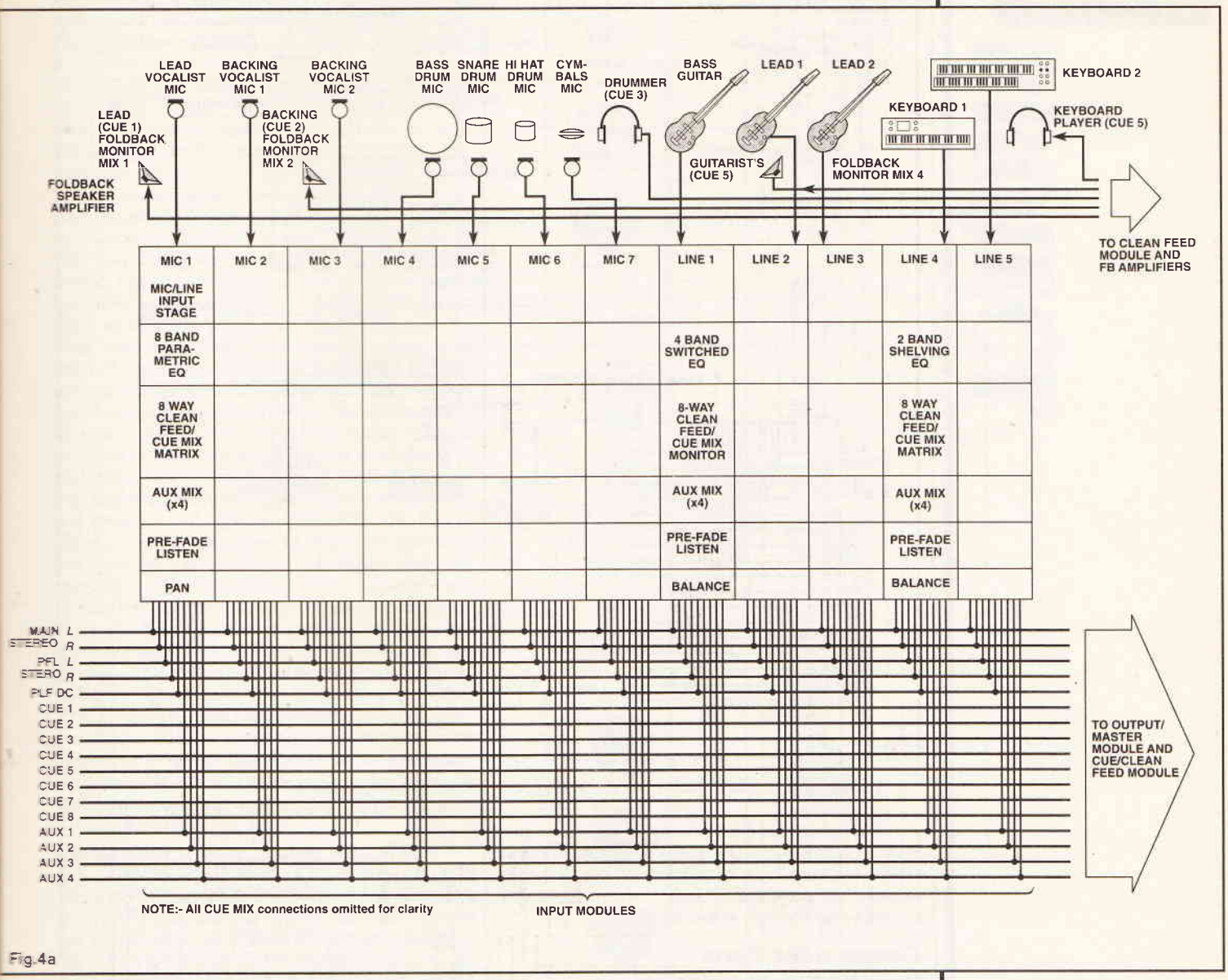

Fig.4a

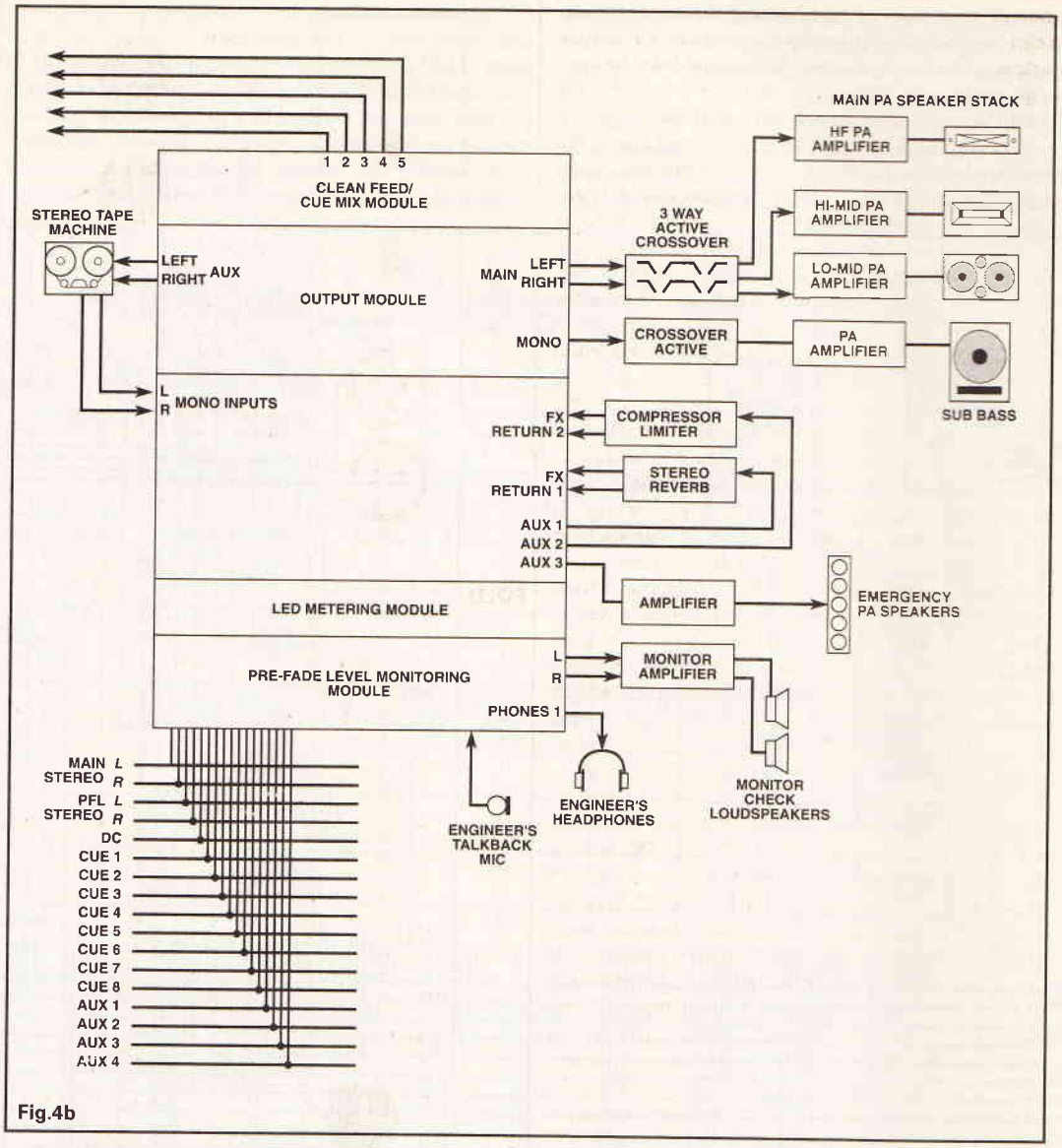

Fig.4b

Use of the console in each of its three intended environments

Please note that this is a listing merely of the order in which each will appear, and either because of space constraints, complexity of certain modules or simply because it is more logical, some of the parts may be featured over a period of two issues.

Component Parts

Mono Mic/Line Input Module

The input modules are fairly self-explanatory, allowing either Mic or Line Inputs on the mono input module with up to 80dB of gain for microphones and 20dB of gain or attenuation for line inputs whilst both inputs may be balanced or unbalanced although ultimate performance is gained when the modules are used with balanced inputs. A 48V supply is available for the phantom powering of microphones which require it, this being switched on or off via a facia-mounted push-button. Inputs are via XLR chassis-mounting connectors for both Mic and Line inputs with an additional 1/4" 3-pole mono switched jack socket as a parallel input for line level signals – more of the reasoning behind this later – and a socket of the same type for the channel insert point.

There is a 100Hz high pass filter and a 4 band equalisation section, with high and low pass shelving filters offering ±20dB of control at 100Hz and 10kHz respectively and two, swept, full parametric mid sections with boost or cut, Q and centre frequency all independently variable.

The EQ section may be switched in or out as required.

Post EQ but prefader, there is a CHANNEL INSERT socket which is wired in the 'normal' way, that is, with no jack inserted, any signal present passes in, through and out of the socket's switch contacts unimpeded. Inserting a stereo jack socket breaks the signal away, it passing out from the channel via the 'tip' contact, where it may, for example, be inputted to an external FX unit such as reverb. It is processed and can then re-enter the channel circuitry via the ring contact of the socket. In this way, effects units can be patched to individual channels in isolation.

There can also be fitted up to four separate Auxiliary Mixes, each independently switchable either PRE or POST FADE. In disco or presentation type situations, AUX 1 and its associated PRE/POST switch can be re-configured as an ACTIVE/PASSIVE MIX, the setting of the PRE/POST switch in this instance determining whether this channel is active in ducking other channels when live or whether it is one of the channels which itself is 'ducked' or attenuated when an ACTIVE channel is live. The level pot in this instance controls the amount of 'ducking' or attenuation.

The first of the input module options is the Group Routing Switch Matrix, which will be of most use to those who envisage constructing the console for a Multitrack recording situation. This can be a passive switching matrix ie direct mechanical switching of

sources or for those who wish to automate the console, it can be made active using logic control and analogue switches. The Group Routing Matrix could also be used to generate up to eight foldback, PA or monitor mixes when the unit is used as a live music mixer.

The second of the input module options is the clean feed matrix, which can be used to originate up to eight clean feed mixes. A clean feed mix is one where the mix contains all channels but one so for instance on an eight channel desk, clean feed mix 1 would contain inputs from channels 2 to 8 inclusive and might be used to send cue programme to the telephone contributor on channel 1. In this way, he would here everything but his own contribution — hearing one's own voice in the telephone earpiece, especially after EQ etc, can be a most disconcerting experience. Also on this channel,there is a Pan pot used to position the source in the stereo image and finally, and most importantly, the Channel Fader. Options in this area of the module include Fader or pushbutton control of remote units eg 'Mic Live' lamps or fader control of loudspeaker muting. The channel fader can control channel signal level directly or it can control a VCA, which then allows fitting of the fader automation unit. There is also a 'Peak' LED fitted which lights when the signal level within the module is 5dB below clipping and the very important PREFADE LISTEN button which allows monitoring in isolation (via headphones, loudspeakers or console metering) of that channel. It also operates as a SOLO button when the console is operated in multi-track Mixdown mode, SOLO in effect being an exclusive AFL (After Fader Level) monitor of that point and channel. The optional CHANNEL ON button allows manual or automated muting of the channel if and when this is required and the UPDATE LED's are connected with this same facility, showing local channel write of the new fader or group position or status. An eleven element bargraph adjacent to the channel fader shows the gain setting through that channel — this may or may not be equal to that shown visibly by the channel fader depending on which WRITE mode has been selected on the master module. The display changes from bar to dot after any fader movement or when the VCA is no longer under machine control. In this way there is an immediate and highly visible marker of both the control status and gain settings of individual channels.

Stereo Line Input Module

This is similar in many respects to the Mono input module apart from the obvious difference, of course, in that it allows the connection of two stereo sources, one balanced and one unbalanced as channel inputs. The unbalanced input may have an optional high quality RIAA phono equalisation module fitted.

Provision is also made for the 'monoing' of inputs, either using an input on left, right or both channel input connectors.

Again, there is a switchable 100Hz high pass filter and an EQ IN/OUT pushbutton. A two band high and low shelving equaliser is fitted as standard although full parametric EQ may be fitted as an option. This parametric equaliser differs from that fitted on the Mic/Line module in that centre frequency is variable in only discrete steps and boost/cut and Q are the only parameters available as fully variable although both, of necessity, operate over a much more restricted range than those fitted to the mono channels.

There is also the facility for the fitting of up to four AUX MIXes, all able to be switched PRE or POST FADE. A Group Routing matrix may also be fitted if required. A BALANCE pot replaces the PAN control and allows minor errors in the stereo balance of the channel to be corrected.

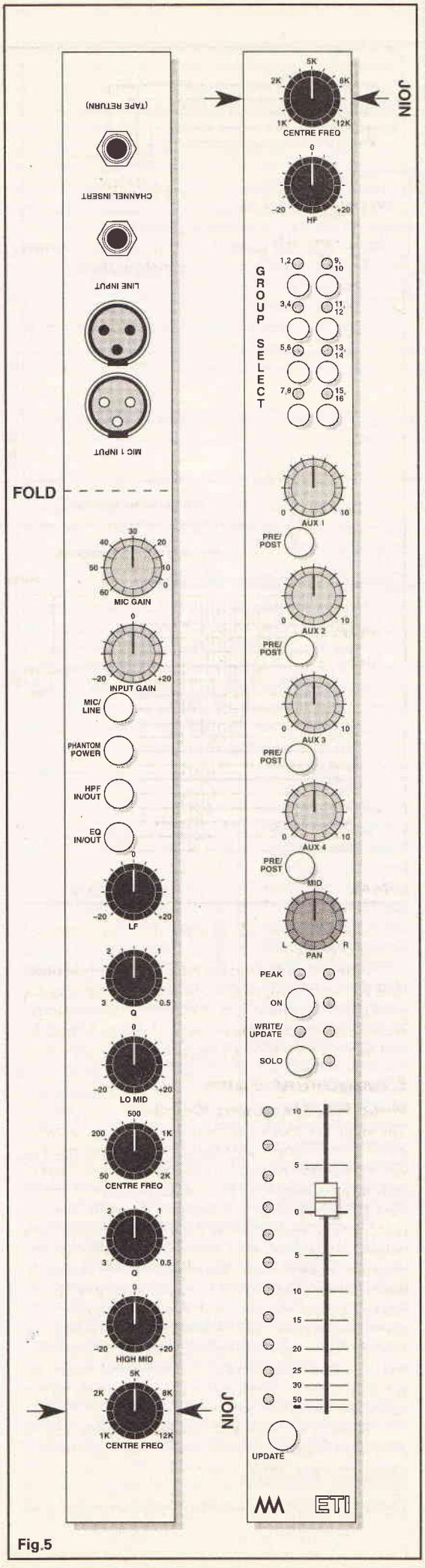

Fig.5

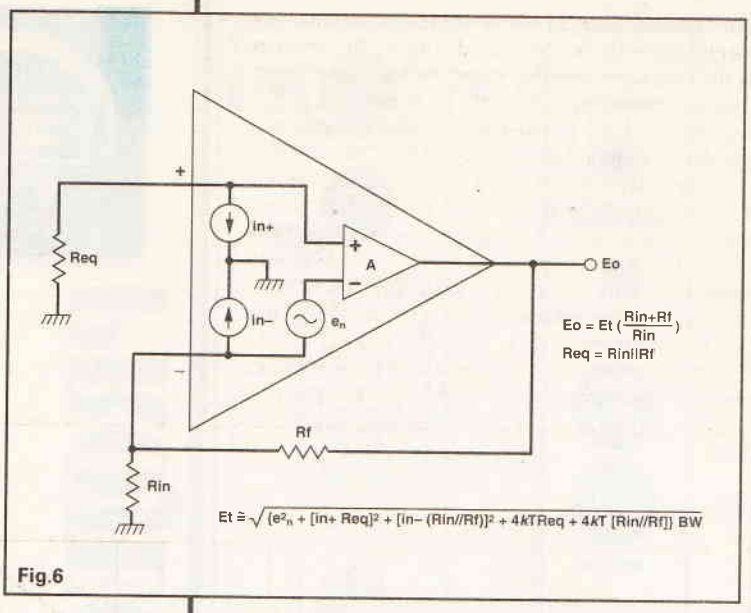

Fig.6

The PFL, CHANNEL ON, remote switching and fader automation/muting are as on the mono input channel, as is the CHANNEL INSERT socket.

Group/Monitor Module

The Group Module is the first of the optional MODULES as opposed to sub-modules and as with the Group Routing Switch Matrix, is of most use — mandatory — in a multitrack recording situation. Each module houses controls for two separate Group/Monitor sections which are entirely independent. The console therefore uses the Split — as opposed to In-line — method of monitoring, so-called because these are modules separate or split from the input modules. An In-line configuration would mean that the controls for the group and monitor functions were included and in-line with those of the channel input controls. This split desk topology allows for expansion far more easily and cost effectively than the In-line method, although this layout has advantages in its own right (not least of which is the fact that monitor channels have all of the facilities — full EQ etc -available to the input channel) and so is preferred by some.

Controls for Group signals (which are, of course, normally outgoing from the desk and destined for one track on a multi-track recording) include a Group Fader, Peak LED, PFL button and optional fader automation/mute facilities. In the associated monitor section,there is a high and low band shelving EQ section, MON. LEVEL control, GROUP PAN control and two switchable AUX MIX send level pots. There are also two buttons labelled RET and SUB, these switching between group output (source) or tape as Monitoring inputs and controlling the sub-grouping of the module. A GROUP INSERT socket is also provided.

Master Module

This is the main output module and has two LEFT and RIGHT MASTER LEVEL faders, an AUX MIX MASTER section, test oscillator and rudimentary talkback system controls. It also houses the PFL and other monitoring circuitry as well as controlling the desk metering, loudspeaker muting and headphone driving circuitry. Other outputs are provided, their levels being controlled by the respective LEVEL controls and each able to be mono-ed if so desired. Master Insert sockets are provided. This is the most basic form of this module and is the simplest required for correct operation of the console. It can be fitted with additional sub-modules (these sharing the same metalwork) or in some instances, it may be preferable for these units to become proper 'full' modules in their own right — indeed, this may prove necessary for some as there is not enough room physically in the Master module 'strip' to accomodate all of the sub-modules.

Figure 5 shows the front panel marking of the input module fitted to the prototype.

The 'hybrid' modules include the Meter Bridge, Communications module, Automation module and MIDI/Group Routing module.

A fuller explanation of the facilities available to the user in each of the different configurations would be somewhat pointless at present, since a detailed description of each of the modules is necessary before any full understanding of the ancillary parts can be gained. Suffice to say that it will be worth the wait!

Mic Input Amplifier

As we said more than once in the feature on mixing consoles, the noise performance of the unit as a whole is dictated by two main factors generally, these being the design of the input channel (mic input) and the design of the mixing bus. There are, of course, other areas where bad or marginal design will impair the ultimate noise performance but none more seriously than those just mentioned.

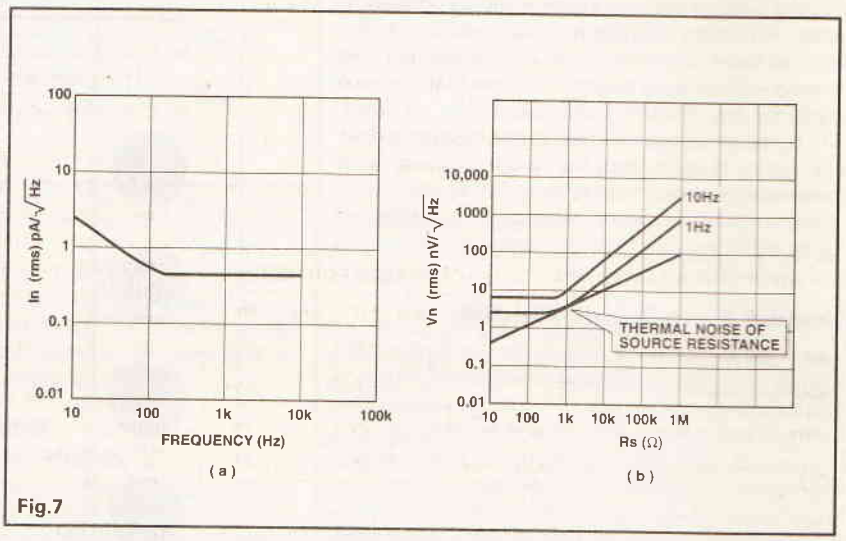

Fig.7

Microphones — Taking The Hiss

I said in the opening paragraphs that we would discuss at greater length both the options open to us at each stage in the design and evolution of a particular function and the pros and cons of each and all available. There are obviously certain areas where our choice is limited by complexity, cost or any number of different reasons and where this is the case, I shall endeavour to explain why I have chosen a particular avenue of thought or design. In this way, I hope that I can both educate those who know less than myself on the subject and also stimulate the design-orientated thought processes of those who know more. It should be an interesting eight months or so . . .

PROJECT

Mic/Line First Input Stage

Microphones used in professional applications encounter an extremely wide dynamic range of sound pressure levels, ranging from about 30dB SPL (ambient noise in a very quiet room) to over 130dB SPL. (Anyone who has miked up something like a dance or swing band will know to the deciBel just exactly how wide. The output voltage of a typical low impedance (200R) microphone over this range of SPL's will vary from 20µV to 2V RMS, while its self-generated output noise would be in the order of 0.25µV over a 20kHz bandwidth. Since the dynamic range of the output of the microphone is so large, any preamplifier intended for use with a microphone should have adjustable gain so that it can be optimised for the signal levels that will be present in a given situation. Large signals should be handled without clipping or excessive distortion whilst small signals should not be degraded by amplifier noise. In a conservative low noise design, the preamplifier should contribute no more noise to the output signal than does the resistive portion of the source impedance. In practical applications, however, it is often reasonable to allow a higher level of input noise since ambient room noise will usually cause a noise voltage at the microphone output terminals that is in the order of 30dB greater than the intrinsic noise floor (due to source resistance) of the microphone.

When long cables are used with a microphone, its output signal is susceptible to contamination by external magnetic fields (especially mains hum). In order to minimise this problem, the outputs of most professional microphones are balanced, driving a twisted pair of wires with signals in opposite phase. In an ideal situation, magnetic fields will induce equal voltages on each of the two wires, which can then be cancelled out if the signals are applied to a transformer or differential amplifier at the preamp input.

Operational amplifier noise is nearly random nature and determines the ultimate lower limit of signal handling capability.

It is specified as Equivalent Input Noise (or EIN for short) and is increased by the noise gain of the stage. A circuit model is shown in Figure 6.

IMPORTANT AC ELECTRICAL CHARACTERISTICS FOR NE5534					
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT NOISE VOLTAGE	fo = 30Hz fo = 1kHz		7.0 4.0		nV/√Hz
INPUT NOISE CURRENT	fo = 30Hz fo = 1kHz		2.5 0.6		pA/√Hz
BROADBAND NOISE FIGURE	f = 10Hz-20kHz, Rs = 5kΩ		0.9		dB
GAIN BANDWIDTH PRODUCT	Cc = 22pF, C_L = 100pF		10		MHz

Fig.9

The noise generators are modelled as a series voltage noise generator, e_n and as shunt circuit noise generators, i_{n+} and i_{n-}. These generators represent the mean values of voltage and current noise referred to the input of the amplifier and are specified in terms of noise density in volts-squared or amperes-squared per Hertz of bandwidth. To these noise generators we must add two other noise sources – the thermal noise of the source resistances, Rs, seen by the amplifier, which is Req and Rin//Rt.

Thus, an amplifier in a real life situation – a mixing console mic. amp, for example – has five potential sources of noise to be considered for minimising. First, there is the thermal noise of the two source resistances seen by the inputs, which is an irreducible minimum, existing even in an ideal, noiseless amplifier. Next, there are the noise current and noise voltage generators. For low values of source resistance, the effect of i_n is a minimum. Under these conditions, e_n will dominate as the source of amplifier noise. As the source resistance is increased, the effect of i_n increases until at high source resistances, i_{n+} (Req) and i_{n-} (Ri_n//Req) are the dominant components of amplifier input noise. Thus, in op-amp specifications, these two parameters are detailed separately, with e_n specified at low source resistance and specified at high source resistance. Both e_n and i_n are specified in terms of spectral density, measured with a narrow-bandwidth filter at a series of points across the useful spectrum of the amplifier. Data is given in terms of e_n (or e_n^2) or (or i_n^2). Graphs of the important parameters of a typical low noise op-amp, the audio industry standard NE5534, are given in

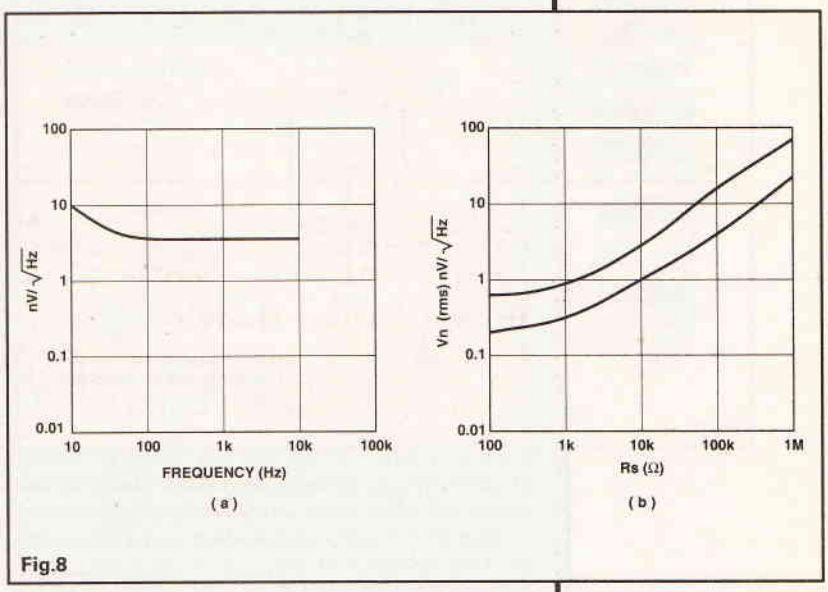

Fig.8

Figures 7, 8 and 9. These curves are given in terms of $e_n/\sqrt{Hz}$ and $i_n/\sqrt{Hz}$, but conversion can be obtained by squaring or extracting the root of the given parameter as appropriate.

Although the spectral densities of both e_n and i_n are obviously not flat, it is not unreasonable to select a mean value for e_n and i_n, if their total variation is within the same order of magnitude. Accurate calculation of total RMS noise would involve integration across the bandwidth of the amplifier, but the simplified (simplified?) approach given here yields order of magnitude estimates of noise performance and is more than adequate for the purposes of comparing different products. It follows, therefore, that given values for e_n, i_n and bandwidth, the total noise of the circuit can be approximated as follows

$$Et = \sqrt{(e_n^2 + [i_n + Req]^2 + [i_{n-}(Ri_n//Rf)]^2 + 4kTReq + 4kT[Ri_n//Rf])BW}$$

where Et = Total circuit noise
e_n is the amplifier noise voltage $V/\sqrt{Hz}$
i_n is the amplifier noise current i_n $A/\sqrt{Hz}$(i_{n+} or i_{n-})
Req and Ri_n//Rt are the source resistances (Req = Ri_n//Rf)
K is Boltzmann's constant (1.38×10^{-23} J/K)
T is the absolute temperature
BW is the noise bandwidth in Hertz

From the expression, it is obvious that as e_n and i_n are reduced, the total noise approaches the thermal noise of Rs. In choosing an amplifier, requirements (such as those for a microphone pre-amp) will often dictate a certain Rs from which the amplifier must work. This will dictate which of the noise generators is

dominant and therefore, which specification must be minimised — e_n or i_n. In general, low bias current bipolar types or FET input types will have lower current noise and tend to be quieter with Rs above 10k. Below 10k, bipolar types (because of lower voltage noise) have the advantage. In any instance, an absolute minimum of Rs must be used so that Rs is composed largely

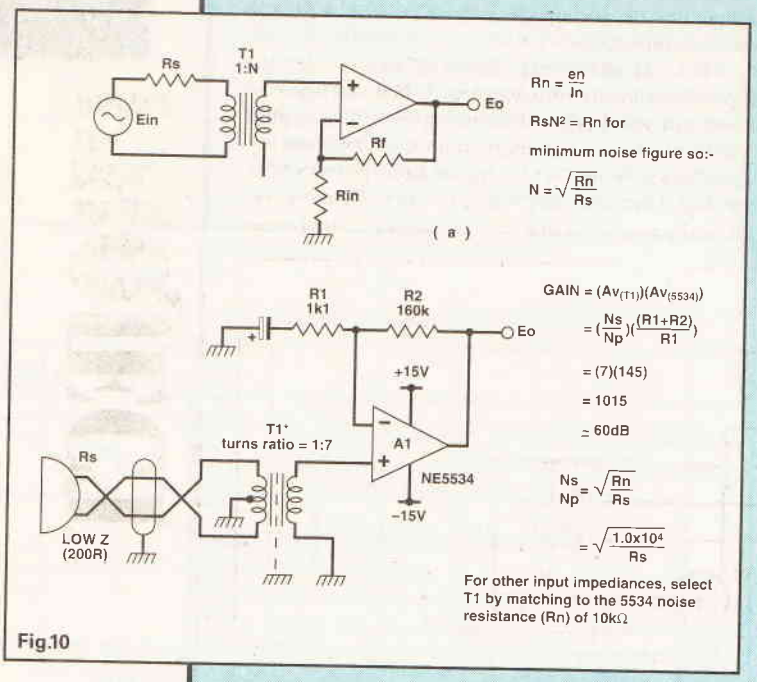

Fig.10

of generator resistance. This means that feedback resistances must be low in relation to the generator resistance. Another consideration is that the non-inverting configuration has only half the noise gain of the inverting configuration for equal signal gains, thus offering a distinct advantage in signal to noise ratio.

In circumstances where it is possible to control source impedance, the characteristic noise resistance, Rn, of the amplifier may be used to advantage; best noise performance for a given IC is obtained when the source resistance is equal to Rn. Thus, in AC applications, optimum performance may be obtained by using a transformer with a turns ratio selected to transform the actual source impedance to the noise resistance of the amplifier. I said in previous issues that designs using transformer inputs had lost vogue somewhat in recent years — this was a slight generalisation as we can see from the above that they can be very useful. They are still used extensively in mixers designed for broadcast purposes where the isolation they afford is completely unsurpassed by any electronic balanced input stages. Other shortcomings listed included cost, linearity at low frequencies and distortion. Cost becomes less of a deciding factor when a manufacturer can place an order for 2000 of the devices and so negotiate bulk discounts, and the linearity problem can be minimised by good design. A typical transformer Mic Input is shown in Figure 10.

The transformer must fulfil certain important requirements. It should:

Transform the impedance of the mic capsule (typically in the order of 150-200R) to the impedance required of the input channel (typically 1k2).

Provide good rejection of common-mode signals.

Match the source resistance to the characteristic noise resistance of the op-amp so that the best noise performance is attained. This is the case when Rs = Rn.

Provide some degree of voltage gain for the mic input signal.

Refer to Figure 10 and part of the op-amp specification. We have shown that in order to determine an optimum turns ratio to match a given source resistance, Rs, to the characteristic noise resistance, Rn, of the op-amp in the circuit, Rn must be first calculated from the specified data for e and i as follows:

$$Rn = e_n/i_n$$

where e_n is in $V/\sqrt{Hz}$ and i_n is in $A/\sqrt{Hz}$. The turns ratio for T1 may be calculated as:

$$Ns/Np = \sqrt{Rn/Rs}$$

For the NE5534, the values for e_n and i_n are $4.0nV/\sqrt{Hz}$ and $0.4\ pA/\sqrt{Hz}$ respectively; therefore, $Rn = e/i = 4.0 \times 10^{-9}/0.4 \times 10^{-12} = 10k$

Since both e_n and i_n will change with frequency, Rn will also change with frequency. Therefore, an approximate value for Rn can be used with little error for calculation purposes in broadband amplifiers. In this example, if Rs is 200R, then the turns ratio for T1 will be;

$$Ns/Np = \sqrt{Rn/Rs} = \sqrt{10000/200} = 7$$

A transformer which fulfils this requirement would then be selected for T1 — the transformer, of necessity, would be a shielded type and one suitable for operation in a low-level environment.

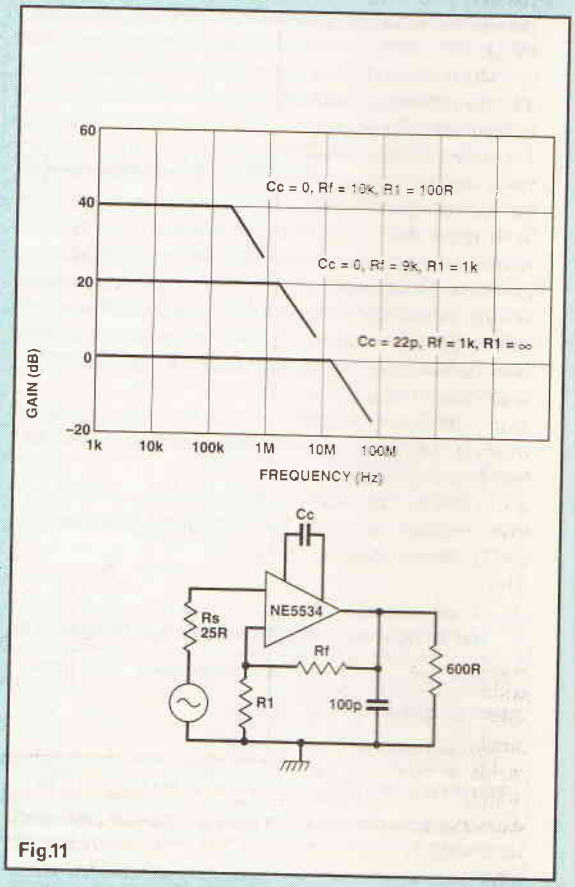

Fig.11

Input Impedance (Req) = $N^2 \times R = 7^2 \times 200$

The use of a transformer allows the input stage to achieve an equivalent input noise (referred to T1 input) that is only a few dB above the theoretical limit ie very close indeed to the thermal noise of the source resistance. As an example, the thermal noise of a 200R resistor in a 20kHz bandwidth at room temperature (normal operating conditions) is;

$$En = \sqrt{4kT(200)(2\times10)} = \sqrt{4 \times 1.38 \times 10^{-23} \times 298 \times 200 \times 20 \times 10^{-3}} = 260nV$$

Thus, using the noise figure of 0.9dB taken from the manufacturer's data, the circuit shown in the figure can be expected to have an input referred noise of 260nV or less with a 200R source.

One of the other requirements which we specified, that of gain, is also provided for by the turns ratio of the transformer. This gain is advantageous in that it

PROJECT

is 'noiseless'. For a given circuit gain, Av, this reduces the gain required of the op-amp, A, to;

A = Av/Ns:Np

It follows that the composite gain is the product of the transformer gain (Ns:Np) and (R1 + R2):R1. This is advantageous in that it allows more loop gain and so greater accuracy and lower distortion since in practice, almost all of the full unloaded voltage gain of the transformer is realised as it looks into the bootstrapped non-inverting input of the op-amp, which has an impedance of many Megohms.

In Figure 10, the source resistance seen by the op-amp is relatively high (10k) and so feedback resistances can be higher without affecting noise performance.

We must remember that a real operational amplifier has neither infinite gain nor infinite bandwidth. Open loop bandwidth begins to roll off from the full DC value at some low frequency (usually about 10Hz in general purpose amplifiers).

As shown in Figure 11, the roll-off is 6dB/octave with increasing frequency until the unity gain frequency, f_T is reached. In a curve such as this, the product of gain and frequency is constant for any point on the curve. Thus the unity gain frequency also defines the available gain at any point along the curve. The product of gain and bandwidth (Gain Bandwidth Product or GBP) in an amplifier response such as this is constant. Thus;

GBP = AvBW

As an example, for a gain of 100, the bandwidth is 100kHz,(for a GBP of 10MHz), and similarly, a gain of 60dB yields a bandwidth of 10kHz. Thus, the rationing of gain and bandwidth is an exchange process – if more gain is necessary, reduced bandwidth is the consequence. We must ensure that all amplifier circuits have the necessary bandwidth when configured for high gain.

And so to the other type of mic input stage, that of the electronic balancing circuitry. From the previous transformer example, we can see that for optimum noise performance, it is imperative that we match as best we can the source resistance and the characteristic noise resistance of the op-amp. From the spec. of the op-amp and because of the internal design of the IC, we can see that the best performance is realised with source resistances much higher than the 1k2 of a normal direct-coupled Mic Input. This means, of course, that unless we can tolerate a serious compromise in the front-end noise performance, the use of the op-amp for direct low noise amplification of microphone signals is strictly verboten.

Instead, we put to good use the superior noise performance at lower source resistances) of the transistor. Figure 12 shows a typical example of this input stage. Q1 and Q2 are a super-matched beta pair operated in differential, long-tailed pair configuration. They provide source impedance matching and initial amplification of the mic signal. Using a supermatched pair, close-tolerance resistors and a differential-style output to the op-amp means that noise and common-mode rejection are excellent. The op-amp provides the remainder of the amplification necessary and also gives an unbalanced output.

Now, which type of circuitry shall we use as the Mic Input stage for the Anniversary 20 Mixer? Until next month, in true 'Perils of Pauline' style, we'll leave all of you to muse over the information thus far presented and deduce from it what kind of circuitry HAS been employed in the Input Channel circuitry. Next month, I'll briefly recap and then go on to explain why I chose what I chose. Circuit diagrams etc will then be published. We'll also discuss the merits of good power supplies.

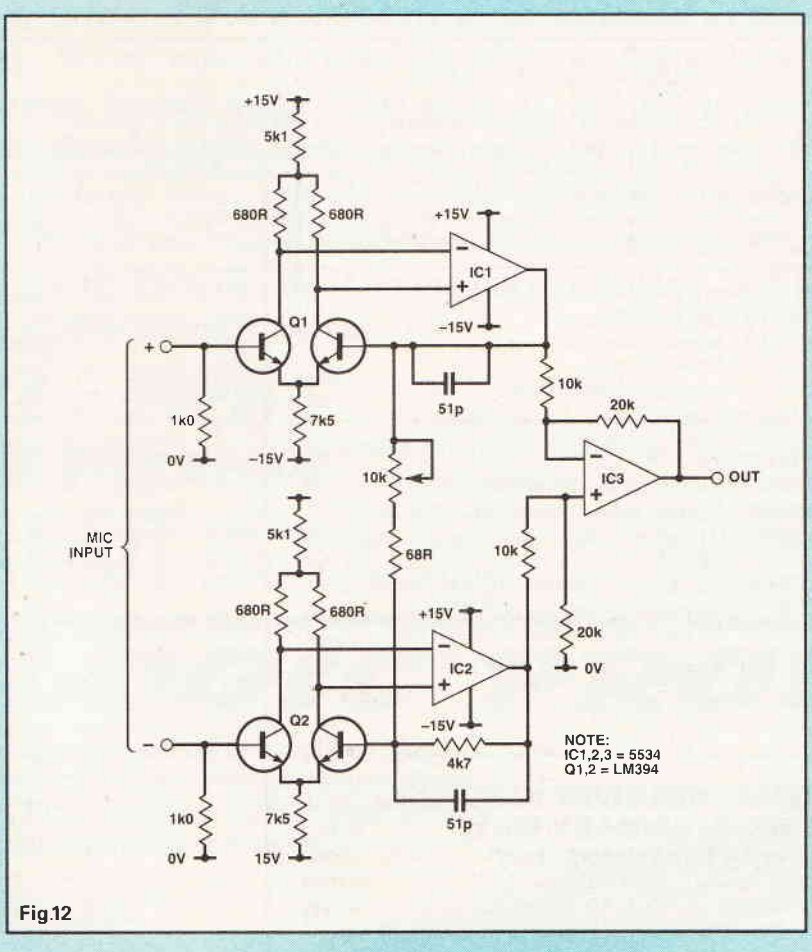

Fig.12

As a footnote, I should like to say that I have approached a number of companies who I thought might be interested in marketing a kit of this project. Thus far, there has been a resounding lack of success. If there are any directors of small metalworking companies out there who would be interested in producing the metalwork for this project, I would be delighted to hear from them . . .

References

Horowitz and Hill The Art of Electronics – Low noise design

Walter Jung : IC Op-amp Cookbook – Miscellaneous Audio Circuits

National Semiconductor Linear Applications Handbook : Application Notes AN20 (Applications Guide for Op-amps) AN346 (High Performance Audio Applications of the LM833)

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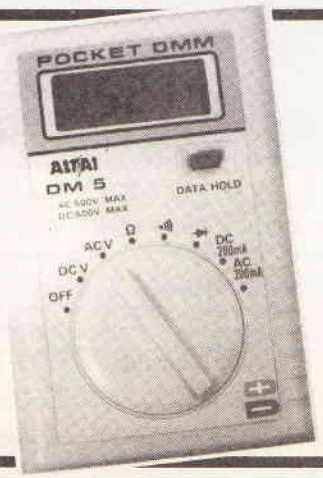

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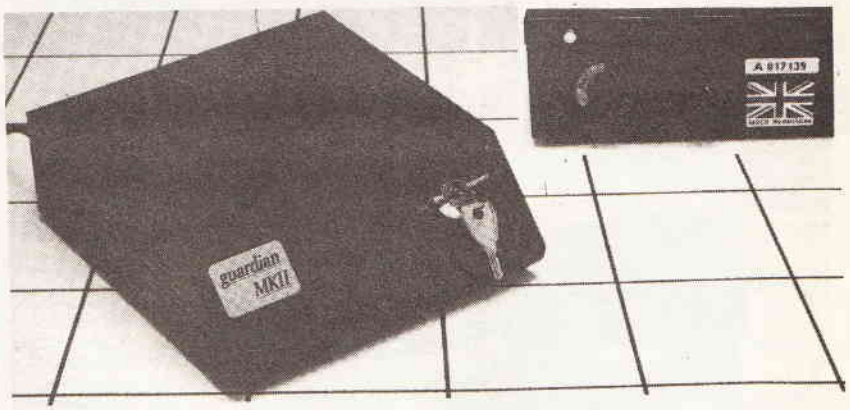

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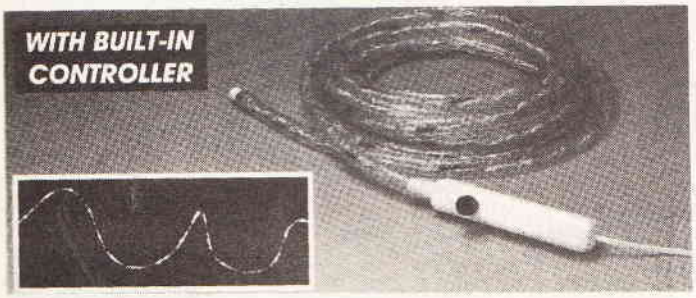

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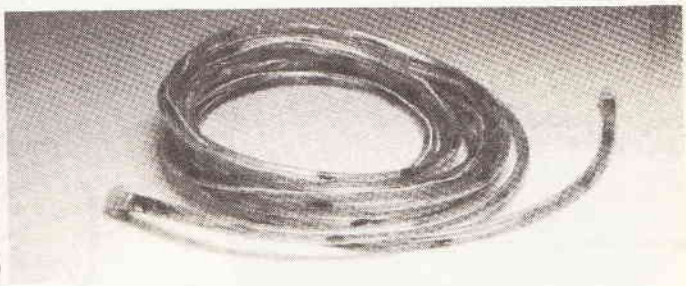

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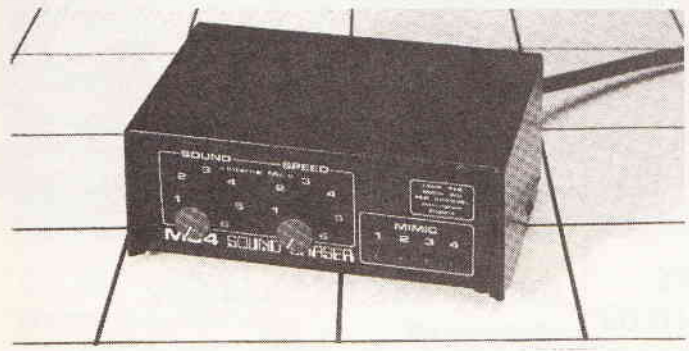

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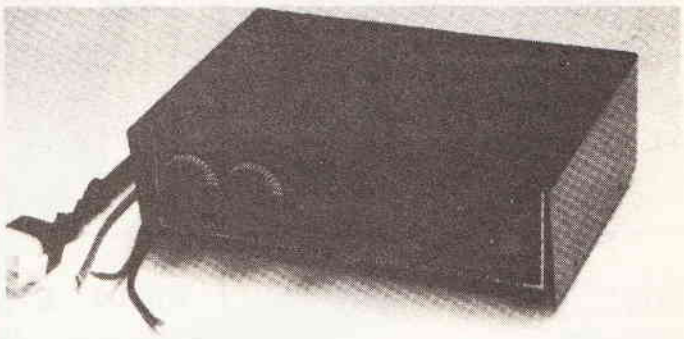

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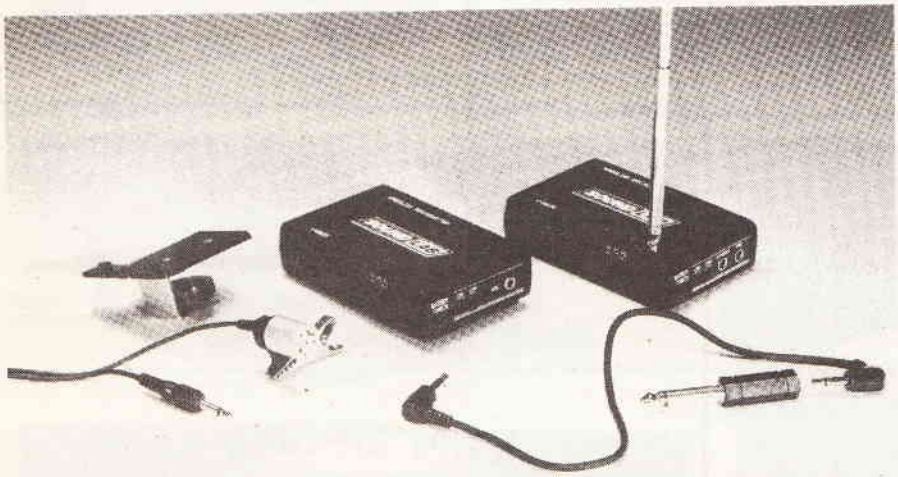
G164G £32.95 3+ 22.11

CAMCORDER DUBBING MIC

A unique mic designed for direct dubbing of an external soundtrack, voice-over, etc. at source, whilst the camcorder is recording. A stereo 3.5mm input is provided in the side of the mic for insertion of the soundtrack and a rotary control provides balance between mic and soundtrack. An earphone jack is provided for monitoring the mix. Supplied with a mono in-ear phone.

Type	Super uni-directional electret condenser
Impedance	1kΩ
Response	80-15000Hz
Sensitivity	-46dB (@ mix max.)
Length	185mm

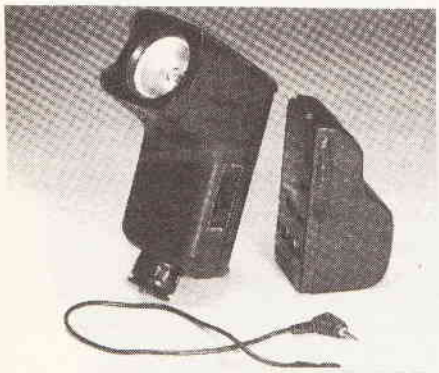


G211 £49.95 2+ 35.52

WIRELESS MICROPHONE

A 3-channel 2-part wireless microphone system designed for use with video cameras. The tie-clip mic has a remote belt clip transmitter with on/off switch. The receiver has a hot shoe for mounting on the video camera. The system allows greater mobility with a microphone than can be achieved with the camcorder mic.

WITH VINYL CARRYING CASE



T081 £47.95 3+ 32.09

VIDEO LIGHT

30W halogen video light with 6V 1700mAh battery pack. The video light is provided with a synchronisation lead which, when the light is switched to "remote", allows the light to switch on when the camcorder is switched on (Sony and Panasonic camcorder). The on/off/remote switch has a lock button to prevent accidental movement.

Packed: BOX

T081AA
Spare bulb **£4.95** 5+ 3.28

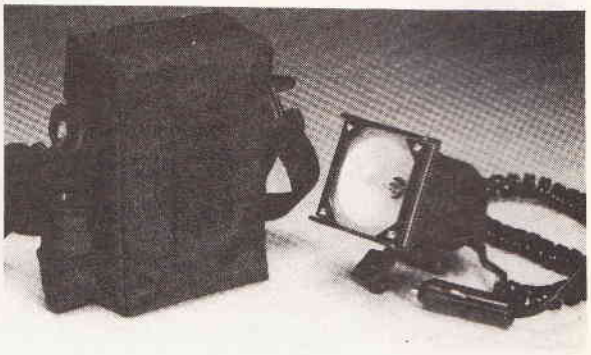
T081A £15.95

VIDEO LIGHT 4+ 10.63

30W video camera light with hot shoe fitting and power on/off switch. Accepts 6V 1700mAh battery pack (Sony NP55 and NP77 typically)

Packed: BOX

T081AA
Spare bulb **£4.95**



T081B £66.95 3+44.89

VIDEO LIGHT KIT

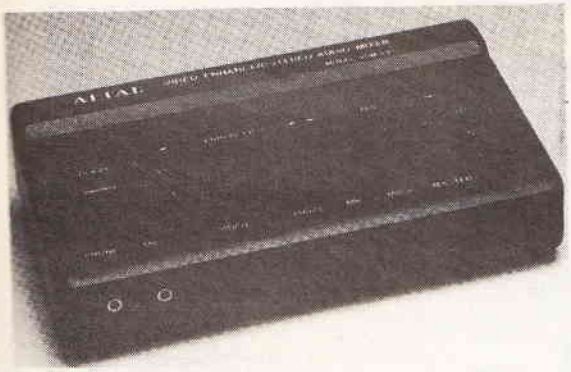
A semi-professional video light kit comprising 100W halogen lamp, remote 12Vdc 7Ah sealed lead acid battery in carrying case with shoulder strap, 220/240Vac operated battery charger and camcorder power supply adaptor.

Packed: BOX

T081BA Spare bulb **£3.75** 5+ 2.80

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

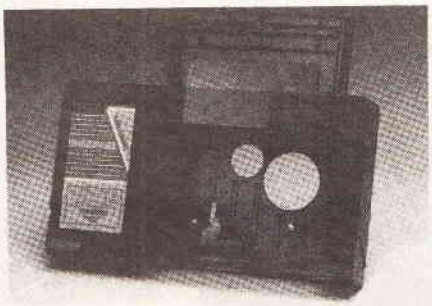
SPRING SUPPLEMENT 5



T128D £36.95 5+ 24.79

VIDEO ENHANCER/AUDIO MIXER

A 3-channel stereo video sound mixer with a built-in video enhancer, specificially designed for video dubbing. The audio input from the camera/VCR, mic and music sources can be mixed at will, with overall output controlled by a master slider. The video enhancer will clean up the picture on older recordings. Powered by an external 12Vdc power supply (not supplied). Complete with all connecting leads and adaptors.



T122D £12.95 10+ 8.56

VHS-C TO VHS ADAPTOR

All mechanical adapter cassette allowing the playback of VHS-C tapes on VHS video players. The action of closing the door moves the tape into position.

T122K £6.95 10+ 4.80

45 minute tape.

T122J £6.95 10+ 4.80

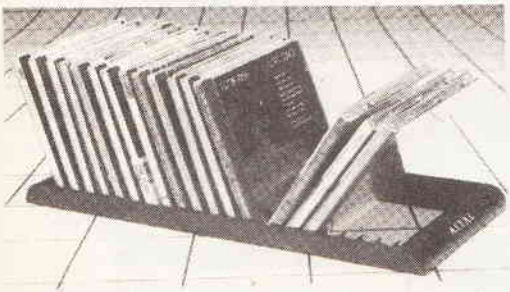
30 minute tape.

GAFFA TAPE

50m rolls of 2" wide self adhesive Gaffa tape

L099R Silver £6.50 10+ 4.36

L099S Black **£6.50** 10+ 4.36



A163A £2.95 40+ 1.03

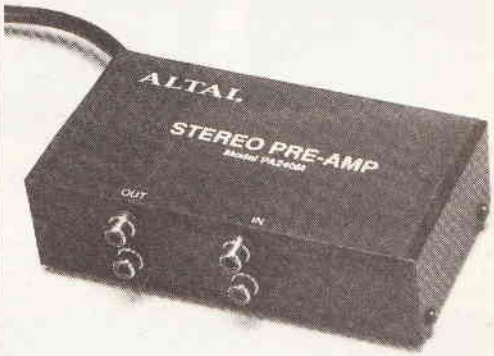
CD RACK

A unique CD storage system which will hold up to 20 CD's, in their cases, allowing them to flip back and forth as you search for the CD you want. Free standing and interlocking.

DC POWER LEAD

Useful universal lead - reversible socket on the end of a DC power lead with 4 interchangeable plugs - 1.3, 2.1, 2.5DC & 3.5mm mono jack. 1.8m long.

A133A £1.25 50+ 0.75

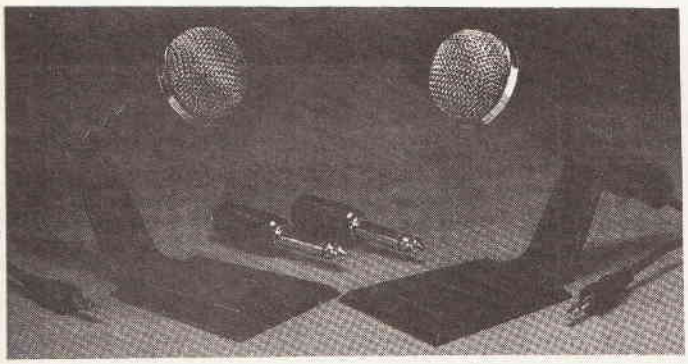


A005A £27.95 5+ 19.03

STEREO PRE-AMP

Mains powered stereo pre-amp suitable for insertion between turntables, mics and other low level sources and aux/line inputs on mixers, amps, stack systems etc.

Input impedance	50kΩ
Max. input level	33mV (@ 1kHz)
Max output level	3.8V (@ 47kΩ load)
S/N ratio	more than 50Hz
Input sensitivity	2.5mV (output 300mV)
Frequency response	30 - 15kHz (RIAA)
Power	220/240Vac 50Hz
Dims	140 x 75 x 40mm

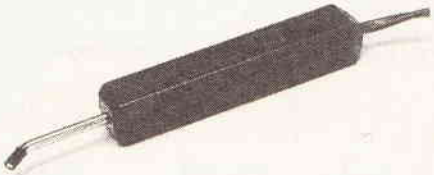


G170C £5.95 10+ 3.35

DYNAMIC MIC 200Ω

Pair of matched dynamic microphones. Black plastic body with chrome metal grille and chrome trim. On/off switch. Independent 1.2m leads terminating in 3.5mm jack plugs. Mic stands and 6.35mm adaptors included.

Type	Omni-directional dynamic
Impedance	200Ω
Response	90-10000Hz
Sensitivity	-76dB @ 1kHz
Dia: Head	32mm.
Body	17mm
Length	120mm



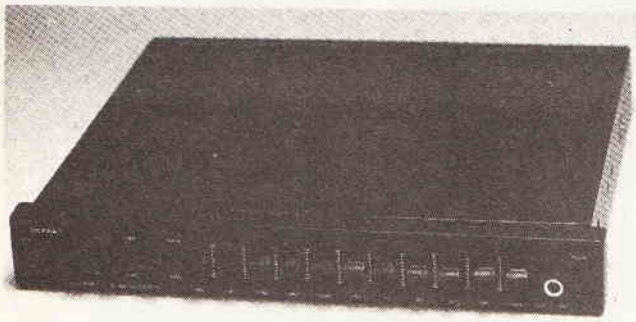
A170A £2.95 10+ 1.88

TAPE HEAD DEMAGNETIZER

A compact and easy to use tape head demagnetizer. Simply plug the demagnetizer in, press the red button and place the tip gently in contact with the tape head. Rotate the tip across the surface and withdraw slowly. Demagnetizng every 50 hours of play time improves playback and record quality.

Power: 220/240Vac 50Hz

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

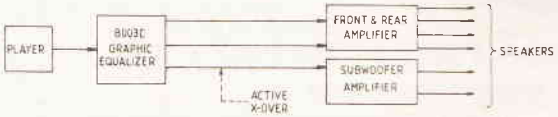


B003C £39.95 5+ 26.40

GRAPHIC EQUALIZER

11-band graphic equalizer with sub-woofer output and CD input. The sub-woofer output has an adjustable cut-off frequency and level control. The case is standard DIN width for in-dash or under-dash mounting. Low level inputs and outputs only, via phono sockets.

Frequency response	20 - 25000Hz
Total harmonic distortion	Less than 0.05%
S/N ratio	85dB
Separation	65dB
Control frequencies	60, 120, 250, 380, 500, 750, 1k, 2k, 4k, 8k and 16kHz
Control range	12dB boost or cut
Power	12 - 14Vdc
Dims	178 x 25 x 140mm



A085 £99.95 2+ 73.70

RADIO HEADPHONE SYSTEM

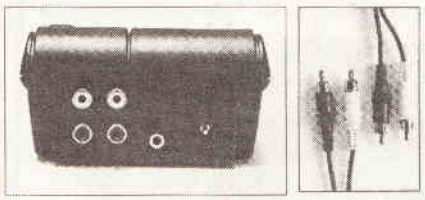
A radio headphone system comprising a radio transmitter, a belt-clip receiver and a pair of high quality headphones. The transmitter will accept inputs from three separate sources; CD, DAT, tape etc and additionally has a built-in mic with talk button for contacting the headphone wearer. The system allows complete freedom of movement within a range of approximately 100 feet of the transmitter.

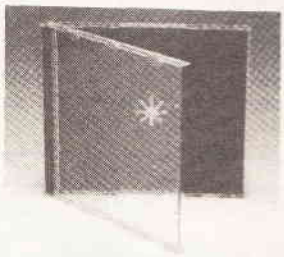
Transmitter:

Input sensitivity	Source 1 & 2: 10kΩ/100m
	Source 3: 22kΩ/100m
Power	12Vdc 150mA

Receiver:

Frequency response	48 - 16000Hz
Power output	30mW/channel
Range	100ft (36m)
Power supply	PP3 battery
Battery life	8hrs nominal





A162B £1.20 50+ 0.66

REPLACEMENT CD CASES

Replacement CD storage cases designed to be direct replacements for the originals supplied with compact discs. Two cases per pack.

GREENWELD ELECTRONIC COMPONENTS

A087F £8.95 10+ 5.15

STEREO HEADPHONES WITH BOOM MIC

Lightweight stereo headphones with adjustable dynamic boom mic. Tough plastic headband with stainless steel adjusters. Foam padded earpieces containing high quality samarium cobalt transducers for clear sound reproduction. High sensitivity miniature dynamic mic cartridge with foam windshield. Straight screened lead terminates in 6.35mm stereo plug for headphones and a 3.5mm mono plug for mic.

Headphones:

Type	Mylar transducer
Impedance	32Ω
Response	20 - 20000Hz
Power	150mW

Microphone:

Type	Omni-directional dynamic
Impedance	250Ω
Sensitivity	-78dB @ 1kHz

General:

Lead	2.5m straight screened
Plugs	6.35mm stereo and 3.5mm mono
Weight	80g

B049A £12.95 6+ 7.50

12Vdc TRAVEL KETTLE

12Vdc kettle complete with mounting stand, cup and cup holder with a self-adhesive base. Plugs directly into a car cigar lighter socket for power. A power-on light is provided at the base of the kettle. Ideal for cars, vans, campers etc.

Capacity.....0.5 pints (0.3lts)
Power.....12Vdc 9A, 14Vdc 11A
Dims.....143 x 125 x 112mm (approx)

B200Z £1.95 20+ 1.14

PLUG-IN FLASHING LED

A flashing LED built into a car cigar lighter plug to give visual warning that an alarm is activated (whether or not an alarm is fitted). Simply plugs into the car's cigar lighter socket.

B201 £17.95 10+ 11.93

CAR ALARM

Keyless, self-contained car alarm with simple, three wire connection into the car's wiring harness. The alarm is self arming one minute after the ignition is switched off. The alarm is current sensing and will operate 10 seconds after a door is opened. Once triggered the alarm will sound for 30 seconds before re-setting.

Operation.....Current sensing
Reset time.....45 seconds
Power.....12 - 14Vdc

B047D £12.95 10+ 8.84

AIR PURIFIER AND IONIZER

A compact, stylish ionizer and air purifier with a coverage volume of 14m³. Ideal for in car use with the DC lead provided or as a room purifier with the AC adaptor provided. Removes unpleasant smells, airborne dust, bacteria, tobacco smoke etc.

Power.....9-15Vdc or 220/240Vac via adaptor
Dims.....160 x 95 x 43mm

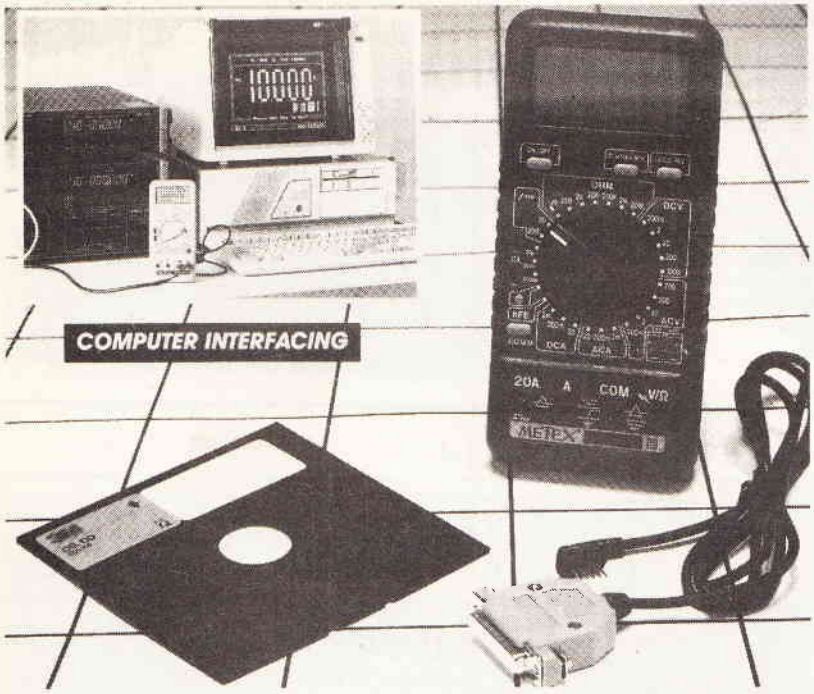
B047E £9.95 10+ 6.50

AIR PURIFIER AND IONIZER

A compact, stylish ionizer and air purifier designed specifically for car, truck and bus use with a coverage volume of 14m³. Removes unpleasant smells, airborne dust, bacteria, tobacco smoke etc. Supplied with a double sided self adhesive pad.

Power.....12Vdc 1.8W
Dims.....110 x 110 x 65mm

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT



Y122HR £99.95 2+ 66.73

10MΩ

The Y122HR (M3650CR) multimeter is capable of communicating either the current LCD readout or up to 5 stored measurement values direct to data acquisition systems, PC's, pen plotter, printer, etc. via its MT/RS232C interface cable. Interface cable and program disc included with meter.

- ★ 3.5 digit 17mm LCD display
- ★ 30 ranges including 20A ac/dc
- ★ Data hold
- ★ Max/min value capture
- ★ 40 point analog bargraph
- ★ Frequency counter
- ★ Logic test with auto level
- ★ Capacitance test
- ★ Continuity test with buzzer
- ★ Transistor and diode test
- ★ Built and tested to IEC 348
- ★ Fully shrouded test leads

Battery, instruction manual and carrying case included.

AC volts	0-200m-2-20-200-750Vac ± 0.8%
DC volts	0-200m-2-20-200-1000Vdc ± 0.3%
AC current	0-2m-200m-20Aac ± 1.8%
DC current	0-200µ-2m-200m-20Adc ± 0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ± 0.5%
Capacitance	0-2000pf-200n-20µF ± 2.0%
Frequency	0-20k-200kHz ± 2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

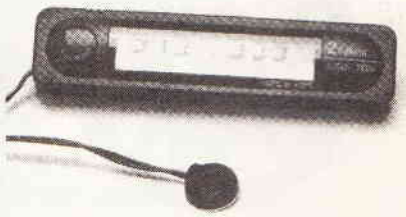
Packed: BOX

Y137M £8.95 5+ 6.03

DIGITAL THERMOMETER

A dual sensor digital thermometer designed for comparative temperature measurement, for example inside/outside temperature. The thermometer can be free standing or mounted with the Velcro strips provided. The remote sensor is fitted with a 3m lead and mounted with double sided tape. A digital clock is built in.

Temperature range	-20 O to +70OC ± 1OC
Resolution	0.1OC
Power	P009H button cell

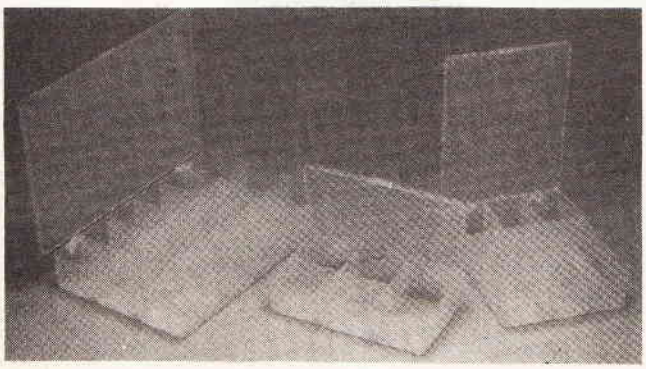


Y137N £11.95 5+ 7.50

DIGITAL THERMOMETER

Dual channel inside/outside comparative temperature thermometer with dual readout display. Dual thermocouple, one internal and one on a 3m extension lead. Free standing or double sided tape attachment.

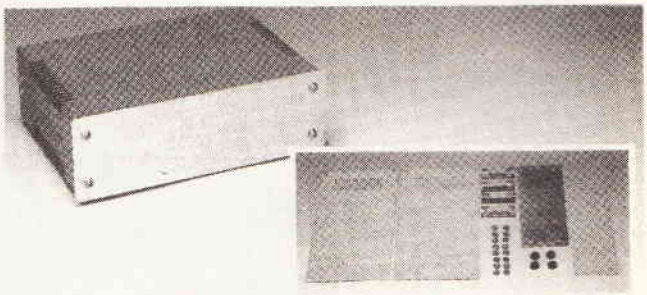
Temperature range	-50 to +70°C
Power	1 x P009H battery
Dims	107 x 25 x 13mm



COMPARTMENT BOXES

A range of three strongly constructed polypropylene compartment storage boxes with hinged lids. Semi-transparent finish.

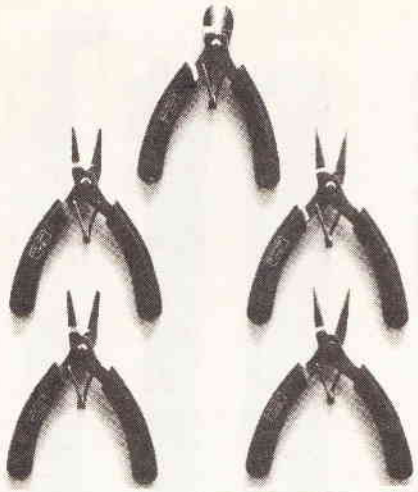
F662	180 x 97 x 43mm 5 compartments	**£1.20**	40+ 0.74
F662A	185 x 142 x 42mm 9 compartments	**£1.60**	40+ 1.03
F662B	275 x 180 x 42mm 18 compartments	**£1.99**	40+ 1.33



METAL CASES

A range of flat pack steel cases with aluminium front and rear panels. Rust proof finish, ready for painting.

Ref:	Size		
F660	80 x 46 x 85mm	**£3.96**	10+ 2.65
F660A	110 x 50 x 80mm	**£4.78**	10+ 3.20
F660B	140 x 56 x 110mm	**£5.96**	10+ 3.99
F660C	180 x 56 x 130mm	**£7.90**	10+ 5.29
F660D	230 x 56 x 190mm	**£10.99**	10+ 7.37

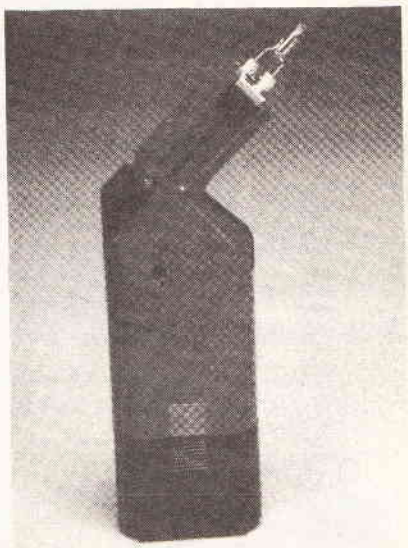


Y030B £12.95
5+ 8.01

PRECISION TOOL SET

5-piece precision, pressed stainless steel tool set with precision ground blades. The set comprises side cutters, bent nose pliers, round nose pliers, long nose pliers and flat nose pliers. Sprung, insulated handles.

Length.....4" (100mm)



A150B £6.95
10+ 3.95

MINI VACUUM CLEANER

A battery powered mini vacuum cleaner which is ideal for removing the dust from turntables, cameras, video recorders, computer keyboards etc. 5 piece kit. Powered by four AA alkaline battieries (not supplied).

Power.....4 x AA alkaline batteries

Y060S £6.95 10+ 4.42

PORTABLE SOLDERING IRON

Battery operated portable soldering iron. Powered by 4 'C' cells in the handle (not supplied). Tip heats up in seconds from operation of the biased off slide switch. Tip retracts into the body for safety. Supplied with one spare tip and 300mm of solder.

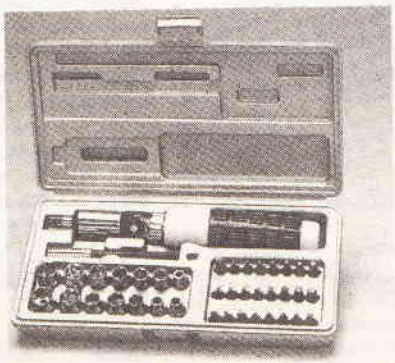
Power.....6Vdc (4 x C cells)
Dims.....190 x 66 x 30mm

Y006E £6.95
10+ 4.29

PRECISION MAGNIFIER

Precision made magnifer with a fixed focus. The lens fits directly over a graduated scale for magnified measurement. Metric and imperial scales. All metal construction. Folds down for storage in the vinyl wallet provided.

Dims.....53 x 48 x 39 (in use)
.....47 x 39 x 14 (folded)



Y012C £9.95
10+ 6.67

40-PIECE TOOL KIT

A 40-piece tool kit comprising a ratchet driver handle with a lockable knuckle, 100mm extension bar, 7 torque driver tips, 8 hex key tips, 6 screwdriver tips, 2 square drive tips, 1 hex to square drive adaptor, 7 metric sockets and 7 imperial sockets in a hinged plastic case.

Y006C 35p
100+ 0.19

PRISMATIC MAGNIFIER

Credit card size prismatic magnifier. All plastic.

Y006D £7.95
10+ 5.29

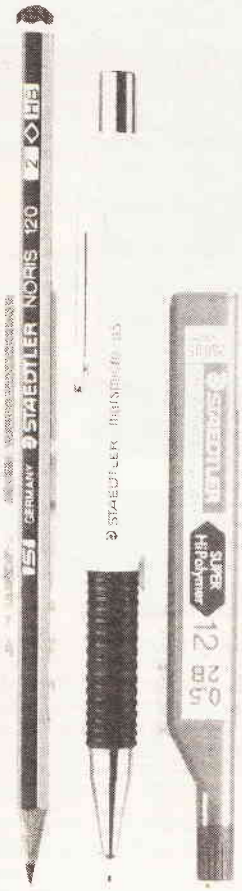
GOOSENECK MAGNIFIER

2X magnification 3" diameter on a flexible 13" gooseneck with heavy base. Useful for close, precise work.

PRICES IN **BOLD** TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

SPRING SUPPLEMENT

Graphic Supplies by Staedtler



(a) Pencils

The Noris school and office pencil available in 5 colour coded degrees:

Code	Description	1–11	12+	144
S120-2B	2B Pencil	24p	0.17	0.14
S120-B	B Pencil	24p	0.17	0.14
S120-HB	HB Pencil	24p	0.17	0.14
S120-H	H Pencil	24p	0.17	0.14
S120-2H	2H Pencil	24p	0.17	0.14

(b) Propelling Pencils

Fineline propelling pencils. Available in 4 sizes for technical applications. Contoured slip-proof finger grip. Perfectly balanced for convenience and precision. Has 3mm retractible safety sleeve. Replaceable eraser with cleaning pin under push button.

Code	Description	1–9	10+	30+
S775-03	0.3mm lead	£2.75	1.95	1.56
S775-05	0.5mm lead	£2.75	1.95	1.56
S775-07	0.7mm lead	£2.75	1.95	1.56
S775-09	0.9mm lead	£2.75	1.95	1.56

Replacement leads. Fineline black leads with extraordinary point strength, slow wear and opacity. Supplied in tubes of 12.

Code	Description	1–9	10+	30+
S250-03	0.3mm HB lead	£1.70	1.20	0.97
S250-05	0.5mm HB lead	£1.05	0.74	0.60
S250-07	0.7mm HB lead	65p	0.46	0.37
S250-09	0.9mm HB lead	65p	0.46	0.37

(Available in different degrees of hardness to order)

(c) Lead Holders

The MARS Technico lead holder with sliding pocket clip. Lead sharpener built into the push button. For all 2mm leads.

Code	Description	1–9	10+	30+
S780CCA	Mars holder	£3.25	2.30	1.84

Lightweight plastic model for 2mm leads

Code	Description	1–9	10+	30+
S789OOC	Noris holder	£1.85	1.31	1.05

Lumograph 2mm leads for above holders, sold in boxes of 12:

Code	Description	1–5	6–11	12+
S2002B	2B leads	£3.85	2.72	2.18
S200B	B leads	£3.85	2.72	2.18
S200HB	HB leads	£3.85	2.72	2.18
S200H	H leads	£3.85	2.72	2.18
S2002H	2H leads	£3.85	2.72	2.18

(Other degrees from EB to 9H available to order)

Lumochrom Coloured 2mm drawing leads for use on paper or film. Pack of 12 assorted colours

S204S12	12 colours	£4.10	2.91	2.33

(d) Ball point pens

Ventilated caps. Fine point.

Code	Description	1–9	10+	30+
S430F-9	Black	16p	0.11	0.09
S430F-2	Red	16p	0.11	0.09
S430F-5	Green	16p	0.11	0.09
S430F-3	Blue	16p	0.11	0.09

(e) Fibre Pens

Low cost fibre tipped pens – 0.8mm robust point, ventilated cap. Available in a range of colours:

Code	Description	1–9	10+	30+
S333-9	Black	25p	0.17	0.14
S333-2	Red	25p	0.17	0.14
S333-5	Green	25p	0.17	0.14
S333-3	Blue	25p	0.17	0.14
S333-1	Yellow	25p	0.17	0.14
S333-W1	Pack of 10 assorted colours	£2.50	1.70	1.40
S333-W2	Pack of 20 assorted colours	£5.00	3.40	2.80

(f) Graphic Liners

Pigment liner, multipurpose fibre tip pen. Fade proof black pigment ink. Excellent reproduction qualities. In 4 line widths:

Code	Description	1–9	10+	30+
S308-01	0.1mm liner	£1.45	1.02	0.82
S308-03	0.3mm liner	£1.45	1.02	0.82
S308-05	0.5mm liner	£1.45	1.02	0.82
S308-07	0.7mm liner	£1.45	1.02	0.82
S308WP4	Plastic wallet with one each of the above 4 pens	£5.80	4.11	3.29

(g) AV Pens & Markers
A range of high quality Lumocolour markers with permanent waterproof ink that will write on all smooth surfaces. Fadeproof. Ideal for OHP – available in 8 colours. Ventilated caps.

Fine Points 0.4mm

Code	Description	1–9	10+	30+
S318–9	Black	72p	0.51	0.41
S318–2	Red	72p	0.51	0.41
S318–5	Green	72p	0.51	0.41
S318–3	Blue	72p	0.51	0.41
S318–W8	Pack of 8; one each black, red, green, blue, yellow, brown, orange and purple	£5.76	4.10	3.30

Medium Points 0.8–1mm

S317–9	Black	72p	0.51	0.41
S317–2	Red	72p	0.51	0.41
S317–5	Green	72p	0.51	0.41
S317–3	Blue	72p	0.51	0.41
S317–W8	Pack of 8; one of each as S318–W8	£5.76	4.10	3.30

Broad Points 1–2.5mm

S314–9	Black	£1.00	0.71	0.57
S314–2	Red	£1.00	0.71	0.57
S314–5	Green	£1.00	0.71	0.57
S314–3	Blue	£1.00	0.71	0.57
S314–W8	Pack of 8; one of each as S318–W8	£8.00	5.67	4.54

(h) Highlighters
In 3 popular colours. Universal pigment ink, lightfast for all types of paper including fax, telex and carbonless copy paper. Chisel point.

Code	Description	1–9	10+	30+
S364–1	Yellow	£1.10	0.77	0.62
S364–23	Pink	£1.10	0.77	0.62
S364–5	Green	£1.10	0.77	0.62

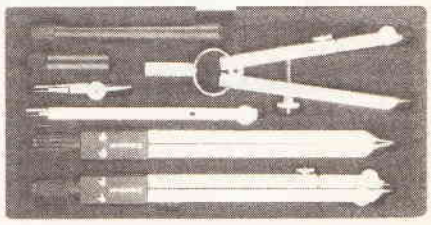
Marsmatic Techniset
S700C7 Compact desktop set with 2 slide out trays. Upper tray contains 3 Marsmatic 700 technical pens (0.25, 0.35, 0.5mm), 4 ink cartridges, an eraser, fineline pencil and tube of leads, and a compass attachment for technical pens. The lower tray is empty.
£29.30 5+ 20.79

Erasers

Code	Description	1–9	10+	30+
S526–B20	Rasoplast Soft white vinyl eraser 58x22x12mm	23p	0.16	0.13
S526BT30	Duoplast dual eraser. Removes ink and graphite	35p	0.25	0.20

S526–61 Rasor eraser pencil with brush **75p** 0.53 0.42

Drawing Sets
High quality student compass sets. The Arco range is sturdy and robust, and incorporates features normally only found on more professional models.

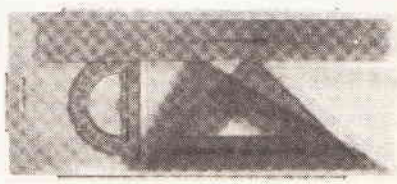


S559–09 Arco drawing set – compass, dividers, extn bar, springbow and lead box. **£9.95** 5+ 6.66

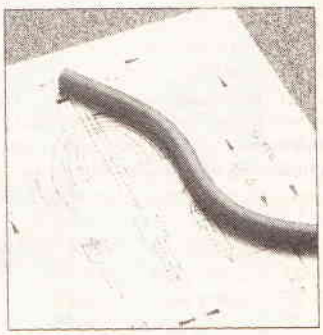
S559–50 Low cost school compasses and lead box **£1.35** 10+ 0.96

Rolling Ruler
Versatile instrument for drawing parallel lines both vertically and horizontally; drawing angles, circles, curves and arcs. Comes with full instructions.

Code	Description	1–9	10+	30+
S962–31	6" model	£4.50	3.19	2.55
S962–30	12" model	£6.25	4.43	3.55



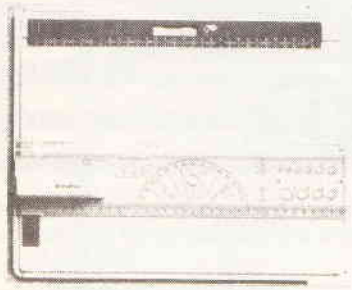
S569–22 Set of 45° and 60° set squares, 6" ruler and protractor **75p** 0.51 0.41



S971–12 Flexible Curve **£2.60** 1.92 1.63

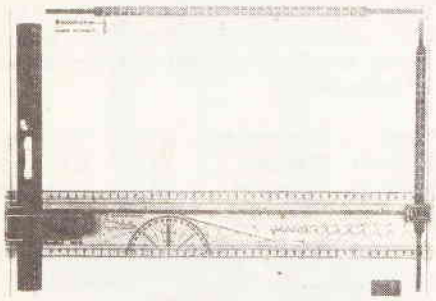
S571–40 French curve set – set of 3 in plastic wallet **£3.75** 2.66 2.13

Drawing Boards
Portable drawing boards suitable for student and technical draftsperson alike. Advanced features make these quality products excellent value for money. They are made of especially break resistant plastic



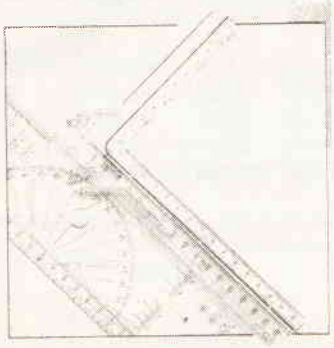
S661A4 DIN A4 size has perimeter guide grooves, a recessed sheet clamp with locking key, paper alignment edges and reduction scales. Fixmatic drafting arm has 2 guide grooves for a drafting head. **£24.95** 5+ 14.18

S661A3 DIN A3 size with fixmatic drafting arm **£34.95** 5+ 19.86

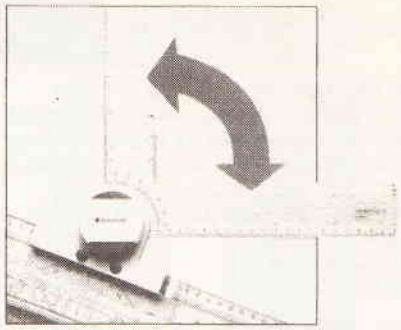


S660A3 DIN A3 Mars Technico drawing board with additional features a s shown for the professional. **£46.50** 5+ 26.38

Accessories
All suitable for above boards



S660-15 The quickmatic drafting head. Quickset angle can be set in the guide grooves and moved along the entire length of the drafting arm for hatching. Locks at 15° intervals. **£4.25** 5+ 3.62



S660-20 Variomatic drafting head – fits the guide grooves of the parallel drafting arm. It allows instant drawing of 30° angles, has opposing scales 0-90° and automatic locking at 15° intervals **£14.50** 5+ 8.23

Kuratake

A range of top quality supplies from a company established in 1902. Kuratake has been established in the UK for 5 years, providing graphic markers and equipment to education, industry and commerce.

Ceramic Rollerball Pen
The Zig ball 200 is a low cost high quality 0.3mm rollerball pen, available in 4 colours. Waterbased ink.

Code	Description	1+	12+	96+
KCB220K	Black	70p	0.43	0.34
KCB220R	Red	70p	0.43	0.34
KCB220G	Green	70p	0.43	0.34
KCB220B	Blue	70p	0.43	0.34

Textile Markers
Double ended pens to give a hard line (2mm) and a brush effect. Waterbased pigment ink exclusively for marking on cloth and fabric that once dry will not wash out. Available in a range of colours and packs as shown:

Code	Description	1+	12+	48+
KTC4000K	Black	£2.23	1.34	1.08
KTC4000R	Red	£2.23	1.34	1.08
KTC4000G	Green	£2.23	1.34	1.08
KTC4000B	Blue	£2.23	1.34	1.08
KTC4000Y	Yellow	£2.23	1.34	1.08
KTC4000A	Pack of 12 assorted colours: Black, Red, Green, Blue, Yellow, Brown, Orange, Violet, Grey, Pink, Light blue, Light Green.	£16.92	10.13	8.10

Gold & Silver Pen
Double ended pen 210mm long with valve action and fine tip – Gold one end, Silver the other. Instant drying, high opacity.

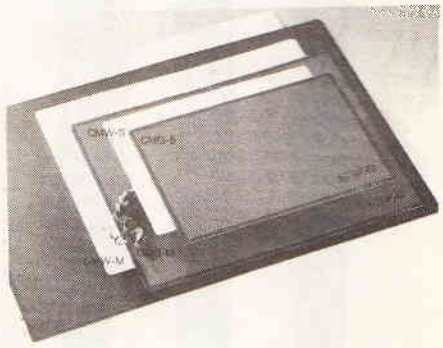
Code	Description	1+	12+	48+
KFMP20	Gold & Silver	£3.80	2.28	1.83

Whiteboard & Markers
A revolutionary new product – a flexible whiteboard! The Flexiwipe needs no fixing, just peel off backing sheet and smooth on to any non-absorbent surface. Easily removable for storage in tube supplied. Available in 3 sizes as shown:

Code	Description	1+	3+
FWA2P	A2 (594x420mm)	£27.23	15.73
FWA1P	A1(840x594mm)	£55.46	31.15
FW2M	2m x 930mm	£126.12	70.85

Markers for above and other whiiteboards. Alcohol based ink that simply wipes away when dry. Sold in packs of 4 bullet tipped markers – Black, Red, Green and Blue.

Code	Description	1+	12+	48+
KOMW35	Pack of 4 pens	£4.51	3.17	2.54



Cutting Mats
High quality double sided green cutting mats with high durability and elasticity. Self healing surface on both sides. Printed with a 2mm grid.

Code	Description	1+	12+
CMG/ES	220x300mm	£7.47	4.20
CMG/S	300x450mm	£14.95	8.40
CMG/M	450x600mm	£29.68	16.67

Changin' Glue
Instant adhesive for paper and card – on application the glue is blue, but dries clear. Non-toxic emulsion based. Can be used as permanent (stick while blue) or temporary (wait till clear – can be repositioned as required). Available in 2 sizes:

Code	Description	1+	12+	96+
KMSB15	10gm, 6mm tip	£1.69	1.02	0.81
KMSB30	25gm 15mm tip	£3.37	2.03	1.63

Airbrushes
The Humbrol range of airbrushes and spray guns is designed to offer both modellers and graphic artists an inexpensive introduction to this medium.

H30003 Modellers airbrush designed to give a cost effective method of applying paint. Features include adjustable air jet pattern, air volume and paint flow volume adjustments. The set includes an aerosol power pack and three additional storage jars. **£19.95** 3+ 13.58

H30006 Hobbicraft airbrush set. This offers greater precision and finer atomisation than the above model. It features a dual action control trigger, controlling both paint volume and airflow, with an additional air supply volume control for attachment to aerosol power packs. Included in this set are an aerosol power pack and three spare storage jars. **£46.50** 3+ 31.66

Aerosol Power Packs

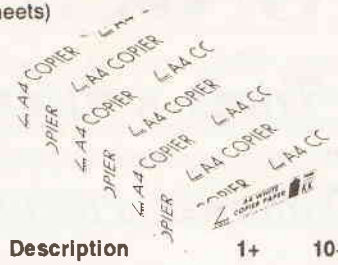
H30201	Standard size	**£2.95**	12+ 2.00
H30202	Large size	**£4.99**	12+ 3.40

OHP Film
Clear acetate film for overhead projection, also ideal for PCB layouts. Available in A4 size only, 0.1mm thick. Supplied in packs of 10 sheets

Code	Description	1–9	10+	30
S632-1021		**£1.60**	1.06	0.71

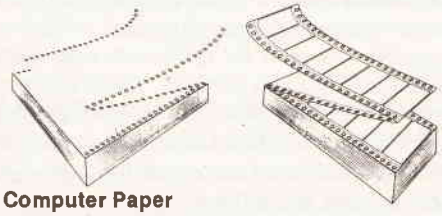
Other Stationary Products

(a) Paper & Labels
80gsm high grade copier paper, sold in reams (500 sheets)



Code	Description	1+	10+
A701	A3 size 420x297mm	**£9.95**	5.73
A702	A4 size 297x210mm	**£3.70**	2.31

Laser Copier Paper
A high quality paper giving excellent results with all laser printers. Price per ream.
A703 A4 size 297x210mm **£4.50** 3.30



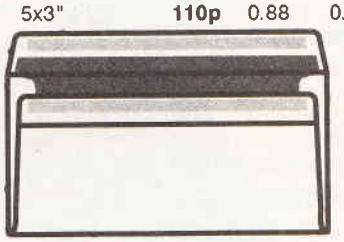
Computer Paper
A458 Computer Listing Paper 11x9½" plain. 60gsm wood free, microperf. Sold in cases of 2000 sheets. **£15.00** 11.06

CL01 Continuous labels 3½x1.7/16". One label across sheet. Vertical spacing 0.2"
Pack of 1000 £6.95; 8000 32.00+VAT

CL02 Continuous labels 4x1.7/16". Three labels across sheet. Vertical spacing 0.2"
Pack of 1000 £6.95; 12000 51.00+VAT

3M Post-it notes.
The original removable self-stick notes, available in 3 sizes:

Code	Description	1+	12+	144+
S16	1½x2"	**36p**	0.28	0.23
S17	3x3"	**75p**	0.59	0.48
S18	5x3"	**110p**	0.88	0.70

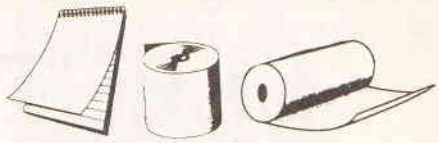


(b) Envelopes
White DL, size 220x110mm (takes A4 folded in 3) Self-seal. Sold in packs of 100

Code	Description	1+	10+
A711	80gsm opaqued, plain	**£2.00**	1.15
A712	80gsm opaqued, window	**£2.20**	1.29

Brown C4, size 325x230mm (takes A4 unfolded). Sold in packs of 100

Code	Description	1+	10+
A716	80gsm gummed	**£4.20**	2.27
A717	80gsm self seal	**£4.60**	3.09



(c) Pads and Rolls
A721 Shorthand notepad, spiral bound 8x5". 80 sheets (160 pages)
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A721 Fax Roll. Standard for most makes of machine. 210mm wide x 30m long (equivalent to 100 A4 sheets) 12.5mm tube. **Reduced Price:**
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Pack of 100 £4.40; 10+ 2.81

Adhesive Tape
A731 1" wide clar adhesive tape, polypropylene 30 micron
60p; 12+ 0.36; 72+ 0.29

A735 2" wide buff packaging tape, polypropylene 30 micron.
£1.30; 12+ 0.83; 36+ 0.66

Ballpoint Pens
Low cost ball pens with ventillated caps, in 3 popular colours:

Code	Description		
HPE01	Black	**10 for £1;**	100+ 0.06
HPE02	Blue	**10 for £1;**	100+ 0.06
HPE03	Red	**10 for £1;**	100+ 0.06
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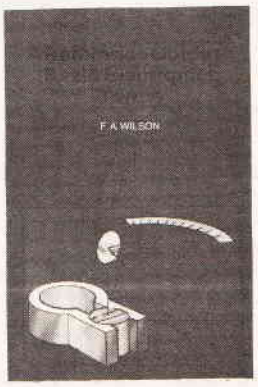

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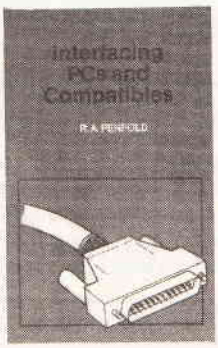

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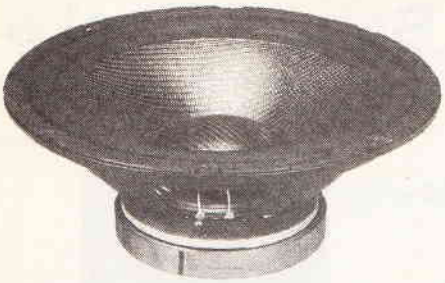

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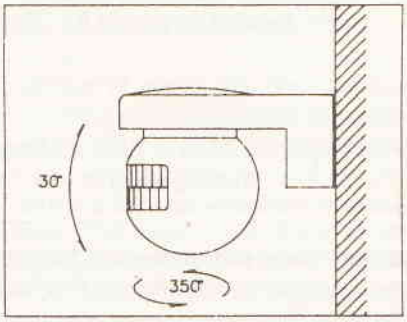
TRICOLOUR LED BARGAIN
F166T Chrome holder needs 10mm hole. LED has 3 leads – common, red and green, when used together produce yellow. These normally sell for around 80p each – Our special offer price **4 for £1.00;** 100+ 0.12; 1000+ 0.09



SECURITY SENSOR

BPW1 Outdoor light control motion sensor. This automatic sensor is powered from the mains and will handle up to 1000watts. It has 110° elliptical view field, 9 meters on each side and 12m forward. Automatic turn on and off of lights.

Features:

Security – instantly reacts to intruders by turning light on

Sensing motion, turns on/off lights automatically in daylight

Adjustable light sensitivity and shut off time

Manual override

Easy installation

For both incandescent and fluorescent lights.

Ideal for outdoor areas:

Front or back porch
Deck or patio
Secluded walkway
Garage and driveway
Cluttered areas

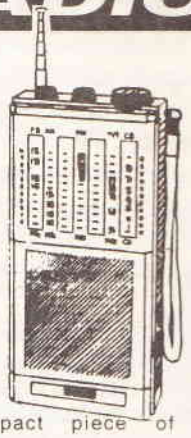
The globe shape makes adjustment exceptionally simple – just rotate to direction and angle required.. Overall size 110mmx100x75mm.
Price: £29.95 5+ 21.30

D90 TDK low noise high output cassette tape, normal bias **£1.20** 10+ 0.80

Goods sent in error

We have received a batch of leads which are not normally stocked - so we'd like to clear them at a Bargain Price!
Z5273 AV lead - 4 pin mini DIN plug both ends. 2m long **£1.95**

MULTIBAND RADIOS!

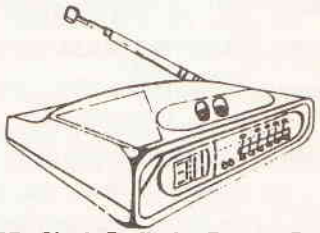


This compact piece of equipment 200 × 95 × 50mm comes in an attractive metallic grey case with controls on top - timing, on/off and volume. squelch. The telescopic aerial extends to 500mm and can be rotated in any direction. The 3 wavebands are:

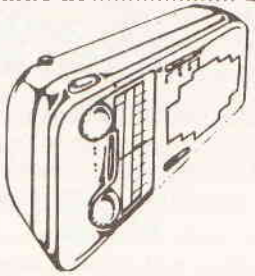
1) CB, channels, 1-80
2) TV1 54-87 MHz & FM 88-108 MHz
3) AIR 108-145 MHz & PB 145-176 MHz.

The large 3" full range speaker delivers 280mW of undistorted power. There is an earphone jack and DC adaptor jack. The unit is powered by 4 × AA cells. All this technology for just **£17.95**

Order Code **MB100**



Z4357 Clock Radio by Ross. Extremely neat unit measuring 140 × 80 × 35mm. MW/FM bands, telescopic aerial, stand, carrying pouch and strap. Clock has LCD display and can be used in 12 or 24 hr mode. Alarm. Light. Earphone socket. Takes 2 × AA cells.
Great value at **£13.95**



Z8891 Superb 4 waveband radio by Ross, model RR5. Covers FM 88-108MHz, MW 518-1610kHz, LW 150-275kHz SW 5.7-18.1MHz (16.5-52.6m). Nicely styled case measuring 210 × 145 × 70mm with clear scale markings. Telescopic aerial, headphone socket. Volume, tone and tuning controls. ON/ OFF switch/ waveband selector switch and AFC switch. Mains/ battery. (Takes 4 × C cells). Originally retailed at £19.95
Our Price **£14.95**

BARGAIN LIST 78

March 1992

Greenweld Electronics Ltd
27 Park Road
Southampton
SO1 3TB

Tel (0703) 236363
Fax (0703) 236307

The next few pages feature goods that have arrived recently - some are available only in small quantities, so don't delay, order today!!

Changes to Bargain Lists.

We're making a few improvements to our Bargain Lists to make them even more interesting reading!
Quite soon, you'll find included a few circuit ideas for the surplus parts we sell – maybe even a complete project or two. We know our customers' range of knowledge, ability and interests is extremely varied – from the novice who has problems identifying a resistor to eminently qualified experts engaged in design and research of leading edge technology – so we'll try and include a wide variety of ideas. Contributions are welcome, and any published will be paid for.
We're aware that some of our surplus comes without any information, and that this can be very frustrating, but the cost reflects this – the quantities involved are usually too small to justify chasing data. In future, those items that do include data will have a **'D'** suffix to the **Z** number: i.e. **Z8963D.** If the info runs to several pages, there will be a seperate charge quoted.
Data can be supplied seperately at 20p per item + SAE if not ordering any goods

SWITCHES

The parts listed below have come from a manufacturer of aids for the physically handicapped. There's a lot more hardware to sort out, but below is a selection from this parcel. As you would expect, there are quite a few switches and relays:

(a) Microswitches

Z2486 Burgess type V12K 41x14x18mm, short lever SPCO, probably 15A rating. 2 for £1.00.

Z2487 Honeywell heavy duty with brass screw terminals and brass threaded plunger. SPCO rated 15A 380V ac. **£1.50**

Z2488 Std 5A microswitch with roller lever on steel bracket with steel plunger. **£1.20**

Z2489 Std 5A microswitch with plastic assembly enabling operation by blowing down tube. **£1.50**

Z2490 2 std 5A microswitches on plastic bracket with lever arrangement. Operate each switch by blowing or sucking. **£3.50**

(b) Other Switches

Z2491 Single pole heavy duty push switch with screw terminals made by Burgess, type KB5-A2 **2 for £1.00;** 100+ 0.30

Z2492 The above switch mounted in a plstic box 49x54x18mm with plunger assembly **£1.60**

Z2493 Very large light action rocker switch, SPCO. Lever is 43mm square. Clip fix mounting. **£2.00**

Z2494 Celing switch with pull cord DP on/off rated 30A 250V ac. Red bezel, but no neon fitted. **£2.50**

Z5258 Air operated indicator(?) Plastic box 83x40x34mm with rocker type top. 2m length of twin tubing – and by blowing or sucking the rocker moves. **£2.50**

Z5259 Twin version of above **£3.50**

Z5260 AEG LS07 contactor rated 600V 16A. 4 pole and subsidary circuit **£3.50.**

Z2495 Small suppressor 28mm long x 12mm dia by LCR. Rated 250V ac **2 for £1.00**

Z2498 Unimax high quality illuminated push switch, DP contacts. Needs 16mm dia fixing hole and takes wedge lamps. Available with green **(Z2498G),** orange **(Z2498R)** or black **(Z2498B)** bezel. **£1.00**

Z8970 Lift control panel. Self contained metal box 265x90x60mm with fascia plate 292x100mm and 5 heavy duty double pole push switches fitted with 12V MBC lamps inside. **£15.00**

Z2387 PC mounting push switch – 1 pr make and 1 pr break contracts. Right angle plunger is 5mm long x 2mm dia. With protective cover. Again, very high quality. **2 for £1.00**

Z2499 Neat limit switch with lever and microswitch action, 1 pr make and 1 pr break contacts. 18.5 x 10 x 7.8mm. Lever is 30mm long. **4 for £1.00** 100+ 0.14 1000+ 0.10

Z2485 PCB mntg keyboard click switch, low profile, only 3.8mm thick. 10mm sq. SP make. **12 for £1;** 100+ 0.04

K591 Pack of 25 miniature toggle switches from page 125 of the 1991 catalogue **£4.00**

K592 Pack of 25 miniature rocker and lever switches from page 125 of the 1991 catalogue **£4.00**

K593 Pack of 25 push and slide switches from page 125 of the 1991 catalogue **£3.50**

FUSES

Thermal Fuse Offer

A job lot of thermal fuses allows us to offer these at much less than our normal selling price (60p each). Available in the following values:

Z2525 104°C short leads – 12.5mm long. **5 for £1.00** 100+ 0.10

Z2526 109°C full length leads. **3 for £1.00;** 100+ 0.15

Z2527 121°C one lead cut to 17mm. **4 for £1.00;** 100+ 0.12

Z2528 152°C full length leads **3 for £1.00;** 100+ 0.15

K834 Pack of 20 assorted thermal fuses (4 values), some with cropped leads. **£2.95**

Thermal circuit breakers. Voltage rating 32V dc, 250V ac. Right angle PCB mounting with manual off/reset button and aux contact. Size 20x6x10. DP 4.33
Z5191 2A rating **£1.00** 100+ 0.40
Z5192 3A rating **£1.00** 100+ 0.40

Z439 Wire ended fuse. 20mm 1.5A antisurge. **Pack of 20 £1.00**

Z2440 Miniature circuit breaker (MCB) rated 250V ac 1.5A. Size 51x40x19mm. Made by Heinemann. **Only £2.00**

Z2444 Protector 14A. This surge arrestor made by Beswickis designed to protect equipment from voltage surges. DP 5.27. Our prices: **£1.00 each,** 100+ 0.60, 1k+ 0.40

Z8962 8 way industrial fusebank, 32A 415V ac. Totally shrouded incoming terminal will accept conductors up to 120mm². DP(1987) 30.55. **Our clearance price £10.00**

HARDWARE

More Hardware - seems to be very popular, especially the smaller sizes for modelmakers. However, most of this lot is a bit on the large side - you don't really need M16 nuts to hold bit of veroboard in a case!!

K830 M8 screws/bolts. Good assortment from 16-90mm long c/s, hex, pozi, some hi-tensile. All steel! **Pack of 50** £3.80.

K831 M10 Bolts - mostly high tensile hex head , lengths from 16-90mm. **Pack of 20** £3.20

K832 M12 Bolts-mostly high tensile hex head, lengths from 40-150mm. **Pack of 10 £ 2.40**

K833 M6 pack. Excellent value - contains screws in various lengths and head. Mostly steel, some hi-tensile. **Pack of 100 £4.50**

K553 2BA screws - c/s, cheese, hex, pan heads, slot and pozi in lengths from 7-63mm. **Pack of 100 £2.60.**

Z7001 M16 Full nut-you really shouldn't be with out some of these! **Pack of 12 £1.00.**

Z7002 Threaded hoop overall length 490mm. Ends are threaded. M10 to a length of 75mm. They are 125 mm apart. **Pack of 3 for £1.00**

Z7003 M18 nut and hex bolt 30mm long. **3 pairs £1.00**

Z7004 M10 Masonry anchor. Drill 12.5 mm hole 40mm deep and insert. Use M10 screw to force anchor into brickwork. **Pack of 8 £1.00**

Z7005 Screw and nut pack- 1/4 " Whit: 25 each of 38mm C/S, 25mm C/S, 63mm (threaded 14mm) hex bolts and 25 mm (threaded 14mm) hex bolts +100 steel nuts. **Pack of 200 parts** £5.00

Z7006 Supertwin tufscrew, 8x1.25" combination pozi/straight pan head. Zinc plated. Great as woodscrews. **Boxes of 250 £3.00**

Z7007 M3 x 50 mm csk pozi steel screws. **Boxes of 250 £4**.00

Z9029 M4 x 50mm pan head pozi steel screws **50/£1.00; box of 200 £3.00**

Z9030 M6 x 50mm csk slot steel screws **16/£1.00; box of 100 £3.00**

Z9031 M8 x 60mm (23mm threaded hex head steel bolt **8/£1.00; box of 200 £12.00**

Z9032 M10 x 35mm hex head bolt HT steel **8/£1.00; box of 100 £6.00**

Z9033 M10 x 90mm hex head bolt HT steel **4/£1.00; box of 100 £12.00**

Z2373 M16 Full nuts, steel – **pack of 6 £1.00**

Z2374 M16 Half nuts, steel – **pack of 8 £1.00**

Z2371 5/16"x1" UNC hex head bolts. **A pack of 10 costs £1.00**

Z2372 3/8 x 1.25" set screws, hex head, **pack of 6 for £1.00**

Z2365 M6x16 Hex head set screws, pack of 25 for £1. **Box of 200 is £4.00**

Z2366 M6x1/4 as above. **Pack of 50 for £1.00**

Z2367 5/8" UNC half nut, **pack of 10 £1.00**

Z2368 5/8" UNC thin nut, **pack of 20 £1.50**

Z2369 1/4"x1.5" UNF hex head high tensile steel screws, **Pack of 25 for £1.50**. Box of 200, £8.50

Z2370 1/2"x1/2" as above, **pack of 10 for £2 or a box of 50 for £8**

K552 4BA Screw mix **200 £2.75**

K812 M6 Screw mix **100 for £2.50**

K596 Pack of 200 assorted nuts, believed to be all BA , from 2BA to 8BA. Mostly steel. **£2.40**

K595 Big mix of screws – very few BA, mostly metric, BSF, Whitworth, DZU etc. Tremendous variety of heads – cheese, cs, pan, hex, allan, round etc, etc. As for size, well we've seen some as small as 3mm and a few as long a s 80mm. There's even some 12.5mm dia in this pack! You'll probably also find a few odd clips, washers, nuts etc, too. 500gm pack **£2.70**

K812 Pack of 100 assorted rivets **£1.80**

K813 Pack of 100 self tapping screws, sizes 4–8, lengths to 20mm most with pozi head **£1.50**

Z2378 T03 Silicone impregnated insulated washers. **Pack of 25, £1.00**

Z5175 High quality heavy duty ball type castor 63mm dia, chromed steel with brass insert with 9.3mm threaded insert. DP 6.25 **Our price £4.00**

Z5176 Smaller brown ball type castor 50mm dia made by Kenrick. Stel insert with 8mm threaded insert. DP 3.15 **Our price £2.50**

Z2429 Black plastic foot 19mm dia x 5mm thick with 4.5mm dia hole. **Pack of 20 £1.00** 100+ .03

Z2375 High quality Sifam 1/4" collet knob S150, 15.5 dia x 14 high black knob, cap, and nut cover. **Pack of 10 of each £4.20**

Z5269 Olivetti cartridge ribbon - correctable carbon type 16.5mm wide x 120mm long, lexicart 90/92 Type No. 568N **£1.00 each**

Z5270 Black nylon ribbon type NCR 499 12.4 mm wide by Caribonum. Box of 4 **£2.00**

Z2502 Olivetti Summa Add ribbon. Twin spools, black **£1.00.**

Z23154 Nylon printer ribbon type N465, ref KSR430. Boxed. **£1.50**

NEWSLINE weekly update on new stock. Call 0891 505121 (48p per min. peak 34p off peak)

Z2437 Nylon stand off 2.5mm high. OD 5.8mm ID 3.2mm. **Pack of 1000 £3.00**

Z2438 White plastic oblong stand off (for 7 seg LED's) 19.5x10.2x12.2mm high. **Pack of 100 £2.00**

Z5261 Orange ABS case by boss, type 2002. 100x50x25mm. Threaded brass inserts and PC slots. 2 BIMdaptors included. DP 1.56. **Our price 80p**

Z9028 Strong compression spring 125mm long x 31mm dia. **£1.00**

Z2431 Compression spring 62mm long x 12 mm dia. **Pack of 6 £1.00**

Z5177 Self adhesive grey cable clip 38mm long. Will take up to 6mm dia cable. DP 3.48. **Pack of 20 £1.00** 10+ packs 0.60

Z2391 Cable gland in black nylon for 8–13mm dia cable. **Pack of 5 £1.50**

Z2392 As above best for 7–10.5mm cable. **Pack of 5 (DP 2.22) £1.20**

Z5152 Plastic Bits. 100 assorted stand offs etc. **£1.00**

Z635 Digital multimeter case DP2010, 110x80x20mm with cut outs for switches and terminals. Aluminium fascia plate. **2 for £1.00**

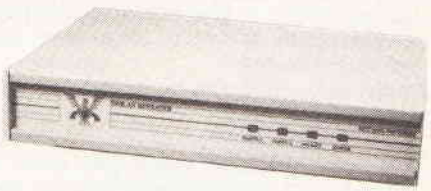
Z343 Ceramic insulating beads. **Pack of 100 £1.00**

Z1669 Veropins, wirewrap 18–0226. **Pack of 500 £2.00**

Z2443 TO3 heatsink – bolts on top of transistor using same fixing screws. Diecast ally 25x41x27mm. 7.3°C/W.DP 1.93. **Our price 75p**

Z2381 Small heatsink, 25 x 7 x 6mm, for sticking on top of DIL IC's. **Pack of 5 £1.00**

INSTRUMENT CASE



Z8969 Superb heavy duty steel instrument case finished in light grey 426x290x78mm with 4 plastic screw on feet. This was an Isolan repeater for use on a data network, and although the contents have been removed (before being used), the front and back panel remain, the former having 4 oblong red LED's and the latter a fused, suppressed IEC mains inlet, on/off DP rocker switch and 2 x 15 way D sockets joined to 16 way IDC skts with a short length of ribbon cable. Ther's a 60mm circular cut-out for a speaker on one side and mounting pillars in the base. Just look around and see the price this type of high quality case normally costs! – somewhere around the £30–£40 mark – then compare it to our low, low price – **just £9.95**

SEMICONDUCTORS

MICROPROCESSOR CHIPS

P8035AHL Intel 8 bit CPU, 11MHz **Our Price £3.00**

8051AH Phillips 8 bit CPU **Our Price £1.00**

M80C31F OKI 8 bit CPU 16MHz **Our Price £2.00**

N8097-90 Intel 16 bit H-MOS CPU 12MHz PLCC 68 pin. DP 13.86. **Our Price £6.00**

R80C186-12 Intel 16 bit CMOS CPU. 12MHz clock. PLCC 64 pin. DP 28.37 **Our Price £12.00**

CP82C59A CMOS programmable interrupt controller. DP 3.00 **Our Price £1.50**

P8256AH UART. DP 7.00 **Our Price £2.50**

Z2507 L4962 1.5A switching regulator, 16DIL. 5.1-40V. DP 2.50 **Our Price £1.50**

Z2513 L4960 2.5A switching regulator, 7 pin TO220. 5.1-40V. DP 2.64 **Our Price £1.80**

Z2508 LF13331 quad SPST J-FET analogue switch. 16DIL. DP 7.58 **Our Price £3.00**

Z2509 OPA27 low noise precision op-amp 8DIL. DP 1.86 **Our Price £1.00**

Z2510 SL670C gain controlled pre-amp. 8DIL DP 2.31 **Our Price £1.50**

Z2511 TCA785 16DIL chip by Siemens **£1.50**

Z2512 LF398N sample and hold amp 8DIL. DP 2.64 **Our Price £1.50**

Z2514 ZTX751 PNP TO92 transistor rated 80V, 2A, 1W. DP 0.48 **Our Price 5 for £1.00;** 100+ 0.14; 1k+ 0.10

Z2524 2N3703 PNP TO92 transistor rated 50V 0.2A 360mW. Our normal price is 12p. Surplus stock offered at **15 for £1.00;** 100+ 0.04; 1k+ 0.025

Few SGS Chips:
Z2481 M491BB1 List 11.10. **Our price £4.50**
Z2482 M293B1 List 7.40. **Our price £3.00**
and an ITT chip:
Z2483 SAA1293-02 List 7.64. **Our price £3.00**

Z2484 2N3903 TO92 transistor. **12 for £1.00;** 100+ 0.04

Z2112 Ceramic filter 5.5MHz by Murata. **5 for £1.00**

Z2515 VN2410L TO92 N-channel MOSFET. 1A 0.4W. DP 1.08 **Our Price 3 for £1.00;** 100+ 0.18; 1k+ 0.14

Z2516 AD517JH TO99 converter **£3.00**

Z2517 LM350K steel variable voltage regulator, 1.2 to 33V at 3A. DP 7.20 **Our Price £3.50**

Z2523 TICP106D TO92 SCR rated 400V 100mA. DP 0.56. **Our Price 6 for £1.00;** 100+ 0.09; 1k+ 0.06

Z2518 BYT13-1000 fast recovery diode rated 3A 1000V. Plastic body, axial leads. DP 0.35 **Our Price 5 for £1.00;** 100+0.13; 1k+ 0.09

Z2519 AD667JN 28DIL D/A converter, 12 bit uP compatible. Extremely flexible. DP £28.18 **Our Price £10.00**

Z2520 SN75372 8 pin dual MOSFET driver. DP 1.74 **Our Price £1.00**

Z2521 Crystal, HC60 20.000MHz. **Only 50p** 100+ 0.25

Z2522 Watch crystal 32.768kHz, case 2.7mm dia x 8mm. **Pack of 3 £1.00** 100+ 0.15

OPTO

Z2498 Toshiba TLC501 LCD. 24 x 2 line display with standard connexions (supplied). V. similar to our **Z2171 £9.95**

A couple of small matching rectangular LED's, 3.8 x 1.75 mm :
Z2500 Green **Pack of 12 £1** 100+ .05 1k+ .04
Z2501 Red **Pack of 12 £1** 100+ .05 1k+ .04

Z2505 HCPL2531 dual optocoupler, 7% CTR. DP 3.52 **Our Price £1.00**

Z2506 HCPL2630 dual optically coupled high speed logic gate. DP 5.24 **Our price £2.00**

Z1935 LED clip for right angle mounting to PC board. Plastic holder for 5mm LED has 2.3mm dia spigot. Great value at **40 for £1.00;** 1000+ 0.015

PANELS

Z5264 Handy black plastic panel 102 x 22mm with 5 pin 180° DIN skt, 2 phono skts and a single wire aerial/earth socket. Pack of 10 £1.00 100+ 0.05 1K+ 0.035

Z5263 Panel 80x60mm with FPT100A phototransistor, LM324 quad op amp, 24v SPCO heavy duty relay, BC546, diodes, R's and C 's, Smashing little board - **only £1.00**

Z5262 Panel in the Z5089 etc. series as listed in main Bargain List. This one has 8 x 2764 in sockets + 10 74LS chips. **Only £4.00**

Z2529 Thick film circuit - small PCB 51x12mm with 13 surface mount transistors. R's are etched into substrate. **Pack of 5 £1.00**

Z4252 Seat belt alarm kit. Just a few of these remaining at **£3 each**

Z5271 Some more Currah Microspeech returns, for the Spectrum. No tape or handbook, sold for spare parts only. The 67 x 65 x 18 mm case has a 28w edge socket, phono lead, 3.5 mm jack plug lead and phono socket. Inside is 78M05 reg, SP0256 speech chip and 2 support chips, trimming cap. transistor etc **Only £1.50 each to clear.**

Z5272 PCB 71x64 with SP0256 speech chip , 2 support chips and few other bits and 5 pin DIN plug. 22way edge connecter. These are returns and may be faulty - **but they** are only 50p each!!

SOFTWARE

COMMS SOFTWARE
A few odds and ends delivered with a parcel. As far as we can see, all are new and complete as described below:

Z6003 Multicom - handbook + 5.25" disk for Epson QX10/4.1A

Z6004 Multicom - handbook + 3,5" disk for Apricot PC/XI 4.24

Z6005 Multicom + handbook + 3.5" disk version 4.16

Z6006 Vicom - handbook + 5.25" disk for Apple

Z6007 Sage Chit-Chat - Handbook + 3.5" disk for Apricot V2.2

Z6008 Dial-Up Educational - handbook + 5.25" disk + dongle for RML480Z

Z6010 Dial-Up Educational - handbook + 5.25" disk for RML Nimbus

Z6011 Dial-Up Personal - handbook + 5.25" 80 track disk for BBC B, B+ & Master

Z6013 Dial up Personal - handbook + 3" disk for Amstrad PCW

All the above are at the same price - now reduced to just **£10.00 each** - please give 2nd/3rd choice as numbers are very limited.

Z4266 Software tape for Spectrum - "Mountains of Ket". Returns - may not work. **4 for £1.00**

SOUNDERS

Z2376 Sub-min buzzer 12 dia x 8mm high. PC mounting by Star QMB111P. **Only £1.00**

Z2377 Star CMB 6V buzzer 22.5 x 15.8 x 14.4 mm. PCB mounting. High quality, low cost - **only £1.00**

Z1771 Sounder QMB06 by Star. **3 for £1.00**

CONNECTORS

Z042 2 pin DIN speaker sockets, PC mntg. **Pack of 25 £1.20**

Z4350 A set of 3 different pairs of test leads, offering great value! – a) 67mm long, 2mm probes both ends; b) 110mm long, 2mm probes one end, 4mm plugs the other; and c) 90mm long silicon rubber, 2mm probes one end, shrouded 3mm sockets the other. All are red and black pairs. **All three for just £2.00**

Z739 40 way DIL header plug, gold plated. **3 for £1.00**

Z1485 RC4200-8S 8 way gold plated socket – matches McMurdo red range, but blue **£1.50**

Edge Connectors

Z1828 31 way double sided 0.1" pitch gold plated PC mntg **£1.00**

Z1668 38 way single sided 0.1" pitch solder tags. **40p**`

Z5117 19 way single sided 0.1" pitch – takes flexible wiring and locks into place. Sample free. **20/£1.00**; 100+ 0.03; 1k+ 0.02

Z2504 PS2 Keyboard adaptor 6 pin mini -DIN plug to 5 pin 180° socket. Carded. **£2.00**

Z2504 Useful battery holder - 3AA side by side with lead and attached. Supplied with double sided sticky pad. Bagged. **25p**

Z5265 9 way ribbon cable just under 1m long with 10 pin DIL plug (0.1 pitch) one end and 9 way header skt the other. Pack of 10 leads £2.00

SURFACE MOUNT

SURFACE MOUNT SURPRISE !!

A parcel of 650,000 devices has been purchased and reveals a wide selection of mainly transistors and resistors. We're selling this in a variety of packs as described below :

KS102 Transistors – about a dozen different types plus a few diodes, mostly SOT23. Type numbers include BCF29/30, BSR15, BC856, BCV71, BCW29/71/72/81. Supplied with code sheet. **Pack of 100 for £3.00**

KS103 Resistors. 0.125W 2% in a range of values from 3R3 to 10M. Although there is a fair range (about 50 values), many are E24. **Pack of 1000 for £3.00.**

ALSO AVAILABLE INDIVIDUALLY ARE THE FOLLOWING PARTS:

Type	Mark	P/N	Equiv	Vceo	Ic	£1 pk	100+	1k+
BC856	3AR	P	BC556			15	.03	.02
BCF29R	C77					15	.03	.02
BCF30R	C9	P	BC559			12	.04	.03
BCV71	K7	N	BC546A	60	0.1	15	.03	.02
BCW29R	C4,	P	BC558A	20	0.1	15	.03	.02
BCW71R	K1,4	N	BC547A	45	0.1	15	.03	.02
BCW72R	K5	N	BC547B			15	.03	.02
BCW81R	K31	N	BC547C			15	.03	.02
BSR15R	T71	P	2N2907			12	.04	.03

(b) Diodes
BZX84 – C18V(Y6) 18V 350mW zener. **Pack of 10 for £1.00.** 100+ .05 1k+ .03

RESISTORS

Z320 1 Watt wirewound pots – 2 additional values, 250R and 1k.

Z761 0R056 wirewound resistors 10% type HWR21. 0.5W **10 for £1.00**

Z1983 Thermistor, pack of 20, type VA1040. **£2.00**

Z414 30M 10% resistors. **Pack of 10 £1.00** 100+ .06

K446 Bourns mini cermet trimpot type 3362. 200R. **3 for £1.00**

SIL networks in original packing. 9 pin, 8 resistors. DP 38p. Available in these values, all the same price: **Pack of 10 £1.00;** 100+ .05; 1k + .04

Z5195 330R
Z5196 10k
Z5197 47k

Z2394 TO5 case cermet trimpots type 81E. Value 50R. **Pack of 6 £1.00.** Plastic case of 50 £4.00. 10+ cases £3.00

Z2359 miniature pot 17mm diameter with 6.75mm bush and splined spindle, PC mounting. 1k lin. **Pack of 4 for £1.00.**

Z2388 Plastic stand-off for 3/4" trimpots (our 75CER type) **Pack of 50 £1.00**

Z5208 PR52 2.5W wirewound resistors, 10k. **In boxes of 500 £5.00**

Z5209 As above but 1k2. **Box of 500 £5.00**

Some more Diplohmatic trimmers, to go with those on page 35 of B/L75

Type156 (like 146)
Values available:
200R 500R 10k 20k 50k 100k 500k 2M
Prices (any mix) 1+ 56p 100+ 0.28

Type 382
Value available: 500R
Price 1+ 44p 100+ 0.22


382

Type 386: (like 383)
Values available:
1k 10k 50k 100k
Prices: 1+ 44p 100+ 0.22


386

POWER SUPPLY CAPACITORS

Incredible value - these two jumbo electrolytics are offered at a fraction of their normal price!! Screw top cans made by Siemens, type B41455

Z5146 10,000µF 100V 105x64mm dia **£4.00; Box of 20 £60.00;** 100+ 2.00; 1k+ 1.70

Z5147 4700µF 100V 105x51mm dia **£3.00; Box of 35 £70.00;** 100+ 1.50; 1k+ 1.20

Z2447 Siemens dual thermistor type P6350. **Pack of 10 £1.00** 100+ 0.05

STOP PRESS -STOP PRESS-STOP PRESS-STOP PRESS-STOP PRESS

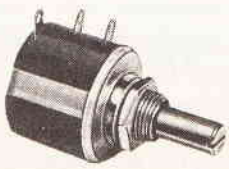
Z5292D 'Power one' power supply. Conventional unit, 120/240V input, output 15V @ 1.5A fully stabilized. Part enclosed size 123x102x54mm. Comprehensive data supplied **£10.00**

Z5293D 'Power One' power supply. Conventional unit, 120/240V input, outputs +5V @ 2A; + or –12V @ 0.4A; –5V @ 0.4A. Each output uses a 723 regulator and has a preset for adjusting voltage. With data **£14.50**

Z5289 Push button bank – 11 switches, all DPCO interlocking. **£1.00**

Z5290 Push button bank – 6 switches, 4 interlocking DPCO and a further 2 DPCO interlocking **60p**

Z5291 Push button bank – 6 switches, 4 interlocking DPCO and a a further 2, one non-locking DPCO, the other locking 4 pole changeover. **60p**



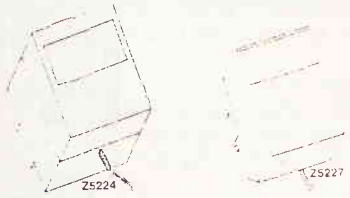
Z2530 Precision helical pot by Spectrol, model 534. 3Watt 10 turn, linearity ±0.25%. Value 100R ±5%. DP 4.23 Our Price **£1.00**

THE POW-POW-POWER PAGE!!!

Some great value power supplies - both conventional and switched mode - all offered at a fraction of their original cost!!

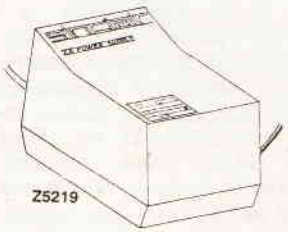
Z5278 Plug in wall type, 24V ac 100mA output on 2m lead. **£1.75** 100+ 1.10

Z5279 Plug in wall type switchable non-regulated 3-6-9V 100mA. Comes complete with multiway reversible spider lead (worth 99p on it's own!). **Special Price £2.00** 100+ 1.25



Z5224 Jupiter Ace mains adaptor (there's a bit of history!) plug in type 240V, output 9V 800mA on 2m lead with 3.5mm plug. **£3.20**

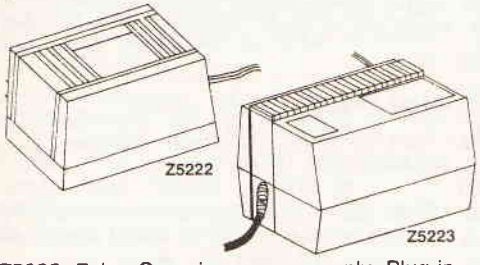
Z5227 Plug in 240V ac Beautronix power supply. Output 9V 333mA on 2m lead with 2.5 power socket. **£2.00**



Z5219 Sinclair ZX powers supply model UK700. 240V ac in, 9V 0.7A DC out. 2 core mains lead. 3.5mm jack lead output. **£2.50**

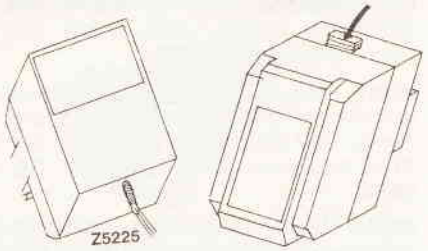
Z5220 Sinclair ZX powers supply model Euro1200. 220V ac in, 9V 1.2A DC out. 2 core mains lead. 3.5mm jack lead output. **£3.00**

Z5221 Sinclair ZX powers supply model Euro1400. 220V ac in, 9V 1.4A DC out. 2 core mains lead with 2 pin Euro plug. 2.1mm power socket lead output. **£3.50**



Z5222 Psion Organiser power supply. Plug in type, 220/240V ac . Output 10.4V 175mA on 2m lead with 2.5 po wer plug **£2.00**

Z5223 Psion printer power supply, input 220/240V ac via lead and 2 pin Euro plug. 10.4V 600mA DC output on 2m lead with 2.5mm power plug. **£3.00**

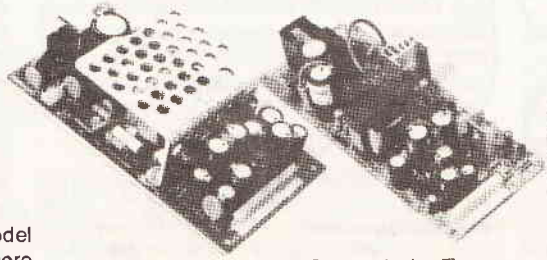


Z5225 Universal mains adaptor, plug in type 240V ac. Output switchable 3-6-9V @ 300mA on end of short lead with 2 pin socket **£2.00**

Z5226 Plug in 240V ac unlabelled power supply with short lead and 5 pin DIN socket. Outputs: 18V @ 250mA ac and 10V @ 500mA ac. **£3.00**

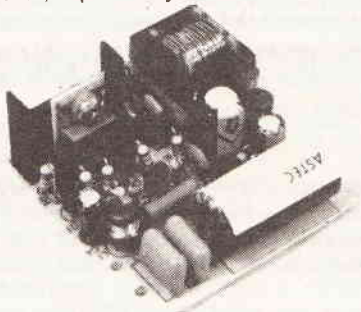
Z5276 Plug-in-wall power supply with 2m lead fitted with 2.5mm power socket. Output 12V 0.2A DC. Fitted with thermal fuse. **£2.00**

SWITCH MODE PSU's



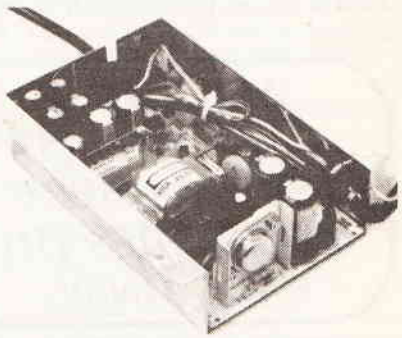
Z5256 Switch mode PSU made by Tamura Corporation. Board 195x100mm with outputs on PCB pins. Input 120/240V ac; Outputs: +5V @ 7.5A; +12V @ 1.25A (2A peak); -12V @ 0.1A. **All this for just £12.95**

Z5257 Switch mode PSU on PCB 190x78mm. 120/240V ac input. Outputs: +5V @ 3A; +12V @ 1.2A; -12V @ 0.1A. Made by Tamradio, Japan. **Only £7.95**



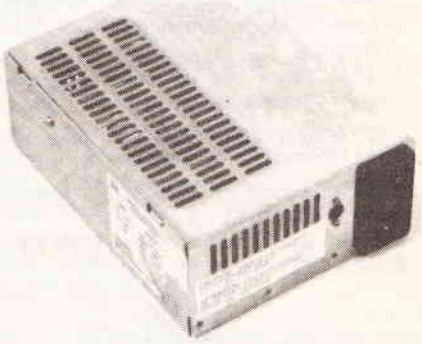
Z660 Astec switched mode PSU type AA7271. This small PCB, just 50 × 50mm will accept 8-24V input and give a stable 5V dc at up to 2A output. The 6 transistor circuit provides current overload protection, thermal cut-out and excellent filtering. Offered at a remarkably low price.
Price **£5.00**

Z5280 Neat switch mode PSU on panel 120x100mm and only 32mm high. Mains input via skt supplied, 3 outputs on socket are +5V @ 2A; +12V @ 0.3A; -12V @ 0.2A. These have been removed from equipment, but are clean and in full working order. **£7.50**



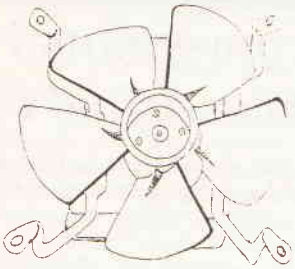
AA12531 Switch mode PSU by Astec partially cased. 160x104x45mm overall with 160x100mm Eurocard PCB. Inputs and outputs are on colour coded flying leads. Input 115/230V 50/60Hz. Outputs: +5V @ 5A; +12V @ 0.15A. Total wattage 50W.
£6.95; 25+ 5.43; 100+ 4.53

Conversion Kit
K725 This kit converts the AA12531 PSU into a much more versatile supply, giving +5V @ 2.5A; +12V @2A; -12V @ 0.1A and -5V @ 0.55A. Complete set of parts and full instructions **£3.50** Instructions only **(K726) £1.00**



BM41012 Superb switch mode PSU made by Astec. Enclosed case 175x136x65mm with switched and fused IEC mains inlet. 160x80mm PCB with output pins extended to external connector. Input 115/230V 50/60Hz. Outputs: +5V @ 3.75A; +12V @ 1.5A; -12V @ 0.4A. Total wattage 65W
£14.95; 25+ 11.70; 100+ 9.75

MOTORS



Z5171 Open construction mains fan. Five blade plastic blade 110mm dia (easily removable). Ex-equip in good condition, **£2.50.**

Z5246 Mains synchronous motor with easily accessible gearbox giving a final speed to the 5.5mm dia 12 toothed gearwheel of 0.2RPM (12 revs per hour). **Only £3.95;** 100+ 2.50

ARE YOU A BARGAIN LIST SUBSCRIBER? DON'T MISS THE BARGAINS!!

CAPACITORS

Z5218 22,000μF 16V electrolytic can 35mm dia x 102mm long. Tag ends. Silly price – **only £1.00 each**

K265 4700uF 40V Phillips can, PC mntg 47x35 dia. **2 for £1.00**

Z5180 1000uF 10V radial electrolytic by Nippon 13 dia x 25mm. **Pack of 10 £1.00** 100+ 0.05

Z5181 330uF 16V radial electrolytic by ITT. 13dia x 21mm. **Pack of 14 £1.00** 100+ 0.035

Z5274 40 μF 2.5kV capacitor by Bosch. Size 155x100mm dia. Superb quality **£3.50.**

Z1529 0.22uF ceramic cap. 5mm pitch. **Pack of 30 £1.00**

Z1965 0.01uF disc ceramic 6mm dia. **Pack of 40 £1.00**

Solid dielectric trimmer caps in 3 values, all PC mounting:

Z2454 5.5pF Phillips 808 series, polyethylene film DP 36p **8 for £1.00**; 100+ 0.06

Z2455 10pF Phillips 809.05 series PTFE film. DP 1.66 **3 for £1.00;** 100+ 0.15

Z2456 18pF As above, **3 for £1.00;** 100+ 0.15

PANELS

Z5203 Relay panel – some panel, this! 50, yes 50 DPCO 24V DC min relays, Omron type G2V (our type W834) on PCB 230x160mm with 2xDIN41612 64 way plugs. At 1 off prices, this would cost around £100, but you can have a complete panel at just 20p per relay – **that's only £10.00!**

Z5217 Relay panel – Eurocard 160x100mm with 64 pin DIN41612 plug, containing 8 x Omron G2V 24V min DPCO, LS00, 125 and 14 all in sockets, 4 red LED's, R's, C's, etc. **£2.00**

Z5244 Mosfet panel: 56 x VN0808M (DP 1.01 each!) 80V N-channel 1W 2A device in TO237 case + 28 x ILCT6 8 pin opto isolators, also 30+ CMOS, 74SC etc; 26 SIL networks, 56 0.1uF caps and a few other odd bits. **Super value – only £7.50**

Z5231 Memory panel, contains 208 4164 64k RAM chips all in sockets. **£30.00**

Z5232 As above, but chips are soldered in. **£20.00**

Along with the panels **Z5231/2** mentioned on page 12 (which are here now) there are a great many packed with hi-tech chips – not just 74LS, but Z80 and other processor chips, EPROM's etc. The boards are 430x320mm and mostly contain over 250 chips, date coded '84. **Order Code Z8967** – clearing at **£5 per panel** – but to get a good mix, you'll need 2 or 3 boards.

More GEC Cablevision units – these were the rack mounted distribution panels. 2 types available as below:

Z5204 Diecast housing 252x140x25mm (subscriber module) contains PCB with lots of nice high frequency bits, much of which is containedwithin 2 diecast boxes bolted on to the board. Most of the transistors (there are 17 of them) are BF980, BFR90A/91A BFW92 etc. Single output socket, 2 DIN41612 plugs. **Great value at £4.50**

Z5205 Larger diecast housing 252x140x57mm with 2 PCB's each containing a number of HF parts, pot cores, crystals, etc. These are input modules – 1 traffic and 1 data panel **£4.40**

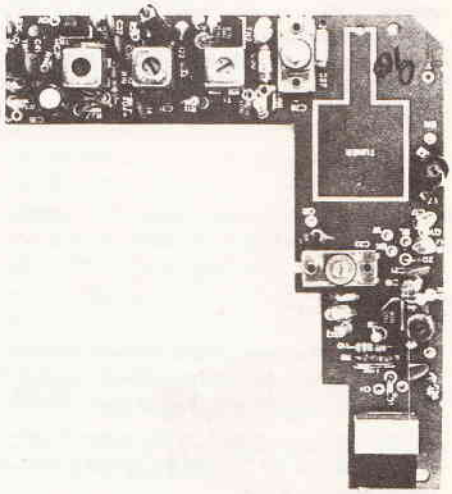
Z4295 Although listed in our main Bargain List, we have large stocks of this panel, and it's not selling very quickly – although it contains a number of interesting and useful parts. There's a 27C64 Eprom in a socket, 80C85A microprocessor, 2x82C51A support chips + 5864 RAM, as well as 8x74HCT chips. There's a small length of ribbon cable to a small sub-panel with 2xMC1488 and 1489, and 3 DIL header plugs. These error correction cards by Tulsedata originally cost over £70 each – they were in last year's catalogue at £10, reduced this year to £5. Will you buy them at **£2.50?**

Z1641 PCB. Printer driver board by Teijin. Contains M5L8041A, 8x74 series, 3.579545MHz xtal etc **£2.00**

Z5167 'S' module-like Z492/3. 11 pin plug in module 80x50x50mm with a small PCB inside containing 2xBC184L, R's, C's, etc. **4 for £1**

Z5210 Power supply panel – PCB 150x65mm that has been partially assembled but nit soldered. Contains 79M05, 741, BDX339, FRC730, 4x1N4001, 10,000uF 10V cap + R's, C@s etc. (No transformer) **Only £1.00**

Z5211 Another smaller PSU panel 97x55mm, again not soldered. Each board contains 9x1N4001, 121C thermal fuse etc. **8 panels (72 rects) for just £1.00**



Z911 Found some more of this useful 135x135 L shaped panel – nearly a complete radio front end. Although the tuning cap is missing, there are 2 trimmers, IFT's, lots of R's and C's, 2xBF241 FET, BF194, BC208A, 2xBC148C, 2xBC149C etc. Best of all, the board hasn't been soldered, so the components are easily removeable. All this for just **£1.00**

OPTO

Z2434 Dual 7 seg LED , type TDDR5250 by TFK. Red common anode 13mm digit height. DP 1.14. Our special low price (we have 10000 to clear) **2 for £1.00;** 100+ 0.25; 1k+0.18

Z2435 Single 7 seg LED 10mm high digit. Type LN514RK. Common cathode. **4 for £1.00;** 100+ 0.15; 1k+ 0.10

Z2362 MS463M 0.6" common cathode 4 digit multiplexed display on PCB 70x30 with 15 way connector. Intended for digital clock use. Supplied with pin out. **ONLY £1.50**

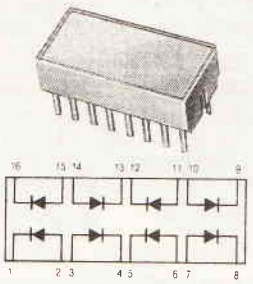
2 more LCD's in small quantities, both fitted with pins:

Z2357 6 digit 0.5" 50 pin device **£2**
Z2358 2 digit 0.5" 18 pin device **£1**

Z2432 LCD 8 digit 10mm high. Single sided 36 way edge connector. **Only £2.00** 100+ 1.00 1k+ 0.80

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

LED BAR MODULES

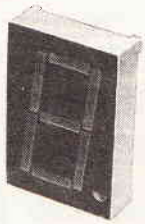


A couple of large LED light bars in 16 DIL package, 10mm high. Made by HP.

Z2462 HLMP2685 HE red 80mcd @ 20mA. DP 2.19. **Our price £1.00;** 20+ 0.70

Z2463 HLMP2785 Yellow 70mcd @ 20mA. DP 2.19. **Our price £1.00;** 20+ 0.70

Using these, you could build up a massive 7 seg display – each module being 1 element. (In practise, to maintain proportions, you'll need 10 displays for each 70mm high digit – details on request)



Z1854 7 seg LED 81720R – giant 1" digit, red. Common anode. **£1.00 each**
Z1855 As above but common cathode **£1.00**

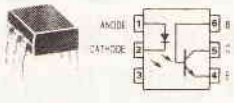
Z1857 Single 7 seg LED LA6480, matches above – green 0.56" **4 for £1.00**
Z1858 7 seg LED LA301MA green 0.3", CA. **4 for £1.00**
Z1859 7 seg LED LA301MK green 0.3" CK **4 for £1.00**

Z2436 3mm red LED's with preformed cropped leads 7.5mm long. Super buy for quantity user – **pack of 100 £3.00** 1000+ 0.02

Z2461 PC mntg packaged red LED – mounts at right angles to PCB. 10.5x8x3.9mm. LED is 3mm. Ore type 9301A. **Pack of 10 £1.00** 100+ 0.05; 1k+ 0.04

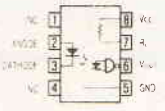
Z1934 Stackable red LED – white casing round 6x3.5mm. **Pack of 10 for £1.00**

Z1932 Red square LED with rounded corners, 5mm. Pack of 15 **for £1.00**
Z1933 Thin rect. red LED – 5x1.5mm. **Pack of 20 £1.00**



Transistor

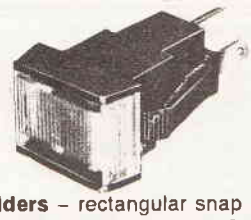
Z2467 4N25 optocoupler – transistor output. DP 0.80. **Our price 3 for £1.00**
Z2469 CNY17-1B optocoupler, transistor output 6DIL. DP 0.67. **3 for £1.00**



HCPL2300

Z2470 HCPL2300 optocoupler by HP. Logic gate output. DP is astaggering 6.33 – **our price £2.00**

Z2466 ILQ1 16 pin DIL device, probably quad opto isolator, but no info. **2 for £1.00**



Lampholders – rectangular snap in type that take LES bulb. Needs 16.1x11.6mm cut-out. DP (1978) 92p
Z5193 Red **3/£1.00** 100+0.15
Z5194 Green **3/£1.00** 100+ 0.15
Z2385 6V 5W SBC bulb. **Box of 10, £1.50**

Z2459 Neon bulbs 5.5mm dia x 15mm long – wire ended 90V neons at a great saving over normal prices! Made by VCH International. **In packs of 100 at £4.00** 10+ 3.00

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Fibre Optic Cable

Z5245 Fibre optic cable, multistrand sheathed, 2.28mm od, 0.095mm sq. Type A181. **Approx 5m length £4.00**

Z2476 Similar to above, but 3.6mm od. **£2/metre**

Z2477 Single strand 1mm dia. **Approx 5m length £2.00**

Z2478 Single strand 0.2mm dia. Approx 10m (may not be in one length) **£2.00**

SEMICONDUCTORS

(a) Diodes

Z2439 BZY88C36. 36V 400mW zener diodes. **Pack of 100 £2.00.** 1000 £10.00
Z2465 Dual fast recovery diode BYW51-150A 150V 20A. TO220 case. DP 0.99. **Our price 2 for £1.00**
K129 8 AA113 diodes **£1.00**
K197 50 AA139 diodes preformed for horiz. mntg **£1.00**
K237 200 SD3 diodes, 2 joined back-to-back, preformed **£1.00**
K242 10 S2AR2 rects, 200V 1A **£1.00**
K283 100 1N922 silicon diodes preformed **£1.00**
K285 25 CV8790 signal diodes **£1.00**
K286 10 Germanium signal diode **£1.00**

Z2454 MPS5010 1.2V voltage ref, 2 pin TO92. **3 for £1.00** 100+ 0.15

Bridge Rectifier Clearance

Z2347 4A 200V in line **6 for £1.** 100+.09 1k+.06

(b) Transistors

Z2383 2N6027 P.U.T DP 49p, Our price **6 for £1.00** ;100+.08 1k+ .05

Z2384 MPSA13 3OV Darlington TO92 transistor. Hfe 10,000 @ 0.1A DP 32p. **Pack of 8 for £1.00.** 100+ .06 1k+ .04

Z2453 TIPL762 NPN 6A 120W 350V transistor. DP 4.02 **£2.00**
K448 12 MPSA92 **£1.00**
K449 20 BC258A **£1.00**
K447 10 BF419 **£1.00**

(c) Voltage Regs

Z2460 78M12 500mA 12V voltage regulator at a super price – **6 for £1.00** 100+ 0.09 1k+ 0.06
Z2455 7805 riveted to small ally heatsink (unused) **5 for £1.00**
Z950 LAS1510 voltage regulator. 10V 1.5A TO3 case. **2 for £1.00**

(d) Digital IC's

Z2452 74HCT164 **4 for £1.00**

(e) Linear IC's

Z2456 CA3161E BCD-7 seg decoder driver, with pin out **£1.00**
Z2457 CA3162E A-D converter, 3 digit display, with data. **£2.50**
Z4160 TDA1035. Versatile audio amp chip, with IF amp and demodulator. Electronic volume control. Max output 4 watts into 8R. Supplied with cct and data. **Only £1.00**

LOW COST SOUND CHIPS

A new range of sound effect chips is now being stocked. Supplied with typical circuit.
UM34811A Melody generator **£1.20** 100+ 0.75
UM3562 3 gun sound generator **75p** 100+ 0.38
UM66 3 Christmas carol medley **75p** 100+ 0.38

Z2471 SN75372 interface chip **50p**

Z2472 LF398N sample and hold amp. 8DIL DP 3.94 **Only £2.00**

Z2473 OP27 low noise precision op amp. 8DIL. DP 1.70. **Only £1.00**

Z722 TDA2653A vertical deflection chip. 13 lead SIL package, with comprehensive data **£1.00**

(f) Crystals

Z2464 8.000MHz crystal HC16 case **50p**

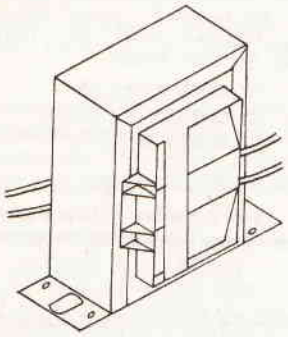
Data sheets giving pin-outs and brief spec are available on all above items at 10p each

PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

TRANSFORMERS

Z5207 Torroidal transformer rated 75VA. Mains primary, 3 secondaries: 7V @ 7A, 8V @ 1.5A, 14V @ 1.5A. Useful voltages at a low price – **£4.50**

Z5202 Torroidal transformer. This is the same series as our Z4290 type by Belclere – 75mm dia x 33mm thick. Fixing by means of a tapped bush. Mains primary, secondary 14–7.5–0–7.5–14V @ 1.25A **Excellent value at £2.95 each** 100+ 1.50



Z5206 Super transformer for railway and other modellers. Mains primary, secondary 16V 3A. Size 50x55x60mm high. 61mm FC. Great value for money, **only £3.00** 100+2.00 1k+1.50

Some new mains transformers, ideally suited for PSU's:

Z5212 21V 1A Clamp, wires 60x45x50mm **£1.50**

Z5214 11V 0.5A PC mntg 53x40x4 4mm **£1.00**
Z5215 15V 0.25A PC mntg 43x33x3 6mm **75p**

All the following are mains transformers, and have secondaries as shown. Current rating is estimated from size of transformer.

Z5233 17V 1A 56x67x53mm **£1.50**
Z5234 14V 0.5A 45x54x41mm **£1.00**
Z5235 9V + 10.5V 15VA max. 56x67x50mm **£2.00**
Z5236 21V 500mA 50x60x45mm **£1.50**

Z568 Transformer, large auto rated 8.3A **£12.00**

Z8971 Transformer rated 100VA – 0–120, 0–120V primary and 0–20, 0–20V secondary (5A total). Size 89x75x68mm. DP 19.06. Our price **£9.50**

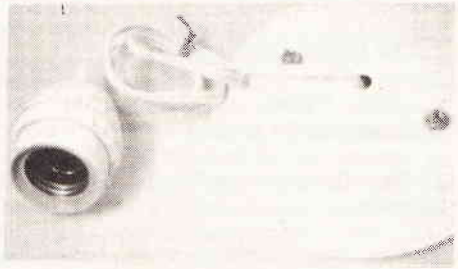
Z8972 Transformer rated 100VA by Majestic, 0–240V pri, 25V 4A sec. 100x85x70mm. **£6.50**

Z1773 DC–DC Converter – 5V in, 15–0–15V 10–34mA (1W) Size 34x26x10. **Only £3.00**

FINISHED GOODS

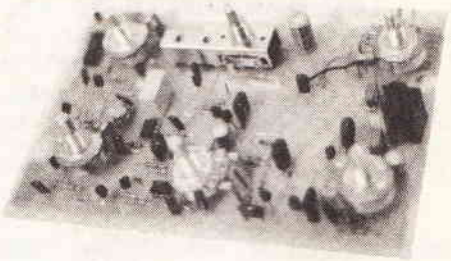
Z5285 Oscillator /amplifier type RT5001 by GEC, housed in an aluminium and bakelite case 180x52x50mm. The PCB has on it a small transformer, 3x100µF 16V tant bead caps, 2xBCY40 etc. **Only £1.50**

Z5287 Here's an oldie – we had a batch of these some time ago – the "Tyrometer" – used to indicate tyre pressures on HGV's, this is the pod that fitted into the drivers cab. On the front panel are two small push and a toggle switch. Inside is a PCB with 11 miniature wire ended bulbs, a choke, 2 caps and a buzzer. There's a short length of 14 way ribbon cable, too. **£3.95**



Z5268 Boxed suspension cord set. White painted steel domed ceiling plate 137mm dia with 0.5m twin lead terminated to ES plastic hanging socket, also white. (250V 500W max rating). **£2.50** 25+ 1.75

Z2109 Dynamic microphone with lead by Adastra, model M8. **£3.50**



Z5286D Metal detector panel 185x115mm. This is the complete PCB from an expensive (£80+) "treasure detector" – just add wire coil and meter to make a working unit. Circuit uses 15 transistors and 3 IC's. There are 5 pots and a rotary switch. Detailed info inc. cct diagram and coil windings supplied.. **£12.95**

Z5201 Ingenious level indicator for LPG tanks. Magnetic strip attaches to exterior of tank and works by pouring hot water down gauge. Colour change will indicate level of gas left. 220mm long. Supplied on card with full instructions. **Only £1.00**

Z5288 Polycarbonate grey sealed box 82x80x55mm with clear lid (DP 9.11!). Inside is a steel panel with loud 12V buzzer and a PCB with push button (operates when lid is removed) a green LED and 1N4005. There's a 12mm hole in the side of the box and a cable gland to fit. **Exceptional value at £4.00**

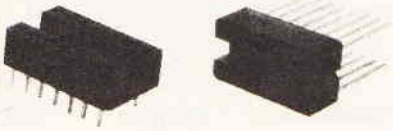
We buy surplus stock - send details to the Managing Director, Greenweld Electronics, 27 Park Road, Southampton, SO1 3TB

LIGHT UP YOUR LAYOUT

K692 Super deal for modellers - we supply a mains power supply, 100 miniature lamps for wiring into your railway layout or dolls house, and 100m of flex. Circuits and details of how to wire up the lamps in series/parallel are provided. Everything for just **£19.95**

CONNECTORS

Extra special price on gold plated DIL sockets – a parcel of Vero DIL sockets has arrived:



(a) PCB mntg, std profile:

Z5237 28 way **£1/10** 100+ .06
Z5238 40 way **£1.50/10** 100+ .08

(b) Wirewrap

Z5239 18 way **£3.80/10** 100+ 0.20
Z5240 20 way **£4.30/10** 100+ 0.25
Z5241 28 way **£7.00/10** 100+ 0.40
Z5242 40 way **£10.00/10** 100+ 0.65

Z2360 Turned pin DIL socket – 24 pin, but 0.3" pitch not 0.6". **Pack of 5 for £1.** 100+ 0.10

ARE YOU A BARGAIN LIST SUBSCRIBER? DON'T MISS THE BARGAINS!!

P5430 14 pin DIL header plug, gold plated solder type. As listed in our cat at 65p – special purchase price **3 for £1.00;** 100+ 0.16; 1k+ 0.12

Z739 40 way DIL header plug, gold plated. **3 for £1.00**

P9016 16 way IDC header socket. **Pack of 5 £1.00** ; 100+ .10

Z2379 IDC 16 pin DIL socket. **Pack of 5 £1.00**

Z2382 Double row 0.1 socket PCB/chassis mounting 16 way x 2, but only 1 row of pins. **Pack of 5 £1.00**

High quality 3.5mm mono jack plugs with coloured plastic sleeves made by Cliff:
Z2457 Red **10/£1.00** 100+0.06
Z2458 Green **10/£1.00** 100+ 0.06
Z2479 White **10/£1.00** 100+ 0.06
Z2480 Cream **10/£1.00** 100+ 0.06

Z1485 RC4200-8S 8 way gold plated socket – matches McMurdo red range, but blue **£1.50**

Z1768 Numicator/CRT base 13 pin PC mntg by Cinch. **Pack of 4 £1.00**

Z042 2 pin DIN speaker sockets, PC mntg. **Pack of 25 £1.20**

Z2448 Phono plug. Black plastic cover. We have a large quantity of these to dispose of, so are clearing them at **25 for £1.00**, 100+ 0.03, 1000+ 0.02

The 1992 GREENWELD Catalogue is out now! 132 pages of electronic and modellers supplies.

Only £2 (UK/ BFPO; £4 O'seas)

ORDER NOW!
See order form for details

Z2397 25 way 'D' type shells. Can be used as either plugs or sockets, according to pins fitted. (No pins available) **Pack of 6 £1.00**

Z2395 Right angle 50 way 'D' plug, PCB mounting, plastic housing. **£2.00**

Z2396 Right angle 9 way 'D' socket. **40p**

Z2430 37 way 'D' type plug, IDC type **£2.00** 100+ 1.00

Z2429 15 way 'D' connector sliding lock retainer by ITT type DA51220-1 DP £3.45, **Only £1.00** 100+ 0.40

Z2445 Data connector – like BT skt – 6 way PCB mntg for right hand plug. DP 1.74 **Our price 2 for £1.00,** 100+ 0.30

Z2398 DIN 41612 IDC socket, C body, rows A and C only. List £6.65. **Our price £2.50**

Z2399 20 way card edge IDC socket. DP 2.47. **Our price £1.00**

Z2426 25 way double sided 0.1" pitch edge connector, gold plated, solder tags. **£1.00**

Z2427 50 way double sided 0.125" pitch edge connector, gold plated, wirewrap terminals. **£2.00**

Z2428 PC mounting edge connector, 13 way double sided 0.15" pitch. Gold plated. **Pack of 2 £1.00** 100 + 0.25

NEED A LEAD?

Here's a selection from a recent parcel:

Z5247 1.1m long twin thick flex, 2x3mm wander plugs one end, 3.5mm mono jack plug the other. Assorted colours. **Pack of 3 £1.00;** 100+ 0.18

Z5248 1.8m long twin flex, 3.5mm mono jack plug to open end. Fitted with sleeved square grommet. **Pack of 5 £1.00;** 100+ 0.10

Z5249 2m long twin flex, 2 pin socket to open end. Fitted with sleeved round grommet. **Pack of 5 £1.00;** 100+0.10

Z5250 1.1m long 3 core sheathed cable with odd socket one end, yellow 5mm LED in plastic housing the other. **Pack of 8 £1.00;** 100+ 0.06

Z5251 1m long twin flex, 2.5mm power socket to open end. Fitted with sleeved square grommet. **Pack of 3 £1.00;** 100+0.18

Z5252 Super ***heavy duty extra long*** (2.7m) twin sheathed cable with moulded on 2.5mm power socket to open end. **2 for £1.00;** 100+0.25

Z5254 2m long 4 core sheathed cable fitted with a sleeved grommet. 4 pin DIN socket to open end. **4 for £1.00;** 100+ 0.12

Z5255 2m long 2 core black sheathed mains cable (3A). Moulded 2 pin Euro plug one end, 0.25 tags the other. **3 for £1.00;** 100+ 0.18

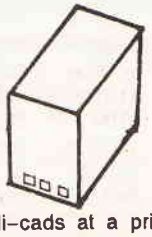
BATTERIES

Z2452 Lithium battery – inorganic type by Tadiran, type TL5104. AA size, 3.6V PC tabs. Date code 06/88 **£1.70**

Z2453 As above, but type SL360, date code 4/87. **£1.50**

Z2450 Tadiran AA size battery 3.6V PC mounting. Date code 6/89. DP on these is 5.17. Our price **£2.00** 25+ 1.50 100+ 1.20

Z2451 Tadiran 0.5AA size battery, 3.6V PC mntg. Date code 8/86. DP 4.58 Our price **£1.75** 25+ 1.35 100+ 1.05



Z4150 AA Ni-cads at a price never before seen! Pack of 8 in a tough plastic case 56x63x33mm – either use as a 10V battery pack or remove and use cells individually. Special low price **£1.60 each;** 25+ 1.10 100+ 0.80

RELAYS

Code	Mnf'r	Type	Coil V	Coil R	Contacts		Base	Type	Size l.w.h	Qty	Pic	Price
Z2423	VARLEY	VP4	48V	5800R	4PCO	1A	ST	C	29.18.29	93	A	1.00
Z2414	SIEMENS	V23154	12V	800R	4PCO	1A	PC	C	29.18.29	96	A	2.00
Z2421	ITT	A2825	24V	1000R	6PCO	1A	PC	C	33.30.29	57	B	1.00
Z2424	ITT	A2446	48V	3000R	DPCO	1A	PC	C	29.16.13	59	C	1.00
Z2425	FEME	RCP11	110V	10K	3PCO	10A	11PIN	C	35.35.56	84	D	2.00
Z2420	AMF	KUP14D	24V	450R	3PCO	10A	ST	C	37.34.51	82	E	2.00
Z2419	NATIONAL	AE1324	24V	2000R	DPCO	1A	PC	C	30.20.10	218	F	1.00
Z2413*	AX	481F	12V	1500R	SPCO	1A	PC	M	32.10.10	533	G	1.00
Z2408*	CLARE	HGR2M	5V	500R	DPCO	1A	PC	M	40.25.10	117	H	1.00
Z2418	OUB	SS124D	24V	1200R	SPCO	5A	PC	C	21.17.15	118	I	1.00
~~Z2412~~	~~OUB~~	~~SS-210D~~	~~12V~~	~~800R~~	~~DPCO~~	~~2A~~	~~PC~~	~~C~~	~~18.18.18~~	~~20~~	~~J~~	~~1.00~~
Z2417	OUB	SS-224D	24V	1200R	DPCO	2A	PC	C	18.10.12	196	J	1.00
Z2422		AZ1530-04Y	36V	4300R	SPCO	2A	PC	C	26.14.11	648	K	1.00
Z2400*	GENTECH	G42F	3V	130R	SPB	1A	PC	M	33.16.11	127	L	1.00
Z2416	HAMLIN	HE221A4860	24V	11K	SPM	1A	PC	R	32.10.09	799	M	1.00
Z2411	HAMLIN	HE221A7080	12V	800R	SPM	1A	PC	R	32.10.09	1501	M	1.00
Z2407	HAMLIN	HE262A7780	5V	470R	DPM	1A	PC	R	32.12.09	135	N	1.00
Z2406*	ELLIOTT	36876/5	5V	130R	SPB	1A	PC	R	32.15.10	345	O	1.00
Z2410	ALMA	CPR3	12V	1100R	3PM	1A	PC	R	38.23.12	38	P	1.00
Z2405*	CLARE	PRME15005AB	5V	470R	SPM	500MA	DIL	R	20.07.05	354	Q	1.00
Z2404*	HAMLIN	HE721A5262	5V	520R	SPM	500MA	DIL	R	20.07.07	51	Q	1.00
Z2415	AX	132A-1	12V	180R	SPM	500MA	DIL	R	20.07.07	31	Q	1.00
Z2403*	AX	132A-4	5V	520R	SPM	500MA	DIL	R	20.07.07	65	Q	1.00
Z2402*	CLARE	CUPV10201	5V	170R	SPB	1A	PC	R	25.10.9.5	50	N	1.00
Z2409*	CLARE	CUPV10302	12V	370R	SPB/SPM	1A	PC	R	31.12.04	27	O	1.00
Z2401*	AX	175A-4	5V	500R	SPM	1A	PC	R	32.15.9.5	47	R	1.00

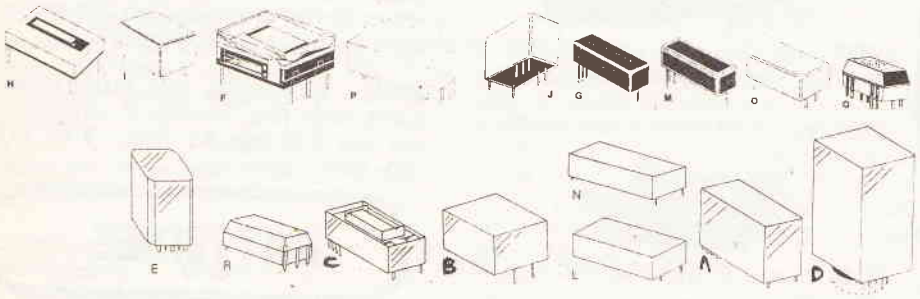
Discounts for larger purchases: 100+ (any mix) less 40% 1000+ less 60%

Type: C= conventional
M= mercury
R= reed

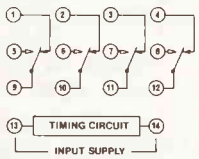
*Internal diode protection

Contacts: 4PCO Four Pole Changeover
DPCO Double Pole Changeover
SPCO Single Pole Changeover
SPM Single Pole Make
SPB Single Pole Break
3PM Three Pole Make

Base: ST Solder Tags
PC PCB mntg
DIL 0.3" pitch dual in line



TIME DELAY RELAYS



These all originate from the largest component distributor in the UK and are in original packing. Sub min 4 pole changeover plug in type, delay before energize. Same as Omron H3Y4 series

Code	Volts	Time	DP	Price
Z5186	240V ac	5s	25.83	**£5.00**
Z5198	240V ac	10s	25.83	**£5.00**
~~**Z5190**~~	~~240V ac~~	~~10m~~	~~25.83~~	~~**£5.00**~~
Z5183	110V ac	5s	25.83	**£4.00**
Z5184	110V ac	10s	25.83	**£4.00**
Z5185	110V ac	60s	25.83	**£4.00**
Z5186	110V ac	5m	25.83	**£4.00**
Z5187	24V DC	5s	24.19	**£5.00**
Z5188	24V DC	10s	24.19	**£5.00**
Z5189	24V DC	60s	24.19	**£5.00**
Z5190	24V DC	5m	24.19	**£5.00**

Z2350. Open construction 12V relay with 0.25 tabs. Ideal for car use. Single pole make contact rated 15A. **£1**

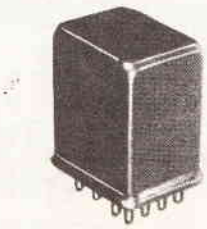
Z2496 Omron MY4 relay. 48V ac coil, 4PCO contacts rated 5A **£1.00**

Z2497 IMO 60.32 relay. 12V DC coil, DPCO contacts rated 10A **£2.50**

Z5178 Ex-equip PCB mntg 12V heavy duty rela - DPCO contacts rated 10A 250V. IMO model 60.42. **£1,50**

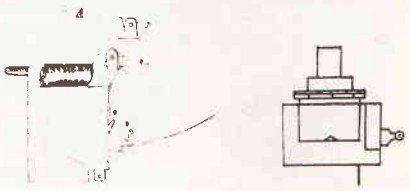
Z5179 As above but 3 pole changeover IMO 60.43. **£2.00**

Z2442 PCB mounting relay 30x24x10mm. 4PCO. 1150R coil, operates from 15-30V. **£1.50**



Z2433 Hermetically sealed mains relay, miniature plug in type with 4PCO contacts. Size 22,5x29x32mm. DP (1987) 17.75. **Our special low price £4.75**

SWITCHES



Z5174 Timer switch by Diehl of Germany. Superb geared mains motor, (1 rev per 12 hours) operates a cam that switches 2 change over contacts with centre - off positions rated 16A 250V. Size 60x54x43mm. Spindle is 14x6mm dia. **Only £3.00** 100+ £1.50.

Z2361 Heavy duty push switch - push to change over, locking. Needs 12mm hole. Plunger is 8mm dia x 9mm high, **3 for £1.00**

Z2387 PC mounting push switch - 1 pr make and 1 pr break contracts. Right angle plunger is 5mm long x 2mm dia. With protective cover. Again, very high quality. **2 for £1.00**

POINTS LEVER SWITCHES

Great switch bargains for railway modellers - these small switches 18mm wide and 12mm high (excluding lever) and just 4mm thick with 14mm FC come in two versions:

Z2363 2 position, 2 pairs make and 2 pairs break. **Pack of 5 £1.00** 100+ 0.10

Z2364 3 position, 6 pairs contacts (2 pole 3 way). **Pack of 5 for £1.00** 100+ 0.10

TRANSDUCERS

Z5266 Miniature 15R speaker 45mm(1.75") dia. **3 for £1.00;** 100+ 0.16; 1k+ 0.10

Z5267 75R miniature speaker 57mm dia. **3 for £1.00**

Z5275 57mm 8R speaker with 0.5m twin flex and socket attached. **3 for £1.00**

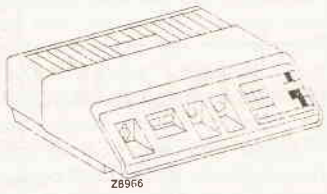
Z2503 Sub-min 8R speaker with mylar cone. 30mm dia with short lead fitted. **2 for £1.00**

We are always looking for new lines to add to our lists. Send details/ samples of goods available to: The Managing Director
Greenweld Electronics Ltd
27 Park Road
Southampton SO1 3TB

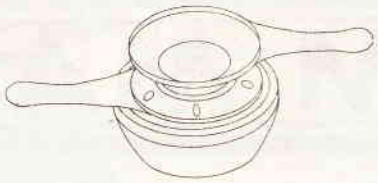
PRICES IN BOLD TYPE INCLUDE VAT: PRICES IN LIGHT DO NOT

Viewdata Terminal/Modem

Tandata TD1100 alphanumeric Viewdata/Prestel Adaptor.
These units were used with a home banking system. The console was hooked up to your TV and telephone line, and by using the standard qwerty keyboard with seperate numeric keypad, you could access your account. The well styled black and grey case 300x180x75/40 has a 75 key keyboard connected inside by a DIL plug to the main PCB. This has mounted on it the modem sub-panel + 3 relays, UM1286 Astec colour modulator with sound, + SAA5020, 5050, 5070, SY6504, 68B10, MCM51101P45, 2x2114 & 2732 EPROM all in sockets, as well as over 20 other LS and linear chips, transistors etc. There's a back up nicad battery and a regulated power supply. On the rear panel is an on/off rocker switch, UHF output socket, printer skt(15 way D), and cassette DIN socket for recording data.
There are 3 leads attached; 4m long mains lead with 13A plug, 4m long BT lead with old-style plug, and a 3m long TV co-ax lead.
All in all, a versatile, useful compact unit either to use as it is or for the parts within. The component value alone is over £60, so you can see what a bargain this is - it even comes with a photocopied handbook!!
Order Code Z8963. The whole unit as described for just **£12.95**
Also available brand new and boxed, **Z8964 £16.95**

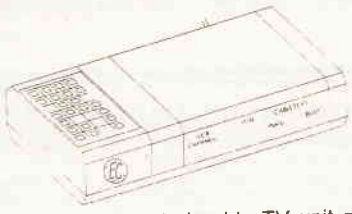


Z8966 Prestel set less monitor. This cased unit 420x430x100mm made by Phillips, model HU01 contains all the logic and control circuitry for Prestel - the monitor (not supplied) sits on top. On the back panel there is an 8 pin DIN socket for text output to monitor, mains outlet to monitor and an 8 pin DIN printer socket. There's also a mains lead and old type lead to telephone socket. On the front panel there is a detachable (on curly lead) keypad (20 keys) on/off keyswitch, tape and keyboard sockets and indicator lamps. Inside there's a large transformer and power supply and 4 PCB's - one is a modem panel; one has 8048 and SBB2626 in sockets + 15 other chips, transistors etc; the third has SAA5030/5042/5020/5050, a bit of memory (2x2114) + a few other chips. The fourth panel has SAA5010 in socket, 9xBSX20, 4xBC548/558. All boards are interconnected with plugs and sockets. These units are complete but not new and may well be in working order - but we're selling them for the parts value only - just **£16.00**



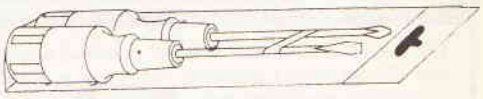
Z5200 Spirit Burner. Very useful in science labs or for the home experimenter. Chromed steel container 93mm diax48mm high has absorbent material covered in wire mesh. Adjusting lever allows variations in temperature. Complete with 70mm dia dish for heating substances in. **Only £2.50**

Z5216 Tandata "Homedeck". These are later versions of Z8963 and are (a) smaller and (b) remote controlled. The two tone grey case is 270x110x28mm and has a full qwerty keyboard and seperate numeric keypad. Inside, on the PCB are a few components to transmit the data via 2 IR LED's to the receiver. The unit is powered by a PP3 battery. Super value at just **£3.00**



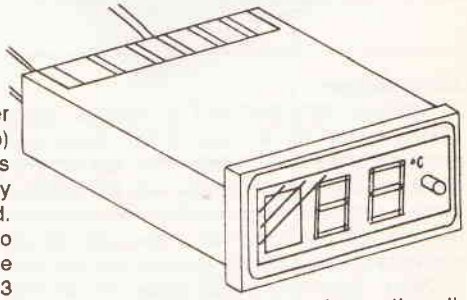
Z8970 Remote control cable TV unit made by GEC. Attractive black plastic case 205x120x40mm with membrane pushbutton keypad (22 keys). Front panel has 4x5mm red LED's to indicate status and a dual 7 seg display to show channel. On the 195x102mm PCB is a small regulated power supply (12V & 5V) derived from **Z5226** plug in PSU (not supplied). The main chip is a KS49429 and there are also TBA120T, ULN2003B, 4049 + 4.000MHz crystal & 3 small signal transistors as well as the IR detector diode. 2 screened cases contain (a) a PCB with some filter circuitry utilizing surface mount technology, few small chokes, couple of trimmer caps and input and output sockets; and (b) the infra red decoding circuitry using a TDA3047 chip. Regrettaby, we don't have any remote controllers, but these units offer great value for money - **just £5.95 each**

MONSTER SCREWDRIVER BARGAIN !!!



Tremendous value - 2x200mm screwdrivers, 1 pozi, 1 straight blade in plastic pouch. Wooden handles. Overall length 340mm. **ONLY £1.50.** Order code **Z5172**

A nice parcel of digital thermostats has just been delivered - these are high quality units badged BIRCH and manufactured by Wrynech.



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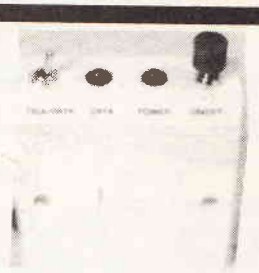

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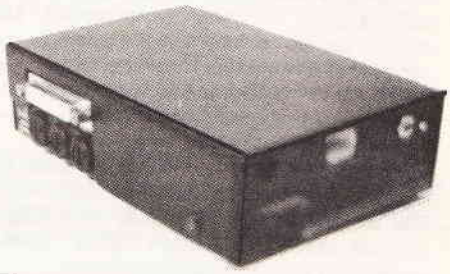

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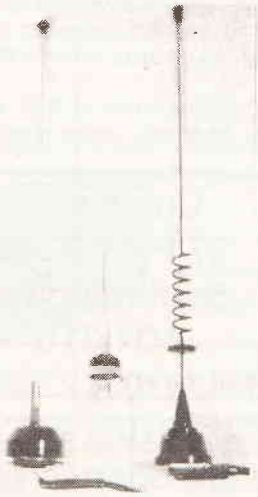

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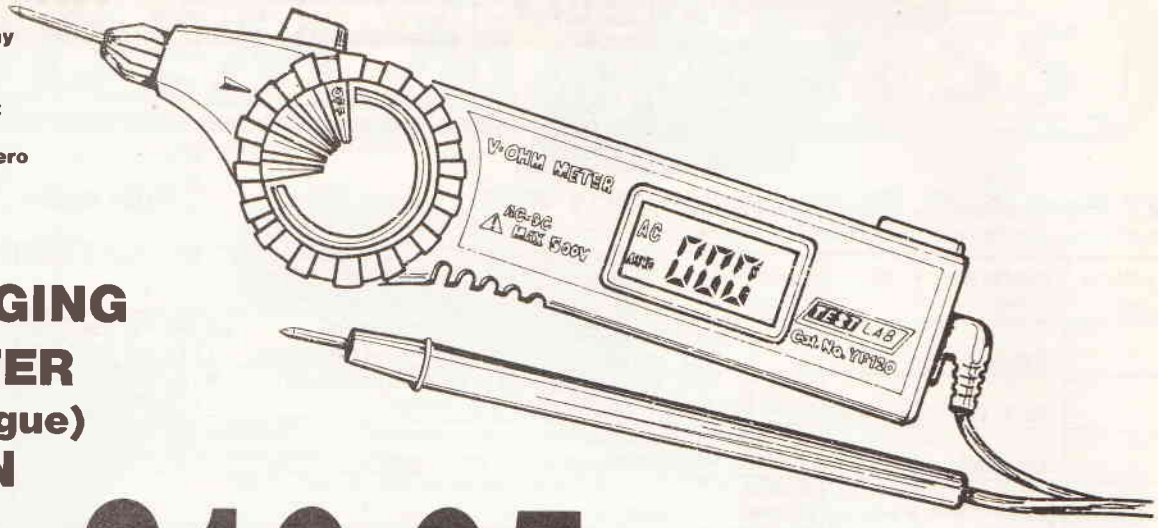

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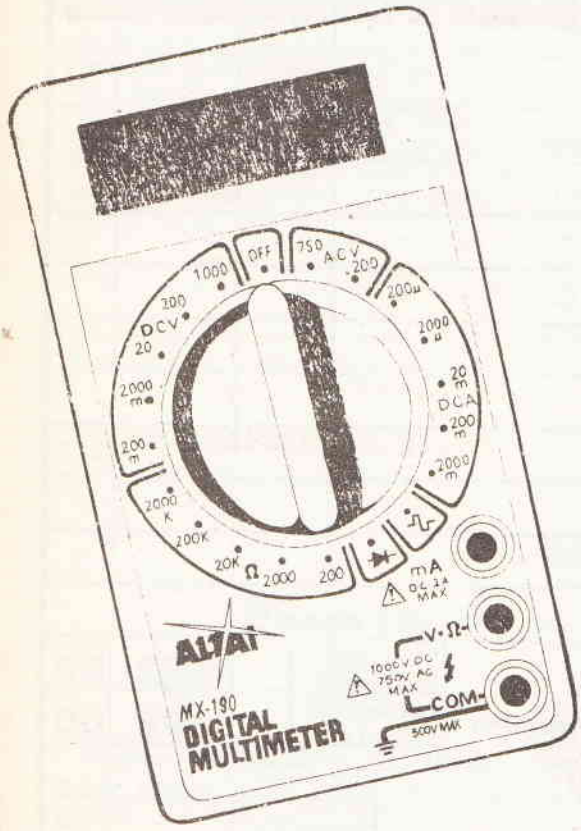

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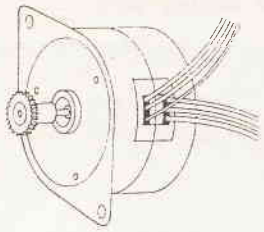

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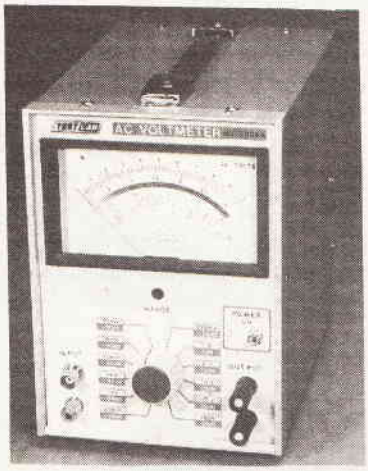

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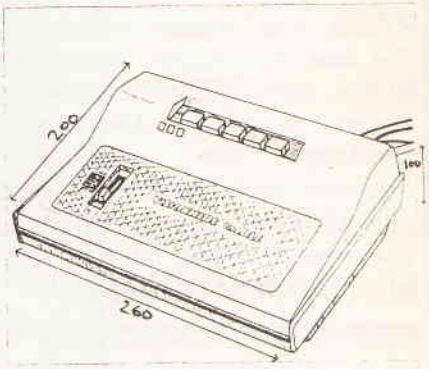

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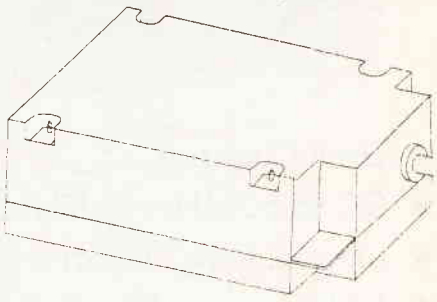

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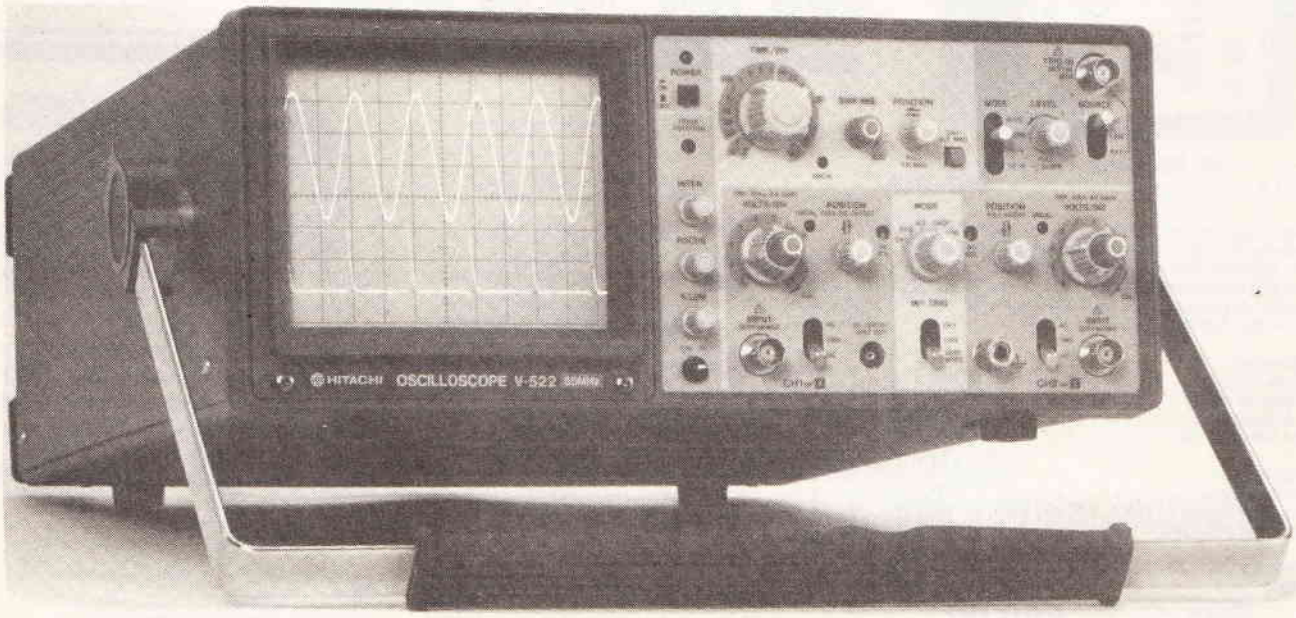

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Keyboards

An alternative to the typewriter keyboard by Stephen Waddington.

Speed, size and cost, the three dimensions of computing design become ever closer to their respective limits as years go by: the advent of the 80486 microprocessor conveys the reality that the limiting boundaries of computing power have almost been attained. New machines are favourably reviewed and it is assumed that each new device employs the height of technology and that the manufacturer has laboured intensively to ensure that it works efficiently. Most computer users are happy to continue regardless, knowing little of the insides of the machines which they operate. It would probably come as a shock therefore if they were to be told that the very instrument by which they communicate and command has been deliberately designed to be slow and to make progress difficult for the operator.

To discover the reasoning, a history lesson is required. Returning to the end of the last century when everyone was getting excited about the invention of the electric light bulb. American Christopher Scholes found that his innovative writing machine jammed and was frequently having to be repaired because the typewriter operators who used them were too good. His initial keyboard simply had the keys arranged in a purely alphabetical order. It was soon discovered that once the operator became familiar with the device the machine could not cope. In early manual typewriter machines, the typebar did not simply strike the ribbon and then bounce back instantly into position — instead it lingered somewhat and often became jammed by the next bar on its return. The result is familiar to anyone who has used a very old manual machine. The typebars became locked very tightly and inky fingers resulted after unjamming them. In his solution to the problem, Scholes separated the most commonly used letters so that they became more awkward to reach. The delay thus introduced gave sufficient time for the previous letter to return and the new arrangement overcame the typebar jamming problem sufficiently for the typewriter to achieve commercial success.

The Qwerty format, inherited to this day, has never been successfully challenged because of the huge investment in typing skills. Outbreaks of operator stress problems, which only occasionally occurred with mechanical typewriters have in recent years demanded reflection. These problems, broadly grouped under the

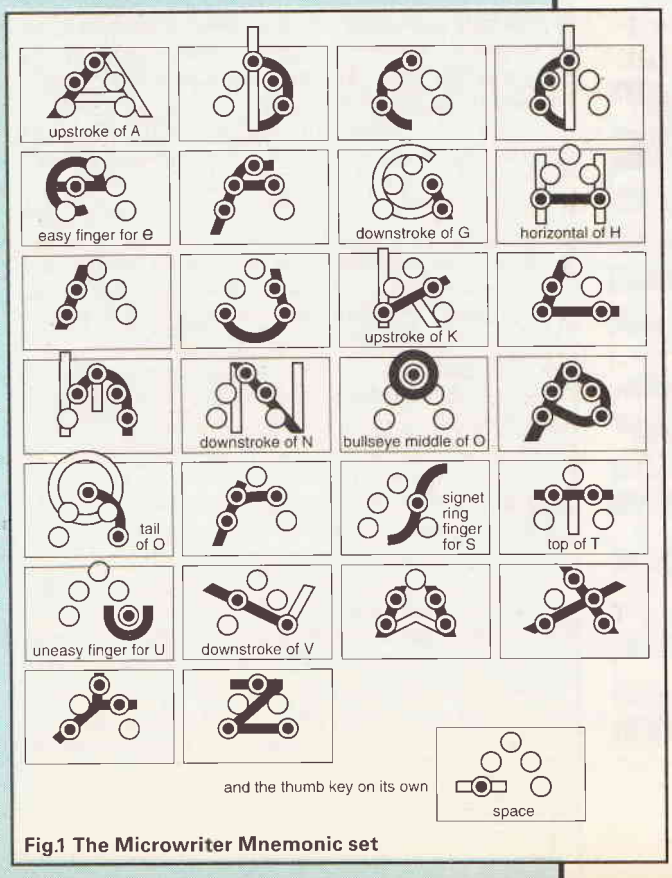

Fig.1 The Microwriter Mnemonic set

heading Repetitive Strain Injury (RSI), are associated with the over use of particular muscle groups and are to be found in a number of occupations. Writers' Cramp and Tennis Elbow are two of the names associated with this type of injury. The problem of RSI is faced by numerous professions according to Catherine Blinman of the Department of Medicine, at the University of Bristol. "Whenever the hand is placed under continual pressure or strain there is danger of injury. Such impairments occur in meat cutting and assembly line work, to hair dressers and concert pianists."

Technology has been blamed for an encyclopedia of medical problems varying from headaches to every kind of muscular ache and pain. The various ills experienced by computer operators are probably due to a wide variety of causes, including bad posture, poor lighting and occupational stress. Increasingly however keyboard operators discover that they are suffering continual aches, twinges and in some cases complete immobilisation of the hands.

Repetitive Strain Injury is now a recognised work disorder but that is of little consolation to anyone who is suffering from it. Numerous strains of RSI exist dependant on the suffers occupation. The classical form is called Tenosynovitis and is apparent by a sheathing of the tendons in the wrists and hands. It is caused by fast, small repetitious movements. No convincing cure has been found and much medical doubt surrounds the best mode of treatment. Prolonged rest seems to be the only effective answer. Symptoms when presented should be regarded seriously, prompting immediate action to change work patterns if permanent damage is to be avoided.

The major problem with Qwerty is that the use of common letters requires awkward finger movement. Attempt to type 'Electronics Today International' and you will see that a cross country assault of the keyboard results. The letter E requires the attention of the middle finger of the left hand, a wide sweep of the little finger of the right hand and the flexibility of a gymnast is then demanded to attend to the letter L and so the onslaught continues.

Keyface layout aside, consider for a moment the actual physical design of a keyboard — it has been proved on numerous occasions that simply swapping letters around is not enough to prevent RSI. Every flat keyboard breaks fundamental rules of ergonomic design by insisting that the user sits arms pointing inwards, palms outstretched, encouraging a hunched posture. The touch typist must then stretch his or her fingers to the near limits of movement to encompass the whole keyboard.

Since the turn of the century, a number of curious bids have been made in an effort to break the edge established by Qwerty. The first challenge was made in 1932, by an American professor, Dr August Dvorak. A complete arrangement of the keys was designed to bring the most common used letters under the best fingers. When first launched, the keyboard caused great excitement and was thought to be a real threat to Qwerty with a number of manufactures considering its adoption.

The Meir keyboard splits the key array down the middle, spacing them somewhat, and angling the two halves so that the fingers extend in a straight line from the hand. Endeavouring to assist the transition from Qwerty to Meir, the Qwerty layout is retained so that the typist does not have to be retrained.

Perhaps more drastic are the keyboards with only five or ten keys arranged in a halo beneath the fingers of one of both hands. Pressing keys together in a chord provides the desired character. The established chord keyboard is the Microwriter developed by American Cy Enfield and marketed by Microwriter of Mitcham, Surrey. Though not produced as a personal computer or wordprocessor keyboard, the Microwriter has been adopted in a number of systems and boasts a distinguished but yet diminutive following. Specialised software allows for the serial connection to a PC compatible where upon the user can employ the Microwriter keyboard in place of the Qwerty standard. The latest gadget from Microwriter is the Agenda, an electronic Filofax which includes an address book, a diary, a clock, numerous note pads, filing systems and a keyboard. A powerful wordprocessor allows the compilation of text documents and connection to a printer or a personal computer furthers it plausibility as a truly personal organiser.

The machine has never made the mass market — a small four line liquid crystal screen, an additional pad of keys covering every letter and number, together with the characteristic Microwriter chord keyboard result in a device which is small enough to slip inside a pocket. Surprisingly, the chord keyboard is incredibly easy to learn according to Engineering Consultant and Agenda user Alastair Wiggins, "It took a mere ten minutes to master the chord keyboard, the matter is assisted by the fact that the key mnemonics required to log an alphanumeric character coincide in form with the physical outline of the number or letter. Since there is no need to move the fingers to the keys, high speeds can be developed." Figure 1 provides illustration of the key arrangements and character mnemonics — such a design can only assist in the reduction of RSI problems.

Probably the most exciting and revolutionary new keyboard design is the Maltron, a creation of Systems Design Consultant Lillian Malt and Electronic Engineer Stephen Hobday. A split design, moulded in a three dimensional semi-circular bowl form, the Maltron comes as something of a culture shock to the previously unacquainted. Its functions are diverse, both left and right single handed boards cater for disabled people, whilst a two handed version seeks to replace the Qwerty keyboard in an effort to reduce problems of

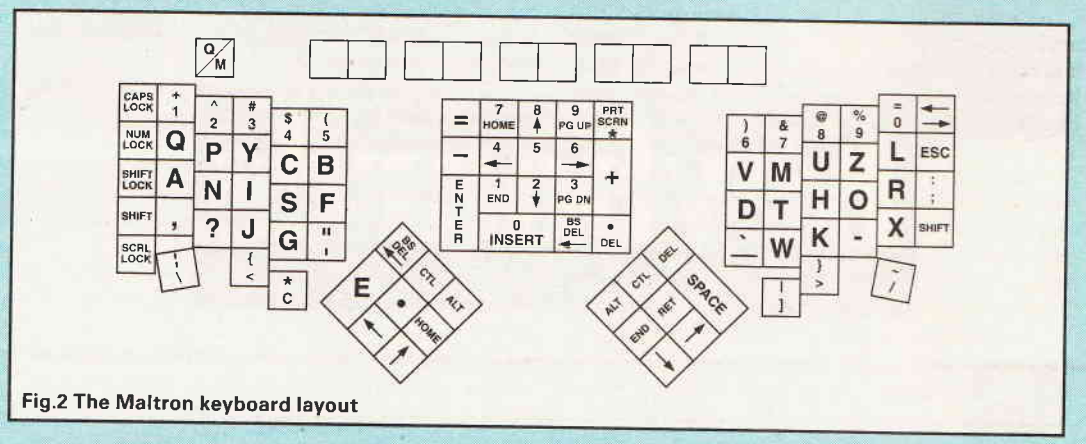

Fig.2 The Maltron keyboard layout

RSI. The Maltron can be configured to suit any keyface format dependent on the wishes of the user, indeed many opt for the existing Qwerty layout. Lilian Malt has devised a standard format illustrated in Figure 2, a product of extensive research and analysis. The rudimentary concept of the Maltron is to minimise the extension of the fingers as they reach for keys in the upper and lower rows. The thumbs are allocated more work which Malt justifies with investigative work proving that the thumbs are apportioned more brain power than the fingers and should consequently be made to work harder.

Manufactured by husband and wife team Stephen and Pamela Hobday from the confines of their own home in East Molesley, Surrey the keyboards are made to order and cost between two and four hundred pounds. Customers are predominantly disabled or sufferers of RSI, though many newcomers to computing have opted for Maltron keyboards with great delight. A fellow colleague who took such an inverse vantage after being persuaded to replace her antique typewriter, now has a typing speed twice that of myself, a seasoned proponent of Qwerty.

Recommendations come from numerous sources and although the Maltron is a preventative measure and not a cure for RSI, suffers have found their problems greatly reduced. So why has the Maltron never been adopted as a standard keyboard and why do we insist on continuing the finger calisthenics of Qwerty. Pamela Hobday provides explanation, "Current developments tend towards membrane keyboards which are very cheap and durable. To base the Maltron upon a membrane is impossible purely because of the dish formation. The moulding and casing is complex and therefore expensive to manufacture."

Potential manufacturers are apprehensive to take up new ideas fearing user rejection of anything other than the standard Qwerty form. Apprehension and keyboard retraining will always be a problem, yet the benefits of increased productivity and fewer keyboard related injuries make the adoption of an alternative keyboard format essential.

Are You Sitting Comfortably?

For those with specific back problems ergonomically designed chairs are available which encourage the spine to remain in its natural position.

The operator's chair should be set so that the thighs are horizontal and feet are flat on the floor.

If the chair is too high to allow the feet to rest on the floor, the use of a foot rest is recommended.

The chair back rest should be adjusted to fit the natural curvature of the spine thus encouraging an upright posture.

The top of the screen should be slightly below eye level so preventing awkward neck movement.

The display should be adjusted to an angle which minimises glare from artificial light.

Set Contrast and Brightness controls to a comfortable level, adjusting several times during the day to account for changes in light level.

Break off from the keyboard and screen for a few minutes every hour if using intensively.

The use of vertical paper holders and Polaroid filters are beneficial to those who continuously use computers.

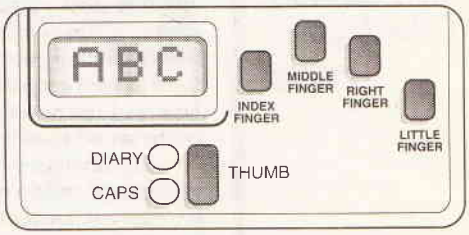

Fig.3 The Agenda complete with microwriter keypad

Auto Car Lights Controller

Take away the worry of forgotten lights with this project by Colin Meikle.

Electronic gadgets are becoming very popular in modern cars. Many of these gadgets are of little practical use, however some are designed to give added safety or to make driving more convenient. One such device which would do both is automatic lights, but as far as I am aware there are no such devices available. This is somewhat surprising since it would greatly add to road safety.

The circuit described here, does not replace the conventional light switch but works in parallel with it, therefore allowing the conventional switch to be used if desired. The circuit was originally designed to be a back-up but worked so well the conventional switch is never really required. The completed unit is reasonably small and only requires a few connections to the cars existing wiring. The light sensing is done by a Light Dependent Resistor (LDR), this can be mounted either inside or outside the car, e.g., in the corner of the windscreen or in-between the front grill. There are also connections for a switch to disable the circuit if this is required.

The circuit has two (variable) predefined levels a 'light' threshold and a 'dark' threshold. When the ambient light level falls below the 'dark' threshold the car's dipped headlights are turned on (if properly set-up, the circuit will turn the lights on during foggy or rainy conditions). When the ambient light level increases above the 'light' threshold the car's lights are turned off. If the circuit is allowed to control the lights they cannot be left on since the unit works from the ignition. One of the most important requirements of this circuit is that it does not respond to false conditions e.g., overhead lights, oncoming traffic or passing under bridges.

The circuits ability to reject false signals is achieved in various ways. By using two threshold levels (i.e., the 'dark' and 'light' thresholds) rather than a single threshold, the light level must change a significant amount before the circuit will change state. This stops small fluctuations in the light level affecting the circuit. However during normal driving conditions there are many instances where the light level will vary by a large amount over short periods of time, for example passing under a bridge or past a bright overhead light. These conditions do not affect the circuit because when one of the thresholds is crossed (e.g., when it has become dark) the light level must remain almost constant (i.e. it must remain dark) for a period of time (approximately 10 seconds), before the circuit will change state. Hence changes in light level over short periods in time do not affect the unit.

Differences Between Lighting Circuits

The circuit diagram shows two possible ways to connect

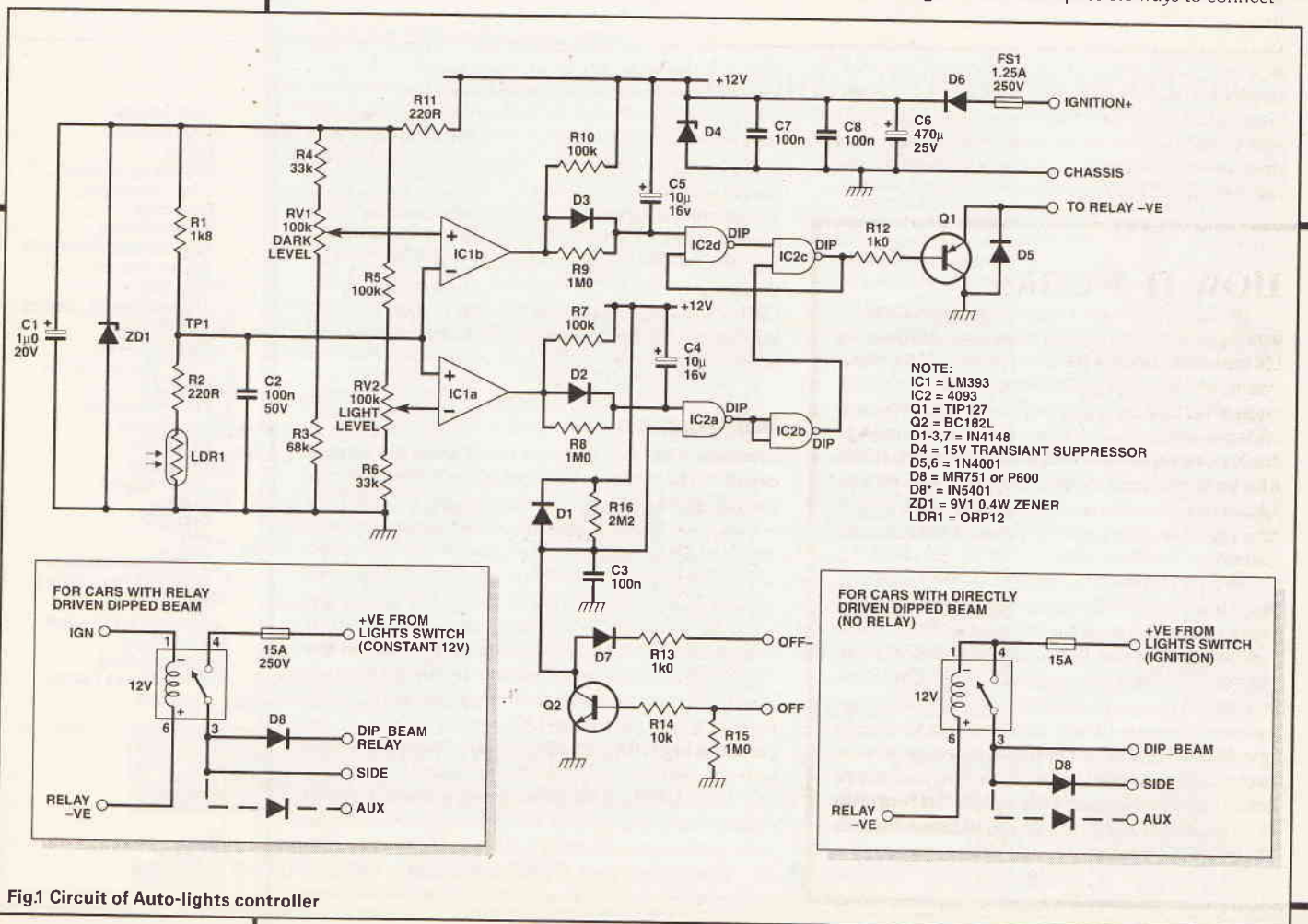

Fig.1 Circuit of Auto-lights controller

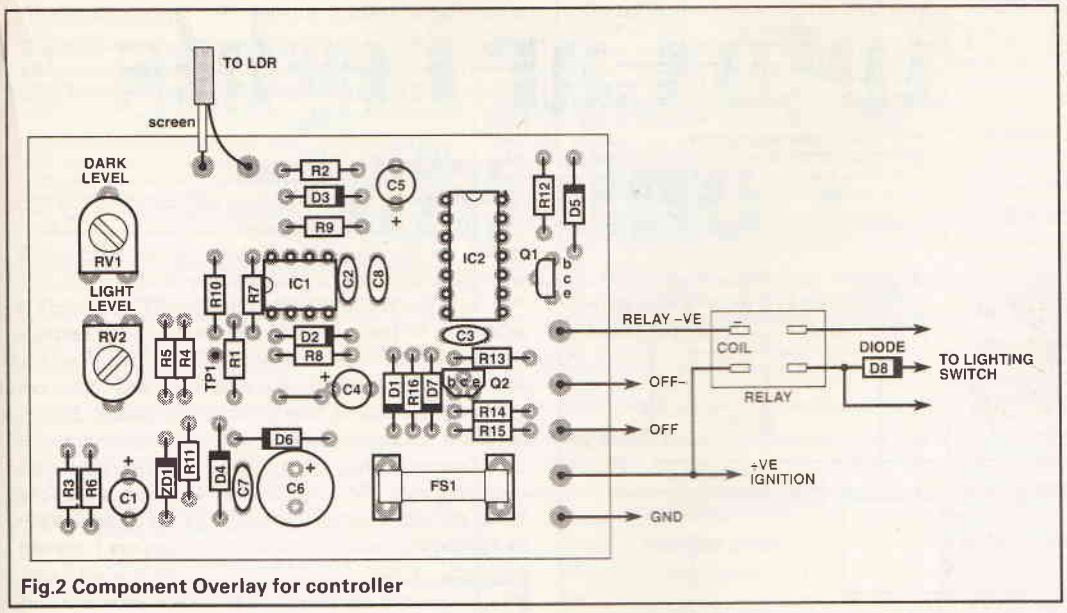

Fig.2 Component Overlay for controller

the circuit to the car wiring. For cars with directly driven lights (i.e the cars lighting switch switches the dipped beam directly and does not switch a relay), the relay RLY1 drives the dipped beam and diode D8 drives the side and auxiliary lights via the relay. The diode is required to keep the car's side light and dipped beam circuits separate (otherwise the dipped beam would come on when the side lights were activated manually). However some cars dipped beam lights are not driven directly but are driven via a relay. In this case, although the previous set up would work, it would be better to use the diode to drive the car's dipped beam relay and use the circuit's relay to drive the side lights. (If this is the case a smaller relay and diode could be used as the current through each is much smaller). A second diode is shown in the circuit diagram (dotted), this may be required where the auxiliary lights are on a separate circuit. If this is the case this diode should be connected to the auxiliary circuit. This diode could also be used to drive an additional indicator lamp to show the circuit has turned the lights on.

HOW IT WORKS

The circuit diagram is given in Figure 1 - its operation is straight forward. The LDR and R1 form a potential divider; as the light falling on the LDR decreases the voltage at TP1 increases (since the LDR resistance increases with decreasing light). This voltage is compared, by IC1, with two predefined thresholds set by RV1 and RV2. When it is light the output of IC1a is low which causes out-of the latch, formed by IC2d&c to be high, thus Q1 and the relay are in the off state. When it is dark the output of IC1b is low and the latch is reset, causing Q1, and the relay which drives the lights to turn on. When the ambient light level is in-between these levels both outputs of the comparator are high and the latch remains in its previous state.

The circuitry in-between the comparator and the latch, ensures that the light level is constant for approximately 10 seconds before the latch is triggered. Assume it is light going on dark, when the threshold level set by RV1 is crossed, the output of IC1b will go low. This will cause C5 to discharge via R9, if it remains dark the input of IC2d will go low after 10 seconds and hence the latch will be triggered. However if there are any interruptions in the 'darkness' C5 will be charged rapidly via R10 hence the input of IC2d will not go low until the darkness has remained above the dark threshold for 10 seconds. When the circuit is initially powered up the latch is reset by R16 and C3 (hence the relay is turned off), so the car can be started with the lights off. (If it is dark, the lights will come on 10 seconds after the ignition is turned on).

Construction And Testing

The layout for the PCB is shown in Figure 2. There should be no problems constructing the PCB, just be careful that all the polarized components are correctly orientated. If IC sockets are used, good quality ones should be used, as poor quality sockets may give problems in years to come with the harsh environment of the car. Testing and initial setting up is best done on the bench rather than in the car. Firstly connect temporary wires to the LDR and relay, next connect up a 12V supply.

With the LDR positioned under a light or in daylight the voltage at TP1 should be approximately 2.0V (it will be slightly higher under artificial light), adjust RV2 so it is just above the voltage at TP1. Now put the LDR in the shade and measure the voltage at TP1, it should be a few volts higher. Adjust RV1 so the voltage at its wiper is slightly below the voltage at TP1. Now position the LDR in the light and allow to settle for 30 seconds, the relay should now be off. Put the LDR in the dark, the relay should turn on after 10-15 seconds. When returned to the light, the relay should take 10-15 seconds to turn back off. Two off lines are provided — one positively and one negatively activated. To test these, cover the LDR so the relay comes on. Touch the OFF wire to ground or the OFF wire to 12v, the relay should go off. Before final fitting to the car give the board a good coat of PCB lacquer to protect it.

Installation

Installation will vary from car to car since the lighting circuit will be different from car to car. Figure 3 shows the two most common lighting circuits and the connections necessary to the completed circuit. The best way to establish the exact wiring layout is to consult the relevant manual. However, it is normally quite easy to determine how the car's lights are connected using a meter to 'buzz out' the lighting switch connections. If you are unsure if a relay is being used to switch the dipped beam, check by measuring the current through the dipped beam contacts of the lighting switch, if the current is low (less than 1A), a relay is used. If the current is high (8A), no relay is used. The gauge of the wire will also give you a good indication.

If diode D8 is driving the dipped beam (cars with a dipped beam relay) sleeve all the connections so there is no chance of short circuits. If diode D8 is driving the side lights, it will have to be mounted on a heatsink. The heatsink can be made from a piece of PCB as

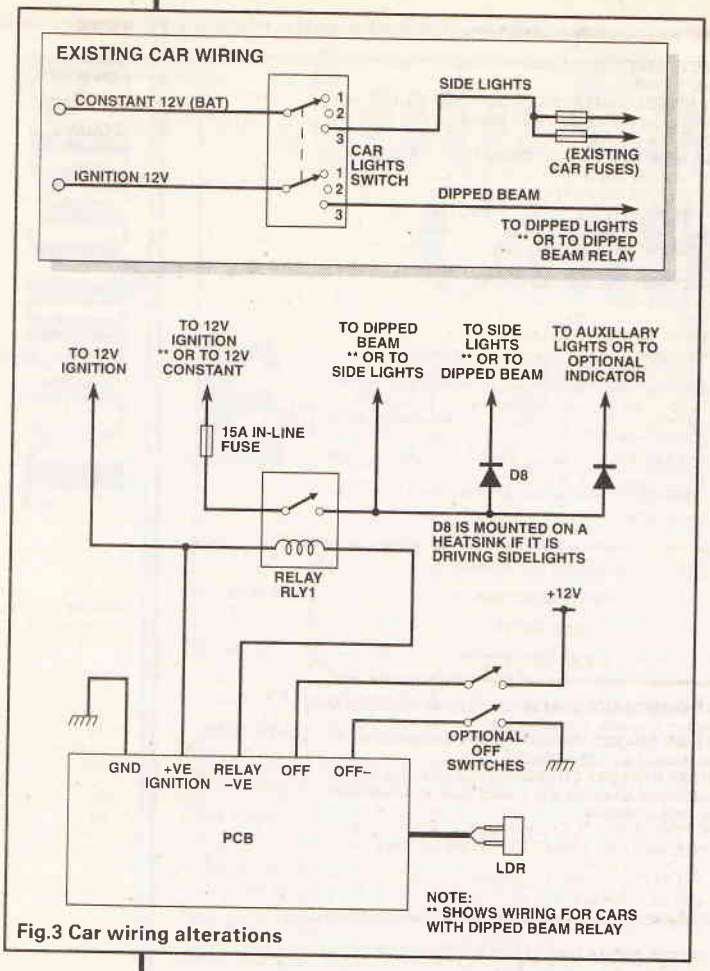

Fig.3 Car wiring alterations

shown in Figure 4, this can then be mounted inside the box, ensuring nothing will short out against the heatsink. When you have established which wire is which connect up the circuit as shown in Figure 2, 'snap-lock' type connectors make connections to existing wiring simple and neat. Ensuring you position the box where you are able to adjust the pots — if necessary put it in a temporary position until the settings are final. I found the best place to position the LDR was in the corner of the windscreen, when connecting the LDR use screened cable to limit any noise pick-up. If mounting the LDR outside the car, e.g. in between the grill, ensure the connections are protected

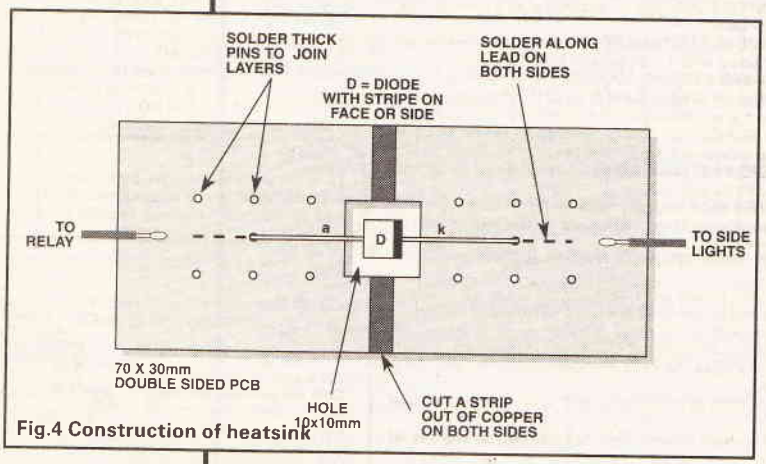

Fig.4 Construction of heatsink

from moisture. (One way is put the LDR in a piece of plastic tubing and fill the end with the wire with silicon or epoxy resin.)

With the LDR in place the light and dark thresholds can be set in the same way as done during testing. When it is just light the voltage at the wiper of RV2 should be set to the voltage at TP1. When it is just getting dark (not dark!) the voltage at the wiper of RV1 should be set to the voltage at TP1. The connections to the Off switch(es) is optional, there is no real need for an off switch. (Both polarities of signal were provided for convenience, only one is required to turn the lights off.)

Possible Problems

D8 will get warm during normal operation but if it gets very hot or disintegrates, the chances are you have mixed up the dipped and sidelight connections or wrongly assumed that a relay drives the dipped beam.

If, when setting the light threshold, you find the voltage at TP1 is higher than the maximum obtainable from RV2 then increase the value of R1. When setting the dark threshold, if you find that the minimum voltage from RV1 is greater than the voltage at TP1 decrease the value of R1. If you find that the dipped beam stays on when the full beam lights are turned on connect a wire from one of the full beam connections to the off signal of the unit. (note : it is normal for the dipped beam to stay on when the lights are flashed).

PARTS LIST

RESISTORS (all 0.25W 5%)

R1	1.8k
R2	220R
R3	68k
R4	33k
R5	100k
R6	33k
R7	100k
R8	1M
R9	1M
R10	100k
R11	220R
R12	1k
R13	1k
R14	10k
R15	1M
R16	2M2
RV1	100k
RV2	100k

CAPACITORS

C1	1µ 16V Electrolytc or Tantalum
C2,3,7,8	100n 50V Ceramic (5mm pitch)
C4,5	10µ 25V Electrolytic (radial)
C6	470µ 25V Electrolytic (radial)

SEMICONDUCTORS

IC1	LM393 Dual Comparator
IC2	4093 CMOS Schmitt Trigger
Q1	TIP127 PNP Darlington
Q2	BC182L NPN G.P.

TRANSISTOR

D1,2,3,7	1N4148 G.P. Silicon Diode
D4	15V Transient Suppressor
D8	MR751 or 6A Power Diode P600
*D8	1N5401 3A Diode (cars with dipped beam relay)
D5,6	1N4001 1A Diode
ZD1	9V1 0.4W Zenner Diode

MISCELLANEOUS

LDR	ORP12 Light Dependent Resistor
RLY1	15A (or Greater) SPST Relay (Automotive Type)
F1	1A 20MM Fuse

Set of 20mm Fuseclips
15A In-line Fuse with Holder
Suitable box 80x60x50mm (Maplin YN37S)
* See text

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Solar Powered Tech-Tips

A selection of easy-to-build 'sunshine' circuits by Robert Penfold.

Solar cells can be based on something as basic as two sheets of dissimilar metal, or something more high-tech such as silicon junctions. Either way, it is important to realise that the power provided by solar cells is pretty small. At least, it is unless you are going to use a large array of cells and will always be blessed with strong sunlight. Although you may find some fairly small cells advertised as having quite impressive output powers, it is important to realise that these output powers will almost certainly assume a light level that is roughly equivalent to strong sunlight. The power available on a dull day will only be a small fraction of this. The maximum output under normal artificial lighting (which tends to be much weaker than you might think) tends to be very low indeed. In fact with some cells their output level under typical artificial lighting is such that you need a sensitive multimeter in order to measure it.

In my experience, the ideal circuit for solar operation is one that requires no current, or something very close to it! A solar cell can be regarded as a voltage source in series with a resistor. If the light level is varied, the voltage source provides an almost constant output level. The series resistance, on the other hand, varies greatly with changes in light intensity. If the output voltage of a solar cell is measured using a high impedance voltmeter, it therefore remains fairly constant regardless of the light level. This contrasts with the results obtained if the output voltage is measured with a modest load current being taken. The output voltage is then roughly proportional to the light intensity.

This obviously makes life difficult for the circuit designer. Provided circuits consume microamps rather than milliamps, the supply voltage will remain close to the rated voltage of the solar cell and there should be no problem. Producing practical circuits that use really low output powers is not easy, and is impossible in many applications. What is often a more practical approach is to use circuits that require somewhat higher supply currents, but which will operate at quite low voltages. If the supply voltage should then happen to sag under loading, it should still leave a high enough supply voltage. Where the circuit is voltage-conscious, a simple shunt stabiliser circuit should ensure satisfactory results.

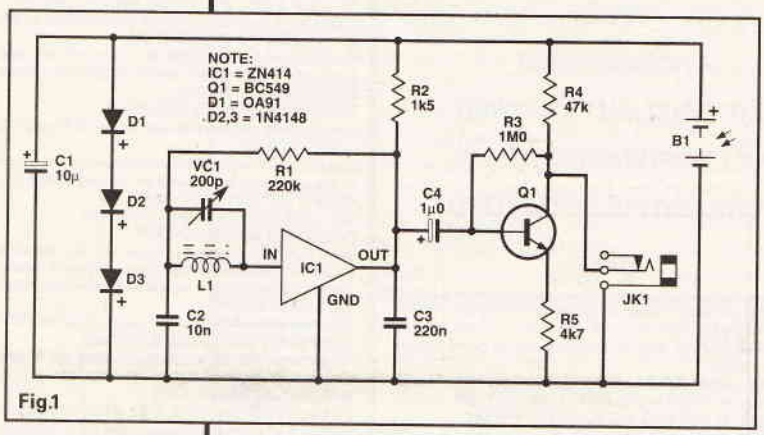

Fig.1

All the circuits described here are designed for use with the Solems solar panel type 14/096/048. This measures 96mm × 48mm, and has a rating of 8V at 100µA. This is a good compromise between small physical size and reasonably high output power. Note that these output ratings do not assume that the cell is used at the equator on a cloudless day, and at midday! Under bright conditions this cell can actually produce appreciably higher output currents at this voltage. These cells work well under artificial lighting incidentally, although much lighting of this type is inadequate to produce the full rated output. The circuits may well work satisfactorily with other solar cell arrays which offer similar output figures, but I have not tried any other cells, and obviously can not guarantee that satisfactory results will be obtained using an alternative.

The sensitive surface of the solar panel is the purple coloured one. The connections are made to the underside (the green side), and there are metal electrodes running the full width of the panel, one at each end. The polarity is clearly marked with '+' and '—' signs. I found no difficulty in making soldered connections to the electrodes, but it is probably best to ensure that the joints are completed speedily. This will avoid any damage to the panel caused by excessive heating from the soldering iron. The panel is based on a sheet of glass, and it should therefore be treated with due care. In use it should be mounted on a panel of the case so that it is physically well supported.

Solar Powered Radio

A radio receiver is an obvious candidate for solar operation, but the power required by an average 'tranny', is rather more than can be supplied by a small solar cell array. There are actually solar batteries that can do the job, but only with the aid of reflectors to increase the effective cell size, and only under reasonably bright sunlight. However, a small radio driving an earphone can run on quite low voltages and currents, and will work well enough even on dull days, or under most artificial lighting. A well known radio magazine featured a project of this type about twenty five years ago and suggested that it might make a good pocket radio — the idea was later withdrawn!

The circuit of the solar powered radio is shown in Figure 1, and is basically just a conventional ZN414 design. L1 is a medium wave ferrite aerial. I used an aerial coil and ferrite rod from Cirkit, but any commercial ferrite aerial should be satisfactory. Most aerials have a small coupling winding, but this is not required in this case. Either remove the coupling winding or just ignore it (leaving it in place does not seem to have an adverse affect on performance). A home constructed aerial can consist of 70 turns of about 32 swg tinned copper wire wound well towards one end of a 10mm diameter ferrite rod about 100mm or more in length. The winding should be reasonably neat with closely spaced turns in a single layer, and all running in the same direction. CV1 is the tuning capacitor, and any value from 200p to about 350p should be satisfactory.

D1 to D3 act as a simple shunt regulator to keep supply voltage at no more than about 1.5 volts. It is

possible that the circuit will become unstable, and if this should happen the supply voltage should be reduced slightly by replacing D1 with a shorting link.

The demodulated audio output from the ZN414 is at too low a level to drive an earphone at good volume. It is therefore followed by a common emitter stage having a voltage gain of about 20dB (ten times). This has a fairly high collector load resistor value in order to keep the current consumption of the circuit down to an acceptable level. This gives the circuit a fairly high output impedance, but it is able to drive a crystal earphone satisfactorily. Note though, that it will not drive any other type of earphone.

If the set uses a ready made ferrite aerial it will be necessary to adjust the position of the coil on the rod so as to give full coverage of the medium waveband. A little trial and error should soon produce a suitable setting, which will almost certainly be with the aerial coil almost right at one end of the ferrite rod.

Although the performance of the set should be quite good, remember that it is a simple TRF receiver and not a superhet type. When using the set remember that the ferrite rod is directional. If there is a problem with interference from an unwanted station, try rotating the set to null the unwanted signal. Bear in mind that the solar cell will only operate efficiently if it is aimed roughly in the direction of the light source. The receiver will work quite well under dull daylight and most artificial lighting, but with any solar powered device there is inevitably a minimum light level below which it will not function properly. No solar powered device can run on power which is simply not there.

When the receiver is used under artificial lighting there is a risk of problems with mains 'hum', due to the 100Hz signal amplitude modulated onto the light. In practice this does not seem to be a problem. C1 provides a certain amount of supply smoothing, but the slow response time of the solar cells seems to result in a minimal amount of 'hum' on their output anyway.

Solar Radio – 2

This is similar to the previous circuit, but it is based on the ZN415E rather than the ZN414. The ZN415E is basically just a ZN414 plus a simple audio amplifier and output stage. It is designed to drive medium impedance headphones of the type sold as replacements for personal stereo units. The headphones are driven direct from the output of the amplifier, and should be connected in series in order to obtain good efficiency.

This circuit in Figure 2 consumes somewhat more current than the original circuit. It will work quite well from a single solar panel, but results under low light levels are much better if two solar panels are used. Nothing drastic seems to happen if two panels are simply wired in parallel, but connecting any two power sources directly in parallel has to be considered a bad practise. Therefore, diodes D4 and D5 are used to ensure that one solar panel can not force a current through the other one. However, they can both feed their output to the radio circuit.

Signal Tracer

A signal tracer is a very simple but useful piece of audio test equipment. It is basically just a high gain audio amplifier feeding an earphone or a loudspeaker. You first check that the input signal to the faulty equipment is present. Then checks are made at various points in the circuit, working from the input towards the output. At some stage the signal will be absent, or be at a grossly inadequate level, and the fault should then be at or just prior to this test point. Most signal tracers, including the one featured here, are also capable of detecting amplitude modulated radio signals. This enables them to be used for checking ordinary MW/LW radio receivers as well as audio equipment. Sometimes the demodulation is provided by a separate probe assembly, but in this case the demodulation is built into the main circuit.

The signal tracer circuit is shown in Figure 3, and it really consists of little more than two common emitter amplifiers with capacitive coupling. In order to keep the current consumption down to a very low level the

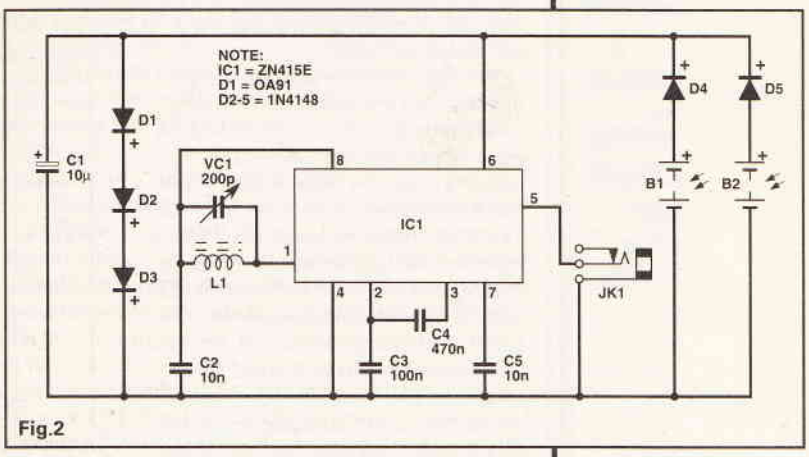

Fig.2

collector load resistors for both stages have been made quite high. A unit of this type should have a fairly high input impedance, but there is no need for a high impedance buffer stage at the input. Running the transistors at low currents produces a suitably high input impedance.

RV1 is the volume control. After some experience has be gained using the unit, the approximate input level can be gauged from the setting of this control and the volume from the earphone. Roughly gauging signal levels is important when using this type of equipment, since you will often be searching for a lack of gain somewhere in the faulty unit, rather looking for a total break in the signal path.

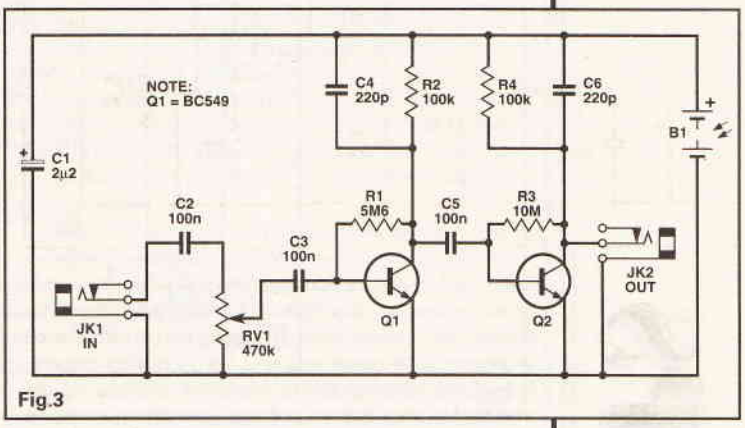

Fig.3

Demodulation of AM signals is provided due to the non-linearity of the transistors. They tend to amplify more on negative half cycles than on positive ones. This is simply because the gain of a transistors tends to rise with increases in the collector current, and the collector current is higher on negative half cycles than on positive ones. This gives a rather crude and inefficient form of rectification, but it is adequate for simple AM demodulation. C4 and C6 are the filter capacitors in the demodulator circuit. They also provide high frequency attenuation which helps to avoid instability.

The output of the unit will drive a crystal earphone at good volume, but it is unlikely to drive anything else satisfactorily. The current consumption of the circuit is only around 100µA, and it will therefore operate quite

well even under fairly dim conditions. The circuit can detect extremely small signals with RV1 set at maximum volume, but this high sensitivity makes it essential to keep the input wiring well screened from mains 'hum' etc. An oscilloscope style test lead is the best type to use with a unit of this type.

Remember when using a signal tracer that it can be used to check for a signal where there should be none. In particular, it can be used to check for a signal across a decoupling capacitor. If a signal is detected, then the decoupling capacitor must be faulty or not connected correctly.

It is possible to get the circuit to operate with a loudspeaker (of sorts). R3 must be decreased to 2M2, and R4 must be reduced in value to 15k. The output will then be capable of driving a Maplin Piezo sounder type 41/2.05. The sound output level will not be very high, and will be practically zero unless the sounder is firmly fixed in a suitable case. It should be adequate for this application though, where high volume levels are not normally required. Unfortunately, this modification greatly boosts the current consumption of the circuit, and it will only function under fairly bright conditions unless the unit is powered from several solar panels wired in parallel.

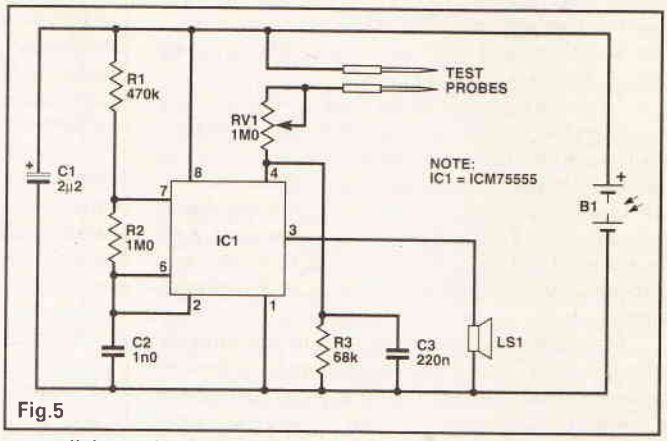

Fig.5

Transistor Checker

This transistor checker is a simple go/no-go type for small signal NPN and PNP devices. If the test component is basically functioning (i.e. is has reasonably high gain and low leakage) a 'buzzing' sound is produced from the unit.

Silence indicates that the test device is almost certainly a 'dud'. Due to the small test current used this checker can not be guaranteed to give satisfactory results with power transistors.

The circuit (Figure 4) is based on a conventional astable multivibrator. In fact, if an NPN test transistor is connected to the unit, the circuit is then a conventional astable circuit. R4 acts as the collector load for the test device, while R3 provides base biasing. R5 and R6 are connected into the circuit, and will pass small currents. However, their effect on the circuit is negligible, and they can be ignored.

If the component under test is serviceable, the multivibrator will function, and oscillation at a low audio frequency will be produced. This will be confirmed by a 'buzzing' sound from loudspeaker LS1. Note that LS1 is a cased ceramic resonator, and not an ordinary moving coil loudspeaker. The output power of the circuit is too low to drive even a high impedance moving coil loudspeaker, and trying to use a speaker of this type will simply prevent the circuit from operating at all.

Rather than using NPN/PNP switching, separate test sockets are used for these two types of transistor. With a PNP transistor connected to the unit it still functions as a form of astable circuit. R5 provides the base biasing and R6 acts as the collector load resistor. There is no need to switch R3 and R4 out of circuit as the currents that flow through them are too small to prevent the circuit from functioning correctly. Neither does the fact that one section of the circuit is based on an NPN transistor while the other is based on a PNP device prevent proper operation of the unit.

The current consumption of the circuit is low enough to ensure that it will function under fairly dim conditions. The test sockets can be sets of three 1 millimetre sockets grouped closely together. Most small transistors will then plug straight into these without any difficulties. However, it is probably worthwhile making up a set of crocodile clip test leads to enable any awkward transistors to be easily connected to the unit. The unit should work properly using any cased ceramic resonator (I used the Maplin wire-ended type). The peak frequency of the resonator is not important in this instance. The unit must simply produce a series of 'clicks', and no attempt is made to generate a piercing tone (which would obviously be undesirable in this application). A non-cased resonator should also be suitable, provided the tester is built-up as a properly cased unit with the resonator mounted on the case in a suitable manner.

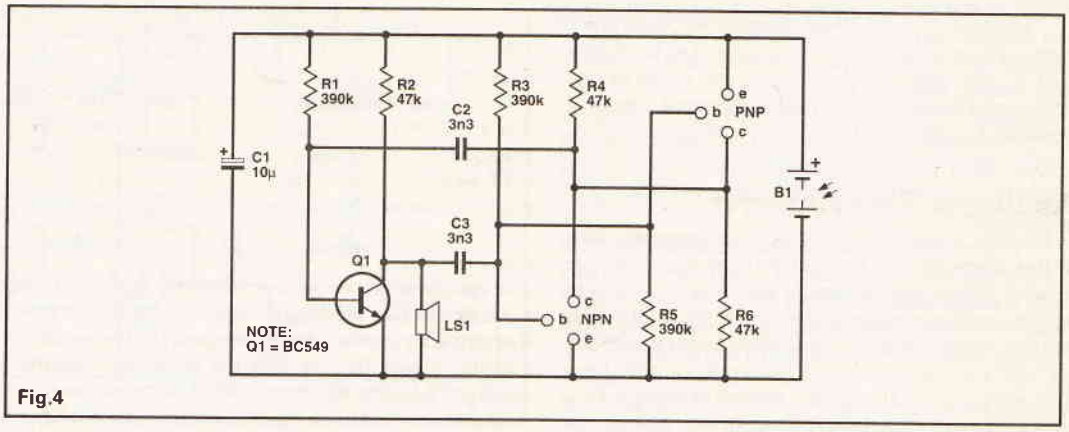

Fig.4

Continuity Tester

Producing a solar powered continuity tester seems easy enough, but it is not quite as straightforward as you might think. Firstly, the audio oscillator must produce a reasonably loud tone from some sort of loudspeaker, but it must draw a very low supply current. A low current audio oscillator is not difficult to produce, and as we have seen in previous projects, a ceramic resonator will produce a reasonably loud tone from a very

small drive signal.

In this circuit (Figure 5) the oscillator is built around a low power version of the NE555 timer chip. Some low power 555s seem to be better than others with regard to their current consumptions. Of the devices I tried, the ICM7555 seemed to have the lowest current consumption of all. It does have lower maximum drive currents than most other low power 555s, but in this application high drive currents are clearly not required. The circuit will operate using other low power 555s such as the L555, but operation at low light levels will be more reliable if the ICM7555 is used. The timing resistors have been made high in value so that the current drain in this part of the circuit does not greatly add to the current consumption of IC1.

The second problem is that having designed a circuit which will operate from a current of only 100 to 200µA, placing quite a high resistance in series with the supply will not prevent the circuit from oscillating. This can cause misleading results, with continuity being indicated when there is actually tens of kilohms across the test prods. In order to avoid this, the circuit is not controlled by having the test prods in series with the supply.

Instead, it is controlled via pin 4 which is normally taken low by R3. This blocks oscillation, but if the test prods are short circuited, the potential divider action across RV1 and R3 produces a high enough voltage at pin 4 to enable oscillation. RV1 must be correctly adjusted in order to obtain proper operation of the circuit. To set up RV1 correctly, simply short the test prods together and adjust RV1 for the highest resistance that does not cause the output to cease. Provided RV1 is set up correctly, quite small resistances across the test prods should be sufficient to block oscillation. It is certainly adequate in this respect for a simple continuity tester. It will not be 'fooled' by semiconductor junctions, which is more than can be said for most units of this type. Of course, if you want the unit to respond to semiconductor junctions and higher resistances, then all you have to do is adjust RV1 for something close to minimum resistance.

LS1 can be any cased ceramic resonator, or a plain type mounted on the project case in a suitable fashion. Although IC1 is a CMOS type, it has built-in protection circuitry which renders any special handling precautions unnecessary.

Analogue Thermometer

In the past, ordinary silicon diodes have been popular as the sensors for electronic thermometers. If they are forward biased they act rather like zener diodes, but with an avalanche voltage of only about 0.6 volts. This voltage varies to some extent with changes in current, and with changes in temperature. If a diode is fed from a constant current source, the voltage across it is then dependent only on temperature. The change in voltage is very small, being around two to three millivolts per degree Celcius for most diodes, but the linearity is quite good. If necessary, the change in output voltage can easily be boosted using an operational amplifier, and the voltage offset of around 0.6 volts can easily be removed as well.

Most modern electronic thermometers are based on one of the specialist temperature sensing integrated circuits. In essence these are not really much different to the discrete circuits of years gone by. The basic temperature sensing element is still a forward biased semiconductor junction, but it is usually accompanied by some on-chip amplification and other signal processing. This idea is taken to its ultimate in the LM35 series of temperature sensors, which provide an accurate output of 10 millivolts per degree Celcius, with no offsets to remove. The device used in this unit is the LM35DZ, which operates from 0 to 100° Celcius. The linearity is guaranteed to be no worst than ±0.8° Celcius over the full 0 to 100° temperature range, and would typically be much better than this.

The circuit (Figure 6) requires very few discrete components due to the signal conditioning circuits included in IC1. The LM35DZ is primarily designed for use with a digital voltmeter — an in particular as a temperature probe for a digital multimeter. However, it will work perfectly well with lower impedance loads, such as the analogue meter circuit used in this case. R1, RV1, and ME1 form a voltmeter having a full scale deflection sensitivity of 0.5 volts. With an output of 10 millivolts per Celcius from IC1, this gives a full scale temperature of 50° Celcius. If a full scale value of 100° Celcius is required, use a 100µA meter for ME1.

This circuit does not utilize a negative supply, and as a result of this it can not be guaranteed to operate properly below 2° Celcius. However, after trying several LM35DZs in this type of circuit I have always found them to operate quite well right down to 0° Celcius.

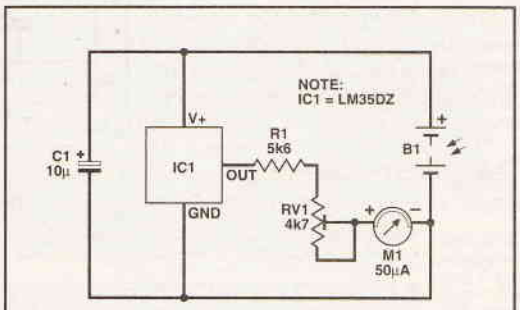

Fig.6

The LM35DZ only consumes about 56µA plus the output current. This means that it provides very little self heating, and also that it is well suited to an application such as this where very little supply current might be available. It is also largely impervious to changes in supply voltage, and it will work quite happily on any supply potential in the range 4V to 30 volts. In this application, where large variations in the supply voltage are to be expected, the LM35DZ will therefore work perfectly without the aid of an external voltage stabiliser circuit.

RV1 must be adjusted to accurately calibrate the unit. A good quality thermometer is needed in order to give an accurately known temperature against which the unit can be calibrated. Simply use the calibration thermometer to measure the air temperature, and then carefully adjust RV1 to give the same temperature reading. Of course, IC1 does not have to be mounted in the main unit. It can be fitted in a probe of some kind and connected to the main unit via a three way cable. This should ideally be a twin screened type, with the outer braiding carrying the 0 volt supply rail. This should eliminate any problems with noise pick up even if quite a long connecting cable is used. It is essential that IC1 is mounted in a waterproof probe of some kind if the unit is used to measure the temperature of liquids.

The Solems 14/096/048 8V 100µA solar cell is available from:

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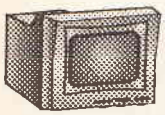

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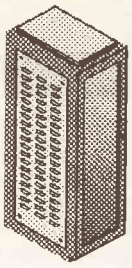

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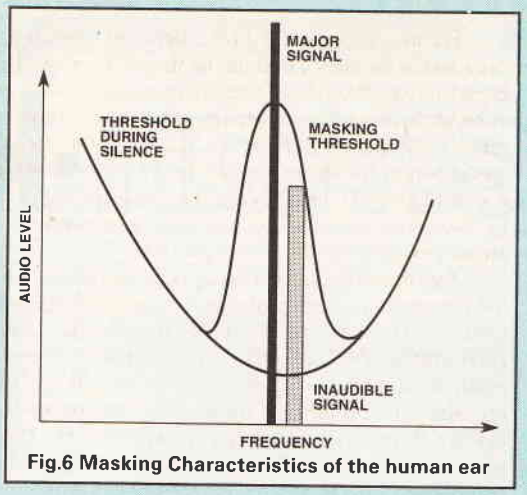


Fig.6 Masking Characteristics of the human ear

the signal which is contained in a particular sub-band, whereas systems using normal PCM (Pulse Coded Modulation) coding can produce disastrous results when errors occur in the most significant bit of a signal. Any individual radio frequency carrier will need to carry only a low bit-rate signal, so that relatively long bit-periods, or symbol times, can be used. Any noise produced by quantisation errors will be distributed over the whole of the available frequency band. This should minimise sensitivity to errors picked up along the transmission path.

The overall effect of using MASCAM plus differential coding is that it is possible to use only about 110Kbit/sec for a mono sound channel, about a third of the 350Kbit/s usually needed. The MASCAM technique for sub-band coding was originally used in the 1988 tests, but since then the idea has been considerably refined, and the latest tests have used an optimised system, MUSICAM – Masking Pattern Universal Coding And Multiplexing. MUSICAM splits the input audio signal into thirty-two sub-bands, rather than the 24 of MASCAM, and each of its sub-bands is just 750Hz wide. Special circuitry detects the peak level of the signal occurring in each sub-band time slot, and derives a scaling factor for that information. The degree of digital resolution that is needed for each sub-band can then be determined, and if the contents of a particular sub-band are likely to be masked by adjacent signals, no information need be transmitted for that sub-band, so reducing the amount of data that needs to be transmitted.

These reduced data rate signals are then transmitted using a form of modulation with the magnificent name of COFDM, although some unenlightened users use just OFDM.

COFDM

- Coded
- Orthogonal
- Frequency
- Division
- Multiplexing

We are all familiar with the idea of FDM, frequency division multiplexing where several different signals are modulated onto a group of adjacent carrier frequencies which are then sent along a common channel. COFDM takes this a stage further, and the figure illustrates what happens.

The COFDM technique breaks the data stream of a single audio channel or multiple audio signals into a large number of simple carriers, and it is the total of all these modulated carriers that makes up the COFDM signal. The individual carriers are derived from the Discrete Fourier Transform of the original signal.

The essential feature of the COFDM technique is that the frequency spectrum of each modulated carrier is allowed to overlap its neighbour, and careful selection of the carrier frequencies, of the phasing of each of the signals, and of the digital coding system that is used, allows the individual carriers to be separated out again by the application of a complex mathematical technique called the Fast Fourier Transform as the signal is demodulated. The same circuitry that can distin-

2

Digital Audio Broa

This month James Archer explains how DAB signals are put together, and shows that the latest in signal processing techniques can result in virtually perfect radio reception anywhere, whether at home, or on the move.

The first step in constructing a DAB signal takes place prior to modulation; a digital signal processing technique called MASCAM is used, primarily to reduce the data rate needed to carry the digital audio signal.

MASCAM

- Masking Pattern
- Adapted
- Sub-band
- Coding
- And
- Multiplexing

This divides the audio frequency signal into 24 discrete frequency bands, each of which is separately quantised. Very little information is actually carried in any one of the sub-bands, which means that a great reduction can be made in the number of bits used for each band. 'Masking' refers to a particular characteristic of the human hearing system which reduces the amount of information that needs to be sent to represent an instantaneous audio signal. The human ear is insensitive to quiet sounds which occur in close proximity to loud sounds, when both sounds are reasonably close in frequency. We say the quieter sound is 'masked' by the louder one. If such a sound is completely masked there is no point in transmitting it, so that we can end up transmitting less data in total. The normal threshold of hearing is shown in the diagram, together with the shifted threshold that exists when a loud sound is present.

Each sub-band is individually coded, and the use of 'dynamic bit allocation', allocating different numbers of bits to the parts of the sound signal where errors would be most noticeable at any given time, is actually taken to the extreme that where the amount of information in any sub-band is below the level that the ear can hear, no bits at all are transmitted. In more technical terms, this bit-rate reduction technique actually works by optimising the matching of the source coding to the characteristics of the human ear.

Another advantage of the scheme is that if any errors do occur they will affect only that small part of

RADIO

guish between the individual carriers is able to take account of out of phase reflected signals, such as those that are produced by multipath interference.

The spectrum produced by the tightly packed overlapping spectra of each of the individual carriers gives an effect like that shown on the bottom of the diagram. We can see the system makes very efficient use of the available radio-frequency bandwidth.

In practice there is some intersymbol interference, i.e. interference between one data pulse and the neighbouring ones, caused by the inevitable multipath interference, but the problem is reduced or eliminated by leaving a guard band interval between each symbol, provided that this is long enough to exceed the delay suffered by any of the reflected signals, all the orthogonal carriers (i.e. carriers which are ninety degrees apart in phase) can be demodulated without difficulty.

As mentioned previously, during 1988 and 1989

lcasting

a terrestrial transmitter operating at 834MHz in Geneva was used to provide demonstrations of how 16 stereo sound programmes could be transmitted using the MASCAM/COFDM system, these demonstrations were given to members of the European EUREKA project 147, a consortium studying DAB, as well as to many other broadcasting engineers. Excellent results were obtained with a mobile receiver throughout the Geneva area, even in road tunnels and in other areas where reflected signals caused severe multipath interference.

Following this, in 1990 the BBC carried out similar trials using the Crystal Palace transmitter, and excellent results were once again obtained. Just to give you some idea of the numbers involved, the Crystal Palace tests used 448 overlapping carriers which were squeezed into a total bandwidth of 7MHz. The effective data rate achieved was about 5.5 Mbit/sec, which could allow perhaps twenty separate stereo audio programme channels to be broadcast at once. Further developments of the OFDM technique are likely to lead to more than 2000 separate but overlapping carriers being used. This can reduce the data rate required on each one even further, making the system even more immune to multipath interference effects.

DAB terrestrial transmissions for the UK?

Although these new techniques were originally developed with satellite broadcasting in mind, we have seen from the various tests that they need not be restricted to satellites, and it is reasonable to foresee that digital sound broadcasting from terrestrial transmitters could be practicable. During the 1991 Radio Festival in Birmingham the BBC gave some excellent demonstrations to highlight just what could be done using DAB terrestrialiy, if only a suitable frequency band could be used.

DAB (Digital Audio Broadcasting)

- BBC test and demonstrations
- Terrestrial
- Used VHF Band 3 – 215 MHz
- Lower power – 11 watts
- DAB compared with standard FM

For the purpose of the DAB demonstration tests they used a frequency in Band III, the old 405-line TV band that was taken from broadcasters some time ago in order to provide more channels for private mobile radio. Although not normally available for actual broadcasting, the frequency band just above 200 MHz is actually usable for broadcast ancillary services, i.e. for broadcasters in-house use, such as communications between outside broadcast units.

Two transmitters were set up on a building in central Birmingham, both radiating the remarkably small power of 11 watts, one using standard FM, the other DAB (MASCAM/COFDM). To get some idea of how small this transmitter power is, it is worth noting that the BBC's Radio WM FM transmitter that covers the greater Birmingham area has an effective radiated power of no less than 11,000 watts, although a fairer comparison might be to say that normally a transmitter of about 1kW would be needed to give comparable coverage to the 11 watt DAB test transmitter.

The BBC provided a coach fitted with both FM and DAB receivers, and arranged for each passenger to have headphones and a switchbox so that instant comparisons between FM and DAB reception could be made as the coach travelled around Birmingham.

DAB/FM Comparisons	
12 programmes in 4MHz	1 programme in 2.2MHz
Test range 25km	Test range 10km
11 watts power	11 watts power
No Hiss	Hiss when signal weak
No multipath distortion	Multipath – flutter/pops

It was fascinating to hear how the FM signals, which the BBC is currently promoting heavily in its advertising, stressing the quality of reception that is possible, were frequently ruined by the snap crackle and pops caused by electrical interterence and multipath. Switching over to DAB always provided perfect reception, and only when the bus passed deep under the bowels of Birmingham into a long underpass did the DAB signal disappear, quickly and without fuss, as the receiver decided that it really couldn't make anything out of the heavily corrupted digits that it was receiving. As a further test, the bus was driven away from the city centre to see how far the low power transmissions would actually reach. At about seven miles from the city centre the 11 watt FM signals were unusable, but the 11 watt DAB transmissions could still be heard perfectly at a distance of over 15 miles, before failing completely a mile or so later.

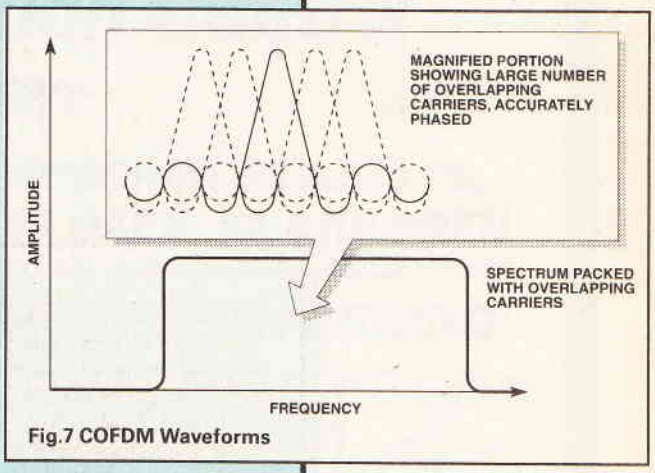


Fig.7 COFDM Waveforms

Such good coverage from such low power transmitters shows that the DAB system is extremely efficient in its use of the radio frequency spectrum. The BBC estimates that if broadcasters could be given an 8MHz slice of the VHF band, which would oniy carry one 625-line TV programme, 24 different stereo radio programrnes could be radiated, including a selection of commercial ones, and the same frequencies could be used over and over again throughout the UK.

DAB (Digital Audio Broadcasting)

- Digital stereo sound
- Satellite or terrestrial
- No interference
- No fading
- No retuning

Single frequency network

One of the major problems with a conventional analogue broadcasting network, whether it uses AM or FM, is that a very large protection ratio is required between the wanted signal and other signals on the same frequency arriving at the receiver after a delay. This situation would occur all the time if there were several transmitters broadcasting the same programme in adjacent areas using the same frequency; notice the parallels with the multipath interference that we discussed earlier. This is the reason why conventional analogue broadcast networks need to use many channels, and conventional networks use carefully planned lattices of transmitters using different groups of frequencies. A disadvantage of this technique is that if it becomes necessary to build a 'fill-in' transmitter to serve a new town, perhaps, it is often very difficult to find a frequency channel that can be used without causing interference to listeners in adjacent areas.

If DAB is used, however, the situation is fundamentally different. We have seen that digital radio signals containing the same programme material that arrive at the receiver with a delay can be distinguished from the direct signal, so long as the delay is less than that of the guard band interval that has been left between the bits of the COFDM modulated digital signals. It thus becomes possible to envisage a network of transmitters covering the country, all of which use the same frequency. As well as using less of the precious radio frequency spectrum than conventional systems, such a system has the further advantage that it allows for any gaps in coverage to be filled by building low power transmitters on the same frequency, since the digital modulation system will ensure that any interference can be rejected; such fill-in transmitters could even be built in tunnels. This single frequency network would obviously make very efficient use of the spectrum, but some means will need to be found of synchronously feeding each of the transmitters in the network with the same modulating signals. This probably implies that all the different radio programmes that are to be transmitted will be pre-assembled at some central location into a single digital multiplex signal, which can then be distributed to the transmitters.

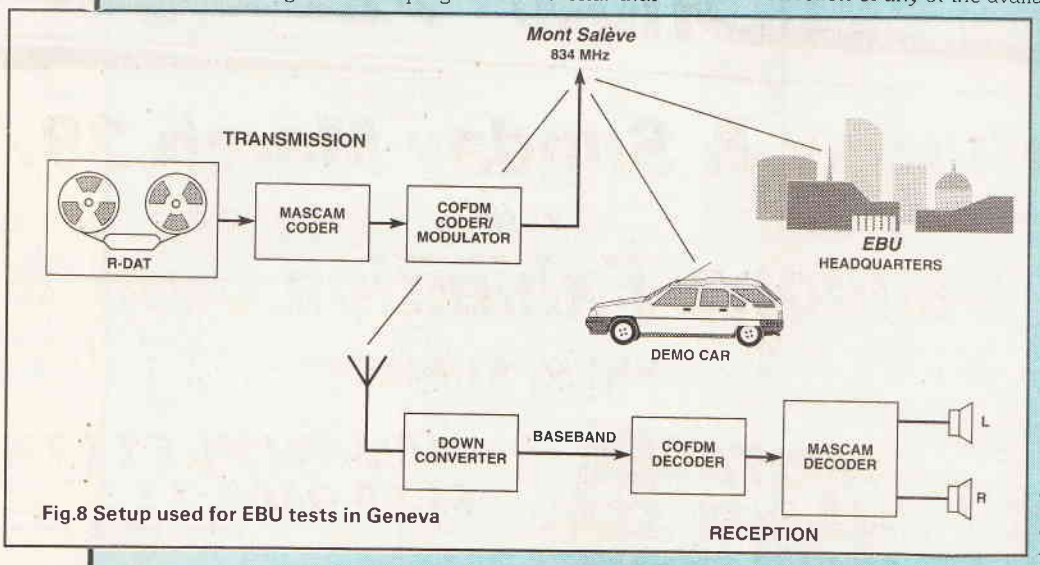


Fig.8 Setup used for EBU tests in Geneva

Hybrid DAB – satellite and terrestrial broadcastmg

We began this article by considering the use of satellites for broadcasting high quality audio. If the DAB system were used from satellites it could be possible to provide the major coverage of countries by satellite, with fill-in stations in built-up areas providing reception in places. where the satellite signals cannot reach, with the same receiver being capable of receiving signals from either source, on the same frequency. Care would have to be taken in designing such a system that the signals from the fill-in stations did not compete for reception with the signals from the satellite, since this could give the effect of a large delay being introduced between the two signals, which, if it exceeded the maximum guard interval allowed by the DAB system, could prevent satisfactory reception. A way around this problem might be to have two complementary DAB systems, with the terrestrial system and the satellite system working on different frequencies. Although this would solve the problem, at the expense of more spectrum space, it would also lead to more expensive receivers, because these would need to switch between the satellite and the terrestrial transmissions.

DAB Receivers

DAB receivers are likely to based on computer technology, with calculator type keyboards allowing for instant selection of any of the available programmes, without the user having to know anything about the frequency or frequencies being used. After the radio frequency input signal has been received by the aerial and appropriately filtered, the multiplex of digital signals will need to be processed, and it seems that Fast Fourier Transform processing will be required. This is currently a fairly complex affair requiring a good deal of exotic integrated circuitry, and if a single world standard for DAB can be achieved it will mean that large scale production of Very Large Scale Integrated Circuits can get underway, and this will lead to very low cost receivers.

Since we cannot introduce DAB on a broadcast band currently used for AM or FM broadcasts, as existing services would be interfered with, DAB needs to begin by operating in parallel with existing services. This means that it needs its own modest but exclusive chunk of the frequency spectrum. There currently appears to be a good deal of interest world-wide in DAB, and it is reasonable to foresee that digital sound broadcasting from satellite and terrestrial transmitters could be practicable within a very few years - if only a frequency allocation can be found! Further demonstrations of DAB will no doubt show members of the public that DAB really can provide perfect quality reception virtually anywhere, but before getting too carried away by this technological marvel it is sobering to remember that it took something over thirty years to convince the majority of the British public of the benefits of switching to FM radio. We will just have to hope that the immediate benefits that DAB can bring will persuade people to make the change much more quickly than this, and it may well be that it is the CD sound quality that does tip the balance in favour of digital radio, and will persuade people to go out and buy a new DAB receiver. I can't wait!

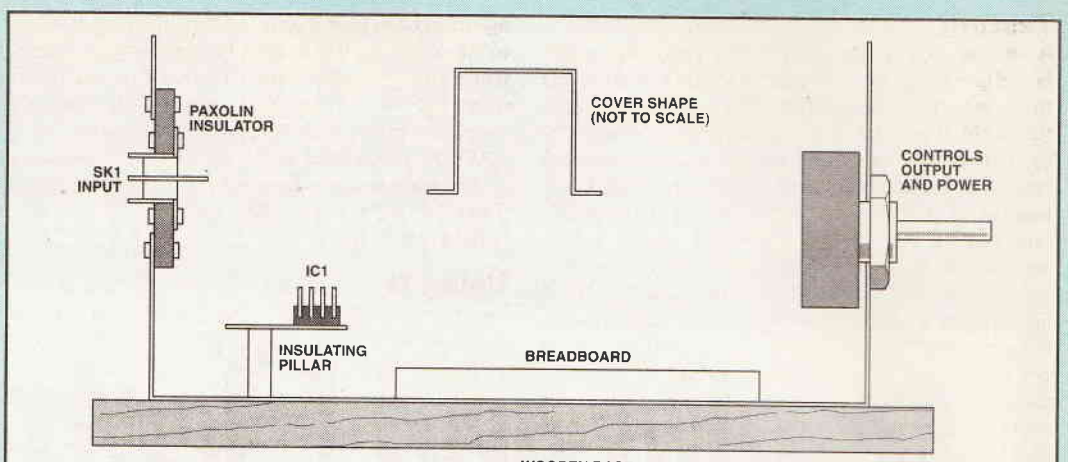


Fig.9 Constructional arrangement

2 Earth Charge Re

The Power Supply

Kevin Garwell continues with his high resistance voltmeter.

PROJECT

The power supply can be quite conventional. Two rails are required, positive and negative. If either of the supplies are used as references the supply or supplies must be regulated. For example referring back to Figure 8 last month, R6 connects the input of IC2 to the +12 volt supply and as a consequence that supply must be regulated. In practice the regulation adds so little to the cost that the regulators might as well be fitted.

The simplest arangement is shown in Figure 11. For the small currents involved (about 10 milli-amps) half-wave rectification is sufficient, and there are no special requirements for the components. The most important point is that the 0v rail is connected to a local earth, ie. not the mains earth.

For the purpose of the ECR almost anything in contact with the earth will do because the currents involved are minute. However there are two most important side effects because the mains electricity is used to power the equipment. The first is safety. Because the mains is involved the earth connection must be a good one. The second is concerned with the capacity between primary and secondary windings. The earth must be sufficiently good to prevent any AC component appearing at the earth. I use a metre length of copper pipe driven into the ground and keep it moist. If you are not happy with the quality of the earth from the safety angle use an RCB in the live and neutral supplies. The RCB is preferable to the earth leakage trip in this instance as the latter employs a relay in series with the earth connection giving the effect we are trying to avoid-a high impedance earth connection.

If the ECR is to be used for experiments in static electricity and the like then batteries can be used. Remember there is less overhead available at the positive rail. Using the ICs suggested the output will only rise to within 2.5 volts of the positive supply, although it will fall to equal the negative supply.

The Probe

The atmospheric probe consists of a flat aluminium plate, 12 inches square, with its edges turned down at 45° to give a little stiffness and stop any tendency to flutter in the wind. Mounted on plastic supports and fitted with a guard-ring to reduce any leakage. I found the method of construction shown in Figure 12 to be effective and fairly simple to make.The aluminium plate is fitted to the top (lid) of a plastic pill box using a couple of small screws and nuts. The pill box, approximately 3 inches in diameter and 5 inches deep, can be obtained empty from a friendly chemist. Cut a hole in the bottom of the pill-box so that it is a snug fit on the plastic tube, 1.5 inch plastic waste pipe as used by plumbers is just the job. Now comes perhaps the most difficult bit. Fastening the pill box to the tube. A hot melt glue gun is ideal for making this joint as it will weld the two together. The joint doesn't actualy have to be watertight but hot melt glue is very handy for welding plastic bits and pieces together. With the aluminium plate fastened to the lid and the pipe fastened to the base of the pill box the next step is fitting the coax. There must be no question of water getting into the coax and the arrangement show seems to be effective. With the ends of the coax prepared for connection it should be bent over into the shape of a walking stick and attached to the wall of the box (I haven't shown this fastening so that I don't obscure the connection details). A 'P' clip and screw is about the simplest so long as the coax is securely anchored and cannot straighten out. Next wrap a length of bare wire round the pill-box to act as a guard ring. Pass the end through a hole in the side of the pill box and connect to the screen of the coax. Add a length of flexible plastic coated wire to the centre conductor and connect the other end of this to one of the screws holding the aluminium plate to the lid. Ensure that there is a loop in both connections so that any moisture would run down the wires and drip off before reaching the coax. Finally fit the lid and the probe is complete. Support it on a length of wood so that the aluminium plate is about 4 metres above the ground. In my case I have to admit to having pinched one of my wife's clothes props. Softwood just over one and a quarter inches square.

Testing

After assembling the components onto the breadboard give the layout a visual check, don't forget to link the case to the 0v/ground line. Then set R1 to 5K and R2 to 1M. If a meter measuring ohms is not available set R1 to half-way and R2 to maximum. And there's the first pitfall. Remember R2 will have 3 connections only two of which are used, the centre and one of the outside ones. But be sure you have turned the pot the correct way for maximum value. Turning it the wrong way ie. to zero will do no damage, it just leaves you with a 100M input resistance meter! For R1 the same applies but as the trimmer is turned half-way it doesn't matter. It will, if you experiment with changing the value. Connect to the power supply or batteries and with NOTHING connected to the input check the output at pin 6 of IC2 is approximately 6 volts, and at the output terminals is 3 volts. With 9 volt batteries the corresponding voltages

ecorder

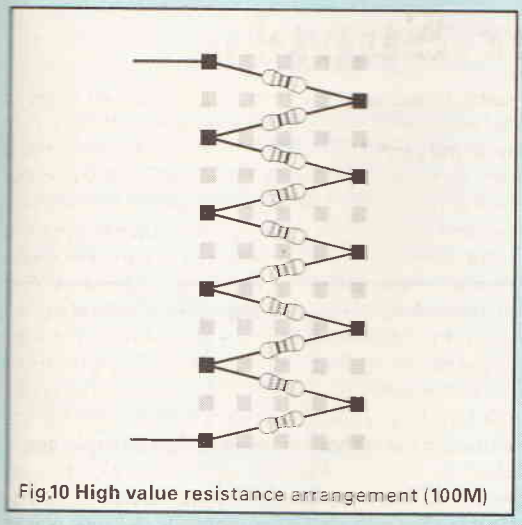


Fig.10 High value resistance arrangement (100M)

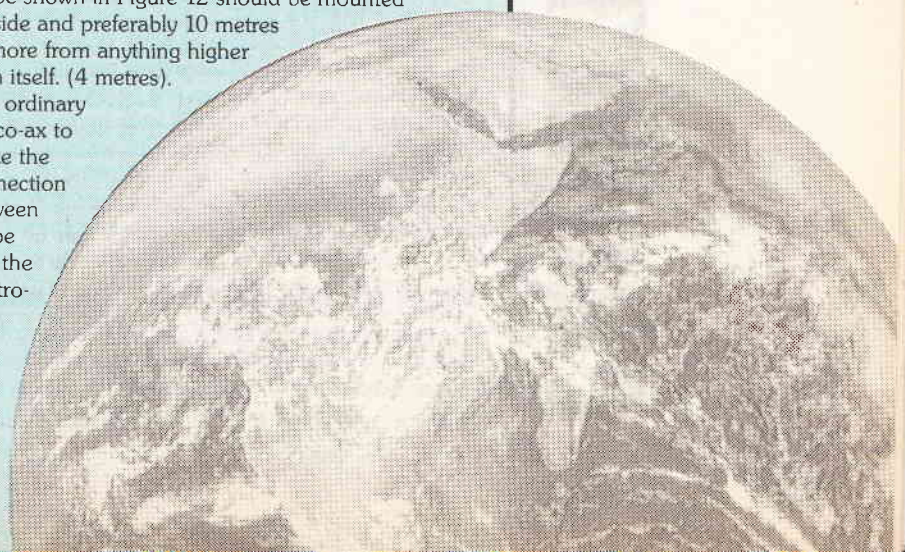
would be 4.5 and 2.25. If the voltage tends to wander about as you move your hands that reinforces the idea that it is working. Fashion a piece of bar copper wire (about 6 inches long) at the end so that it will nicely fit the centre input connector. With power on and a meter connected to the output rub a piece of plastic with a piece of dry cloth. A pen and handkerchief are ideal given that the qualifications apply! Move it towards the wire at the input. The output should rise or fall. Which it does depends on the type of plastic. Try also with a piece of glass. The rise/fall will only occur when the test item is moving. If all this happens then put the lid on and start experimenting. If you want to measure the input resistance it can only be done by experiment. This involves charging a capacitor to a known voltage and then connecting it between the centre input connector and the case (which is connected to the 0v/ground line). Determine the time taken for the voltage to fall to 2/3rds of its start value. This gives the approximate time constant CR where C is the capacitance and R is the input resistance. The experiment is most easily done if a single pole change-over switch is used to connected the capacitor first to the test voltage and then to the input. The other legs of the battery and capacitor being connected to the case of the device. The test voltage must be at least 2 volts less than the supply voltage to the device. eg. 9 volts for a 12 volt supply, or 6 volts if you are using 9 volt batteries. The switch and capacitor must be beyond reproach, the switch preferably ceramic or plastic and the capacitor polystyrene (about 1000p to 4700p) and all dry with it. It only remains to do the arithmetic and here the problem will be getting the indices right because otherwise there will be a lot of noughts sculling about!

Using It

The voltmeter allows the investigation of static charges in general by fitting a 6 inch length of wire directly to the socket on the device and connecting a suitable conventional voltmeter to the output. As shown in Figure 8 the meter should be connected to the output of IC2 op-amp rather than the junction of R9 and R10. This will enable full use to be made of the low resistance output of the IC. A simple moving coil meter of 5mA or less FSD with an appropriate series resistor is fine. There is no need to tie up an expensive multi-range meter. If the meter plus resistor has a full scale reading of 10V then the equivalent input voltages are, 0 is equivalent to −12V in. 6 to 0 in, and 10 to +8 in. These conversions can be used to determine the voltage at the probe. Alternative ranges can be achieved by changing R5 and R6 but the input can only be measured between −12 and +10V. Knowing the voltage at the probe is not the same as the actual voltage because of the voltage drop across the intervening atmosphere. The situation is equivalent to measuring the voltage of a battery with a resistor in series with the voltmeter. A number of effects can be observed. Charges generated by TV sets, or by friction between various materials. There is no need to touch these things with it, getting anywhere near will show that an electric field is present. One effect which puzzled me for some time was observed whilst building and testing the first one. Without the cover on, the output kept changing by a small amount. The movement seemed quite erratic there being no apparent reason. Eventualy I cottoned on to the solution. It was all due to movement of my feet on the floor. I realised that such movement changed the capacity between myself and earth (ground). Such a change produced a corresponding change in my potential with respect to earth. Remember CV=Q. Halving the capacity will double the voltage if the quantity of electricity is constant. It must be remembered that the meter does require a current for its operation however small (FSD = 4×10^{-10} Amperes) so that it will always cause any charge to leak away, unlike the gold-leaf electroscope.

The Atmosphere Charge

In this case the device will be under cover preferably in an atmosphere which is reasonably dry. My workshop, which is not attached to the house, isn't centrally heated, but is brick built seems to be perfectly OK. The probe shown in Figure 12 should be mounted outside and preferably 10 metres or more from anything higher than itself. (4 metres). Use ordinary TV co-ax to make the connection between probe and the electronics. If



any couplings are used be careful to keep them dry as any moisture in them will defeat the insulation and be very difficult to dry out. The meter referred to above, reading 0-10V is suitable for reading the output as an indication of the atmospheric situation. Clear summer skies usually give just above 6V on the meter ie. the voltage at the probe is just fractionaly above zero. On the other hand cloud cover will give values approaching zero and indeed may be so negative that the meter just indicates zero, the input IC being cut off. If a meter is connected you may be lucky and see it kick up with one of the spikes under study. However a more certain way is to provide some sort of recording device. A chart recorder running at 1/2 inch an hour will do fine. However the ones which produce a trace by making dots on

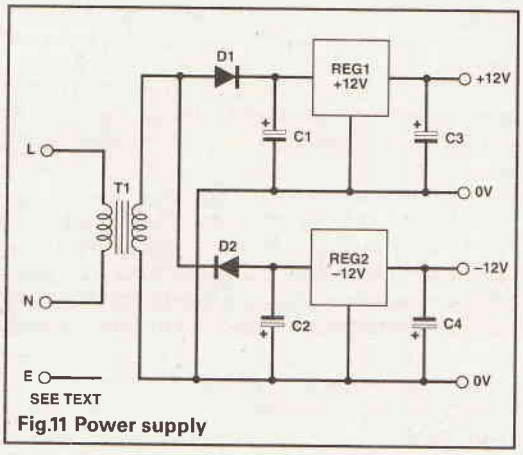


Fig.11 Power supply

the paper will NOT do for the very simple reason that the spikes last so short a period they can so easily be missed on this type of recorder. Between dots as it were. Failing a chart recorder one can resort to our old friend the computer. The requirements are fairly simple. A method of reading (digitising) an analogue input, a timing device, and some form of media for recording the data. The timing device must be fairly accurate eg. not more than a minute of error per week. The digitiser need not be very special. The machine I use only digitises to 6 bits (ie 0 to 63) and that is quite sufficient. Finally for recording, a disc is ideal, but tape is acceptable. The only drawback to tape being the time taken to read the results. In an ideal world a second computer to interpret the results is available! As it happens I have both a Dragon micro with a disc and an Amstrad PC with twin discs. As one might expect the disc format is different so one cannot take discs from the Dragon and read them in the PC. Well you can because both machines are able to read specific tracks, sectors etc, but doing so would become a real exercise in programming which would be fine for the enthusiast but would take time. In the event I was able to avoid the issue because I have a device which will take the output from the printer port (on the Dragon-practically every machine will have a parallel printer output port) and convert it to RS232 serial form which is available on a PC. See Figure 1. The BBC machine would do nicely because if my memory serves me correctly it has an analogue input, a timer and will write to disc or tape. Another possibility is a PC with a digitising board fitted in a vacant slot. Since the are so many ways of achieving the required effect perhaps the best thing is to describe how my system works to illustrate the various points.

What Do We Do With The Data?

The data generated by the ECR/DRAGON recording system is saved minute by minute along with the day number, hour and minute numbers. A typical line might look like this:

7 6 48 30 28 1

Which translates to-day 7, hour 6, minute 48, max 30, min 28 and maximum difference during 1 second is 1. This was taken from an actual record in file T0906.ECR ie. 1991 September 6th. The following 4 records were:

7 6 49 30 28 1
7 6 50 36 28 7
7 6 51 31 29 1
7 6 52 32 30 1

One can see clearly that at the 50th minute there was a blip of magnitude 7. These values are on a scale 0 to 63 the range which the analogue inputs on the Dragon give. Primarily it is the occurence of the blip which is of interest and not its absolute magnitude. However we can easily calculate the real values.

It looks as though it may be easier to derive an expression by starting at the front rather than work backwards.

Let the input voltage be X
Let the recorded value be V

Also the gain of IC1 and IC2 is unity so their ouput voltages will be the same as their input voltages.

Hence the output of IC1 is X
The input to IC2 is (X+12)/2
Output at the junction of R8 and R9 = (X+12)/4
A scale of 0-64 represents 0-5V
Scaling the output by 64/5 gives:
V = (X+12)/4 * 64/5
V*5/64 = (X+12)/4
V*20/64 = X+12
X = V*20/64 −12
or
X = V*0.3125 −12
And for the difference:
X = V*0.3125
The line above for the 50th minute therefore is:
7 6 50 36 28 7
7 6 50 −0.75 −3.25 2.1

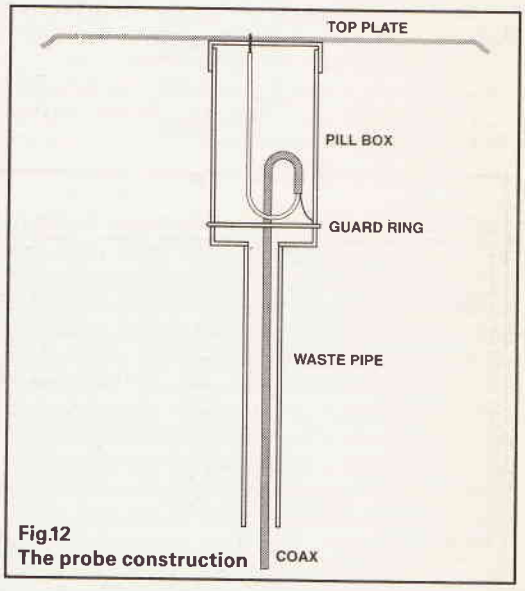


Fig.12 The probe construction

A word of caution here. Remember these are the voltages at the probe and because the input resistance is less than the atmospheric resistance they do not indicate the true voltage. As a very rough and ready guide the true voltages would be about ten times as much.

Having discussed the data we still haven't answered the opening question what to do with it. The answer is fairly simple. Look for the blips. This is more difficult to do because there is a lot of it. The average size of a daily file seems to be about 11 Kbytes. The search for, must be performed by computer would you believe and after much trial and error the currently

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most suitable seems to be to classify the 1 minute differences on an hourly by amplitude basis.

Figure 13 shows one such chart. The figures on the left are the hour (GMT or UTC is best. It confuses the issue somewhat if BST is used. It is also important that GMT is also sun-time ie time 0000 coincides with being furthest from the sun).

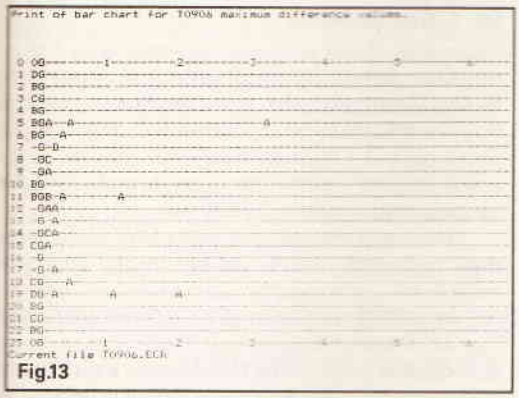

Fig.13

To the right of the hour figures are 64 dashes representing the value from the Dragon digitiser 0 to 63. For each hour the number of occurrences of each value are inserted by using code letters. A is one occurrence, B two or three, C four to seven and so on. Thus for 0000 hours there were 64 or more occurrences of a difference of 1 and no others. For 0100 hours there were 8 or more differences of 0 and 64 or more of 1. At 0500 hours 2 or more 0s, 64 or more 1s, 1 of 2, 1 of 5 and 1 blip of 32.

1900 hours is interesting. A comment in the data file reads "Was it me at 1908" the story is this. At my home where these readings are taken the probe is at the side of the garden not very far from one of these garden swing things. I make a practice of putting the seat cushions in plastic bags when not in use and at 1908 on the evening of 6th September that is just what I was doing. We all know (or we will when we've played with the ECR) that any friction between man-made fibres produces some strong electric charges. So I repeat my comment — was it me? Those three As at 1900 are an odd coicidence if not!

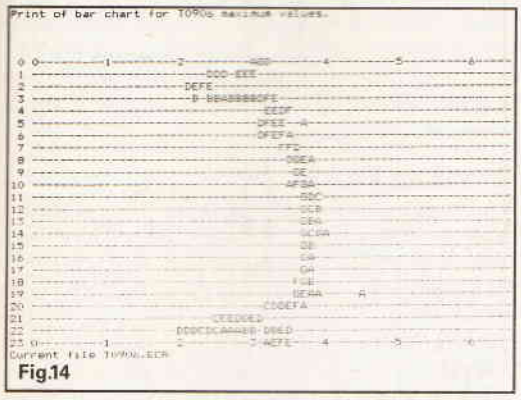

Fig.14

To make a comparison the equivalent chart plotting maximum values is shown in Figure 14. Just to reiterate the destinction Figure 14 shows maximum real values whilst Figure 13 shows maximum differences. The plot in Figure 14 can be converted to real values at the probe by using the formula discussed previously, and which is approximately, probe voltage = 0.3V-12. The highest voltage recorded on the 6th September was (would you believe) at 1900 hours and was 45*0.3 −12 = +1.5 volts. The letters have the same significance as before ie they indicate the number of occurrences.

The day in question (6/9/91) was one of Septembers gorgeous sunny days. The highest voltage reached (ignoring the blip at 1900) being after 1400 hours, at 40 on the chart ie. 0 volts. I have no cohesive explanation of the shape of the chart. It may be reasonable to suggest that the 1400 hours figure is due to the fact that the sun's effect will have produced the lowest humidity. This will give the highest atmospheric resistance and with no strong charges around this would give zero volts input. That seems believable but what about the two dips at 0200 and 2200 with voltages of −5.7 and 6.0 respectively? The evening one might be the effect of a sharp fall in temperature after a very hot day producing condensation which would lower the humidity and hence the atmosphere becomes more conductive, but where did the negative charge come from? As far as I'm aware there were no clouds about.

How Is The Data Analysed?

The data analysis is done by transferring the data from the Dragon to an Amstrad PC1640DD (an IBM PC look-alike), and then using a program I wrote especially for the purpose.

As the Dragon has no RS232 interface I use a convertor fitted to the printer output. This converts to 2400 Baud, no parity, 8 data bits, and one stop bit. Because we have several Dragons in use here and at the Sciences Centre I have produced a board which has an RS 232 interface which converts to 8 bits plus strobe and busy in, and to 8 bits plus strobe out. These are usefull for interfacing logic to RS232 in either or both directions and In this case giving Dragons an RS232 capability.

The fact that the Dragon is in the garage (where else would I keep it?) and the PC is in our small bedroom (which is not what my wife calls it) is of no great consequence as one of the chief reasons for choosing RS232 as our 'standard interface' was the fact that only three wires are required, transmit, receive and common. Any low voltage 3 core cable is good enough, or mains cable, whichever is the cheaper. The required PC commands are encapsulated into a batch file call GETCD.BAT which stands for get comms data.

The batch file is:

```
echo off
echo Setting up coms link
mode com1:
2400,n,8,1,p
echo Waiting for file(s)
b:
for %%n in(A1,A2,A3,A4,A5) do copy com1
%%n.GCD
```

In action I just give the command getcd on the PC. It gives the messages "Setting up comms link" followed by "Waiting for file(s)". Then a trip downstairs to the Dragon to print the appropriate data file(s). Each file must be terminated with decimal 26 which is the PC end of file character. On the Dragon this appears in BASIC as:

```
print#−2,chr$(26);
```

As the PC batch file expects 5 files (no magic just a convenient number), if less than five files are sent the end of file characters must still be sent. In fact I have a little program on the Dragon which sends up to 5 named files, each sending ending with chr$(26). If there are less than 5 named files the end of file characters are still sent. After the end of file character a delay of 5 seconds is inserted to give the PC time to action the closure and get ready for the next file.

Done this way its all fairly straightforward. Just initiate the batch file on the PC and then run the Dragon program giving the named files. Then back to the PC to rename the files as appropriate. That is according to the first line of the file which carries the date.

The Dragon program is as follows:

```
Identity, copyright and declare array
5 DATA TRANSMIT FILE TO COMMS V1.00
8 DATA COPYRIGHT K GARWELL 1991
20 CLEAR500:DIMNF$(4)
Clear screen and put up headers
1000 READHD$:READCR$:CLS:PRINT@32,HD$:PRINTCR$

Read up to 5 file names. A null entry will terminate the loop by setting I=5
1010 PRINT:FORI=0TO4
1020 INPUT"FILE NAME";NF$(I)
1030 IFNF$(I)=""THENI=5
1040 NEXT

Print however many files were specified
Giving the file number and line count as they are sent
1100 FORI=0TO4:LC=0:PRINT@320,"FILE";I+1:PRINT
1110 IFNF$(I)=""THEN1160
1120 IFEOF(NF$(I))THEN1150
1130 FLREADNF$(I);FD$:PRINT#-2,FD$
1140 LC=LC+1:PRINT@352,LC;" ";:GOTO1120
Close the file and send the terminating character, then wait 5 seconds
1150 CLOSE
1160 PRINT#-2,CHR$(26);:WAIT5000
1170 NEXT
```

The program for analysing the data is written in BASIC and then compiled. This gives a faster running program. Interpreted BASIC can be used eg. GWBASIC but be prepared to wait for the results. The following synopsis has been extracted from the source code. The compiler doesn't use line numbers.

```
Data Earth Charge Recorder data Scanner V2.01 data Copyright K Garwell
1991
'History
'V1.00 14/6/91 Derived from ECS Mk1 to print bar charts
'V2.01 07/09/91 Used to replace ECS and provided with write '
bar charts to file facility.
'Synopsis
'Enter list of files, ie. dates for charts
'Select variable to be charted, default %maxdif
'Load data from files to charts, merging all in "accumchart" 'View results in
any order on request or write them direct
' to file
'Set order of printing results
'Set draft or letter quality
'Print results accordingly 2 per page
```

The accumchart referred to is an abreviation for accumulation chart which gives the totals for all the other files processed in the run. Usualy a weeks worth. This chart is useful for the overview it gives and helps to decide whether the is any pattern to the blips.

The important bit is "load data from files to charts" and involves taking each line of data, separating each value and assigning it to the appropriate chart. The synopsis for this is:

```
for each entry in the file
if its a line of data then for each item of data
' (day, hour, minute, max value, min value, max dif)
get its value and store in an array of item values eg. items(5)
increment an array of values depending on chartnumber,hour,item
increment the accumchart
next
else
'its a comment
save comment in a string array
end if
next
```

Having loaded the chart array with the total counts there just remains the question of showing/printing the figures in a form which is easy to assimilate. The form chosen is a horizontal bar chart with a line for each hour. The counts are then encoded into letters, A representing 1, B 2, C up to 4, D up to 8, and so on. A typical pair of charts are shown in Figures 13 and 14.

The two charts are for the 6th Sept. 91. Figure 13 shows the maximum differences. Significant blips occurring at 5am with lesser ones at 1100 and 1900 hours. Figure 14 shows the maximum values for the same day.

As the source for the analysis program is lengthy, about 400 lines, I hesitate to include it here because it would just be hard graft copying it. For anyone who doesn't like the idea of writing it I can provide a copy of mine with a few notes on driving it, for the sake of the price of a disc plus p&p. Send via ETI office.

In Conclusion

Three areas of use have been suggested so far. Experiments into static electricity for instance as generated by friction. Detection of blips, that is short term changes in the potential existing at an external probe a few metres above ground. Observation of daily changes in the actual potential existing at an external probe, possibly with associated weather conditions.

In my case the detection of the blips which, it has been suggested, may be caused by the advent of meteors into our atmosphere is the prime concern. So far only one rig is available which has certainly shown blips at all times during the day. This is contrary to my expectations which would have been to expect a bias towards the hours (midnight to midday sun time) when the portion of the earth containing the observation point is facing (overhead) the direction of the earth's travel. Just how this expectation would be modified if (as I also suspect) the area of perception is local ie. within a 40 km circle I'm not yet sure.

To help to resolve these hypotheses the next step must be to have two rigs a few miles apart and compare the results. If the blips occurr at identical times then it is most likely that they are of natural origin and for the timing to be similar the source must be the same distance from the two probes. This could really only be the case if the source were overhead and fairly distant compared with the distance apart. This would really strengthen the meteor theory. If the timing were similar but not the same it would suggest some natural source for example rapid changes due to cloud motion. If the blips don't match time wise then the origin is likely to be man-made.

The most important factor in this experiment is that the two rigs are identical in every respect. For this reason we are going to adopt a height of 4 metres above ground for the probe and 10 metres of coax connecting the probe to the equipment, even if the full 10 metres is not necessary. The circuitry can easily be made identical, and in my case two Dragons are available. If this were not so the important thing would be to sample the probe potential at similar intervals. Currently one second.

Further Work

One disadvantage of the arrangement as described is that the probe or rather the electronics does require a current to provide the measurement. That is it is not a true electrostatic volmeter and hence the circuit is not strictly as shown in the early Figures. To be accurate the ECR must be represented as having series resistance. This means that the potential at the probe is not the same as the atmospheric potential surrounding it, except in the special case when the input current is zero. However the input resistance of the system can easily be changed by changing the value of R2 in Figure 8. This could be done under program control given a suitable interface. There is therefore the opportunity to take measurements at various input resistances. This lends itself to the idea of solving simultaneous equations with two unknows. The true potential and the resistance of the atmosphere.

Another change which can be made is to alter the interval at which measurements are taken. Recording each event rather than a minute by minute summary. The amount of data produced by such a change could

be reduced by only recording events in which the change is greater than a certain value. As yet I have had no use for the minimum value so there is the possibility of omitting it as a further reduction in the data captured.

Currently the negative excursions at the input are disproportionately large. The output frequently appearing as zero ie: −12V at the probe. A logarithmic scale would be useful here. As an alternative to a logarithmic scale there is the possibility of a series capacitor in the probe so that the device differentiates the probe potential. Given a time constant of a few seconds IC1 would not be cut off. The problem here may be the capacitor since its insulation resistance needs to be an order of magnitude greater than the input resistance. The capacitance would need to be something like 4700p with an insulation resistance of 2×10^{13} ohms. The only readily available and reasonably priced capacitors in this range are polystyrene which claim the insulation resistance to be $>10^{11}$. Alternatively a two gang air-spaced 500p might be worth a try, but they are definitely expensive. Undoubtedly polystyrene would be the first to try.

Clearly much will depend on the result of having two systems operating simultaneously.

PROJECT INDEX 1972-1992

AUDIO

		Mth	Yr	Pg
2W power amplifier		Nov	1980	72
50-50 watt power amplifier module		Jan	1976	33
50/100W amplifier modules		Mar	1977	18
100W disco mixer/amplifier		Feb	1979	64
100W guitar amplifier		Feb	1973	52
	Errata	Apr	1973	90
100W MOSFET power amplifier		Aug	1980	64
	Errata	Sep	1980	11
100W stereo disco console	part 1	Sep	1976	42
	part 2	Oct	1976	51
	part 3	Nov	1976	63
	Errata	Nov	1976	8
150W MOSFET Amplifier		Jun	1982	48
200W power amplifier		Apr	1978	43
300W amplifier module		Apr	1980	58
2040 11 active loudspeaker		Sep	1982	46
	Errata	Nov	1982	75
Active-8 loudspeaker	part 1	Sep	1984	45
	part 2	Oct	1984	56
	part 3	Nov	1984	36
	part 4	Dec	1984	24
Active bass loudspeaker		Jan	1985	15
Active crossover, two or three way	part 1	Dec	1975	11
	part 2	Jan	1976	38
Active loudspeaker		Nov	1983	68
	Errata	May	1984	69
Active loudspeaker, 2040 11		Sep	1982	46
	Errata	Nov	1982	75
Amplifier, 2W power		Nov	1980	72
Amplifier, 15 wpc, SQ quadrophonic		Apr	1974	16
Amplifier, 50 wpc stereo	part 1	Aug	1974	23
	part 2	Sep	1974	60
Amplifier, 100W disco mixer		Feb	1979	64
Amplifier, 100W guitar		Feb	1973	52
	Errata	Apr	1973	90
Amplifier, 100W MOSFET		Aug	1980	64
	Errata	Sep	1980	11
Amplifier, 150W MOSFET		Jun	1982	48
Amplifier, 200W		Apr	1978	43
Amplifier, 12V DC portabie radio booster		May	1975	55
Amplifier, acousdix bridge 20W		Feb	1992	51
Amplifier, (JLH) Audio Design	part 1	Jun	1984	24
	part 2	Jul	1984	44
	part 3	Aug	1984	30
	part 4	Sep	1984	59
	Errata	Oct	1985	58
Audio Design update		May	1989	25
	Errata	Nov	1989	60
Amplifier, bench (Short Circuit)		Feb	1977	52
Amplifier, bench		Aug	1979	67
Amplifier, bench		Dec	1980	74
Amplifier, (The Business) Bass amp	part 1	Mar	1990	14
	part 2	Apr	1990	42
	part 3	May	1990	42
Amplifier, combo (ETI Sonneti)		Mar	1985	22
	Errata	Jul	1985	27
Amplifier for personal hifi systems (ETI Walkmate)		Jan	1986	41
Amplifier for record players (Using the LM380)		Dec	1974	34
	Errata	Jan	1975	70
Amplifier for stereo testing		Jul	1977	30
Amplifier, guitar effects	part 1	Aug	1982	28
	part 2	Sep	1982	16
Amplifier, guitar practice		Apr	1982	12
Amplifier, guitar practice		Jul	1990	39
	Errata	Jul	1990	60
Amplifier miniature (ETI Matchbox)		Apr	1986	40
Amplifier module, 50+50 watt		Jan	1976	33
Amplifier module, 300W		Apr	1980	58
Amplifier modules, 50/100W		Mar	1977	18
Amplifier portable PA	part 1	Apr	1986	19
	part 2	May	1986	43
Amplifier portable PA		Sep	1987	31
Amplifier Power (Virtuoso)	part 1	Apr	1988	26
	part 2	May	1988	36
	part 3	Jun	1988	49
Amplifier (Virtuoso) MOSFET Upgrade		Nov	1989	36
Amplifier simple 1.5W		Sep	1974	32
Amplifier, simple stereo		Mar	1975	26
Amplifier (Small Fry)		Dec	1988	44
Amplifier, stereo, 5 w.p.c.		Jan	1977	10
		Apr	1977	7
Amplifier, stereo (ETI Microamp)		Feb	1986	38
Amplifier, stereo, International'25	part 1	Oct	1975	26
	part 2	Nov	1975	54
	Errata	Dec	1975	76
Amplifier, stereo, 'Sweet Sixteen'		Jul	1976	38
Amplifier, System A	part 1	Jul	1981	52
	part 2	Aug	1981	40
	part 3	Sep	1981	66
	Errata	Oct	1981	13
	Errata	Feb	1986	54
Amplifier, the Audiophile		Oct	1979	55
	Errata	Oct	1980	11
Amplifiers, phono, high quality		Feb	1982	45
Attenuator, variable 0-59dB		May	1973	53
Audio analyser		Oct	1986	43
Audio buffer		Jan	1980	82
Audio Design amplifier	part 1	Jun	1984	24
	part 2	July	1984	44
	part 3	Aug	1984	30
	part 4	Sep	1984	59
	Errata	Oct	1985	58
Audio frequency meter, 50Hz-10kHz		Jul	1973	66
Audio level meter		Mar	1976	17
Audio limiter		Dec	1976	58
Audio noise generator		Apr	1976	22
Audio mllllvoltmeter, 'A' weighted		Apr	1976	26
Audiophile amplifier system		Oct	1979	55
	Errata	Oct	1980	11
Audiophile FM tuner		Jan	1981	62
Audiophile moving-coil preamplifier		Jan	1980	29
	Errata	Feb	1980	17
	Errata	Apr	1980	15
Audio power meter		Jun	1976	29
Audio power meter		Mar	1979	67
Audio power meter		Mar	1984	35
Audio source selector, digital	part 1	Nov	1986	26
	part 2	Dec	1986	47
	part 3	Jan	1987	52
Audio spectrum analyser		Jun	1978	27
Audio test oscillator, 30Hz-60kHz		Nov	1980	27
Audio wattmeter, direct reading 0-50W		Oct	1973	46
Auto-amp 12V DC portable radio booster		May	1975	55

		Mth	Yr	Pg
Auto volume control		Sep	1982	63
Balanced line preamplifier		May	1983	38
Bass booster		Mar	1973	44
Bass enhancer for small loudspeakers		Jun	1977	53
Bench amplifier (Short Circuit)		Feb	1977	52
Bench amplifier		Aug	1979	67
Bench amplifier		Dec	1980	74
Better sound for £2		Feb	1973	58
Bias optimiser for tape recorders		Jun	1980	44
Boosting amplifier output		Feb	1976	51
Bridging adaptor for the Series 5000 amplifier		Jul	1982	85
Bridging amplifier inverter		Oct	1978	41
Bridging two ETI 100w guitar amplifiers		Nov	1975	30
CCD phaser		May	1978	57
	Errata	Jul	1978	7
Ceramic cartridge preamplifier		Sep	1975	41
Click elimInator	part 1	Jan	1979	73
	part 2	Apr	1979	41
Clipping indicator for power amplifiers		Nov	1973	56
Combo amplifier (ETI Sonnet)		Mar	1985	22
	Errata	Jul	1985	27
Compander(compressor/expander)		Nov	1977	11
Compressor gate direct injection		Dec	1985	46
Compressor/limiter		May	1983	32
	Errata	Jun	1983	11
Digital audio selector	part 1	Nov	1986	26
	part 2	Dec	1986	47
	part 3	Jan	1987	52
Digital cassette deck	part 1	Sep	1984	27
	part 2	Oct	1984	28
Direct injection box		Sep	1985	43
Direct injection box, Passive		Mar	1991	47
Active		Apr	1991	15
Direct inject compression gate		Dec	1985	46
Disco console, 100W stereo	part 1	Sep	1976	42
	part 2	Oct	1976	51
	part 3	Nov	1976	63
	Errata	Nov	1976	8
Disco mixer	part 1	Jul	1981	39
	part 2	Aug	1981	76
	part 3	Sep	1981	42
Disco mixer, 4 into 2		Feb	1977	16
Discrete SQ decoder for quadrophonic systems		Jun	1974	60
Distortion meter	part 1	Jan	1985	55
	part 2	Feb	1985	37
	part 3	Mar	1985	43
Double Quad ESLs in parallel		May	1975	44
Dummy load for audio testing		Jan	1982	71
Dynamic noise reducer		Sep	1979	35
Dynamic record noise filter	part 1	Feb	1976	37
	part 2	Mar	1976	62
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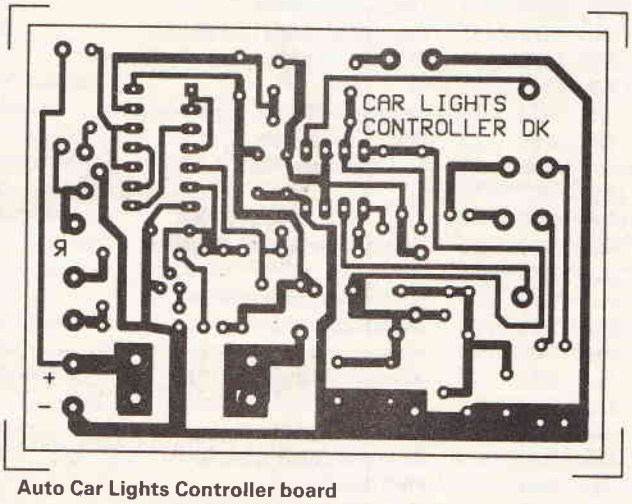

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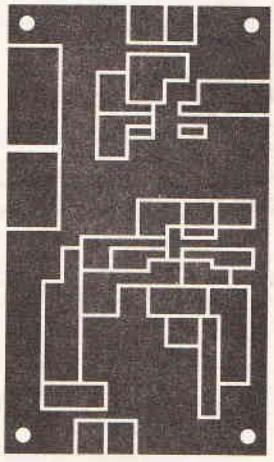

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NEXT MONTH

Future issues of ETI will give you extra value! ETI will contain more projects and more pages. In the extra pages we can bring you more of those interesting project ideas for you to experiment with. From a beginners level to advanced old hands we will try to satisfy every ability in the creation of electronic aids and to keep you informed of commercial and academic developments.

Our projects include, a neat little device for the detection of Bats (the flying kind), a pond or water level control system, a Xenon flash trigger and a scanner for our surface-mount signal generator featured in the March issue. We must not forget our major project, the Automate 20 mixing desk. It continues with a look at the features available in this huge project. John Linsley-Hood also continues with his high quality pre-amp. This exciting world of electronics will be available in your shops on 3rd April, don't miss out!

The above articles are in preparation but circumstances may prevent publication

LAST MONTH

Projects and articles featured in the March issue were:

MIDI Switch
Earth Charge Recorder 1
Audio Sine-Wave Generator
Digital Audio Broadcasting 1
UV Radiation
High Energy Discharge Systems
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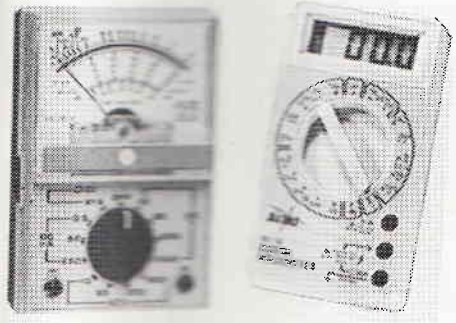

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19 ranges, 3.5 digit 12mm LCD, signal injector, diode test, fuse protection, auto polarity and zero, supplied with battery, leads and instruction manual.
Dim. 125 × 70 × 24mm £14.73

MM195E DIGITAL METER
17 ranges (inc 10A dc), 3.5 digit 12mm LCD, diode test, buzzer, auto polarity and zero, over-range ad low battery indication, supplied with battery, leads and instructions.
Dim. 130 × 72 × 33mm £23.40

TL34 DIGITAL METER
30 ranges (inc 20A ac/dc) PTC and fuse protection, 5 capacitance ranges, transistor test, 3.5 digit large 24mm display. Heavy duty case with tilt stand. Supplied with battery, leads and instructions.
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ELECTROLYTIC RADIAL CAPACITORS

uF	16V	25V	63V	100V
0.47	–	–	£0.05	£0.07
1.0	–	–	£0.05	£0.06
2.2	–	–	£0.05	£0.06
4.7	–	–	£0.05	£0.08
10	£0.05	£0.05	£0.06	£0.08
22	£0.05	£0.05	£0.09	–
47	£0.06	£0.06	£0.11	–
100	£0.06	£0.09	£0.11	–
220	£0.06	£0.12	£0.31	–
470	£0.15	£0.19	£0.57	–
1000	£0.22	£0.29	–	–
2200	£0.37	£0.57	–	–
4700	–	£1.11	–	–

ELECTROLYTIC AXIAL CAPACITORS

uF	16V	25V	63V	100V
0.47	–	–	–	£0.15
1.0	–	–	£0.10	£0.10
2.2	–	–	£0.10	£0.10
4.7	–	£0.09	£0.10	£0.10
10	–	£0.12	£0.12	£0.12
22	–	£0.09	£0.13	£0.17
47	£0.10	£0.11	£0.16	£0.20
100	£0.10	£0.13	£0.21	–
220	£0.13	£0.18	£0.42	–
470	£0.21	£0.20	£0.69	–
1000	£0.33	£0.40	£1.05	–
2200	£0.52	£0.54	–	–
4700	£0.90	–	–	–

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Miniature Toggle Switches 3amp 250v 6.4mm ø mounting	
SPST Toggle	£0.58
SPDT Toggle	£0.54
SPDT CO Toggle	£0.62
DPDT Toggle	£0.66
DPDT CO Toggle	£0.74
DPDT CO Toggle (biased)	£1.20
DPDT CO Toggle (biased 1 way)	£1.20
DPDT mini slide	£0.15
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1 POLE 12 WAY	£0.75
2 POLE 6 WAY	£0.75
3 POLE 4 WAY	£0.75
4 POLE 3 WAY	£0.75
Key Switch SPST	£2.75
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Push to break	£0.24
Latching Push Sw	£0.55
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BNC Solder Plug	£0.85
BNC Crimp Plug	£0.68
BNC Solder Skt	£1.06
BNC Chassis Skt	£0.78
PL259 5.2mm	£0.58
PL259 11mm	£0.58
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SQR UHF socket	£0.40
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F Plug RG6	£0.27
N Plug RG8	£1.64

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W005 1.5A 50V	£0.19
W02 1.5A 200V	£0.20
W10 1.5A 1000V	£0.24
BR32 3.0A 200V	£0.36
BR62 6.0A 200V	£0.64
1004 10.0A 400V	£1.39

D CONNECTORS

SOLDER BUCKET TERMINALS

	Plug	Socket
9 Pin	£0.29	£0.30
15 Pin	£0.39	£0.39
15 Pin HD	£0.81	£0.90
23 Pin	£0.40	£0.42
25 Pin	£0.46	£0.50
9 Way plastic cover		£0.30
15 Way plastic cover		£0.33
23 Way plastic cover		£0.36
25 Way plastic cover		£0.36

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0.25W 5% CF E12 Series	£0.60/100
0.5W 5% CF E12 Series	£0.95/100
0.25W 1% MF E12 Series	£1.72/100
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PRESETS Skeleton Horz or Vert 100R — 1MO 0.1w	£0.11

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CA324	£0.23
LM348N	£0.31
LF351N	£0.36
LM358N	£0.27
LM377	£2.57
LM380N	£1.12
LM381	£2.70
LM386	£0.48
LM387	£1.60
LM392N	£0.79
LM393N	£0.28
CA555	£0.22
NE556N	£0.36
NE567N	£0.36
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LM748CN	£0.31
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TBA820M	£0.39
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CA3080	£0.72
CA1310	£0.98
CA3140	£0.44
CA3240	£1.22
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LM3914	£2.70
LM3915	£2.70
MC4558	£0.36
NE5532	£0.80
ICL7621	£1.70

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78L12	£0.24
78L15	£0.24
79L05	£0.28
79L12	£0.28
79L15	£0.28
7805	£0.28
7812	£0.28
7815	£0.28
7905	£0.38
7912	£0.38
7915	£0.38
LM317T	£0.44
LM723	£0.29

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5mm Red LED	£0.09
5mm Green LED	£0.10
5mm Yellow LED	£0.10
5mm Orange LED	£0.10
3mm Red LED	£0.08
3mm Green LED	£0.12
3mm Yellow LED	£0.13
3mm Orange LED	£0.13
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5mm Flashing Green	£0.54
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5mm Tri Colour	£0.48
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5mm Plastic Bezel	£0.05
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common anode	£1.14
common cathode	£1.14

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74LS02	£0.18
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74LS04	£0.14
74LS05	£0.17
74LS08	£0.17
74LS09	£0.17
74LS10	£0.17
74LS11	£0.17
74LS12	£0.16
74LS20	£0.16
74LS21	£0.16
74LS30	£0.16
74LS30	£0.17
74LS32	£0.17
74LS37	£0.16
74LS42	£0.25
74LS51	£0.19
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14 Pin	£0.11
16 Pin	£0.15
18 Pin	£0.15
20 Pin	£0.16
24 Pin	£0.19
28 Pin	£0.22
40 Pin	£0.25

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IN4001	£0.07
IN4002	£0.07
IN4003	£0.07
IN4004	£0.07
IN4005	£0.07
IN4006	£0.08
IN4007	£0.08
IN5400	£0.09
IN5401	£0.09
IN5402	£0.09
IN5404	£0.11
IN5406	£0.11
IN5407	£0.15
IN5408	£0.15
IN914	£0.06
IN916	£0.06
IN4148	£0.04
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OA47	£0.28
OA90	£0.07
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4000	£0.20
4001	£0.17
4002	£0.19
4006	£0.32
4007	£0.20
4008	£0.31
4010	£0.19
4011	£0.16
4013	£0.17
4014	£0.30
4015	£0.31
4016	£0.18
4017	£0.25
4018	£0.27
4022	£0.32
4024	£0.21
4025	£0.15
4026	£0.40
4027	£0.18
4029	£0.27
4030	£0.17
4033	£0.56
4035	£0.31
4040	£0.29
4042	£0.22
4046	£0.31
4047	£0.25
4049	£0.20
4051	£0.25
4052	£0.25
4053	£0.24
4055	£0.30
4060	£0.31
4063	£0.29
4066	£0.18
4069	£0.20
4072	£0.17
4075	£0.17
4076	£0.30
4077	£0.15
4082	£0.17
4089	£0.55
4093	£0.15
4094	£0.31
4095	£0.56
4510	£0.26
4511	£0.29
4515	£0.78
4520	£0.26
4521	£0.84
4534	£2.48
4538	£0.37
4541	£0.31
4572	£0.25
4584	£0.24
4585	£0.48
40106	£0.24
40174	£0.34

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BC108A	£0.12
BC109C	£0.15
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BC178	£0.16
BC179	£0.16
BC182LB	£0.09
BC183LB	£0.09
BC184L	£0.11
BC212L	£0.09
BC212LB	£0.09
BC213LC	£0.09
BC214	£0.11
BC307	£0.11
BC308	£0.10
BC327	£0.12
BC328	£0.10
BC337	£0.12
BC338	£0.08
BC527	£0.24
BC528	£0.24
BC537	£0.24
BC538	£0.24
BC547C	£0.09
BC548C	£0.08
BC549C	£0.10
BC557C	£0.09
BC558C	£0.09
BC559C	£0.09
BC637	£0.21
BC638	£0.21
BC639	£0.21
BD136	£0.29
BD138	£0.29
BDX33C	£0.46
BDX34C	£0.54
BFY50	£0.24
BFY51	£0.24
BFY52	£0.24
TIP29C	£0.33
TIP30C	£0.33
TIP31C	£0.33
TIP32C	£0.34
TIP33C	£1.02
TIP41A	£0.36
TIP42C	£0.28
2N2222	£0.16
2N2905A	£0.28
2N3704	£0.09
2N3705	£0.09
2N3706	£0.09
2N3771	£1.22
2N3772	£1.28
2N3773	£1.88
2N3904	£0.10
2N3905	£0.10
2N3906	£0.09

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BNC Skt — 2 x BNC Skt	£1.89
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6V DPDT 6A (PCB)	£1.96

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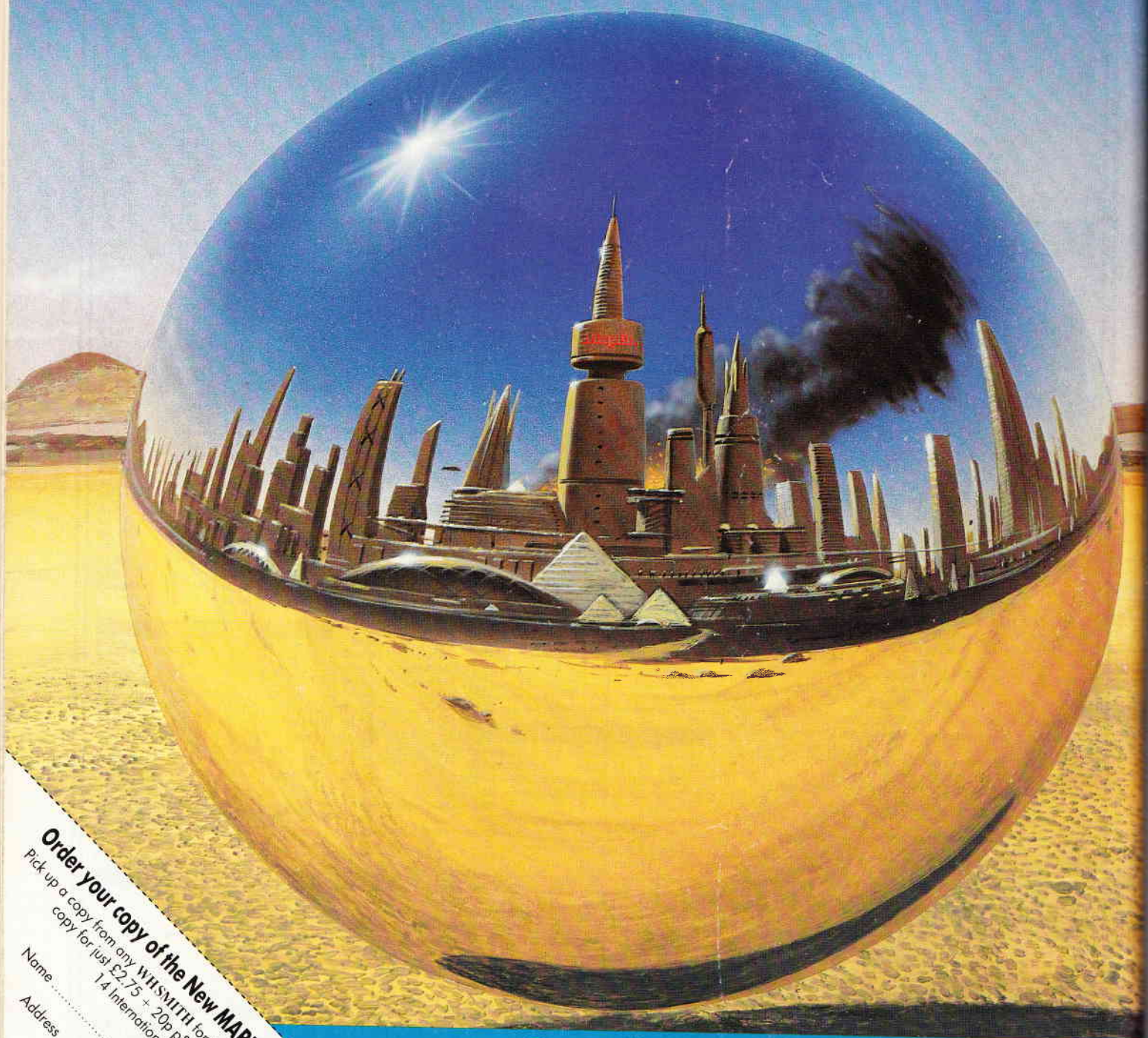

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