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The AUSTRALIAN ELECTRONICS Monthly

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Guide to digital radio communications

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AUSTRALIAN MADE

UPROAR ON THE AMATEUR BANDS

A proposal put to the recent annual Federal Convention of the Wireless Institute of Australia has certainly created some "uproar" amongst the amateur radio fraternity. The proposal I refer to, supported by all state Divisional Councillors with the exception of ACT, suggests that holders of the Novice licence be permitted operation on the 144-148 MHz (two metre) band, including the use of FM (which mode they are currently denied).

As I understand it, this move has been suggested by the Department of Communications partly to provide all licensees with a common band and partly to give Novices some parity with the Japanese reciprocal licence agreement concluded late in December last year which came into effect in February. Apparently, that agreement gives Japanese novice licensees who apply the right to use all bands above 50 MHz with a power limitation of 10 watts and FM, voice only.

Personally, I am not opposed to the Japanese reciprocal agreement. As our trade intercourse with Japan continues to grow, we can only expect increasing numbers of Japanese amateurs, the great body of whom hold the Japanese Novice licence, to spend time here either as working "visitors" or tourists. However, this agreement has substantial consequences for both Novice and Limited licensees and has thrown into sharp relief the inequities inherent in our current amateur licence structure.

There is widespread opposition to the "Novice two metre proposal", from all licensees. I can see why. Firstly, as a "sop" to the inequity introduced by the Japanese reciprocal agreement, it doesn't wash. Secondly, it focusses activity on a band that hardly needs it, and it doesn't provide Novices with a choice should operation on that band be restricted by external factors (like proximity of Ch. 5A TV). Giving Novices allocations on the six metre and 70 cm bands would make more sense. Some Novices cite access to two metres as a major incentive to upgrade.

The whole situation affecting our licence structure needs considerable, open, rational debate amongst the amateur fraternity always, I believe, keeping to the fore the demands of the future, rather than the pressures of the present.

Roger Harrison VK2ZTB
Editor

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COVER

This month's feature project, the Bit Stream Flyer, another design by the Darling Brothers who produced the very successful AEM4610 Supermodem. Picture Andrew Keir, Design Val Harrison.

PROJECTS TO BUILD



AEM4622 Stand-alone V.22 Modem

..... 66
Here's a low-cost 1200 bps full-duplex modem – no need to discard your old modem and spend big bucks upgrading.

AEM6508 Clipping and Fault Indicator

..... 62
Avoid ruining your ears, not to mention your loudspeakers! This project may be attached to audio amps of up to 250 W and warns of the onset of clipping as well as dc faults.



AEM2000 Lab. Standard Power Supply, Part 3.

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Now we get down to building it. You can have a 0-55 V, 100 W power supply with laboratory standard specifications for less than \$500!

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FABULOUS OFFER!



Philips' PM 3055 50 MHz CRO!
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Unbelievable offer, for AEM readers — a top-flite CRO from Philips.

Quick – offer ends soon!

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Getting all those graphics characters together rounds it off nicely.

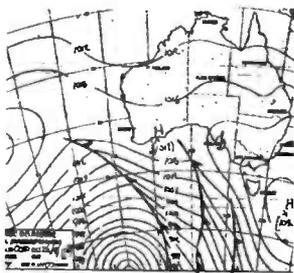
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COMX Plotter
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A plotter that's compatible with AutoCAD, Lotus etc for just \$399!
Hurry – last chance!

COMMUNICATIONS SCENE



The Listening Post Package

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 Decode those digital modes so prevalent on the HF bands — RTTY, FAX and even Morse — using your receiver, our package and your computer (Apple II, C64 and 'Bee).

A Guide to Digital Communications — Part 1

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 The personal computer has brought off a marriage between computers and radio that is right now undergoing explosive growth. Andy Keir VK2AAK gives you the low down.

Today's RF Test and Measurement Equipment

..... 24
 From your cordless phone to your garage door opener, from TV to your CB radio, RF equipment seems to pervade our daily lives more and more. It all requires testing, servicing and maintenance. Here's a look at today's RF test gear.

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 Looking to upgrade your PC or compatible? Want more speed or better graphics? Here's a rundown on the range of hardware and how to assess its application to you.



CONSUMER ELECTRONICS



DAT — knocking on our door!
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 R-DAT is ready to roll! The tapes are ready to market, the machines have been released and it's all about to happen. Malcolm Goldfinch reports.

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NEXT MONTH!



GOOD BUDDY NOSTALGIA — CB TURNS TEN!

CB operation was "legalised" ten years ago next month. We look back at the "pirate era", the aftermath of legalisation, look at rigs then and now, talk to some of the movers and shakers and see where the CB scene is today.

ENHANCE YOUR VZ BASIC!

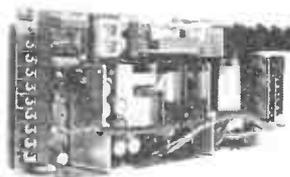
Your VZ200/300 has more power and capacity than most people give it credit for. Give it a new lease of life

GET AMONGST THE "NON-VOICE" ACTION ON THE SHORTWAVE BANDS

For all you enthusiasts pursuing "further horizons" on the shortwave bands in the form of radioteletype and facsimile transmissions etc, here's a basic rundown on where to find the action!

LOW-COST PACKET RADIO INTERFACE FOR THE COMMODORE 64

Here's the low-cost way to get going on packet radio. If you've got a Commodore 64, a soldering iron and a smidgen of common sense, you too can join the happy gang of packeteers.



POWER SUPPLY OFFER

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End-of-line model sellout on a brand-name, quality, multi-output switching power supply.

While these articles are currently being prepared for publication, unforeseen circumstances may affect the final contents of the issue.

"High-tech" electronics training courses launched

A new syllabus to train technical officers and engineers' Assistants in computer integrated manufacturing (CIM) has been developed at Footscray College of TAFE, in conjunction with RMIT. It will lead to a new qualification, the Certificate of Technology (Electronics — CIM).

Following accreditation by the Victorian TAFE Board, the syllabus is likely to be introduced State wide, and possibly nationally. Footscray College of TAFE hopes to introduce some pilot subjects in the second semester of 1987.

One of the developers, Footscray College's Bill Green, says that while the use of high technology is advancing rapidly in Australian industry, training for technicians and technical officers in the electronics industry has lagged behind.

"People employed in the electronics industry must now not only have conventional literacy and numeracy, but also the literacy of computer languages and the numeracy peculiar to the digital regime."

Mr Green, who developed the syllabus with fellow Footscray College staff member Bert Leckie, and Keith Robinson of RMIT, says that they initiated the project about three years ago. It was assisted by a grant from the TAFE Board.

Existing electronic Certificates of Technology already include digital techniques and computer studies, enabling students to design, manufacture and maintain digital equipment.

The new syllabus will provide a specialised stream for students in the Certificate of Technology (Electronics). Mr Green expects that subjects to be offered later this year at Footscray College and RMIT could include design drafting and Basic CAD/CAM.

There will also be opportunities for people already in industry to add on qualifications, and post-COT short courses are likely to be introduced.

Mr Green says that the new CAD/CAM electronics syllabus

will enable technicians to handle any system, not just the one that happens to be in use in a particular workplace.

For further information, contact Bill Green, Footscray College of TAFE, Cnr Nicholson & Buckley Sts, Footscray 3011 Vic. (03) 668 3400.

Record-breaking optical fibre cable

A contract has been signed for the world's longest unboosted optical fibre communications cable to run 135 kilometres between the British island of Guernsey, near the northern French coast, and Dartmouth, in south-west England.

It will travel the entire distance without the benefit of a regenerator, a device sometimes necessary every 50 kilometres on undersea optical communications systems to overcome cable attenuation.

The new cable will have six pairs of fibres, two of which will be in use immediately the cable comes into service in spring, 1989. The transmission speed of 140 megabytes a second will give each pair the capacity of nearly 2000 simultaneous telephone calls.

Parrot's pulchitruces in popular promotion

A TV commercial produced for Philips Australia, the one you've seen starring a parrot, should bring some "local" colour to Morocco. Morocco, you remember is the location of Rick's "Cafe Americain" in the



Architects of the new courses: (l-r) Keith Robinson, Bill Green and Bert Lackie with NC machine controls.

1942-produced black and white Bogart-Bergman classic, Casablanca.

Yet Morocco does have colour. Since 1977 colour television has been transmitted to this north-west African nation's population. One third of the 1.1 million homes there now own colour TV and annual sales are around 100 000 sets.

The most popular brand of colour television receiver is Philips whose marketing executives in Morocco intend to keep it ahead by pushing the "Natural Colour" feature of the picture.

The Philips 1987 advertising campaign in Morocco will include that locally-made TV commercial featuring an artist painting onto canvas the details of a live parrot she is studying on a Philips TV screen.

Tapes of the Australian commercial, originally made in



1985, have been exported at the request of Philips executives in Morocco who judged it the best TV spot on a reel of Philips commercials made around the world in the last few years.

The narrative will be translated into French and the sound effects will be repeated — parrot fashion, of course. So again, it's "You played it for her. You can play it for me. Play it, Sam"; remember?

INTERNATIONAL POST GRADUATE SCHOLARSHIPS

Postgraduate Scholarship applications for places in a Masters Degree of Electronic Engineering program are once again being invited, by Philips, from young graduate engineers and scientists in Australia.

The study and training program will be at Philips International Institute (PII) in Eindhoven, Holland, where 13 Australians have previously studied under this scheme.

The Netherlands University Foundation for International Cooperation accepts responsibility for allocating Masters Degrees to PII students who successfully complete a three semester degree program (17 months).

Financial support, including air fares and living allowance, is paid, and other assistance also provided. English is the language of tuition. Competition for the thirty available places is worldwide and very keen.

Applicants must have a university degree in a field of study related to electronics and its engineering principles. Both men and women under 30 years of age are eligible. Completed applications for the 1988 academic year need to be lodged on or before 31st July, 1987.

Application forms and full information can be obtained from Ian Anstey, Philips Australia at North Sydney; phone (02) 925 3270.

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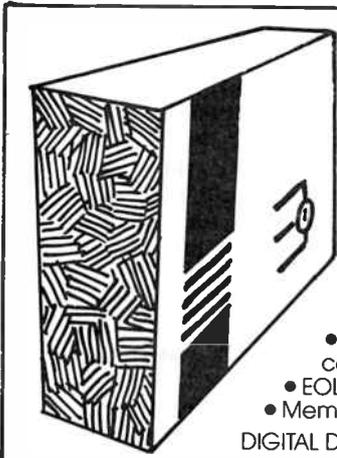


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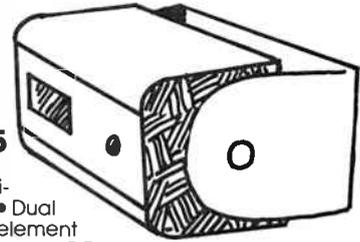
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 issue, A.E.M.

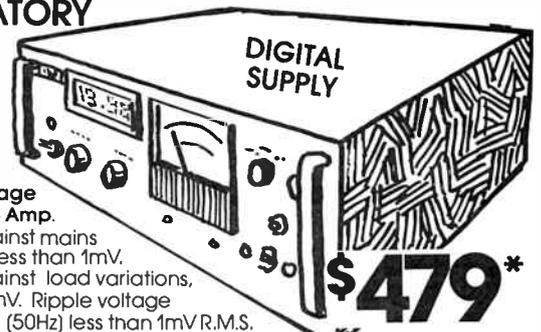


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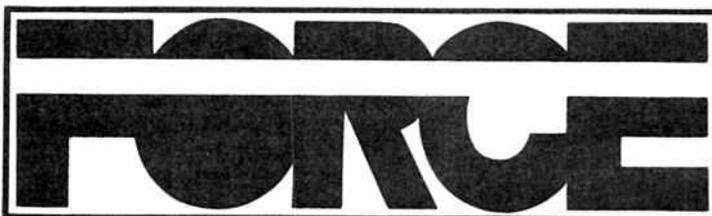
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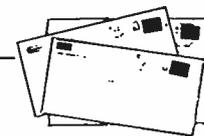
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letters

VZ200/300 software

Dear Sir,

I am writing to you to see if the software is available for the Listening Post and Project 3503 to suit the VZ200/300. You have indicated previously that suitable software might be published sometime.

I find it very hard to get software for my computer in the area of amateur radio. I am looking for software useful for DX, antenna design and propagation predictions as well as satellite data.

**R. Thompson
Gorokan, NSW**

In response to your question about Listening Post software, we are still trying to find someone who can re-write the Microbee program to make it suitable. While both the Microbee and the VZ200/300 employ a Z80 microprocessor, their internal "architecture" is different. The Microbee program also calls routines resident in its ROM and the VZ doesn't have these.

A further complication arises with the VZ in that it does not have any accessible ports other than the Z80 bus expansion so it may be necessary to provide some decoding hardware as well as adapting the software. We will keep you informed of progress and would be very happy to hear from anyone with VZ200/300 experience who might like to attempt the job.

As far as amateur radio software is concerned, there are a number of good books available which supply listings of programs for most aspects of amateur radio. Most of these programs are in BASIC and should run with very few changes on the VZ200/300. We have had a number of enquiries about satellite software and we are currently working on some suitable material which we hope to publish in the near future.

Andy Keir.

Dual Speed Modem

Dear Sir,

I am writing to you with regard to the AEM4600 Dual Speed Modem project. I have built the kit but something seems to be wrong. If I turn on the modem without having it connected to my C64 computer, the power light comes on and all voltages appear to be correct. When I connect the unit to the computer's I/O port, the transmit light comes on and stays on. This doesn't seem right, so I have re-checked everything. It makes no difference whether I wire the 24-pin Commodore connector for host or termi-

nal use, the transmit light stays on unless I disconnect the modem from the computer.

It doesn't sound like it can be much, but it is frustrating and I hope you may have a solution. What are the correct pin connections for the Commodore 64 and do I need any other adaptor?

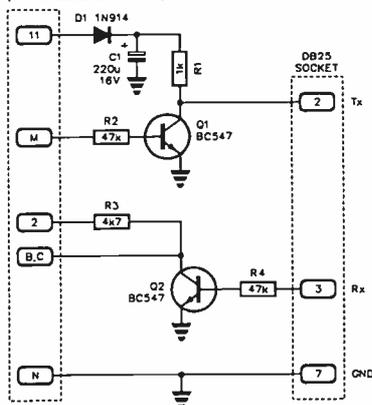
Thanks for a fine magazine.

**B. Fatin
Coolbellup, WA**

Unfortunately the serial interface on the Commodore computer does not conform to the RS-232 standard. Not only is the signal from the serial port incapable of directly driving a true RS-232 device such as the Dual Speed Modem, but the levels are inverted.

In the August 1986 issue of the magazine we published a "Modem Coupler" as the Star Project. This little device was designed specifically to overcome your problem by acting as a "buffer" between the computer and a device such as a modem.

COMMODORE USER-PORT
(24 PIN EDGE CONNECTOR)



Back issues of AEM cost \$4.00 post-paid. A kit for this project was obtainable from the designers, Flexible Systems of 219 Liverpool St, Hobart Tas. 7000. At the time the article was published, the kit price was \$24.95. The unit could also be purchased built-up and tested for \$34.95.

Andy Keir

Synth circuits for the guitarist

Dear Sir,

Since becoming interested in electronics I have come across numerous circuits for voltage controlled oscillators, filters and amplifiers suitable for use with keyboards and John East's

series in Practicalities naturally interested me. However, this does not help the guitarist at all!

To date, I have found little in the way of applicable frequency to voltage conversion circuits for guitarists. Any circuits, or references to such circuits, would be gratefully appreciated.

**D. Johnson,
Kin Kin, Qld.**

We asked the author of the analogue synthesiser series running in Practicalities at present, John East, to answer this one. Here's John's reply:

"The nearest I have come to something like this that might work was presented in different forms at different times in Electronotes, possibly more often than I know about as I have never had the full set of Electronotes.

"Be warned however, that such devices are very complex from the engineering point of view as the basic problem is not frequency to voltage conversion, but perceived pitch to voltage conversion.

"Some of the practical problems involved arise from the very nature of musical waveforms, such as pitch and amplitude transients, and trying to decide which periodic portion of a waveform can actually be relied upon to give pitch information.

"The guitar is not particularly easy to extract useful information from, mostly for the aforementioned reasons and in all conscience, I could only recommend a commercial device that suited you. Many have come and gone, mostly because they did not work well enough for sufficient guitarists to ensure commercial success. They all depend to a certain extent on the particular playing style of the guitarist; ARP went broke trying to put a guitar synth on the market which nobody could play well enough for it to work.

"Roland do, or did, produce a guitar synth which did work well enough to be useful, (I think it was called the GR-500) but it used a very heavily modified Aria guitar with much internal circuitry and separate string outputs etc. Fairlight also made a pitch extractor, but it was very expensive; it may still be possible to get cheaper units. e.g. Korg, 360 Systems and possibly others.

"Sorry to make it so depressing, but unless you are particularly dedicated to acoustic, electronic and mechanical engineering, your only real hope is a commercial unit."



John East

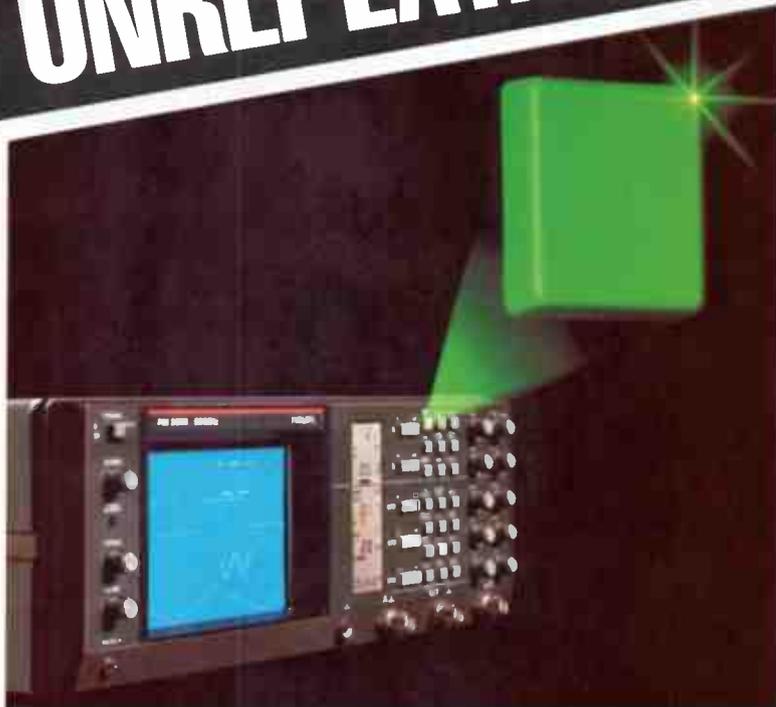
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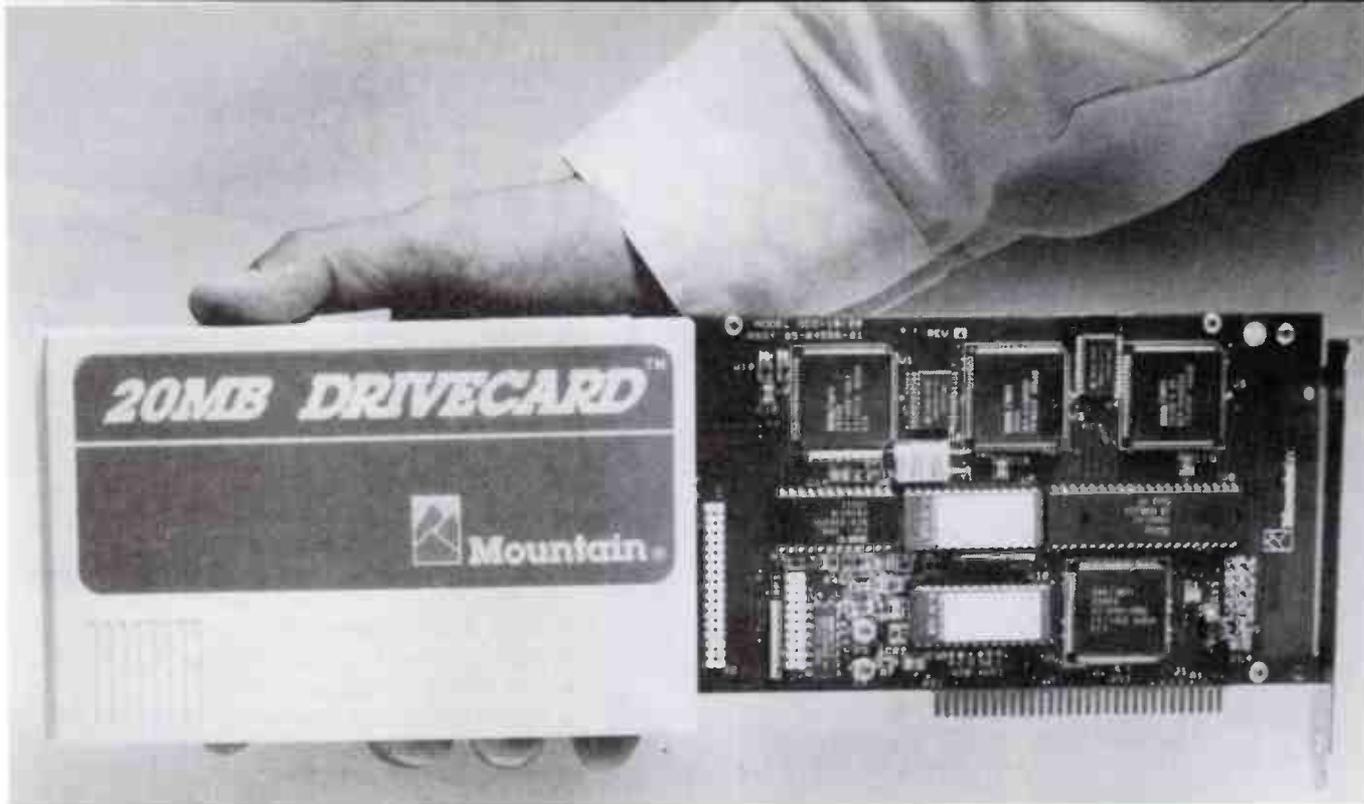
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Hardware enhancements for PCs and compatibles

Andy Keir

Looking to upgrade your PC or compatible? Looking for more speed, a 'strange' interface or graphics enhancements? Here's a rundown on the range and variety of hardware available and how to go about assessing it in relation to your needs.

IT WAS NOT LONG after the IBM personal computer appeared on the market that some enterprising manufacturers started producing accessories for it. In fact, the machine was deliberately designed in such a way that it encouraged the creation of a third-party industry to support it with both hardware and software. Whilst some companies had been in existence producing accessories for other machines, others started up just to support the IBM. It was obvious that they considered there would be a dollar to be made supporting the IBM machine and consequently they took up the challenge. How right they were. The design philosophy of IBM paid off: the machine has become one of the most popular and well supported computers ever released and the industry which sprang up to support it has become a multi-million dollar enterprise.

Today we not only have the IBM personal computer, but dozens of "clones" which are compatible in almost every respect to the original machine. Whilst new models have been introduced offering greater speed, more memory and a host of additional features, they all seem to follow the same general architecture of the original IBM machine based upon a mother-board with a number of connectors into which expansion boards can be plugged. In this article we are going to take a look at some of these expansion boards and the fea-

tures offered by them. I think you'll be surprised at the added computing power they provide.

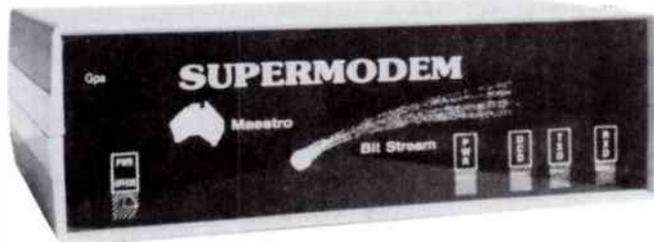
Functions and more functions

At the outset, many of the plug-in accessory boards offered only one specific function. The latest boards have combined many such functions on a single board which means that the expansion slots in the machine are not used up so quickly. As an example of this, the computer which I'm using to write this has one board which provides a parallel printer port, two serial ports, a real-time clock, a games adaptor port and the controller for the floppy disk drives. Not too long ago, each of these functions would have required a separate board, but as it is I still have room for a hard disk controller, expanded memory and a graphics adaptor and still have vacant slots in which to put other options!

There are so many of these "multi-function" boards available today that it can be quite difficult to choose between them. Most boards offer similar features, usually along the lines of the unit described above, so you need to look at value for

Above: The "hard card" is a popular and convenient way of adding mega storage capacity to a PC. The Mountain hard card is distributed by Imagineering (02)697 8666.

MODEMS

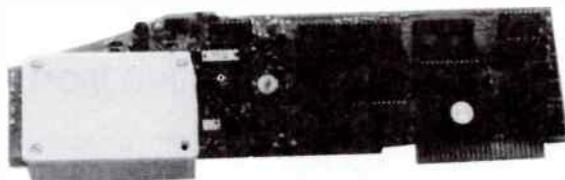


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money as well as what mix of functions best suits your needs.

You should also examine the documentation supplied with optional boards. Some of these units are very sophisticated and often require a fair bit of configuring, both on the board and in the computer, in order to get them going. If the instructions are clear and well written you should not get into trouble but it can be incredibly difficult attempting to work out the correct combination of umpteen dip switch settings if the documentation is vague.

Compatibility is not too much of a problem these days as most manufacturers take steps to ensure their products will work on a variety of machines. All the same, do check with your dealer about your combination of hardware and software before committing yourself to a purchase.

Probably the easiest way to illustrate the wealth of plug-in options available is to describe a few typical types whilst making some relevant comments along the way. We will start with the more general options and work through to some of the more specialised devices.

Memory upgrades

Plug-in memory expansions were probably one of the first options to become available from third-party suppliers. The early machines were often supplied with only 64k of on-board RAM and optional boards allowed expansion up to 512k or even 640k.

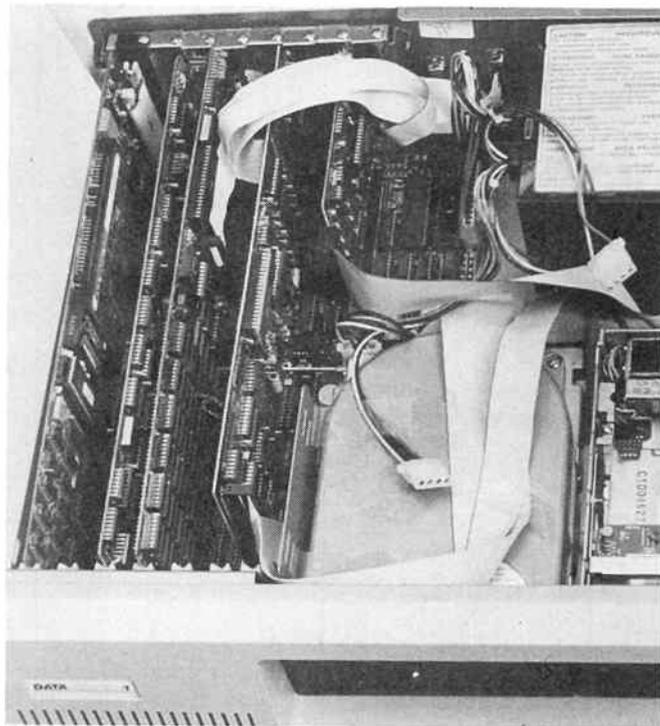
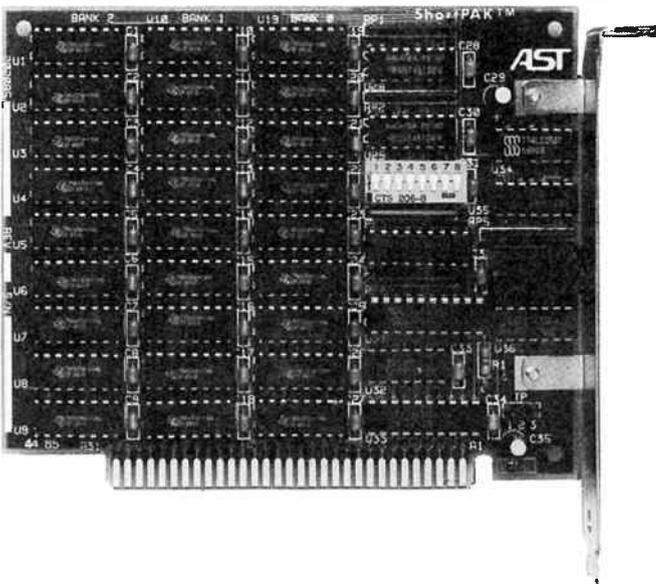
These days, many computers come with 512k or more already fitted but optional boards using "bank-switched" or "paged" memory are available which permit expansion to several megabytes of random access memory. This large amount of RAM can be useful for such things as printer spoolers or memory based disk-drive emulators and can provide significant speed advantages where large files are to be printed or frequent disk access is required.

The software to support these functions is generally supplied with the board but some existing software may need modification to take advantage of the extra memory, particularly if going beyond the 640k level.

Graphics adaptors

Most computers come supplied with some sort of display output facility but it's capabilities will generally be determined by the price you pay. If you need to display very high resolution colour graphics, you will usually end up using an

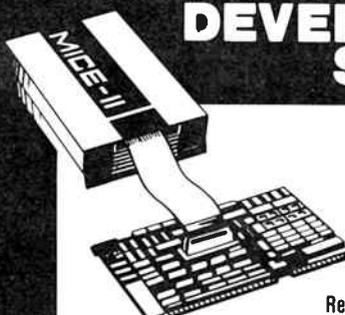
This half card memory expansion unit by AST Research offers up to 576K of RAM and includes RAM drive and print spooling facilities. Imagineering distribute AST (02)697 8666.



optional plug-in board. Some of these, such as the "extended graphics adaptor" (EGA), can produce full colour displays of almost photographic quality.

Software to support the extended capabilities is often supplied with the board and many software suppliers also design their products to take advantage of the high resolution. You should bear in mind that a very high quality monitor will ▶

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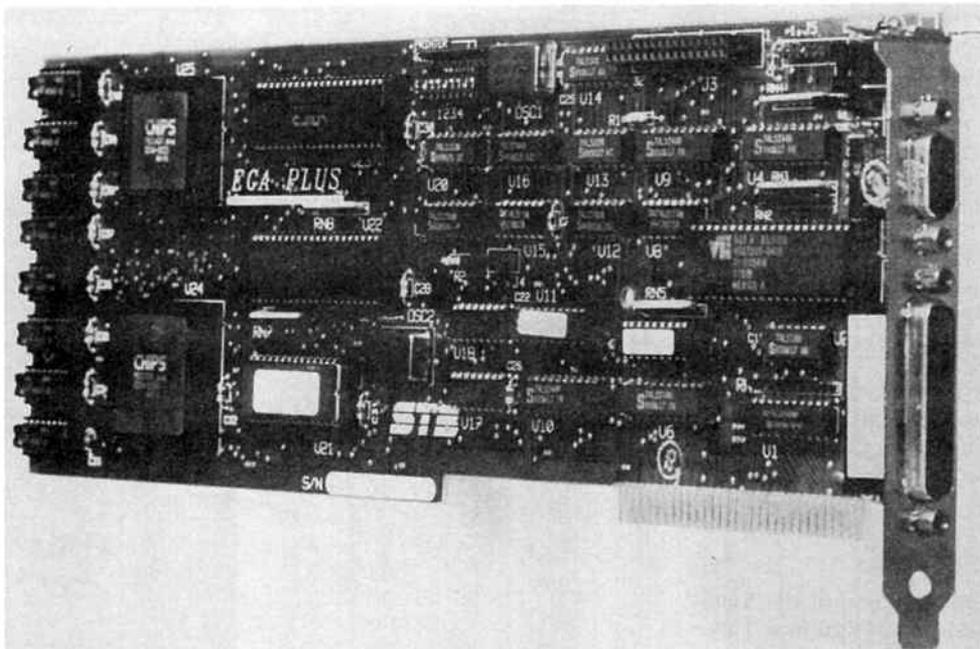
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MD-87/1



Roland Australia has just released this multi-resolution video adaptor from STB for colour graphics users. It is a fully enhanced 256K RAM EGA board with CGA compatibility capable of achieving PGA standard 640 x 480 pixels resolution in the full 16 colours, or alternatively 752 x 410 resolution. STB claim it can turn a 25 kHz 400-line monitor into an EGA (350-line) screen without losing the 400-line graphics capability for other applications. Details from Roland DG (03)241 1254.

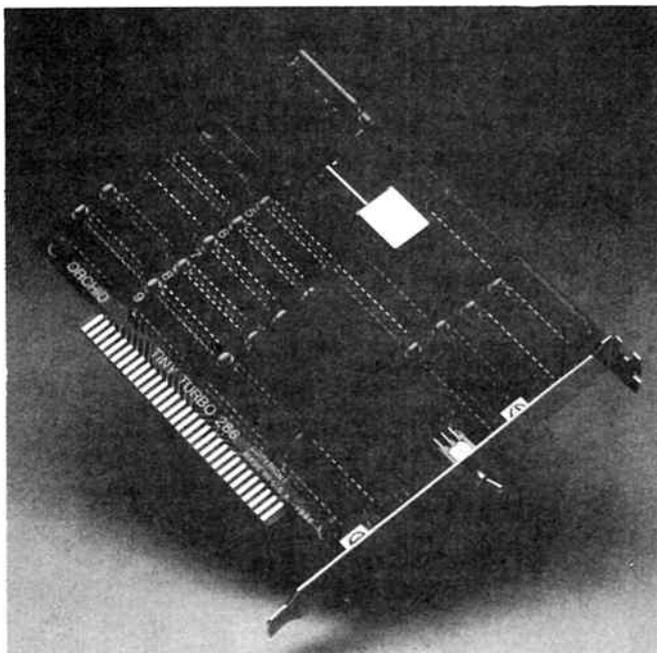
be required to get the best from a high resolution graphics adaptor and although these don't come cheaply, the results are superb.

Speed-ups

A fairly recent development in plug-in options is a board which increases the operating speed of your computer. If you are the lucky owner of one of the newer machines which operate at eight or 10 MHz then you probably won't need one, but if you have one of the older machines with a slower internal clock speed, the increase in program execution speed can be very worthwhile. These boards are generally based around a replacement microprocessor chip which supports genuine 16-bit operations and usually include some high speed memory to allow it to operate at its full potential.

There can be some compatibility problems with these boards and you should choose one which allows switching

This speed-up half-slot board from Orchid Technology, the Tiny Turbo 286, when installed in an IBM XT takes but three seconds on a Sieve benchmark as against 10 for the standard XT, four for the AT. From Porchester Computers (03)537 2722.



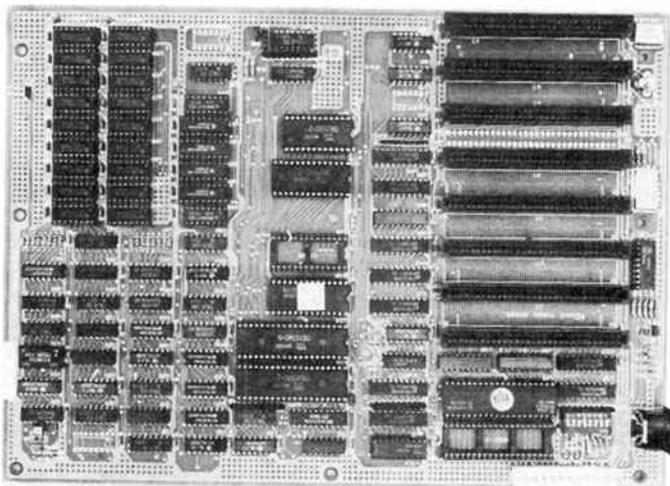
Here's something different! This board, the PC Probe by Atron, is a real-time hardware assisted software debugging tool for C, Pascal, Fortran and Macro Assembler. Available from Macro Dynamics (03)220 7260.

back to the original microprocessor in the event that problems arise. Speed-up boards have been known to upset the resident diagnostics in some machines and also to conflict with some low-level hard disk formatting routines. Many of the boards available include a timer which prevents the high speed mode from activating for a few minutes after the machine is booted up which gets over the resident diagnostic problems. Also be aware that if you have a maths co-processor fitted to your machine, it may not be possible to use it with the speed-up board fitted and it might have to be replaced with a high speed co-processor which can cost big bucks.

If your application requires a lot of heavy number-crunching or you are tired of the agonising time your CAD program takes to re-draw the screen, it might be worth considering a speed-up board as an alternative to a new machine.

Multi-function boards

As the name implies, these boards offer a variety of functions on a single plug-in board. Whilst there are a number of manufacturers producing multi-function boards, the features offered tend to follow a similar theme. The line-up generally consists of a parallel printer port, one or two serial ports and a games adaptor port. In addition a battery-backed real-time clock is often incorporated.



One solution for a speed upgrade is to replace your system's motherboard. Electronic Solutions in Sydney offer this no-wait-state motherboard for \$475, complete with 640K of RAM to drop straight into your chassis. (02)427 4422.

The remaining feature is usually extra memory or a floppy disk controller. These boards are particularly useful when setting up a "bare-bones" computer such as those which are supplied in modular kit form but they can still be a useful enhancement to existing machines provided the facilities offered do not conflict with those already in the machine.

Modems

Modems have become a very popular accessory for those using small computers. Those who have the IBM style machine can obtain modems in the form of a plug-in board and these "in-modems" can offer some advantages. A high

degree of device intelligence can be incorporated in a plug-in modem as it has direct access to the system's bus. Furthermore, as all the interfacing between the modem and the computer is done at TTL levels, the RS-232 interface circuitry as well as extra cables and external power supplies can be eliminated.

The features provided on the plug-in modems are usually similar to those offered in the up-market external types and the range can be quite extensive. If you wish to explore the subject further, you may like to refer to the article on modems in the April issue of the Magazine where many of the features are discussed in detail.

Voice synthesisers

Devices to give your computer a voice have been around for quite some time and it was inevitable that these would surface as a plug-in for the PC. There is a large variation in the price of these units and a corresponding variation in the quality of the speech they produce. The more useful examples provide some sort of text-to-speech conversion but others are quite difficult and time consuming to get going (and I'm not talking about build-it-yourself kits!).

Speech synthesisers can be a lot of fun as well as being very useful in some applications such as for the sight impaired or in games, but you should give careful consideration to your needs before buying on novelty value alone. ▶

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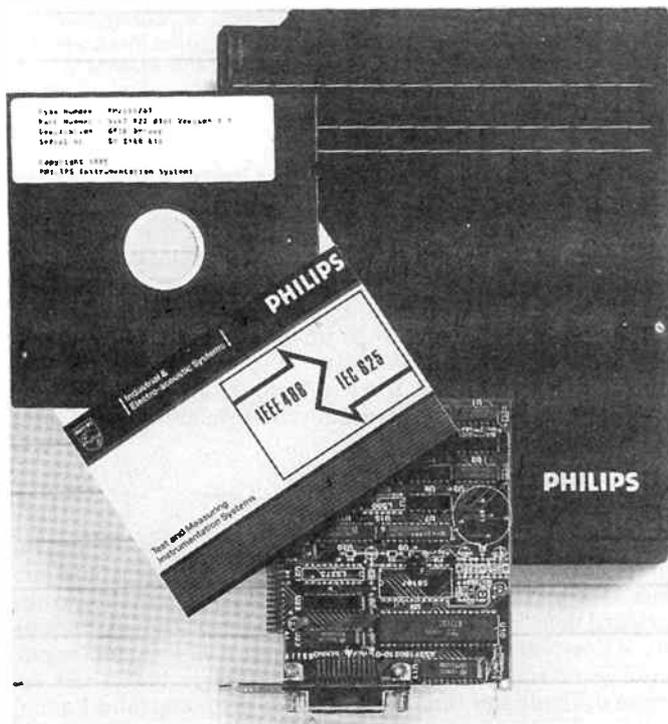
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Nov/022



The PM 2201 is a powerful GPIB interface card and software that allows the control of instrumentation systems using a PC. From Philips Scientific & Industrial (02)888 8222.

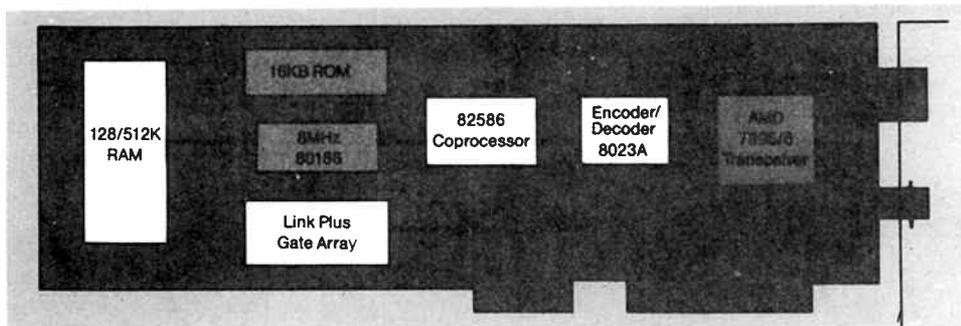
Disk controllers

Most modern computers are supplied with at least one floppy disk drive and thus already have a controller installed. If you are starting from a bare motherboard as in the case of a kit, one of the multi-function boards which incorporates a disk controller could be used as an economical alternative but there is not much point in replacing an existing controller.

Where hard disk drives are concerned, the controller is often supplied with the drive thus ensuring compatibility. Some hard disk controller boards also include a floppy disk controller so this avenue could be explored if starting from scratch.

One innovative plug-in to come on the scene in recent times is the "hard card". This accessory consists of physically small hard disk drive mounted on a plug in board together with the disk controller circuitry. This provides a simple solution to mounting the drive, especially if the computer's cabinet cannot accommodate the drive without sacrificing one of the existing floppy disk units. Capacities of 20 megabytes are common and 30 megabyte units are available from some suppliers.

Network add-ons can be quite powerful and sophisticated. 3Com Corporation's Etherlink Plus board provides a PC to Ethernet connection for IBM PC, XT, AT and compatible machines. It employs two processors and features up to 512K of RAM and a first-in-first-out buffered 8- or 16-bit I/O path.



Networking and emulators

In the sphere of business, it is often an advantage to be able to combine many individual computers in a network to allow resource sharing and facilities such as electronic mail. Many plug-in boards are available to allow networking and these vary in their complexity and capabilities. A great deal will depend on the number and type of machines to be networked as well as the physical distance between them but accessory boards are available to suit most networking requirements.

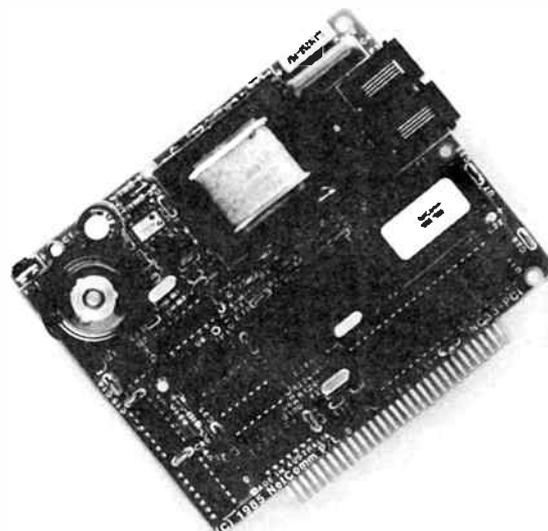
Plug-in emulator boards are used to make the PC behave as some other piece of equipment, usually the terminal in a mainframe system. These boards are useful when you wish to have access to a mainframe computer but also need to retain the versatility of a personal computer. Emulator boards can be quite complex and, like networking systems, are a specialised area requiring a good knowledge of computer systems and plenty of after-sales support.

Other plug-ins

The boards we have looked at so far would cover the more popular applications but there are many more such products available which are aimed at specialised markets. Amongst these are included devices intended for laboratory use such as logic analysers, high-speed analogue to digital converters and IEEE interfaces.

As was pointed out at the beginning of this article, the IBM PC was designed to allow simple expansion and to encourage third part supply of accessories. Whatever your need or application, you can be reasonably well assured that if there isn't a plug-in to suit you now, there will be soon. If you can't wait, you can even get a blank plug-in card fitted with wire-wrap sockets and start designing your own! ↗

Imaging's locally-made "Le Modem" is an in-modem for PCs offering Hayes command compatibility, V21-V23 and Bell 103 operation with "smarts" like auto-dial/answer/hang-up.

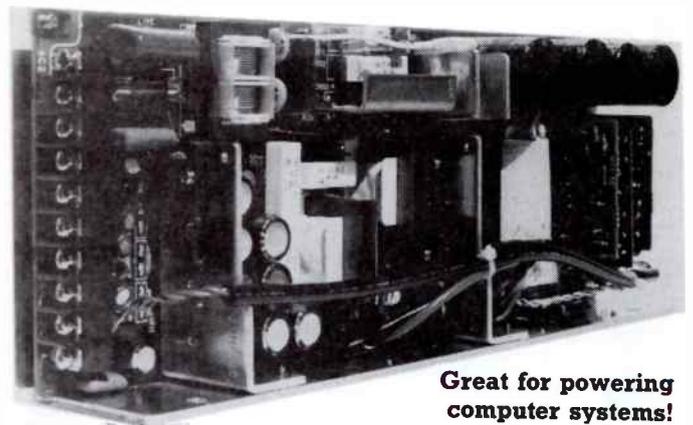


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MODEL NO	OUTPUT A	OUTPUT B	OUTPUT C	OUTPUT D	OUTPUT E
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Load Regulation	Load change from 20 to 100% of rated output current at rated input voltage +5V output Other outputs 3 terminal regulator Non reg	0.6% max 1.0% max 5.0%/A (typ)
Ripple and Noise	Peak to peak	1% +75 mV max
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Over Voltage Protection	+5V output	6.0 - 7.0V (typ)
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TDK updates tape range



A new line-up of audio tapes from TDK was launched recently. Improvements in formulation through to packaging were claimed.

Eight tapes are offered, two metal, three high position or type II and three normal position or Type I tapes.

From their continuing development programme, TDK has released SF (Super Fidelity), a high position Type II tape designed to offer similar performance to their famous SA tape (Super Avilyn). SA is well-known for its acceptance by most leading cassette deck manufacturers as the alignment tape for their cassette decks in the High or Type II position.

"The new SF audio tape is designed to very similar specifications as the previous SA but with an economy price" said Mr Kihara, General Manager of TDK (Australia) Pty Ltd.

SF is an extremely quiet tape with bias noise of -61dB, TDK claim, well-suited to most recording applications, particularly to classical and material with a wider dynamic range. The extended high frequency response to beyond 16 kHz enables the higher order harmonics to be reproduced faithfully, according to TDK.

The SF tape is housed in TDK's new Laboratory Standard Cassette mechanism.

VCR joint venture with Czechs

A joint venture between N. V. Philips' Gloeilampen-

fabrieken, of the Netherlands, Tesla Spotrebna Electrotechnika Konzern Bratislava, Czechoslovakia, and Transakta PZO, in Prague, Czechoslovakia, will establish a joint manufacturing facility for video recorders and mechanisms, to be called AVEX.

Seventy percent of the new company, which will be based in Bratislava, Czechoslovakia, will be owned by Philips and ten percent by Transakta.

Philips will contribute manufacturing facilities and production knowhow. Tesla will be responsible for the industrial infrastructure and Transakta will look after the commercial activities.

Production will start in 1988 when the plant's annual capacity will be 100 000 video recorders. This figure is projected to increase to more than 500 000 in 1993.

The products made in Bratislava will be sold on the Czechoslovakian market and will be exported to countries inside and, via Philips, also outside COMECON. In addition, part of the production of mechanisms will be delivered to other video recorder manufacturers in COMECON.

The supply of components, which will initially take place via Ostimpex, a subsidiary of the Australian Philips organisa-

tion, will largely be achieved from within COMECON countries in about 1991.

The building up of its own network of suppliers and the export of video recorders and parts to the west will enable AVEX to achieve a balanced foreign currency situation.

The partners are convinced that the co-operation will give a new impetus to the consumer electronics industry and suppliers in Europe.

The penetrating VCR

According to the Consumer Electronics Suppliers Association (CESA), who represent both Australian manufacturers and importers, VCR market penetration will reach 63% by the end of the year.

The projected forecast for unit sales for 1987 is valued at \$460 000 000. Australia is the leading "user per capita" of VCR equipment in the world.

CESA project an increase in the total value of colour television sales to \$440 000 000 for 1987.



Sanyo sets the pace in video 8

Latest arrival in the 8 mm video market is the VM-800/P from Sanyo, featuring automatic white balance and 3-head playback.

Sanyo say it is unique in Australia as being the only 8 mm camcorder with a double-azimuth 3-head system.

This system enables noiseless frame moving in still and slow motion modes, giving crystal-clear pictures even through a frame-by-frame advance mode, says Sanyo.

It is also the only 8 mm camcorder to have both still and slow-frame on playback, not simply on "recording", the company says.

The imaging technology incorporated in the unit enables the capture of sharp, distortion-free pictures with no burn-in and after-image scarring. The

unit also includes special AFM (audio frequency modulation) circuitry that delivers a "life-like" audio performance.

The VM-800/P also has a special TV output terminal to enable one to record TV shows off-air (copyright permitting!).

Fully loaded, the unit weighs only 2.1 kg, making it one of the lightest, most compact and easy-to-use camera recorders on the market. Retail price is around \$3000. See your Sanyo dealer.



Sony software?

8 mm video leader, Sony, announced at the release of their second generation V8 Handycam, that 8 mm pre-recorded software will be available from Sony Video 8 specialists Australia wide.

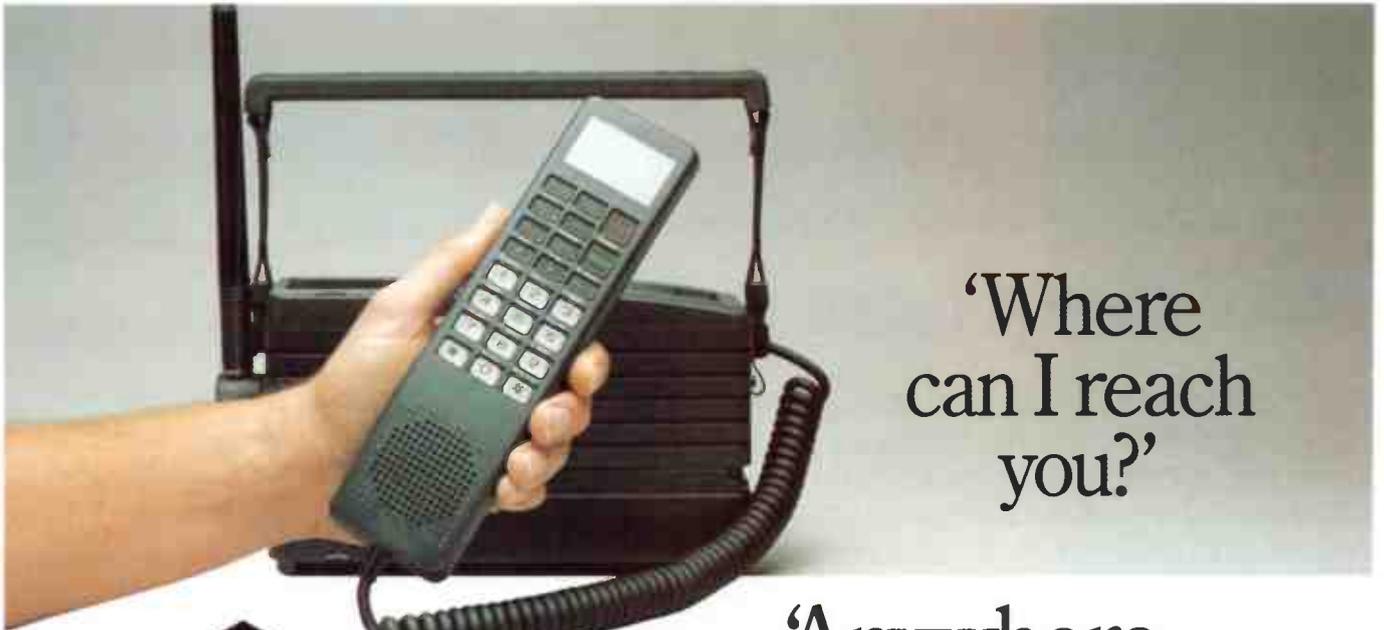
The new CCD-V30 is a full-function unit with the addition of three extra features that are most in demand among home video enthusiasts: auto-focus, zoom lens, and built-in playback.

Sony has undertaken as their responsibility and commitment the development of pre-recorded Video 8 software. This material will only be available through selected Sony Video 8 Specialist Retailers until consumer demand is to a level which will require transition to traditional video software retailers.

The V30 will be available throughout the Sony Dealer Network at a suggested retail price of \$2999.

Just wave your wand!

Reports from Europe say that National has released a PAL standard VCR there featuring time-shift programming using bar codes read-in by means of a special "wand". Printed bar codes of day/date/times are read with the hand-held wand which is then used to program the VCR with the push of a button.



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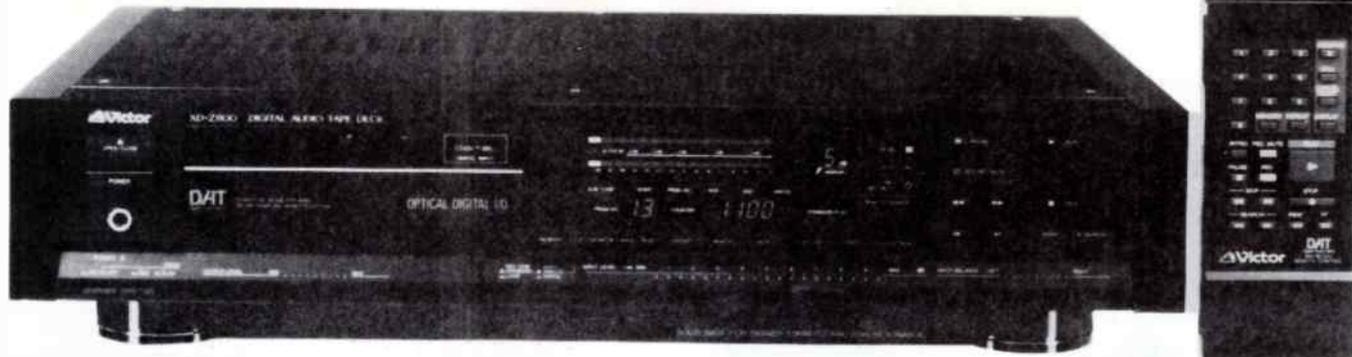
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DAT day has come!

Malcolm Goldfinch

March 2nd (or 3rd, depending on who tells the story) was DAT day for the world when National were first to release a player for sale on the Japanese domestic market, hotly followed by Sony and JVC just three weeks later. Rotary-head digital audio tape (R-DAT) is on the market folks, and in the usual course of events it won't be long before it arrives here. But this is just the beginning of the story.

IN "IMAGING WARS" in the November '86 issue, page 27, I told how, when I was in Japan in 1985, DAT was but a late-night whisper over scotch and saki glasses. Back then, DAT R & D was a most confidential operation, rumoured to have over 50 participants throughout the world. Now, DAT – or the "DAT Conference" – has some 84 subscribers, but they may not all be supporters at this time. Nor do they necessarily support the released format, R-DAT.

There are still those who favour the S-DAT (multiple, stationary-head technology) format and it is common knowledge that there is a split between those wanting to wait for S-DAT to catch up with the commercial development of R-DAT. The latter is more advanced because it borrows heavily from helical-scan VCR technology, adapted to digital data rather than analogue video.

Well, R-DAT is now a commercial reality. The "big guns" have prepared the field and the "troops" are poised to march.

National scoops the field

First with real machines on sale were National (leading brand name of Matsushita), who launched their Model SV-D1000 under the Technics label on 2nd or 3rd March (as we said, depending on who's telling the story), priced around 200 000



Yen. National translate this to "\$A1999, but it would more likely cost in the vicinity of \$3000-\$3500, given the cost of duty, taxes, stolen container insurance, retailer awards, compo, RSI and you-name-it costs of getting it in the stores here. However, National coyly claim that overseas (i.e. non-domestic) marketing plans had not been determined.

User convenience is the keynote to National's marketing strategy. Apart from CD-like audio performance, National emphasize that logic control must be a great improvement of DAT over compact audio cassette decks. The SV-D1000, the claim, is as easy to operate as conventional cassette decks, yet offers programming functions, access speed and performance that rivals that of most sophisticated CD players. The "search" function, for example, is about 200 times the normal DAT record and playback.

All this is good stuff for the consumer who has the Yen and the yearning for DAT, but CDs are already seducing customers with microprocessors that allow all sorts of functions like menus, quick search, sequence and skip. It seems, judging from National's offering, that DAT machines will have all this, and more. "Music number" and time information is encoded on the tape, allowing sophisticated search and play control with simple, computer-like programming (whatever that means – Ed.)

Just as you see in many CD players, National's SV-D1000 uses a 10-key pad plus a memory key to "flag" up to 99 tracks in any order, one-track multi-repeat etc, with the programme selected displayed on a fluorescent display.

National employ "Class AA" low distortion circuits, they say, in both sample-and-hold and buffer amp circuits to improve stability and minimise distortion at both D/A and A/D converters. Separate D/A-A/D converters for the left and right channels are provided in the SV-D1000 to eliminate the phase difference between channels that occurs with a single converter multiplexed between channels and improve sound quality. It has a 25-function wire-less remote control and provision for wire, optical or digital I/O.

As foreshadowed, you can't make direct digital copies from CDs due to the different sampling frequencies: 48 kHz for DAT, 44.1 kHz for CD, apart from the lack of a direct digital output on CD players frustrating direct digital copies. In addition, it seems some pre-recorded DAT software will carry a copy inhibit code and the SV-D1000 is unable to make direct digital copies of such software.

The anti-copy bug bites. I'll come back on this shortly.

JVC weigh-in

On March 23, JVC launched a DAT machine described as "a prototype". Just as we finalised this article, they announced their production model machine – the XD-Z1100, but we don't have a lot of detail on it. However, we do know it offers two-speed operation, so a 90 minute cassette will do 180 mins, a 120 minute cassette, four hours!

JVC's machine looks very much like a video cassette recorder, unlike the National Technics. It features a digital twin bargraph level display in the front, and a "Compu-link" control system (a CD spinoff, perhaps?), "optical" (I presume, infrared) remote control, LSI processing internally and "optical-digital" I/O (which maybe, we'll learn more of in due course). Price was quoted at Y198 000. JVC say there are no export models yet.

Sony, too

Sony, ever seeking a technical or technological lead, incorporated some innovations in their Model DTC-1000ES, also launched on March 23. Chief innovation seems to be the three sampling frequencies provided: 48 kHz, 44.1 kHz and 32 kHz. Exactly how all that comes together has left us guessing for the present. The copy inhibit is automatically activated on playback.

The DTC-1000ES employs a dual A/D-D/A converter and a four-times oversampling digital filter to ensure top audio quality upon conversion. It has four direct-drive motors on a rigid, non-metallic alloy chassis.

Sony developed LSI (large-scale integration) circuitry for their DAT line, claimably to improve reliability, quality and ease of operation at minimal extra cost. Sony has emphasised control and data stream error correction, featuring something they call "feed-forward super strategy". What it means – your guess is as good as mine, at this stage.

Format considerations

As a recording format, DAT offers some wonderful features to justify the price: items like a record-replay frequency response of 20 Hz to 22 kHz flat within ± 1 dB, unmeasurable wow and flutter, dynamic range of 96 dB, etc. And there's no necessity for a noise reduction system and its attendant colouration, distortion etc. All this for two hours on a cassette measuring 73 x 54 x 10.5 mm, almost half the volume of a compact audio cassette. A crazy dream five years ago; today, a reality!

It is evident that the whole DAT technology (R-DAT and S-DAT) is largely piggy-backed (electronically) on CD technology, yet I see a hidden self-destruct – the copy stopper. If the electronics detects an incoming copy inhibit code when recording from a digital source, the system refuses to play ball. Probably, at this moment, all the CDs being sold are as full of copy stopper codes as a 1890 cookie jar is full of weevils!

As an apparent apology or rationalisation for the anti-copy bug, JVC's "format statement" says: "However, analogue copy by D/A \rightarrow A/D conversion causes deterioration of the S/N (signal-to-noise) ratio only by 3 dB, which is a level almost undetectable by human ear. Analogue-copied programmes can be further copied digitally." Can they? My reading of Sony's data is at variance with this as it says: "... when any software with copy inhibit code in the digital signal is played back, the copy inhibit code is automatically transmitted." It's getting to sound like some electronic AIDS virus. Maybe some enterprising DAT manufacturer will sell a DAT deck complete with electronic condom.

If there's negligible loss of quality (or, at least, acceptable loss) in the analogue copy route, what are the software interests paranoid about? Infinite first generation copying,



THE TAPES

TDK, Sony and National have all released DAT cassette tapes at the same time as the decks. The tapes measure just 73 x 54 x 10.5 mm overall, a volume of some 41 391 cubic mm. Compare this to the compact audio cassette which measure 100 x 64 x 12 mm, 76 800 cubic mm. The DAT housing differs from the compact cassette in that it is a dustproof package, not unlike a video cassette.

The base film material is reinforced polyester and tape width is 3.81 mm. Total thickness is 13 micrometres. A metal magnetic material is used. Sony specify "crystal art", while TDK use "Super Finavinx", a high density particle of pure iron, resistant to self-demagnetising particularly at the high frequencies employed in DAT, they say. The tape surface has to be very even else "spacing loss" will result in digital errors, TDK say. They claim a tape surface unevenness of less than 0.02 μ m.

DAT cassettes come in four playing times of 120 minutes, 90 minutes, 60 minutes and 46 minutes. National's tapes are priced at 2000, 1700, 1400 and 1200 Yen, respectively. TDK quote their 90 minute cassette sells for about \$A17.00 in Japan. Sony estimates their DT-90 (90 min.) cassette will sell for about \$28 in Australia. Such is the cost of high-tech products.

they say. Why load onto the consumer a non-standard sampling rate and unnecessarily complicated devices to protect the software interests in a futile and ineffective censorship of copying? The real pirates will laugh at these antics. Home copying of vinyl records, which are filed like books, as masters is part of the hi-fi ethic. What difference for the home consumer does a barely audible D/A \rightarrow A/D copy process mean? An insult and wasteful expense!

Consumers, I suspect, will not tolerate the situation for too long, particularly at A\$3000-plus, before someone finds a solution to the direct digital copy problem. Good quality compact audio cassette decks will still be the way to go for mobile or second copy sound with most discriminating audiophiles. The barrier of DAT sampling at 48 kHz and CD sampling at 44.1 kHz makes a digital input port impossible for even the "legitimate" no-copyright CD, but from a pre-recorded DAT tape, you can copy – if the copy inhibit code is not included. I think these inhibitors are just too much; the digital-to-digital advantage is lost until this nexus is broken.

I suspect it won't be too long before some digital smartypants organises a 44.1 kHz to 48 kHz digital sampling converter, probably stealing from CD-ROM technology to read audio CDs with a fillip of an inhibit code disabler in the decoding.

Apart from the these negative aspects, there are many pluses for the DAT system that will make it attractive.

There are "no plans" to introduce DAT into Australia at present, although the models released in Japan have no technical reasons (apart, perhaps, from electricity authority approvals) for not being available here. No 'format conversion' is necessary (like NTSC to PAL format conversions necessary with new VCR models). TDK Australia has DAT tapes already in production and say they will have them available as soon as DAT decks go on sale here. So much for the "no plans". Give it 6-12 months.

Next month I'll give a detailed rundown on the R-DAT specifications as revealed in real machines. 

New generator offers 2100 MHz coverage



Elmeasco Instruments has introduced the Fluke 6062A Synthesized Frequency Generator, with signal generation capabilities from 100 kHz to 2.1 GHz. In addition, it incorporates a high-performance pulse modulator.

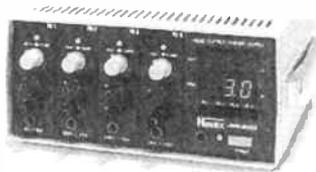
The pulse modulator uses gallium arsenide switch technology for rise/fall times of 15 ns and on/off ratios of 80 dB. The 6062A is designed for L-band applications in avionics, communication and navigation.

The 6062A's output level is adjustable over the range of +16 to -137 dBm (to 1050 MHz), and +13 to -137 dBm to 2100 MHz; absolute accuracy is ± 1.5 dB, fluke claim. Amplitude can be displayed in volts, dBm, dB μ V, or dB mV.

The 6062A increases the modulation capabilities of the 6060 line, with FM deviation to 400 kHz, and adds phase modulation. The pulse modulator on the 6062A has the high on/off ratio (80 dB minimum) that is needed for radar simulations. Fast rise and fall times permit high quality pulses of less than 50 ns duration.

The low noise capabilities of the 6061A are incorporated in the new 6062A. Residual FM is guaranteed to be less than 6 Hz (300 Hz to 3 kHz) in the frequency range of 245 to 512 MHz, with -123 dBc typical SSB phase noise 20 kHz offset from a 500 MHz carrier, Fluke say.

More information is available from Elmeasco Instruments Pty Ltd, Sydney, Melbourne, Adelaide, Brisbane and Perth.



Portable Lab Supply

A compact, portable quad power supply has just been released by Amtex Electronics. Called the MS-200, the device was designed as an accurate laboratory power supply which is robust but light enough at 4 kg to be carried around.

The unit is modular and the customer selects any four modules to suit his requirements from the following voltage ranges: voltage — 4.4-5.6 V, 11.0-17.0 V, 21.0-28.0 V, 42.0-55.0 V; Current — 5.0-10.0 amp, 2.0-3.5 amp, 1.0-2.0 amp, 0.5-1.0 amp.

A 2.5 digit red LED displays the voltage setting while a 2.5 digit green LED displays the output current. Each output can be adjusted independently.

Max. output voltage ripple is quoted as 50 mV p-p and voltage regulation is within 1% for input and load change. For fur-

ther information, contact **Amtex Electronics, 36 Lisbon Street, Fairfield, 2165 NSW. (02) 727 5444.**

Hi-Phon pro audio range complete

Following the announcement in January this year of their new Professional Audio Division, Hi-Phon Distributors has announced their complete range of professional products.

As of May 1st, 1987, the Professional Audio Division is the exclusive distributor for Tannoy Ltd., Allen & Heath Brennel, OHM, Beyerdynamic, Audio Developments, HH Electronics and Gotham Cable.

Bringing in expertise from Britain, Mike Wilson is acting as consultant in the initial development of the new Professional Division.

Mike has a wealth of industry knowledge and experience gained from over twelve years in the Professional Audio Industry in Europe. His previous positions include Sales Manager for both HH Electronics and Martin Audio, in the U.K.

Full product details from **Hi-Phon Distributors Pty Ltd, Unit 1, 356a-358 Eastern Valley Way, Chatswood 2067 NSW. (02) 417 7088.**

Digital FX processor

New in the line of multi-effects processors from Roland is the DEP-3 Digital Effects Processor which incorporates the digital reverb, delay, and equalisation functions of the popular DEP-5 into a very affordable signal processing unit without sacrificing ease of operation or sound quality, Roland say.

The DEP-3 features 16-bit A/D-D/A conversion with 28-bit signal processing. There are three operation modes within the DEP-3: Reverb, Delay and Non-Linear.

The reverb mode consists of eight basic settings including three room, three hall and two plate settings. The delay mode includes one basic setting whereas the Non-Linear mode has two modes, Normal and Reverse. These modes and settings allow a wide variety of effects.

There is also a variety of programmable parameters designed to simulate various acoustic environments. For instance, the size of the room or hall can be simulated using the pre-delay time. Absorption characteristics can be simulated using the reverb time.

The programmable parameters also include a digital three-band equaliser which can be used to adjust the reverb sound in low, middle and high frequency ranges.

All of the DEP-3's parameters can be controlled by independent knobs and can be stored into 99 settings of the programmable parameters.

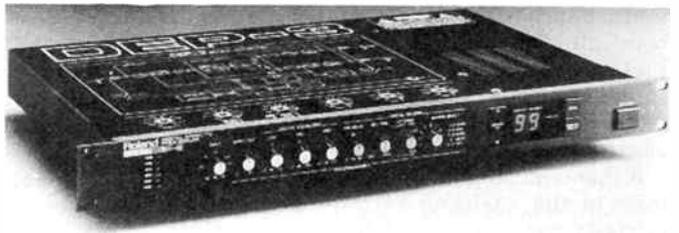
The DEP-3 is also MIDI compatible allowing the pre-programmed patches to be recalled via MIDI program change. System exclusive is also available. See your nearest Roland dealer.

New long-life electrolytic

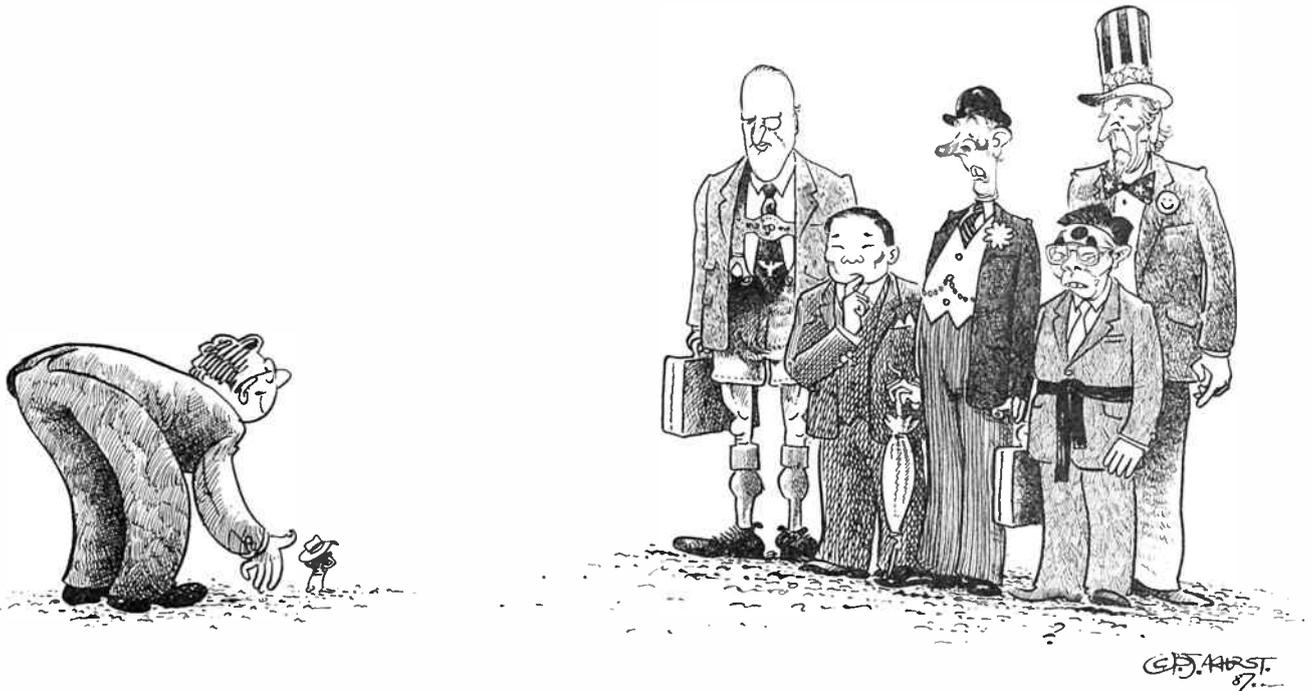
Elma Company of Japan has begun production of telecom/commercial aluminium electrolytic capacitors, the RKA series, which feature a minimum guaranteed life span of 4000 hours at 130°C or 20 years at 75°C.

Main applications are expected to be switchmode power supplies, telecommunications, automotive and test equipment.

Further information is available from **Soanar Pty Ltd, 32 Lexton Rd, Box Hill, 3128 Vic. (03) 895 0222.**



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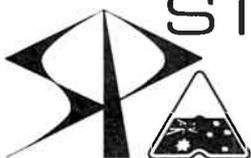
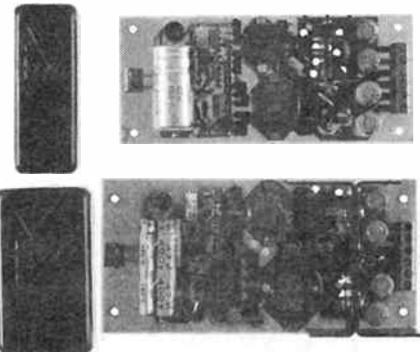
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A look at today's RF test and measurement equipment

Andrew Keir

With advancing technology, we have seen some major changes in the field of communications in recent times. We have come a long way from the days of Morse code on short-wave and these days events such as beaming television pictures around the globe using orbiting satellites or dialling telephones on the other side of the world from your automobile seem almost commonplace.

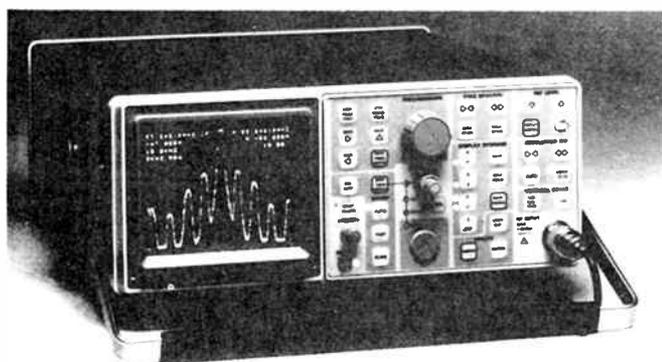
FROM YOUR cordless telephone to your garage door opener, from television to your CB radio, equipment using radio frequencies seems to pervade our daily lives more and more. The increasing sophistication of communications equipment has required a corresponding development in the instruments used in its manufacture and service. There are ever increasing demands for space in the radio frequency spectrum so equipment needs to be efficient and functional in this crowded environment, as well as being designed so that interference is not caused, either to or from other devices.

As you can imagine, the instruments used in the design, manufacture and servicing of such sophisticated equipment, needs to be very sophisticated itself. In this article we will take a look at some typical examples of modern RF test and measurement instruments ranging from the humble service workbench to the R & D laboratory.

Spectrum analysers

To the RF engineer, the spectrum analyser represents the same versatility and usefulness as the oscilloscope does to general electronics work. A spectrum analyser is a device which provides a display of amplitude versus frequency, whereas an oscilloscope provides a display of amplitude versus time. If a signal consisting of two discrete frequencies is applied to an oscilloscope, the resulting display would look something like Figure 1. The solid line represents the display you would see despite the fact that two signals are present (represented by the dotted lines).

The Tektronix model 2710 spectrum analyser is a portable instrument that operates from 10 kHz to 1.8 GHz over an amplitude measurement range of -117 to +20 dBm. Tektronix Australia are based in North Ryde NSW. (02)888 7066.



This multi-function instrument from IFR will be familiar to many radio technicians. The instrument combines such features as a signal generator, monitor receiver and deviation meter with a portable spectrum analyser. The IFR range is available from Vicom Australia. (03)690 9399.

The horizontal axis of the oscilloscope represents time and the display provides information about the amplitude of the combined waveform at any given instant but if we are trying to obtain information about the component signals present in a complex waveform, we will not do very well by using an oscilloscope. All the individual signals will combine and the result will be a single trace on the display which represents the result of adding the component parts. We would have no way of extracting information about the individual signals.

In a spectrum analyser, the horizontal axis represents frequency. If we apply the same waveform consisting of two individual frequencies to a spectrum analyser, the resulting display will be a representation of their amplitude with respect to their frequency. This is indicated in Figure 2 where the two vertical lines indicate the amplitude of the individual fre- ▶

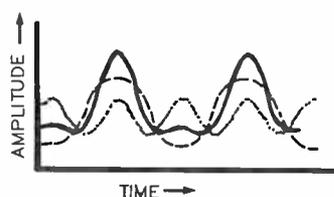


Figure 1.

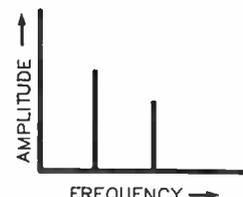


Figure 2.

quencies on the vertical axis and their frequency on the horizontal axis.

By using a spectrum analyser, you can look at a whole segment of the RF spectrum and see exactly what signals are present as well as the amplitude of those signals. A typical example of the use of spectrum analysers is in examination of the output of transmitters. The engineer or technician will be able to quickly determine whether there are harmonics of the fundamental frequency or other spurious emissions present, and if so, what their amplitude is. The use of spectrum analysers is not limited to transmitting and receiving equipment, they are often used for purposes such as determining the amount of RF generated by equipment like computers and other sources of possible interference.

Once you have an understanding of what a spectrum analyser can do, you start to realise what a versatile and useful piece of equipment it is. If you are designing RF equipment for the commercial market, an analyser is essential to check that your product will meet specifications. If you are a hobbyist with a keen interest in RF design, you should try to make friends with someone who works in an RF test laboratory as spectrum analysers are unfortunately rather expensive.

Signal generators

An instrument which will deliver a radio frequency signal at a precise frequency and at a known amplitude is almost essential when working on receiving systems. Signal generators can be obtained which provide a wide range of capabilities but generally the accuracy and usefulness will largely be determined by the cost of the instrument. At the low end, you will find the "economy" type of instrument which, whilst useful for relative checks and straightforward alignment jobs on simple equipment, lacks the features required for serious work.

To be really useful, a signal generator should exhibit a very



A typical example of today's professional instruments, this RF signal generator from Rhode & Schwarz covers the range from 0.1 to 1000 MHz and provides AM, FM and pulse modulation as well as a digital readout of frequency, amplitude and modulation. Rhode & Schwarz Australia are available on (02)267 2622.

stable output, both in terms of frequency and amplitude. It can be very frustrating trying to align a piece of equipment when the generator providing the reference signal is drifting all over the place. Similarly, it is impossible to obtain any sort of indication of receiver sensitivity if the signal source does not remain at a constant level. Due to these requirements, there is a quantum leap in prices between the "economy" type of instrument and the professional grade of equipment.

A laboratory standard signal generator will incorporate an accurately calibrated output attenuator which allows the user to produce a signal of precise amplitude often down to a fraction of a microvolt. The low cost generator by contrast, will usually offer a simple uncalibrated "level" control which makes it useless for attempting precision measurements. In the same vein, low cost signal generators often exhibit frequency drift of tens of kilohertz over a short period. This is particularly true when working in the VHF and UHF range and it is not unusual for a cheap device to drift completely out



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RANGES —

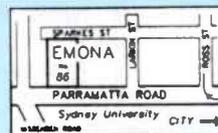
Models	Variable output configurations	Fixed outputs
GPQ-1850	2 x 18V, 5A or 36V, 5A or 18V, 10A	5V, 3A; 5V, 1A
GPQ-3020	2 x 30V, 2A or 60V, 2A or 30V, 4A	5V, 3A; 5V, 1A
GPQ-3030	2 x 30V, 3A or 60V, 3A or 30V, 6A	5V, 3A, 5V, 1A

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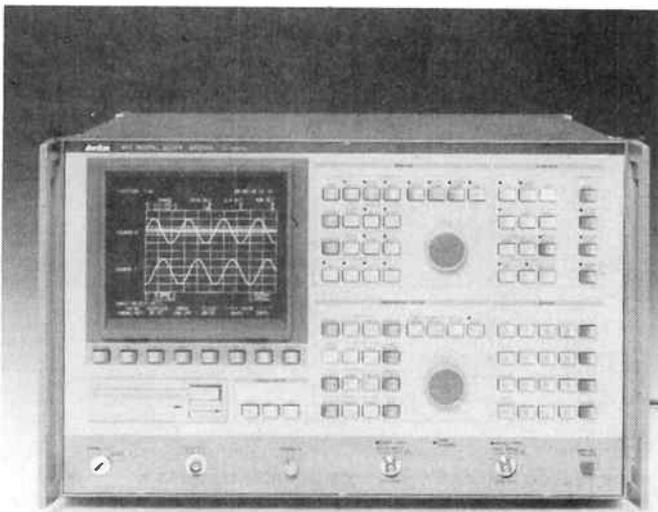
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TAS George Harvey Electronics Hobart
George Harvey Electronics Launceston
WA Henco Engineering Pty Ltd Perth
SA Int'l Communication Systems Pty Ltd
Port Adelaide



The Anritsu FFT (Fast Fourier Transform) analyser model MS210A has a frequency range from dc to 100 kHz and is capable of analysing waveforms in time, amplitude and frequency domains. Well known for their range of RF test and measurement equipment, Anritsu products are distributed in Australia by Standard Telephones and Cables (STC) Melbourne. (03)615 6667.

of the detection bandwidth of a receiver under test in only a few minutes. Professional instruments will usually have a drift of only a few Hertz over long periods of time.

Whilst modern, full-featured signal generators are not inexpensive, it would be false economy to purchase an instrument of dubious quality. If you are working in the professional market, a good signal generator is as much a pre-requisite as a spectrum analyser. If you are on a limited budget, I would seriously suggest looking for second-hand professional

equipment. Even some older valve type signal generators can give surprisingly good performance when allowed to warm up for a while and they often incorporate good quality and well calibrated attenuators. For less critical service and amateur use, ex-professional equipment will generally prove more than adequate for all but the most demanding applications and the cost can be quite reasonable.

Power meters

A quick and convenient method of measuring the output power of a transmitter is a necessity on the service workbench. Again we can draw a distinction between the "economy" instruments intended for amateur use and the professional grade of device although some low cost instruments can give quite a creditable performance.

In the service area, the Bird model 43 thurline wattmeter has become a sort of "de-facto" industry standard for general measurement covering a wide range of frequencies and power levels by means of plug-in modules. For more advanced work there are instruments which can offer a very high degree of accuracy, often with a direct digital readout. Many of these latter types will only measure quite small power levels and are usually preceded by precision attenuators when higher power is to be measured.

Frequency counters

With modern large scale integration techniques it has been possible to produce direct readout frequency counters offering very accurate measurements to be made with relatively inexpensive instruments. Even low cost, semi-professional devices can offer frequency measurement accurate to within a few Hertz. High grade laboratory instruments with temperature stabilized reference oscillators and low ageing rate components can provide results accurate to fractions of a cycle well into the gigahertz region.

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STANDARD
PC VERSION
WITH TAPERED
BEAM FITTINGS
FOR LARGER CELLS

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MPD's horizontal cell holders are made from high temperature resistant UL94V-0 VALOX® material. Unique design assures proper polarity of easily inserted batteries. Also accepts, NiCd, Carbon-Zinc and Alkaline cells.

Australian Distributor  Memory Protection Devices Inc.



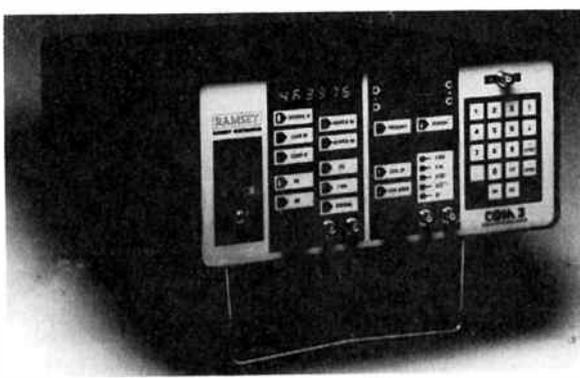
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The ubiquitous Bird model 43 Thruline Wattmeter is a popular and well known "industry standard" which can measure a wide range of power levels over a broad frequency by means of plug-in modules. The Bird wattmeter is available from RF Devices. (02)607 8811.



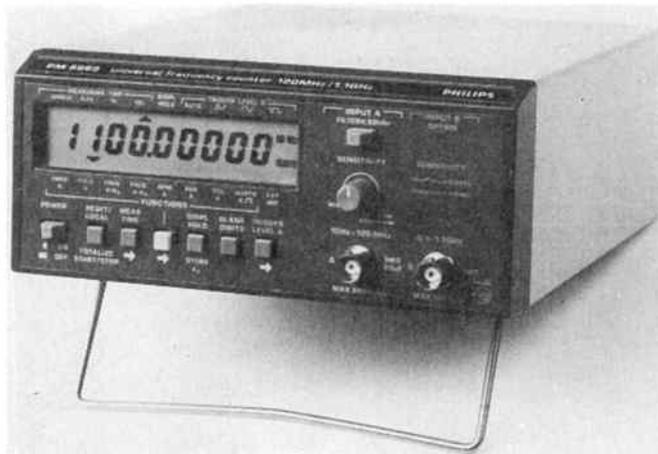
Multi-function instruments

There are a number of instruments available today which combine several functions in an integrated unit. These are generally intended for service type work and are often designed to be portable. These instruments usually include a signal generator, power meter, FM deviation meter and a monitor receiver. More advanced models even incorporate a spectrum analyser resulting in an instrument of unparalleled versatility which makes fault finding quicker and the service technician's job much easier.

Specialised measuring instruments

The equipment we have discussed so far represents the type of instruments more commonly encountered in RF test and measurement but because the field encompasses so many diverse areas, we have to consider those instruments designed for more specialised applications.

Within the categories we have already examined, there exist many permutations designed for specific applications such as spectrum analysers used for satellite communications systems, signal generators covering the high microwave segments where general purpose instruments will not suffice

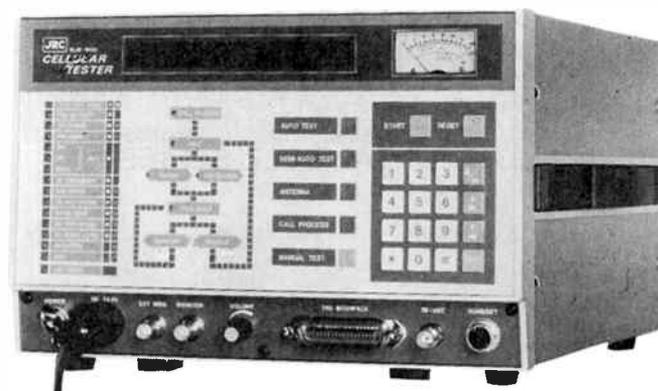


The Philips PM 6669 frequency counter features a mathematically temperature compensated crystal oscillator (MTCXO) which provides very good stability without recourse to expensive crystal ovens. The PM 6669 cover 0.1 Hz to 120 MHz or up to 1.1 GHz with an optional high-frequency input. Contact Philips Scientific and Industrial on (02)888 8222.

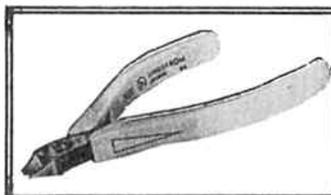
and test sets for particular groups of equipment such as cellular radio and radar.

Beyond these sub-groups we have instruments such as noise figure measuring sets for measuring the performance of low noise amplifiers such as are now being produced in numbers for the satellite industry and complete measuring systems for studying electro-magnetic compatibility and interference.

It certainly gives food for thought when we consider that the instrumentation used to support the communications industry is now vastly more sophisticated than the communications systems themselves that existed only a few years ago. Every time you see some new piece of communications equipment or hear of some new technique, think for a moment about what must be going on in the realm of test and measurement that helped it become a reality. 📌



An example of measuring equipment for a specific service is this model NJZ-500 Cellular radio test set from the Japan Radio Company (JRC). Offering a wide range of facilities, this instrument can be used for field repair and troubleshooting as well as manufacturing of cellular radio products. JRC are represented in Australia by A.C.L. Special Instruments. (03)842 8822.



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The '87 edit. of World Radio TV Handbook gives you a complete listing of international radio and TV stations. Everything that's worth listening to and more besides!
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Here's the book for any serious environmentalists! 286 pages of circuits and designs, building instructions and even component part numbers for alternative electronic projects. Control devices for wind and solar power systems — even an electric vehicle.
Cat B-1775 **\$24⁹⁵**

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Everything you ever wanted to know about National conductors but didn't know who to ask. A valuable reference source for any library.
Cat B-4016 **\$31⁹⁵**

Mail Order Super Special

Ring or write (but you'd best ring — these won't last!) Quality Tasco 10 x 50 wide angle binoculars complete with carry case and strap at an unbelievable price.
Cat Y-1115

SAVE \$50!!

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Quality Needle Nose

The best in quality tools with these Mini Needle Nose Pliers. Stainless steel construction with tiny 1mm non serrated tip for that fine work. Fantastic value!
Cat T-3570 **\$875**

E-Z Cable Checker

Every roadie, every band should have one! Anyone who's involved in audio will find this the ultimate time saver. Simply plug your cable in (and there's a socket for every standard type) and a series of LEDs tells you if it's OK.
Cat Q-1532 **\$79⁹⁵**

24 piece Socket Saver!

Save time and money with this 24 piece socket set. Complete with 9 long sockets and 9 standard hex sockets from 3/16" to 1/2". 1/4" drive ratchet, two extension bars, universal joint and much more!
Cat T-4837 **NOW ONLY \$29⁹⁵**

Auto Ranging 3.5 Digit

The compact Multimeter with memory, two selectable current ranges, auto ranging for voltage and resistance, visual overrange indicator and everything a good workbench needs!
Cat Q-1515 **\$69**

Computer Saver

The Jabel line filter eliminates spikes and other garbage from the mains supply. Give your computer a clean line of supply — and now you'll save \$10 off our normal price!
Cat M-9850



ONLY \$139

An easy change

The RS232 Breakout Box is ideal for modems and other serial applications. DB25 male to female with pin 1 permanently wired — all the others are open and supplied with wire links.
Cat X-3568 **\$27⁵⁰**

Permanent Connections

The RS232 Jumper Box is the DB25 connector made for permanent connections. All 25 pins are open with wire links supplied ready for soldering.
Cat X-3569 **\$17⁵⁰**



Videotext Access

Now you can have Videotext access without having to own a computer! The VDX 1000 Videotext Decoder connects to your phone line and the Videotext computer bank. Once you become a registered user you'll have access to hundreds of pages of information.
Cat X-9700 **\$299**

Antistatic Computer Cleaner

Designed to keep your your valuable computer, screen, etc. looking like new. Cleans and deodorizes in one action!
Cat X-3562 **\$3⁹⁵**

Computer Vacuum Cleaner

A great idea for removing grit and dust from keyboards and circuit boards. The Mini Vacuum Cleaner is battery operated and comes with interchangeable heads for all those hard to get at places!
Cat C-7525 **\$19⁹⁵**

Beat Corrosion

With Cortec 101 you need never worry about corrosion again! Simply slip Cortec into your electronic device and an invisible vapour protects it against corrosion for up to three years. Ideal for marine use.
Cat D-1300 **\$625**

Famous Xidex Disks

From the world's leading disk manufacturer Xidex. Premium quality soft sectored diskettes for the ultimate in reliability!
5 1/4" (13cm) format

Single sided/double density (40 track) **\$4⁵⁰** ea
Cat X-3510

Single sided/double density (Box of 10) **\$44⁹⁵** box
Cat X-3512

Double sided/double density (Box of 10) **\$49⁹⁵** box
Cat X-3514

Double sided/high energy, 80 track **\$99**
(Box of 10)

For AT machines with high capacity drives (1.2Mb)
Cat X-3516

Diskette Files

Top quality diskette files to protect those valuable disks. Constructed of durable plastic with see-thru lids.

5 1/4" (13cm) Format
30 disk storage, with 3 fixed dividers and 5 movable dividers/labels. **\$15⁹⁵** Cat X-3528

50 disk storage. Lockable with 9 movable dividers. Cat X-3531 **WAS \$26.50 NOW \$22⁵⁰**

100 disk storage. Lockable with 9 movable dividers. Cat X-3534

SAVE OVER \$7 ONLY \$29⁹⁵

3 1/2" (9cm) Format
40 disk storage. Lockable with 4 movable dividers. Cat X-3533 **\$28⁹⁵**

Speech Saver

Save \$50 on Votalker Speech Synthesiser! Voltalker board slips into any PC compatible slot and converts written English into speech with amazing clarity. Operates from DOS level or from word processor. Now talking to your machine isn't so silly after all! Cat X-3572

SAVE \$50 ONLY \$699

\$50 off Colour Graphics Adaptor

Slots straight into your Multitech for improved games playing capabilities! Who said computers are all work and no play? Cat X-8140

WAS \$249 NOW \$199

Mono Graphics Adaptor

The Hercules-compatible card for software requiring MGA standard. Also includes a second parallel port and a \$50 saving! Cat X-8141

Now Only \$249

Enhanced Graphics— Lower price!

The most versatile all rounder you can get — PLUS you'll save \$50. The Enhanced Graphic Adaptor gives you switch selectable MGA, CGA or EGA format. Perfect for desktop publishing or highly graphics oriented software! Cat X-8142 **\$699**

Serial Data Cable

2.35 metre serial cable (yes, we're serial about this) with male and female DB25 adaptors at either end (we found it better to put them on the ends). For computer/ computer connections, modems, etc. **\$39**
Cat X-3564

Male Gender Bender

You guessed it! It's just like the one next door but this one has a strong macho image. Turns her into him. **\$15⁹⁵**
Cat X-3565

Parallel Printer Cable

Standard Centronics type printer cable with 36 pin Centronics plug on one end and 25 pin D socket on other. 1.7m long!
Cat X-8614 **\$34⁹⁵**

Female Gender Bender

Adapts male serial cables without re-soldering or reconnecting. Simply plug in twin female DB25 sockets with all pins wired. **\$15⁹⁵**
Cat X-3566

Budget Swivel Base

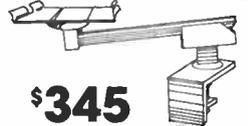
Quality constructed Monitor Swivel Base for your computer screen (or your telly). It's easier to twist the screen than it is your neck!
Cat X-1190 **\$24⁹⁵**

Deluxe Swivel Base

If you're constantly having to adjust the monitor — so others can see the screen, etc — then this is the one for you! Has knurled knob for locking and freeing screen.
Cat X-1191 **\$39⁵⁰**

Gas-Lift Monitor Arm

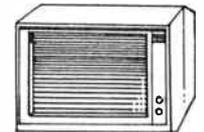
Allows you to move the monitor into almost any position with the little to no effort. The computer cables are hidden away in the arm so it looks neat too! Cat X-1192



\$345

Just a Shade of Difference!

Great value monitors in the two most sought after colours — Green or Amber.



Amber Cat X-1224
Green Cat X-1223

\$249

Get your computer on line! Dataphone 1200

With pushbutton 12 memory phone 300/300, 600/75 and 1200/75 modes. Plus auto answer/answer/originate! Comes complete with RS232 serial interface, 240V supply cable and phone plug. Cat X-3300

\$349

Dataphone 300

For the budget conscious and now with a huge \$30 saving! 300 Baud full duplex modem with pushbutton phone. Simply plug it in for instant communication.

Cat X-3301 **Save \$30**

Now \$169 Only

Dataphone 1200/Smart

We don't call it Smart for nothing! State-of-the-art data transfer is made easier and quicker than ever before. Hayes-compatible offering auto selectable 300/300, 1200/75 baud transmission. Comes ready to plug in! Cat X-3302
All DSE Modems are Telecom Approved **\$499**

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GET UP TO 400 CHARGES OUT OF OUR HEAVY DUTY NICADS.

Ideal for all your toys, radios...

Why buy Nicads?

You should expect at least 400 charges from a NiCad battery. If looked after, this can easily be doubled. Taking worst case, each charge for a "AA" cell costs about 1c (electricity costs are negligible). Compare this to 400 dry batteries at about 60c each. . . the savings are enormous!

But there's more!

A NiCad cell holds its voltage virtually constant over 90% of the discharge cycle. A dry cell starts dropping voltage immediately. You don't get the same "drop off" in a NiCad as a dry cell. Therefore motors continue to run at the correct speed, lamps glow at the right brightness, and so on — very close to complete discharge.

And even more!

The internal resistance of a NiCad Cell is much lower than a dry cell. (less than 0.05 ohms Vs 0.4 to 0.8 ohms) Therefore devices which require high currents (e.g. photoflashes, high torque motors, etc) are much better off with NiCad cells than dry cells.

Still not convinced?

You can get much higher continuous current ratings in a NiCad cell than a dry cell. While not rated the same way, a dry cell discharged at 90mA is considered "flat" (1.1V) after approx. 2.5 hours. A NiCad cell lasts almost 5.5 hours under the same conditions. Even under non-continuous discharge conditions, the NiCad cell wins hands down: because the NiCad can be re-charged between uses!

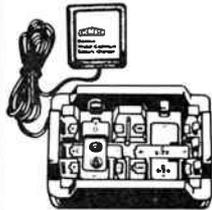
Battery Packs

Qty	Type	Cat No.	Price
4 x AA	500mAh	S-3150	\$16.95
2 x C	1.2Ah	S-3152	\$15.95
2 x D	1.2Ah	S-3154	\$16.50
4 x AA	600mAh	S-3160	\$19.95
2 x C	2.0Ah	S-3162	\$24.95
2 x D	4.0Ah	S-3164	\$27.95

Extra Heavy Duty NiCads

Type	Cat No.	Price
C 2.0Ah	S-3311	\$14.50
AA 600mAh	S-3312	\$5.50
D 4.0Ah	S-3310	\$14.50
Sub C Fast Charge	S-3324	\$6.50

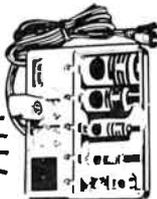
CHARGERS • SAVE ON CHARGERS • SAVE ON CH



Eveready NiCad Charger

Multi-size (AA, C, D or 9V) NiCad battery charger. Takes two 1.2V cells at a time or one 9V. Complete unit including plug-pack: nothing extra to buy. Cat M-9515

\$27⁵⁰



Multi-cell Charger

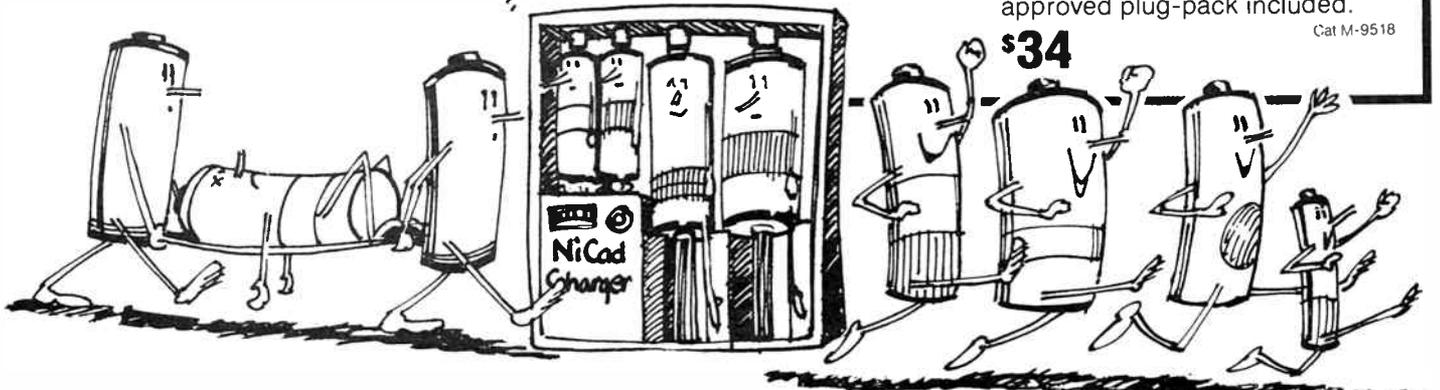
Charge up to 4 batteries at a time — AA, C, D, 6V or 9V. AND you can also charge AAA, and button cells too! But there's more: a test meter to check NiCad voltage under load — the only way to check your battery properly. Fully approved plug-pack included.

\$34

Cat M-9518

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Flat Blade Mini Screwdriver Cat T-6010.....	Was \$1.50
Mini Philips Head Screwdriver Cat T-6015.....	Was \$1.50
75mm Philips Head Screwdriver Cat T-4030.....	Was \$1
100mm Philips Head Screwdriver Cat T-4040.....	Was 70¢
125mm Philips Head Screwdriver Cat T-4050.....	Was \$1
45mm Stubby Screwdriver Cat T-4060.....	Was \$1.75
50mm Screwdriver Cat T-4070.....	Was 60¢
100mm Screwdriver Cat T-4075.....	
200mm Screwdriver Cat T-4080.....	
75mm Screwdriver Cat T-4085.....	Was 60¢
150mm Screwdriver Cat T-4090.....	Was \$1.50
75mm Screwdriver Cat T-4095.....	Was \$1.75
125mm Screwdriver Cat T-4100.....	Was \$1.20

NOT IN ALL STORES
WHILE STOCKS LAST

ALL **50¢**

Sure looks like a Cellular Car Phone!

But it doesn't cost near as much — and no-one can listen into your conversation. The DSE Cellular Phoney has the status we'd all like but few of us can afford. Absolutely static and maintenance free!! (We left out the hi-tech circuitry just to be sure.) Fits all cars and any bank account. No doubt — it looks impressive **\$39.95**
Cat Y-5500



Microwave Oven Leak Detector

Microwaves can damage human tissue. The Microwave Detector can test the door seam for leaks and indicates if any leak is dangerous. Measures as low as 0.1 milliwatt psc! Great one for safety! **\$22**
Cat Y-4100

New Threads!

Three great screw packs for that new project or just to keep the workshop stocked! H-1680

Assorted Metric Pack \$9.95

Over 200pcs

Metric P/H Self Tappers \$2.15

H-1672 1/4" pk pack

500pcs **\$2.65**

Local Alarm

The Piezo two-tone alarm emits a high pitched warble when activated. At only 28 x 22mm it'll fit into a huge range of devices. 9-16 volts. **\$7.50**
Cat L-7027

5-15V Variable Supply

Perfect bench mate! The DSE Variable Power Supply giving from 5 to 15 volts DC at 2A continuous or 4A peak. Meter indicates voltage or current (switchable). **\$99**
Cat M-9549



Fewer Mistakes Calculator

The desk top portable with large error reducing keys, Gross Profit Margin key, memory, floating decimals and battery saver. Fantastic value and performance! Cat V-3034 **\$19.95**

The Best!

These Slim-line adjustable Headphones are the best we've seen. Unbelievable performance and superb sound make them the first choice for hi-fi buffs. Complete with 3.5 and 6.34mm plugs. Cat C-4155 **\$65**

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RF Signaliser

A must for the avid CBer! Inserts into antenna lead to give -25dB to zero to +25dB gain. The gain lifts the signals out of the mud, while the cut stops them bending your needle. Needs 12V DC 35mA >. Cat D-3828 **\$54.95**



16V AC Power Pack

Ideal for heaps of projects where a transformer would normally be fitted or anything that needs a 12 volt AC supply. A nice healthy 16 volts at 900mA and it's energy authority approved! Cat M-9567 **\$14.95**



3-6-9-12V DC at 1amp

Just great around the home or workshop. With a maximum of 1 amp and 4 selectable voltages. Just plug it into the 240V mains. DC connections are via screw terminals on front of unit. Ideal for home alarms and intercoms, etc. Cat M-9530 **\$22.95**



PCB Board

Just what you need for that new circuit you're working on! 16x12 inch fibreglass PCB board. Your projects are quality — so don't let them down with inferior PCB board. Amazing value! Cat J-1017 **\$5.95**

3.5 Digit Pocket Size

Packed with features yet this compact Multimeter is only about the size of a pocket calculator — only 10mm thick! With features galore — look: auto ranging, audible continuity, automatic polarity indicator, 2 times/second sampling and much more! Cat Q-1555 **\$49.95**



Cube Clock Radio

A good square deal! FM radio, clock and alarm in a neat compact cube shape. With snooze button, convenient top mounted controls and telescopic antenna. Ideal for the bedroom table. Cat A-5120 **\$39.95**



Old TV Sounding Tired? TURN IT ON TO STEREO!

That's right! Your old TV can have a new lease of life with our fantastic Stereo Receiver. Connect the receiver to your hi-fi for the ultimate in sound reproduction. Receiver has 6 preset stations which make tuning a breeze. Fully compatible with Australian 'two carrier' system and it comes complete with adaptor plug, connecting leads and features galore! Cat L-4905 **\$199**



Starplug Saver

Four plugs in one unit. 2.1, 2.5 and 3.5mm phono type plugs. Ideal for power supplies, chargers, etc. Reversible polarity. Cat P-167n **WAS \$2.70 NOW \$2.55**

Phone Style Duplex Intercom

The ultimate in simplicity and style. Simply plug each station into any power point on the same phase and lift the handset to talk. No wiring, no buttons to push! Wall or desk mount. Cat F-1015 **\$99**

Budget Intercom

This battery operated, wired system gives you maximum coverage with four stations at our famous DSE great value price! With three slaves offering hands free conversation and master station. Each slave comes with 16 metres of cable. Cat F-1040 **\$39**

6 Speaker Stereo Cassette

Fantastic stereo sound from this compact 6 speaker portable. AM/SW/FM reception, cassette, built-in condenser mics, a huge 14 watts and much more! Available in red or silver! Cat A-5002 Silver **\$129 each**



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Semiconductor Bargain Bag

Unbelievable! Guaranteed minimum \$25 value for only \$9.95!! That's right, a mixed bag of semiconductors — ALL brand new, price specs. — Yours for this incredibly LOW price. Fantastic for service shops, hobbyists, labs... everyone! Don't miss out — at this price it won't last long!

\$25 VALUE NOW ONLY \$9.95

Mugen Bulldog MK2 — Competition Racing!

The Bulldog Mk2 lets you get serious about radio controlled competition. It's fast! With Four wheel drive, four wheel steering, fully independent A-frame suspension and heavy duty air shocks. Three forward and three reverse gears and three limited slip differentials are designed to get you out of trouble and into the race! Cat Y-2542 **\$295**



DSE Longlife Batteries

Here's a great way to life back into that portable radio etc. DSE top quality Longlife AA batteries in packs of two. You won't find better value so get in now before they all go! Cat S-3281 **\$2.95**



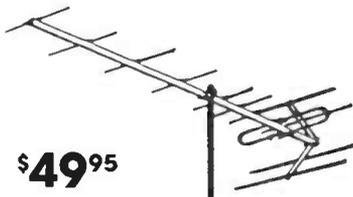
Local Area VHF/UHF



\$39⁹⁵

Reasonably close to the station? You don't need a big antenna. This economy VHF model will give you a great picture on VHF or UHF band 4 — and look at the low, low price! Cat L-4027

Band 4 UHF



\$49⁹⁵

Already have a good VHF antenna up? Why replace it if all you want to do is watch SBS or local area translators on band 4. Fold-out reflector for maximum performance. Cat L-4040

Ghost Buster

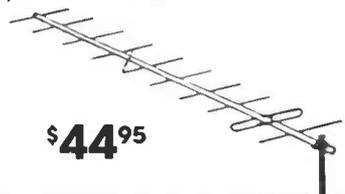
Who ya gonna call? DSE, of course — for this superb ghost buster antenna. High front to back and side ratio means minimum ghosting — great for problem reception areas. Suits VHF and band 4 UHF. Cat L-4023



\$99

Band 5 UHF

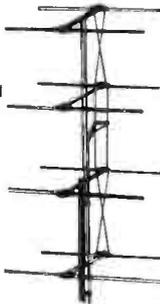
Similar to the Band 4 model, but cut with shorter elements to suit Band 5 (channels 39 to 69). A lot of local translators are being put into this band — check with stations to find the band in your area. Cat L-4035



\$44⁹⁵

Phased Array: the big guns!

For long distance (deep fringe) reception this phased array is a beauty. For high band VHF (channels 6 and up), perfect for country viewers watching city channels — or city viewers watching the footy! Cat L-4025



\$99

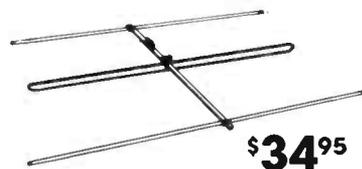
Super Band 5 UHF

For long distance UHF reception — deep fringe UHF can be dramatically improved with this one. 16 elements and 15 element reflector gives you the edge in picking up that elusive signal. Cat L-4045

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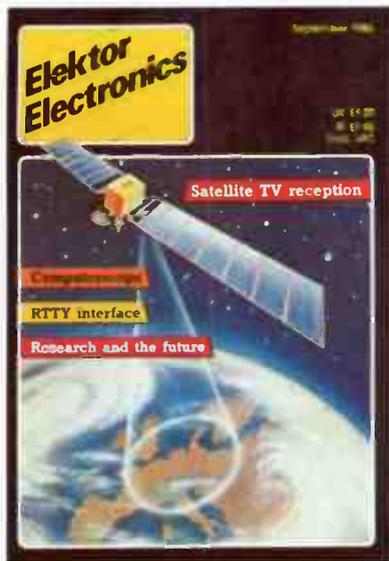
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The projects and circuits chosen for inclusion in the Elektor section are selected on the basis of interest, local relevance and component availability. Intending constructors should consult our 'PROJECT BUYERS GUIDE' in this issue for a guide to component sources and possible kit suppliers.

Unfortunately the artwork for Elektor project pc boards published last issue and in this issue did not arrive from overseas in time for inclusion. We will publish them in the next available issue following their arrival.

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MIDI SIGNAL REDISTRIBUTION

by M Eller

A versatile signal redistribution unit that facilitates interconnecting MIDI compatible instruments and control ancillaries in complex configurations.

The introduction and general acceptance of the MIDI standard have been an important incentive for owners of personal micros to process musical data from electronic musical instruments with the aid of a microprocessor. The standard MIDI interface operates on the basis of a straightforward set of musical parameters. Playing a note, for instance, entails a 3-byte command: the KEY ON code indicates the beginning of a note, but also specifies the relevant MIDI channel number; the KEY NUMBER code specifies the number of the note on a virtual keyboard, whose keys are numbered from 0 to 127 (low to high); the VELOCITY code, finally, carries information on the dynamic characteristics of the played note, which can be stopped on the instrument by once more sending the above 3 bytes, but with KEY OFF replacing KEY ON. This example illustrates the use of but a few of the many available MIDI codes. None the less, it goes to show that the MIDI command set has no provision for the definition of the duration of the note, which is simply determined by the period that lapses between the receipt of the KEY ON and KEY OFF code. There exists a system of codes to control a real-time clock for synchronizing MIDI data (a metronome function), but this provides only pulses, which must be counted to measure the duration of the notes. With or without this synchronization information, called MIDI REAL TIME DATA, it is sufficient for a microprocessor system to have a TIME function. The micro must also be reasonably fast to effect the control of one or more MIDI synthesizers, and to be able to do this on the basis of relatively simple control software. In this context, the performance of the CX5M system from Yamaha, or that of the Atari ST, can be used as a yard stick.

MIDI configurations

The majority of MIDI compatible instruments and control units have but single MIDI IN, MIDI OUT, and MIDI THRU sockets. In most cases, the signal at the THRU socket is simply obtained by reshaping and buffering the IN signal. Since the serial MIDI signal is always received in an optocoupler, phase shift and pulse distortion inevitably increase as

more instruments are series-connected to form a musical configuration. Figure 1a illustrates that the MIDI signal applied to auxiliary synthesizer no. 2 is impaired with respect to that output by the main synthesizer. Before continuing this discussion, it is necessary to point out the different functions of the OUT and THRU sockets: the former carries signals gener-

ated by the instrument it forms part of, the second carries a duplicate of the input signal fed to the instrument it forms part of. Figure 1b shows an alternative set-up, based on the use of a MASTER synthesizer, which is, unfortunately, only rarely spotted among MIDI compatible instruments. This device has several parallel MIDI OUT sockets, which are used for the

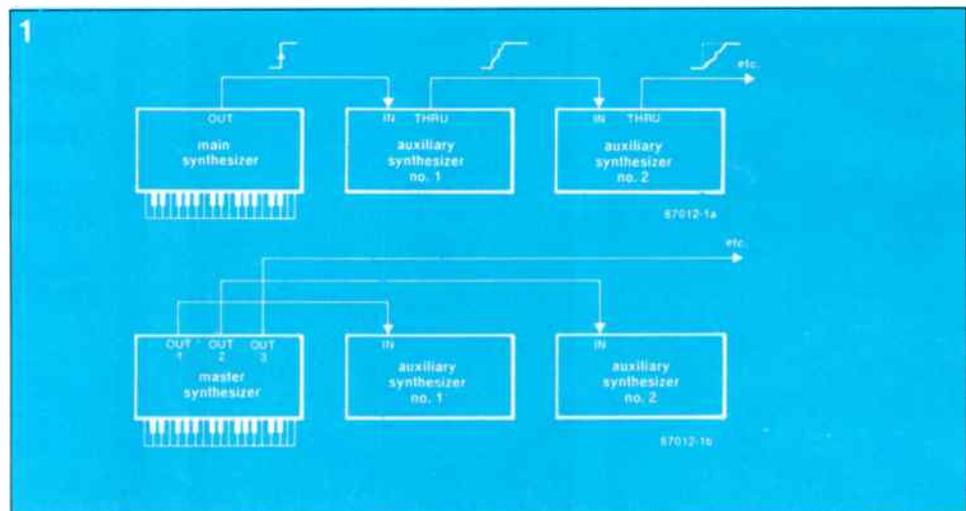


Fig. 1. This shows the advantage of a MASTER instrument over the more common IN-THRU series connection.

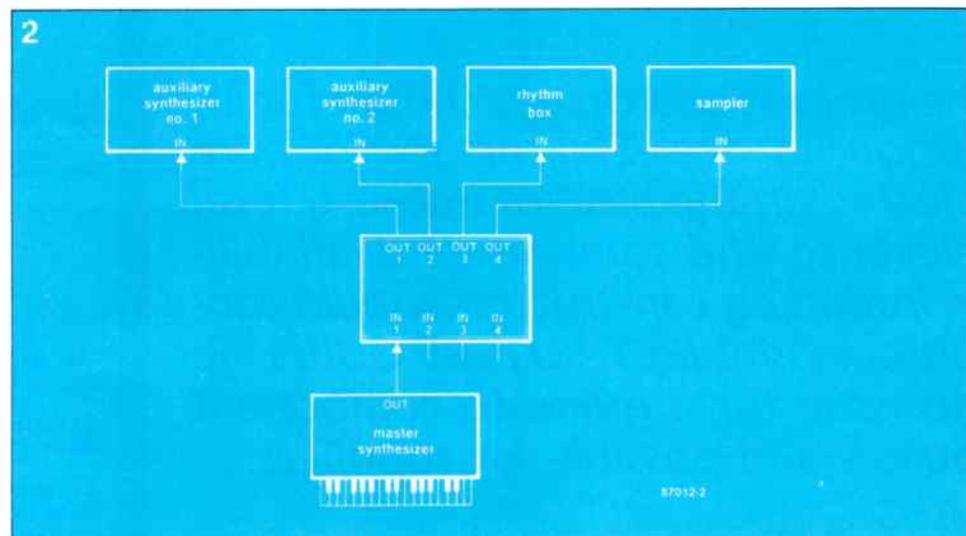


Fig. 2. The use of the MIDI UNIT ensures the absence of phase difference between the signals fed to the four instruments.

direct driving of auxiliary synthesizers. This means that auxiliary synthesizer no. 1 and 2 receive an identical input signal, and hence are correctly synchronized under all circumstances.

The above discussion should not lead to the conclusion that the quality of a MIDI instrument can be judged from its number of input and output sockets. As set out above, a long chain of series connected MIDI instruments readily leads to troublesome asynchronicity, owing to the incurred phase delays and pulse distortion. The MIDI redistribution circuit proposed here provides the means for controlling a large number of instruments from the main synthesizer, without running into difficulty as regards distortion of the serial MIDI signal. The redistribution unit is a relatively simple circuit, which can be built by anyone capable of correctly soldering 5 wires to a 5-way DIN plug.

16 MIDI outputs

The use of the MIDI redistribution unit is illustrated in Fig. 2. Note that the instrument configuration shown is but an example; other uses of the redistribution unit are feasible, as will be seen below.

The circuit diagram of the MIDI redistribution unit appears in Fig. 3. The four inputs are standard MIDI types, i.e., based on the use of an optocoupler. The Type TIL111 is an inexpensive and commonly available optocoupler, but its electrical performance is not spectacular—the MIDI signal is typically delayed by about $9 \mu\text{s}$, and the duty factor is altered considerably. None the less, the device gives satisfactory results in this circuit. For those constructors striving towards near perfection, the design of the circuit board allows the fitting of the fast optocoupler Type 6N135.

After reshaping and inversion of the incoming pulses in gates N_1 , N_7 , N_{13} and N_{19} , the signal can be distributed in various ways over the 16 available DIN output sockets, each of which has a standard current loop interface.

The four remaining inverters N_6 , N_{12} , N_{18} and N_{24} are connected to function as LED drivers for the four inputs of the circuit.

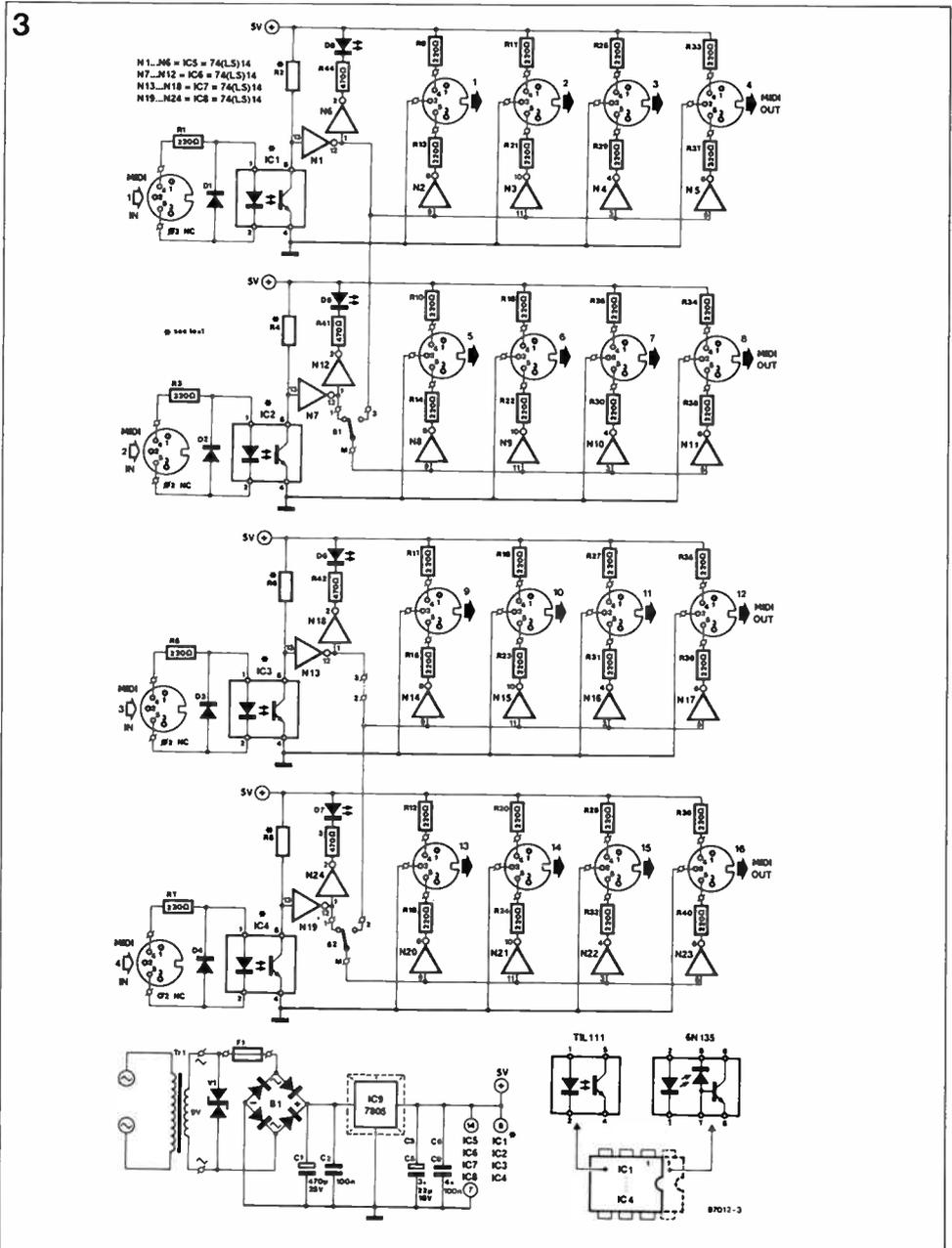


Fig. 3. Circuit diagram of the redistribution unit.

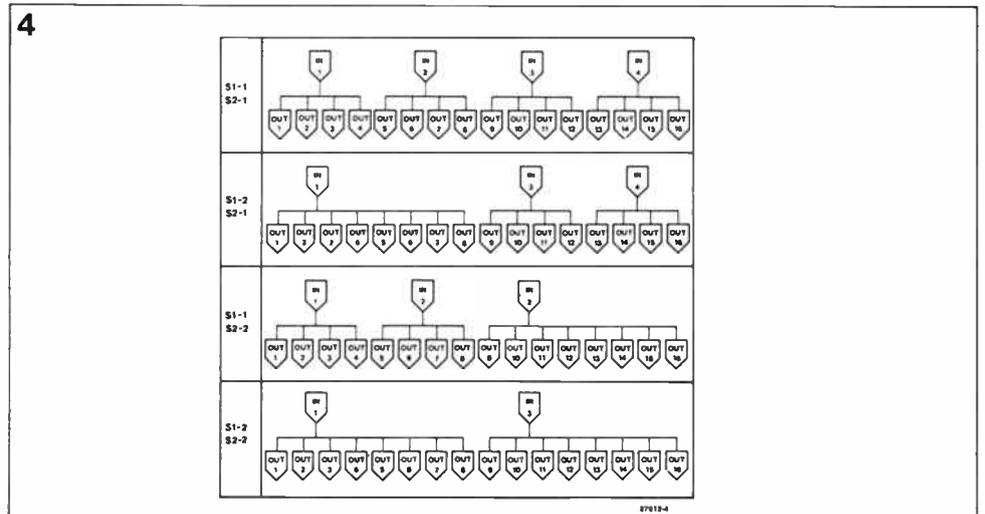


Fig. 4. These four signal paths can be defined with mode switches S_1 and S_2

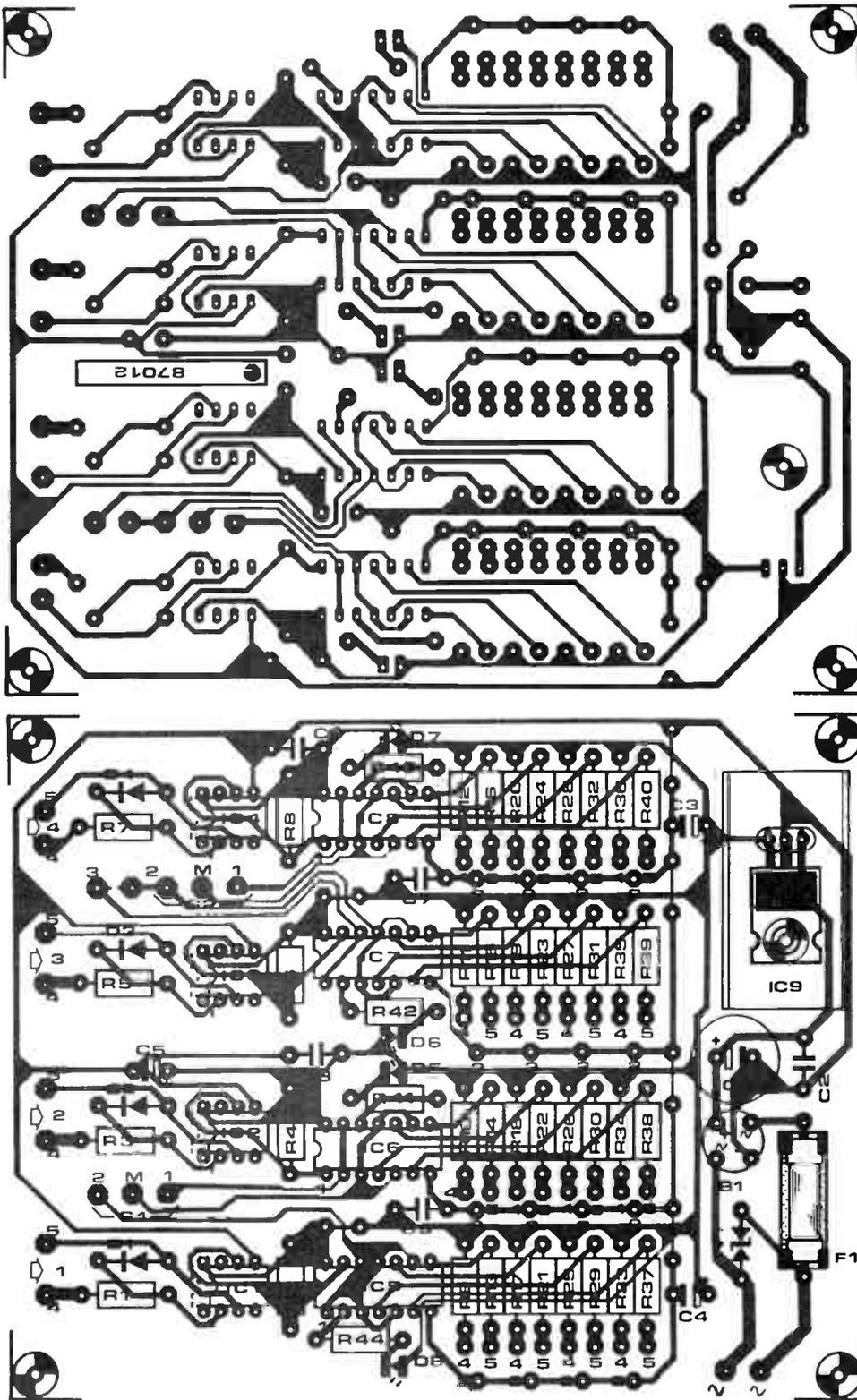


Fig. 5. Track layout and component overlay of the PCB for the redistribution unit.

Strictly speaking, the 16 output sockets on the redistribution unit are not OUT functions, but THRU functions, as can be deduced from the previously given definitions of these MIDI functions. This is because the output signals on these 16 sockets are only re-processed, not generated, by the distribution unit. For simplicity's

sake, however, we will stick to the OUT denotation.

The various signal distribution paths that can be defined with the aid of this design are shown schematically in Fig. 4.

Construction

Figure 5 shows that the 20 DIN sockets are not accommodated

on the circuit board for the redistribution unit. The choice in favour of panel-mounted DIN sockets and standard wiring was made to keep the size, and hence the cost, of the PCB within reasonable limits. Another important consideration has to do with the choice of a suitable enclosure that would accommodate a large PCB

Parts list

Resistors ($\pm 5\%$):

R₁; R₂; R₃; R₇; R₉... R₄₀ incl. = 220R
R₂; R₄; R₆; R₈ = 1K0 for TIL111; 3K3 for 6N135
R₄₁... R₄₄ incl. = 470R

Capacitors:

C₁ = 470 μ ; 25 V radial
C₂; C₃... C₉ incl. = 100n
C₃; C₄; C₅ = 22 μ ; 16 V axial

Semiconductors:

B₁ = B40C1000
D₁... D₄ incl. = 1N4148
D₅... D₈ incl. = LED red
IC₁... IC₄ incl. = TIL111 or 6N135 *
IC₅... IC₈ incl. = 74LS14 or 7414
IC₉ = 7805 plus heat-sink

Miscellaneous:

S₁; S₂ = miniature SPDT switch or 3-pole, 4-way rotary switch. *
F₁ = 800 mA delayed action fuse with PCB-mount holder.
V₁ = varistor S10 250V \neq
Tr₁ = 9 V; 400 mA mains transformer
PCB Type 87012 (see Readers Services).

* See text

fitted such that the sockets mounted onto it are accessible through the front panel. It is, of course, still possible to use PCB-mount DIN sockets, but these would have to be soldered in groups of 5 onto strips of veroboard, secured on the front panel of the redistribution unit. The use of standard, metal, DIN sockets for panel

mounting requires quite some drilling and wiring, but at the same time ensures the required mechanical stability required to cope with the frequent inserting and removing of DIN plugs. Both the Type TIL111 and the 6N135 optocoupler can be accommodated on PC board 87012 without making any alterations to the track layout. Pin 1 of the TIL111 must go into socket pin 2. The 8-pin 6N135 is simply fitted as any other integrated circuit. The value of R_2 , R_4 , R_6 and R_8 is 1K0 if the TIL111 is used, and 3k3 for the 6N135.

The four LEDs are preferably fitted close to the associated MIDI input socket to indicate the reception of MIDI data. Varistor V_1 is an optional component; its absence is not likely to have adverse effects on the operation of the circuit.

Switches S_1 and S_2 may be replaced with the more sophisticated mode selector circuit shown in Fig. 6. The use of the rotary switch instead of the two SPDT switches S_1 & S_2 is only possible when wire link 3-4 is

not installed on the PCB. It should be noted, however, that this modification has an effect on the signal distribution paths shown in Fig. 4. The third configuration shown in this figure ($S1-1$; $S2-2$) is no longer available, but when the rotary switch shown in Fig. 6 is set to position 4, the MIDI signal applied to the IN_1 socket is distributed over all 16 outputs. Any one of the two options for the mode selection switch has its particular advantages, and the user is left free to choose the most advantageous configuration for a specific application. The connections between the circuit board at one side and the switch(es) and the DIN sockets on the other, are made in standard, non-shielded wire.

Finally, Fig. 7 shows a suggestion for the front panel of the redistribution unit, which is conveniently housed in a standard 19 inch rack mounting cabinet of one height unit.

DM

Fig. 7. Suggested layout of the front panel for the MIDI redistribution unit.

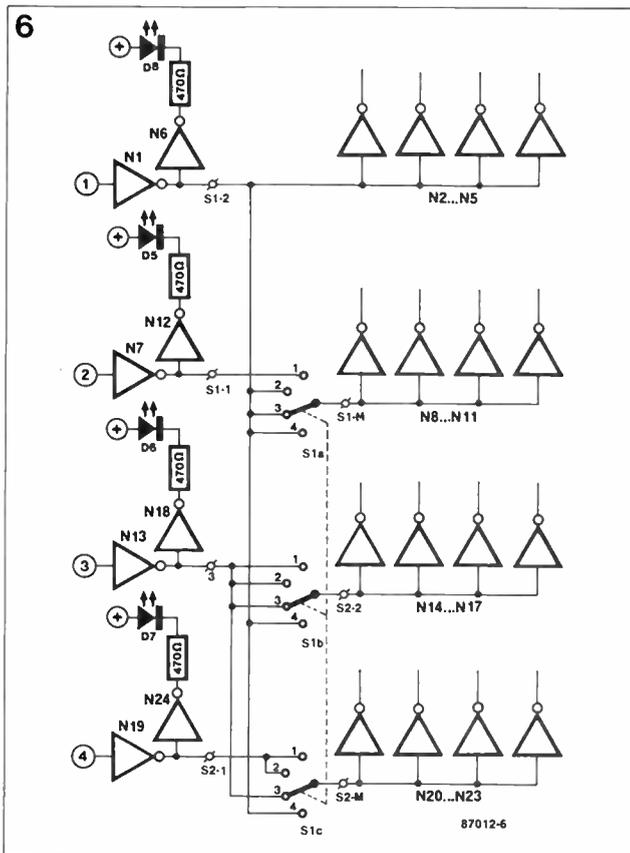
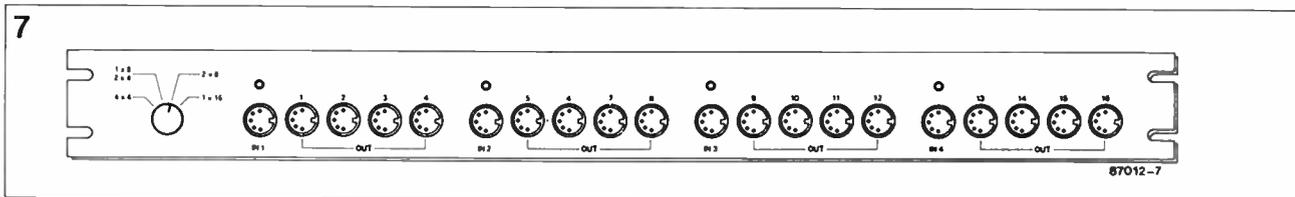
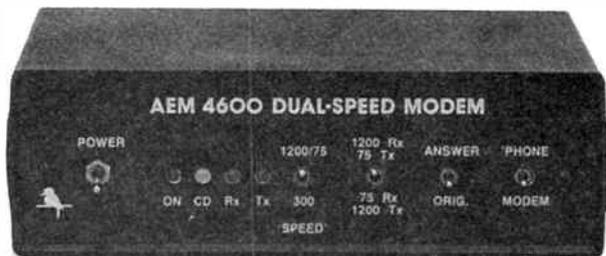


Fig. 6. Suggestion for an enhanced, single switch, mode control on the MIDI UNIT.



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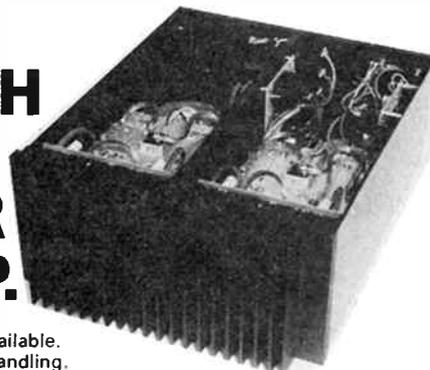
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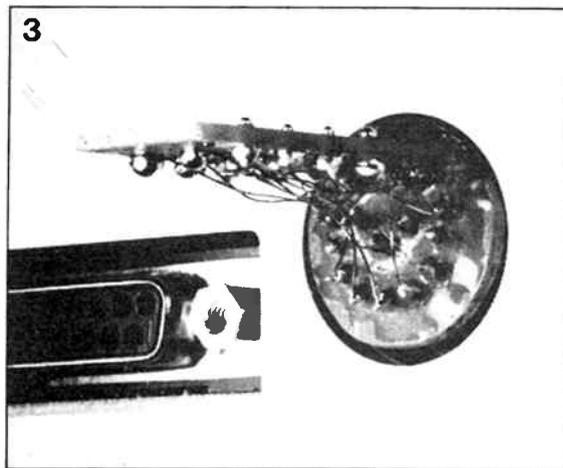
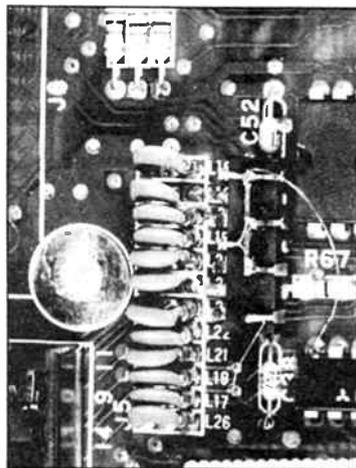
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circuitry voids any warranty. A suggested method of adding the OC buffers is to cut the output chokes' terminal leads furthest removed from the PCB edge ($L_{24} = DS1$; $L_{16} = SS$). $DS0$ is buffered in the 1040ST, and not wired to the second drive socket. It should be noted that the pin assignment of the second drive socket is incorrectly stated in the 1040ST manual; $SS0$ is all right, but $DS1$, not $DS0$, is available at pin 5 of the DIN socket. Pin 6 is connected to a 1 k pull-up resistor.

Two inverters in a Type 7407 package have been used to boost the output drive capacity to an acceptable level. The photograph in Fig. 2 shows how the chip is fitted onto the PCB surface, close by chokes L_{16} and L_{24} . Unused inverters should have their inputs tied to +5 V to prevent them from picking up digital noise. After cutting the terminal wires of the stated chokes, the inverter inputs are connected to the vacant soldering islands. The chokes are next bent up to connect direct to the inverter outputs. Do not forget to wire the 7407 pins 14 and 7 to +5 V and ground, respectively. Since a 14-way DIN connector for the Atari disk interface is a hard to obtain and relatively expensive item for many users wishing to upgrade the system with a non-Atari disk drive, it appears worthwhile to make one from a round piece of veroboard and 14 small soldering pins; a specially etched PCB is, of course, the ultimate solution. Whatever home-made plug is used, all cable connections should be capable of withstanding considerable strain. A sufficiently rigid plug can be made by covering the cable joints in two-component glue or epoxy resin. Fig. 3 shows the prototype connector before



soldering the flat ribbon cable to the appropriate pins, as summarized in Table 1. Finally, make sure that the wires go to the right pins and secure the cable as suggested.

MIDI interface

A nice feature of the ST types of computer is the built-in MIDI (musical instrument digital interface) facility plus supporting software. However Atari have failed to observe the MIDI THRU and MIDI OUT socket convention. Rather than providing a separate socket for each function, they have thought it fit to combine these in a single OUT/THRU connection. This may appear sensible at first, but MIDI users will soon run into trouble when attempting to use their set of standard interconnecting wires; that to the Atari computer should have two functions combined in a single plug!

To get round the problem of having to make a special cable, it is suggested to route the THRU and

OUT signals to separate 5-way DIN sockets, as shown in Fig. 4. A Y-type 5-way male-to-female DIN adaptor is well suited to the purpose, provided the internal wiring is arranged to conform to the MIDI convention. As shown, neat lettering makes for ease of wiring to instruments and/or keyboards.

The MIDI IN socket remains unaltered, but users should check the pin assignment against the relevant statement in the 1040ST manual; in some models pins 1 and 3 are vacant and therefore do not carry the MIDI THRU signal.

(DM)

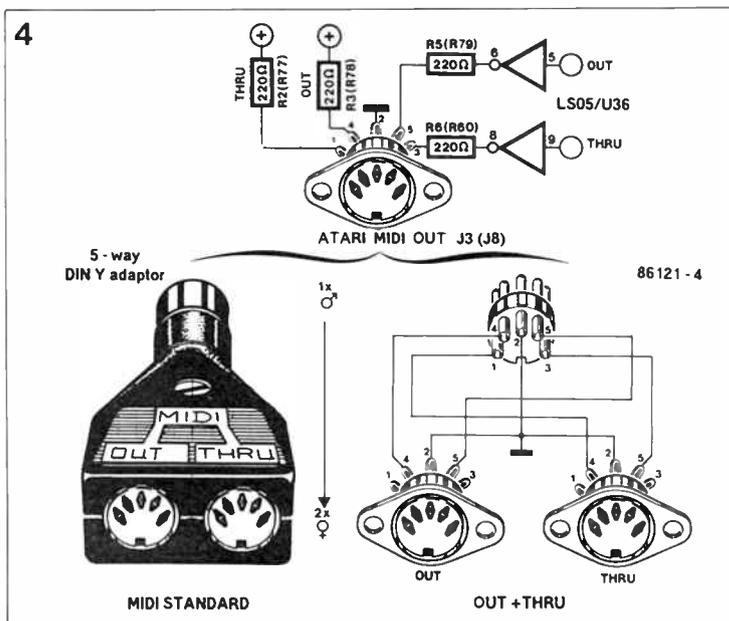
Fig. 2. After having cut the terminal leads of L_{16} and L_{24} , the 7407 chip is located pins up between the WD1772 FDC and the row of chokes. The inverter input pins may be soldered direct into the vacant PCB holes, and the outputs to the remaining lengths of choke lead.

Fig. 3. Making one's own 14-way DIN floppy disk connector is a relatively simple matter; a round piece of PCB material is equipped with 14 soldering pins for the connection of a length of flat ribbon cable. Moulding of the connection area is recommended to ensure sufficient stability of the newly made plug.

Fig. 4. As the combined THRU/OUT socket requires non-standard MIDI connection to the Atari 1040ST, it is suggested to use separate DIN sockets for each function.

Table 1

ATARI	SHUGART
1040 ST/J5	DRIVE
3,7	1, 3, 5, 7...33 GND
—	2 —
—	4 —
—	6 —
4 ---	8 INDEX
—	10 —
5 ---	12 DRIVE 1 SELECT
—	14 —
8 ---	16 MOTOR ON
9 ---	18 DIRECTION
10 ---	20 STEP
11 ---	22 WRITE DATA
12 ---	24 WRITE GATE
13 ---	26 TRACK 0
14 ---	28 WRITE PROTECT
1 ---	30 READ DATA
2 ---	32 SIDE 0 SELECT
—	34 —



METAL DETECTOR

Attention, treasure hunters! Here is a simple, inexpensive, and highly sensitive metal detector.

Metal detectors generally operate on the basis of one of the following technical principles:

BFO (beat frequency oscillator).

In this system, the inductor in the search head is part of an oscillator, whose variable output frequency is mixed with another, fixed, frequency obtained from a second oscillator. The difference (beat) frequency falls within the audible range. When the search head is brought near a metal object, the variable oscillator causes an audible or otherwise detectable change in the beat frequency. BFO-based metal detectors are relatively inexpensive and easy to operate.

TR/IB (transmit-receive/induction-balance).

This system is based on the mutual-inductance coupling between a transmit coil and a receive coil. When a metal object is introduced in the vicinity of the inductors, the degree of coupling changes, and the resultant variation in the oscillator output level is detected.

PI (pulse induction).

A continuous pulse train is transmitted, and the received echoes thereof are examined in respect of their shape and strength. This enables reporting the presence of metal objects in the area covered by the transmitter.

Each of the above methods for detecting metals has its particular advantages. The ideal metal detector is, therefore, based on the most advantageous aspects of all three principles discussed. Such a detector would be very sensitive, and capable of providing an indication of the type of metal the buried object is composed of. It will be understood that the ideal detector does not exist, as it is extremely difficult

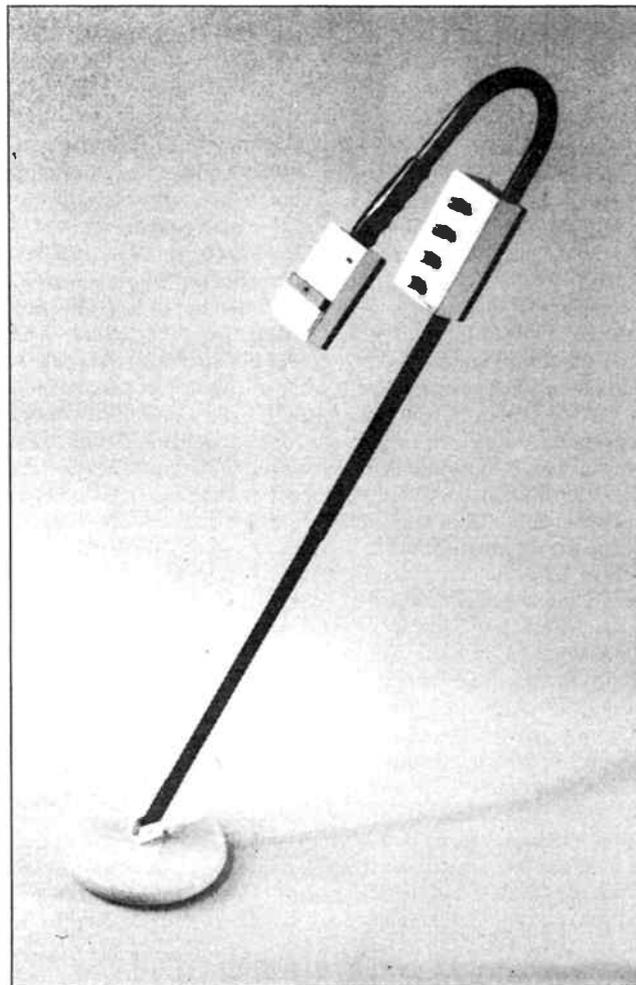


Table 1

Magnetic properties of various substances.

diamagnetic ($\mu < 1$)	paramagnetic ($\mu > 1$)	ferromagnetic ($\mu \gg 1$)
Bismuth	Aluminium	Cobalt
Glass	Silicon	Nickel
Copper	Air	Iron
Water	Platinum	Ferrocube
Silver	Palladium	Steel

to rule out some of the disadvantages inevitably associated with any of the previously mentioned measuring methods.

The metal detector described here is based on the TR/IB principle, and therefore has two inductors in the search head. As will be seen further on in this article, the design is essentially a combination of a variable-L oscillator, and a detector.

Magnetic properties

A metal object can cause a variation in a coil's self-inductance, and, therefore, in the degree of coupling between inductors. The effect can be positive or negative, depending on the relative permeability, μ_r , of the relevant metal. In this context, it is useful to know that materials and substances are classified as *paramagnetic* ($\mu_r > 1$), *diamagnetic* ($\mu_r < 1$), or *ferromagnetic* ($\mu_r \gg 1$)—see Table 1.

Determining an object's substance on the basis of μ_r measurement is generally rather difficult. However, the difference between paramagnetic and diamagnetic materials on the one hand, and ferromagnetic ones on the other, is readily detectable thanks to the appreciable difference in the magnitude of μ_r .

Eddy currents are induced in a conductive object when this is subject to a varying magnetic field. The strength of the eddy currents depends on the shape and the size of the metal object, and the resistivity of the substance(s) it is composed of. Strong eddy currents can be induced in, for instance, a metal sheet if this is flat and fairly large. The eddy currents are considerably weakened, however, if slots are cut into this sheet. Referring in particular to the use of a metal detector, further factors that determine the strength of eddy currents in a metal object include its pos-

ition in the magnetic field (i.e., the number of lines of force that intersect it), and the effect brought about by the composition of the earth's surface. The foregoing considerations may serve to account for the technical difficulties involved in determining the substance of a buried object on the basis of a single measuring method.

Circuit description

The circuit diagram of the metal detector appears in Fig. 1. Transistor T_1 functions as a self-quenching oscillator. This means that it simultaneously produces a low and a high frequency signal that together form an AM-like waveform as illustrated in Fig. 2. Notice that the rising slope of the composite signal is steeper than the falling slope. The oscillator is switched on and off by means of D_1 , C_1 , and R_1 . During the oscillation, C_1 is charged via D_1 up to a voltage that is high enough to turn off T_1 . The oscillation stops, and C_1 is discharged via R_1 , until the voltage is low enough for T_1 to start oscillating again.

The transmitter inductors, L_1 , L_2 , and L_3 are connected between the base and the collector of T_1 . In practice, the transmitter inductor set is arranged such that stray capacitance is counteracted to ensure the stability of the oscillator. Capacitor C_5 is fitted in the search head, together with the inductors, to preclude stability problems owing to the capacitance of the cables between the search head and the detector circuit. Inductors L_4 and L_5 together form the coupling loop, also built into the search head, and partly covering the transmitter's set of inductors. The residual (background) signal from L_4 - L_5 can be compensated with the aid of tuning capacitor C_6 , which serves to null the detector when the position of the transmitter and receiver inductor has been aligned, and the construction of the search head has been completed successfully.

The sensitivity of the metal detector can be adjusted with potentiometers P_1 (fine) and P_2 (coarse). Diode D_2 is a positive rectifier that ensures the absence of negative levels on the inverting input of IC1. The operation of the detector circuit is fairly simple: when the rectified

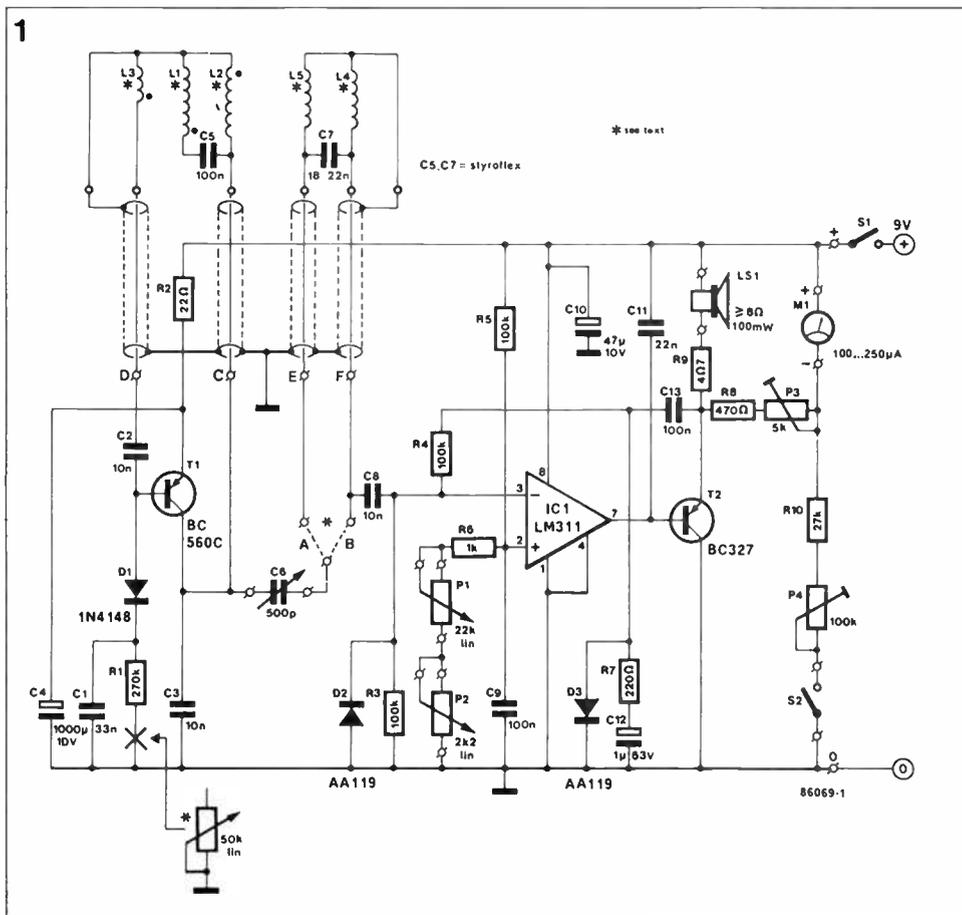


Fig. 1. Circuit diagram of the metal detector.

input signal exceeds the threshold voltage at the comparator's non-inverting input, the IC toggles, pulling its open-collector output low, and turning on loudspeaker driver T_2 . The pitch of the note sounded by the loudspeaker on the detector depends on the level of the signal from the receiver inductor, L_4 - L_5 . This is illustrated by the dashed horizontal line in Fig. 2. Variations in the received signal strength give rise to a corresponding variation in the duty factor of the part of the burst that exceeds the threshold. The effect thus obtained is a clearly

audible pitch shift when a metal object is detected. Components D_3 - R_7 - C_{12} convert the output signal from T_2 into a negative feedback voltage for the comparator. This set-up provides an automatic gain control facility that counteracts strong input level variations. Moving coil meter M_1 provides a visual indication of the signal strength. Push-button S_2 makes it possible to check the battery condition before or during the search for metal objects in the ground.

Construction

The final performance of the

metal detector largely depends on the precision used in constructing the inductor assembly in the search head. Figure 3 shows the shape and size of the formers that hold the inductors. The formers should be made of perspex, which is reasonably easily obtainable in sheet form. Do not use wood, as the resultant susceptibility of the formers to ambient humidity variations gives rise to difficulty in nulling the detector. Cut, rabbet or file a 5 mm wide, 10 mm deep slot into the entire edge of both plates, then use 30SWG (0.3 mm) enamelled copper wire to make the inductors as follows:

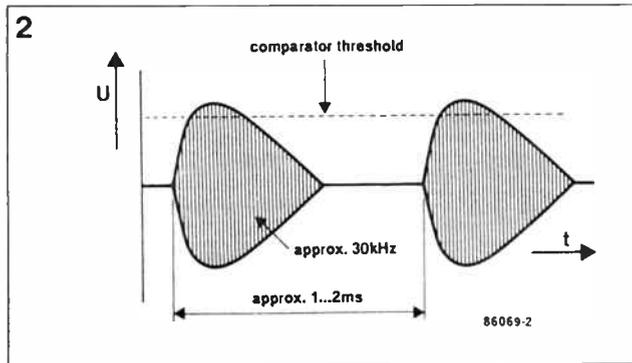


Fig. 2. The output signal of the self-quenching oscillator.

commence with glueing the start of the first winding onto plate 1 at point A. Wind L_1 as 22 clockwise turns in the slot around the side of the plate. Stop at point A and create a tap by twisting the wire over a length of roughly 10 cm, which is glued onto the plate surface. Leave the remainder of the wire unused for the moment, and connect the start of L_3 to the tap. Then wind L_3 as 4 counter-clockwise turns onto L_1 . Start and stop at point A and glue the

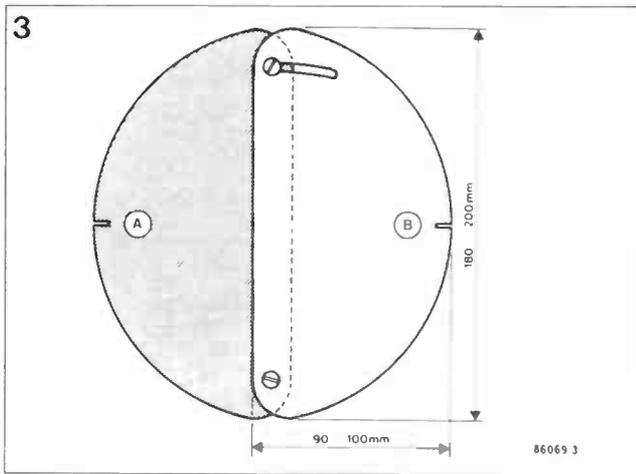


Fig. 3. The coil halves can be aligned for optimum balance.



free end of L_3 onto the plate. Proceed with winding L_2 from the wire that was left flying after winding L_1 . Wind 22 clockwise turns into the slot, starting and ending at point A. Secure the wire end by glueing it onto the plate.

The receiver inductors on plate 2 are made as follows: wind L_4 as 36 clockwise turns, starting and ending at point B. Create a tap as for L_1 and glue this and the start of the winding onto the surface of plate 2.

Proceed with this length of wire and wind L_5 as another 36 clockwise turns. Stop at point B and glue the last wire end onto the plate. Now identify all wire ends and inductor junctions, check for correct continuity, secure capacitors C_5 and C_7 onto the plates, and connect them to the relevant wires.

Cut a slot into plate 2 at the location shown in Fig. 3, and drill holes in both plates to enable assembling and aligning these with the aid of nylon bolts and nuts.

The remaining mechanical parts of the metal detector can be made to individual liking. The search head and the enclosure for the detector electronics can be fitted onto a wooden stick or a length of PVC tubing. The latter construction is preferable because of its lower weight and the possibility to hide the wiring between the search head and the detector circuit from sight.

The construction of the detector's electronics is a matter of fitting all components in accordance with the PCB overlay and the parts list—see Fig. 4. There are five controls on the enclosure front panel: S_1 , S_2 , C_6 , P_1 and P_2 . A sixth may be added as set out in the next section. The connections between the tuned circuits in the search head and the detector PCB are made in screened wire.

A suggested enclosure for the inductor assembly is composed of two plastic, dispensable, plates, which leave sufficient room inside when the rims are glued together. The completed search head can be made sufficiently sturdy by filling it with polyurethane potting compound or epoxy resin.

Before fitting the perspex plates inside the search head, however, make sure that the inductor assembly is thoroughly tested and correctly aligned.

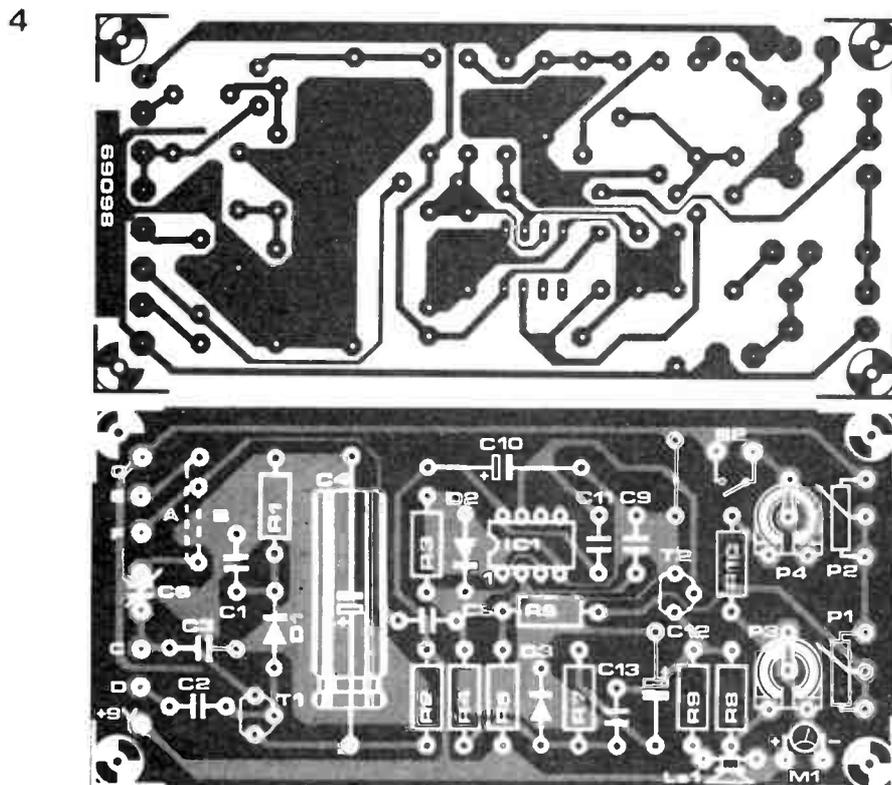


Fig. 4. The printed circuit board for constructing the metal detector.

Parts list

Resistors ($\pm 5\%$):

$R_1 = 270K$
 $R_2 = 22R$
 $R_3, R_4, R_5 = 100K$
 $R_6 = 1K0$
 $R_7 = 220R$
 $R_8 = 470R$
 $R_9 = 4R7$
 $R_{10} = 27K$
 $P_1 = 22K$ linear potentiometer
 $P_2 = 2K2$ linear potentiometer
 $P_3 = 5K0$ preset
 $P_4 = 100K$ preset

Capacitors:

$C_1 = 33n$

$C_2, C_3, C_5 = 10n$
 $C_4 = 1000\mu$; 10 V axial
 $C_5 = 100n$ styroflex *
 $C_6 = 500p$ tuning capacitor Δ
 $C_7 = 18.22n$ styroflex *
 $C_8, C_{13} = 100n$
 $C_{10} = 47\mu$; 10 V axial
 $C_{11} = 22n$
 $C_{12} = 1\mu$; 63 V axial electrolytic

Semiconductors:

$D_1 = 1N4148$
 $D_2, D_3 = AA119$
 $T_1 = BC560C$
 $T_2 = BC327$
 $IC_1 = LM311$

Miscellaneous:

$L_1 \dots L_5$ incl. = *
 $S_1 =$ miniature SPST switch.
 $S_2 =$ push-to-make button.
 $LS_1 = 100$ mW; 8R.
 $M_1 = 100 \dots 250 \mu A$ moving coil meter.
 PCB Type 86069 (see Readers Services).
 * See text.
 Δ May be made by parallel connection of smaller styroflex capacitors.

Setting up

Initially, the perspex plates are spaced to the maximum extent allowed by the nylon adjustment bolt. Neither link A nor B must be fitted on the circuit board, and all controls are set to mid-travel. Switch on the detector, and check whether it can produce an audible note at a particular setting of P_1 - P_2 . Make sure that this test is carried out in the absence of metal objects in the direct vicinity of the search head. Carefully align the position of the plates until a point is reached where the loudspeaker volume is minimal; it may be necessary to redo the adjustment of the sensitivity controls. Increase the distance between the plates by about 0.5 mm, and secure the bolt and nut to retain the position. The inductor assembly can now be fitted into the search head, which is then sealed and filled with a suitable compound. Fit wire link A and check whether C_6 can be adjusted for a dip in the detector's output volume. If this does not work, fit link B. If the adjustment is still incorrect, the inductor assembly is probably unbalanced by it being fitted into the search head enclosure. The final attempt you can make is to fit a 470pF capacitor in parallel with C_6 . If that does not remedy the problem, there is no other solution than to make a new search head. Feed the circuit from a regulated 9 V supply, and adjust the sensitivity controls such that the detector produces no sound. Press S_2 , and adjust P_4

for full-scale deflection of M_1 . Reduce the supply voltage to 7 V, and mark the resulting needle position in red. Preset P_3 makes it possible to adjust the meter sensitivity to individual preference.

A final remark about the oscillator: a hum-like 100...150 Hz beat note may be audible as a result of interference between the two output frequencies. This effect can be obviated by fitting a 50K SYNC potentiometer in series with R_1 (see the cross in the circuit diagram, Fig. 1).

The detector in practice

First-time users of this metal detector are advised to try out the effects of various settings of C_6 . A number of field experiments have shown that the detector's sensitivity is greatest when the note from the loudspeaker is just about audible. Turning C_6 to the left and the right of its null position is a means of determining whether an object in the ground is composed of a ferromagnetic or a dia/paramagnetic substance. Practice is doubtlessly the best way of gaining experience in the operation of this metal detector, and the interpretation of its output signal. It will soon become apparent that the overlapping part of the plates is the most sensitive area of the search head. When this is slowly swept over the ground, it enables detection of a coin the size of a shilling buried some 15 cm deep. B

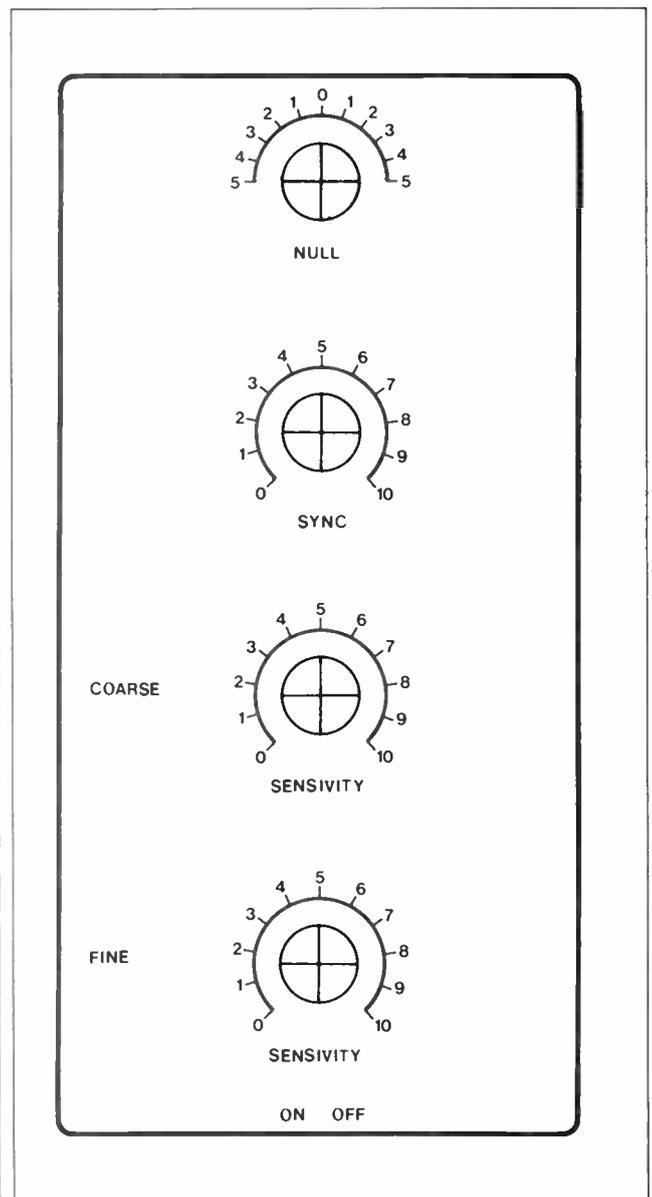
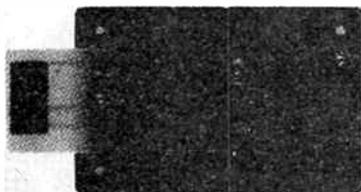


Fig. 5. Suggested lay-out of a front panel for the metal detector.

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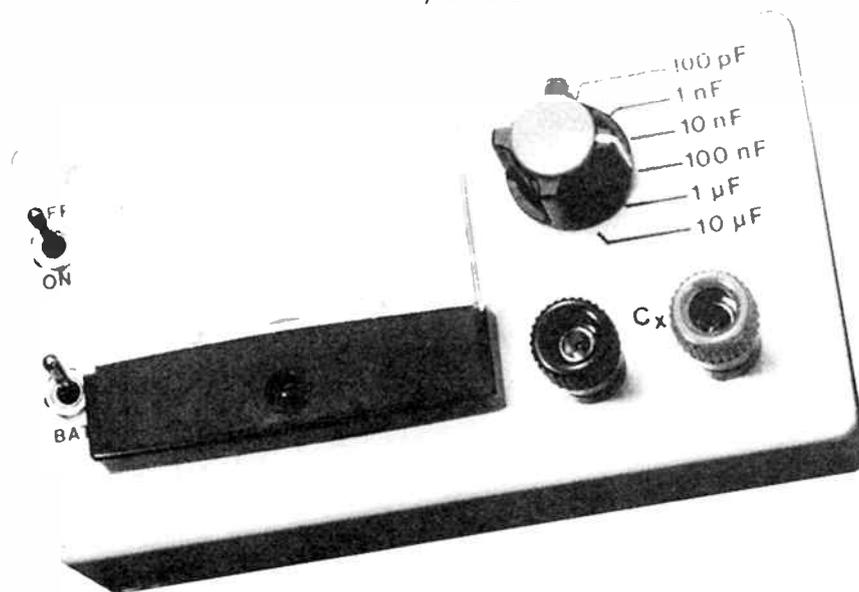
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A smartly designed, inexpensive, yet accurate, analogue capacitance meter.

The capacitance meter described here is intended to meet the need for an accurate, battery-operated, and low-cost instrument, which has no more features than strictly necessary for the testing and measuring of a wide range of capacitors. Considering that a capacitance meter is not the most frequently used of test instruments in the electronics workshop, a relatively simple design can have all the necessary features, and yet be accurate and reliable. The digital capacitance meter described in ⁽¹⁾ is, of course, the ultimate as far as ease of readout and operation are concerned, but the cost of this instrument may be considered rather high in relation to the number of occasions when the instrument is called for.

The present instrument can operate in conjunction with almost any multimeter that has a 1 mA DC current range with sufficient accuracy. However, it is also possible to build a moving-coil meter into the capacitance meter's enclosure, as shown on the above photograph, to make for an autonomously operating instrument at very little extra expense. The operation of the proposed meter is based on measuring the time to charge the capacitor

under test to a certain voltage. The measured time is converted into a voltage that is directly related to the value of the capacitance.

The measuring principle

The functional diagram of the capacitance meter is shown in Fig. 1. Since a single charge and voltage measurement cycle poses practical problems—the charge voltage drops the instant the meter circuit is connected—this meter uses the principle of alternately charging and discharging the capacitor under test.

Figure 1 shows that capacitor C_x is charged with the aid of a regulated voltage and a series resistor R . Capacitor C_x is shunted by a switch, which is opened and closed by the pulses from a clock oscillator. Therefore, C_x is quickly discharged during the on-time of the clock signal, and charged again during the pulse pauses.

The C_x - R junction carries a periodic ramp-like signal, which is converted into a rectangular wave with the aid of a Schmitt-trigger circuit. As the duty factor of the Schmitt-trigger's output signal is di-

rectly proportional to the capacitance of C_x , an integrator suffices to actuate a meter, whose indication corresponds to the capacitance of C_x .

The operation of the Schmitt-trigger section in the circuit is crucial to the operation of the circuit. Since the capacitance meter is fed from a regulated 5 V line, the trigger level can be established fairly accurately at $\frac{1}{2}$ of 5 V.

The voltage, U_c , on a capacitor, C , charging through a resistor, R , from a supply voltage, U , is given by

$$U_c = U(1 - e^{-t/\tau}) \text{ volts}$$

where e is the base of natural logarithms ($=2.71828$) and $\tau = RC$ (and is called the time constant). With this formula, it can be calculated that if $t = \tau \log_e 3$, $U_c = 0.667U$. Since U_c is inversely proportional to C ($U_c = Q/C$, where Q is the charge of the capacitance), and also inversely proportional to t , it may be concluded that the capacitance is directly proportional to the time t , and it is on this that the present circuit is based.

Circuit description

The circuit diagram of the capacitance meter appears in

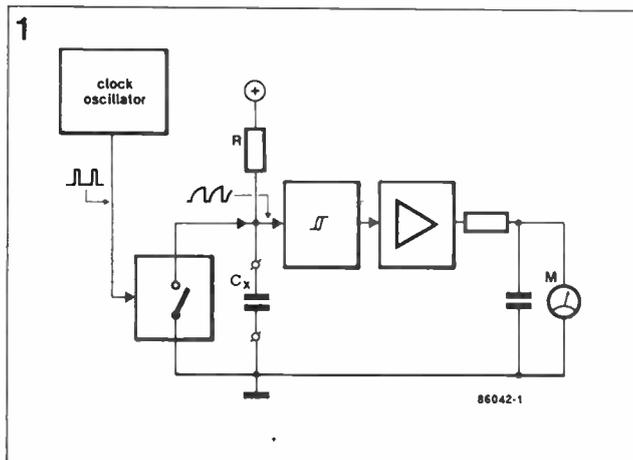


Fig. 1. Functional diagram of the capacitance meter.

Fig. 2. It is not very difficult to recognize the previously introduced functional blocks. The clock signal for the electronic switch across C_x , and the value of the charge resistor, R , can be selected with the aid of 6-position range selector S_1 . The circuit around T_2 and N_3 was added to provide compensation for parasitic capacitances, and the measurement error which inevitably occurs as a result of the leakage discharge of C_x .

The operation of the practical circuit is essentially as follows. The clock signal is generated by oscillator N_1 . Four clock frequencies are available at the outputs of decimal counters IC_2 - IC_5 . Each of these outputs a switching signal with a duty factor of 10% ($t_h = 0.1T$; $t_l = 0.9T$). During the logic high time of the selected pulse, T_1 short-circuits C_x and dissipates its charge, and during the logic low time of the selected pulse C_x is charged via the relevant resistor, R_2 , R_3 or R_4 . As already noted, the switch clock frequency and the charge resistor are selected as required for a particular measurement range. Gate N_2 is an inverting Schmitt-trigger for the voltage across C_x , and drives buffer N_5 - N_7 via XOR gate N_4 . The integration of the proportional voltage is effected with R_7 - C_4 . Preset P_2 serves to calibrate the meter, and push button S_3 to check the condition of the battery. If this contains the nominal charge of 9 V, the current through R_6 is

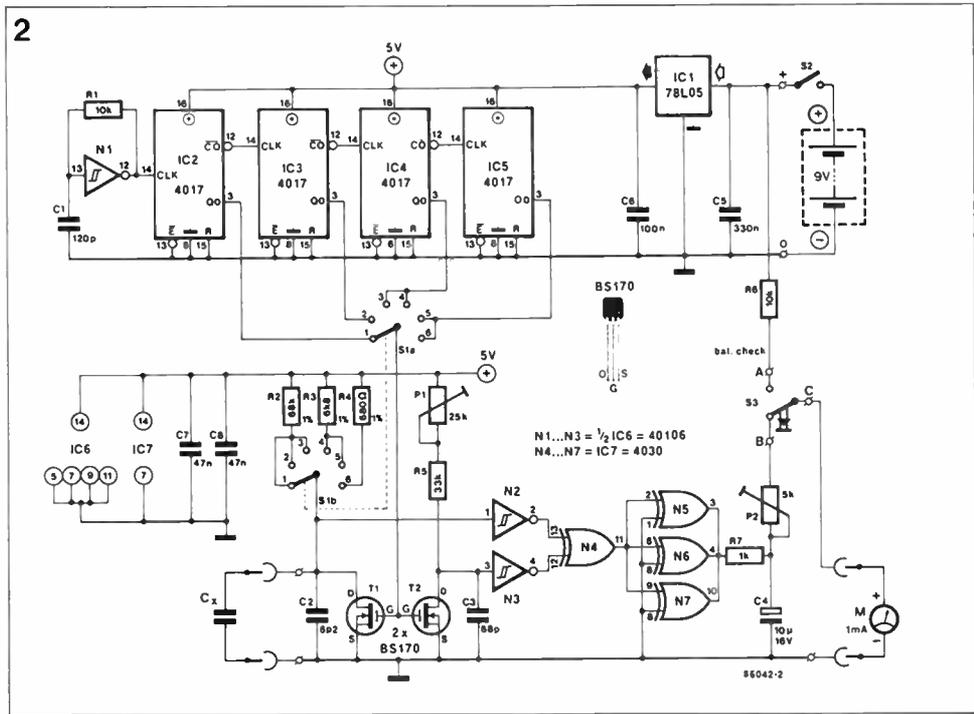


Fig. 2. Circuit diagram of the low-cost capacitance meter.

nearly the fsd current of the meter.

The previously mentioned compensation function is realized by connecting an additional network P - R_5 - C_3 in parallel with the measuring network R_2 / R_3 / R_4 - C_x , and using T_2 as an electronic switch. Capacitor C_3 is switched simultaneously with C_x , and its charge ramp is subtracted from that of C_x by means of XOR gate N_4 . The purpose of this arrangement is twofold. Firstly, the relatively low value of C_3 will cause the output signal of N_3 to be very

similar to the clock signal when S_1 is set to the higher ranges. A near perfect compensation for the 10% discharge time of C_x can thus be achieved by subtracting this signal from the instantaneous voltage across C_x . Secondly, the value of C_3 can not be neglected when measuring relatively small capacitors. The pulses from N_3 are then relatively wide, which effectively compensates for any parasitic capacitances introduced by, for instance, a set of test leads. The timing diagram in Fig. 3 further illus-

trates the above compensation method.

Construction and alignment

The circuit board for this easy to build project is available ready-made from our Readers Services, and its completion should not present any problems. Simply fit all the parts as per Fig. 4 and the accompanying parts list. The capacitance meter is housed in a suitable ABS enclosure that has room for the meter, if used, and the PP3 battery. The introductory photograph to this article should give some idea of the drilling and lettering of the instrument's front panel.

Setting up the capacitance meter is extremely straightforward. Do not yet connect a test capacitor, set the meter to its 100 pF range, and null the moving coil meter by adjusting P_1 . Proceed with connecting a precision capacitor of 10 nF (use the best you can get, an 5% MKT or polystyrene type is the absolute minimum), switch the meter to the third range (10 nF), and adjust P_2 for full scale deflection of the meter (1 mA).

Accuracy

The extraordinary precision of the present meter is best illustrated by Table 1.

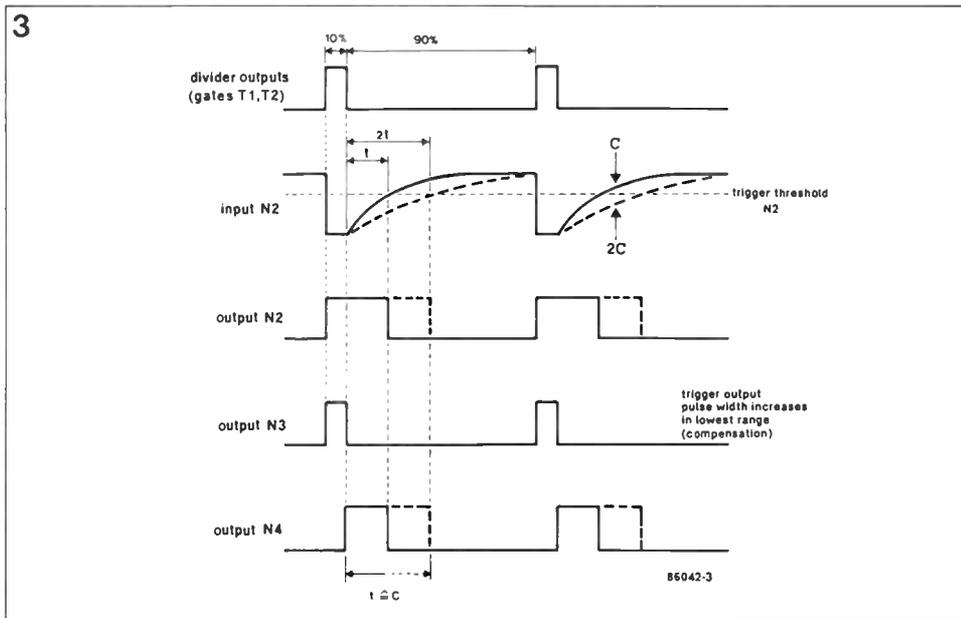
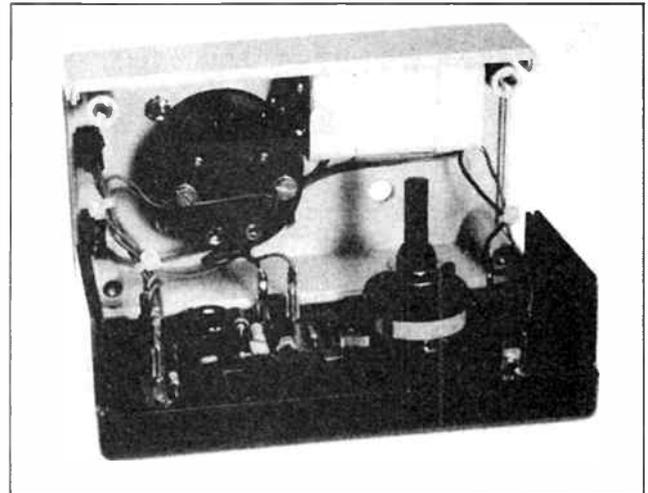


Fig. 3. Pulse diagram illustrating the operation of the compensation circuit.

Table 1

range	test-C	analogue C meter	digital C meter
1	10 pF	10.8 pF	9.2 pF
	33 pF	37.0 pF	31.2 pF
	68 pF	77.5 pF	64.5 pF
2	100 pF	110 pF	94.5 pF
	330 pF	350 pF	330 pF
	680 pF	660 pF	640 pF
	1 nF	0.98 nF	0.95 nF
3	3.3 nF	3.25 nF	3.20 nF
	6.8 nF	6.80 nF	6.65 nF
	10 nF	10.0 nF	9.83 nF
4	33 nF	30.2 nF	31 nF
	68 nF	69.2 nF	69 nF
	100 nF	102 nF	102 nF
5	330 nF	338 nF	336 nF
	680 nF	685 nF	674 nF
	1 μ F	1.01 μ F	0.993 μ F
6	1 μ F*	1.10 μ F	1.09 μ F
	4.7 μ F	5.80 μ F	5.90 μ F
	10 μ F	overflow	11.3 μ F

* Electrolytic capacitor.



A look inside the completed capacitance meter.

Parts list

Resistors ($\pm 5\%$):

- R₁; R₆ = 10K
- R₂ = 68K
- R₃ = 6K8F
- R₄ = 680R
- R₅ = 33K
- R₇ = 1K0
- P₁ = 25K preset
- P₂ = 5K0 preset

Capacitors:

- C₁ = 120p
- C₂ = 8p2
- C₃ = 68p
- C₄ = 10 μ ; 16 V axial
- C₅ = 330n
- C₆ = 100n
- C₇; C₈ = 47n

Semiconductors:

- T₁; T₂ = BS170 *
- IC₁ = 78L05
- IC₂... IC₈ incl. = 4017
- IC₆ = 40106
- IC₇ = 4030

Miscellaneous:

- S₁ = dual pole, 6-way rotary switch for PCB mounting.
- S₂ = miniature SPST switch.
- S₃ = miniature SPDT push-button.
- M = 1 mA fsd meter.
- Suitable ABS enclosure.
- PCB Type 86042 (see Readers Services).
- 1 red and 1 black insulated terminal post.
- PP3 battery plus holder and clip-on connector.

The performance of the low-cost meter described here is the more surprising in view of its simplicity and ease of calibration. Its maximum deviation occurs in the lowest range, where the indication is typically too high. It is seen, however, that the digital capacitance meter gives too low readings with the same test capacitors. A final remark concerning the current consumption of the capacitance meter: this is no more than about 6 mA, so that the built-in battery will last for many tests and measurements.

TW

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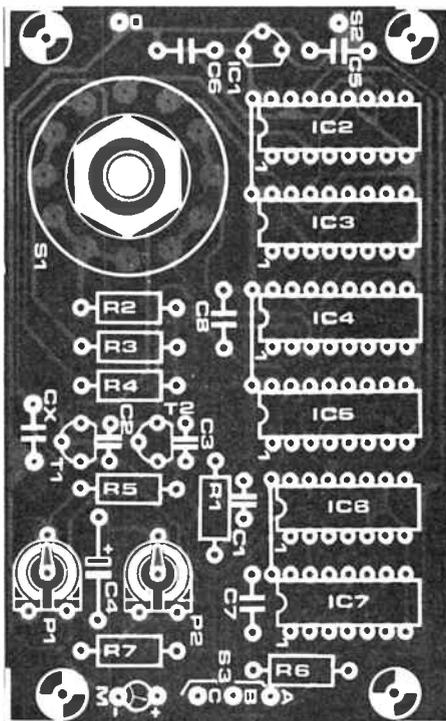


Fig. 4. The circuit board for the capacitance meter. Rotary switch S₁ is fitted direct onto it.

AN INTRODUCTION TO D.C. POWER SUPPLIES

by Peter Bardos*

In this article, Peter Bardos explains the basic workings of power supplies and also considers why they do what they do, and why they behave differently from any other piece of electronic equipment.

Dc. power supplies are used in just about every piece of electronic equipment and yet they are taken very much for granted and usually ignored. Nevertheless the modern direct-off-line stabilised switch mode power supply (SMPS) is a highly sophisticated and specialist piece of equipment on which the whole equipment will rely for its safety, stability and long term performance. To explain what a direct off-line SMPS is, this article will first discuss what a power supply is.

Power

Power is defined as the rate of doing work and, in electrical terms, it is given by the voltage multiplied by the current. Energy, which is the related factor, is the capacity to do work and is defined, in electrical terms, as the voltage \times the current \times the time for which the voltage and the current are present.

The usual source of power is the mains supply. A simple circuit diagram (Fig. 1) of how this works shows a generator (supply) which generates a voltage which is distributed to many different places where different loads are put on the system. For the system to work, the supply of voltage has to be standard and the load current will vary with different loads (resistance). A higher power load will take more current than a low power load, but they will both be rated and operate off the same voltage level which is a standard supply voltage (240 V for the UK domestic supply).

A.c. or d.c.

Having defined the voltage, it is then necessary to decide whether it is d.c. (direct current) or a.c. (alternating current).

Direct voltage is unchanging with time and one terminal of the supply is positive with respect to the other terminal at all times. Examples of direct voltage uses are battery toys (1.5 V), torches (3 V), cars and other vehicles (12 V), telephone system (48 V).

Alternating voltage means that the polarity and magnitude of the voltage of one terminal with respect to the other changes with time. The frequency with which an alternating voltage alternates is called the frequency, and the number indicates the number of times that the voltage goes through a complete cycle of changes in a second. The unit of frequency is Hertz (abbreviated Hz), so a 240 V 50 Hz supply means that the effective value of the voltage is 240 V and in one second it goes through a complete cycle of changes fifty times. The effective value is defined as an alternating voltage which will supply the same power in a resistive load as a direct voltage of the same value. Examples of alternating voltage systems are, domestic mains (240 V, 50 Hz), industrial mains (380 V, 50 Hz), National Grid (11,000 V, 50 Hz). There are many reasons for choosing 50 Hz as the right frequency, but for the moment it will suffice to consider that this is 3,000 r.p.m., which is a convenient speed to run machinery.

The next obvious question is why bother with two radically

different systems, namely, a.c. and d.c.? As Fig. 1 shows electricity has to be generated in one place and then distributed through some distance to different loads in another place. Although there are very many different loads they normally fall into one of three categories: (1) heaters, (2) motors, and (3) electronics. Electronics in this instance covers everything

whose primary purpose is not to heat something or move something. As such it includes computers, television, radios, instrumentation of all kinds, and control equipment—to name but a few examples.

So the ease with which electricity can be generated, distributed and used by heaters, motors and electronics needs to be considered. In addition,

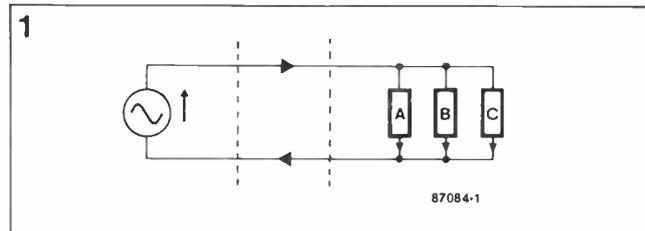


Fig. 1. Basic power supply system.

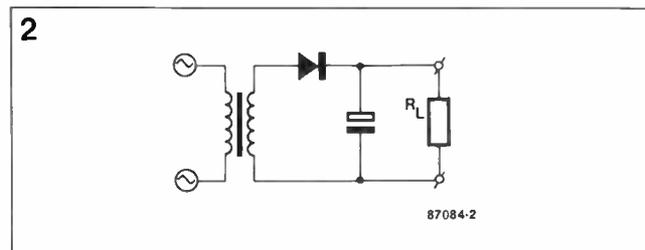


Fig. 2. Basic circuit diagram of a power supply.

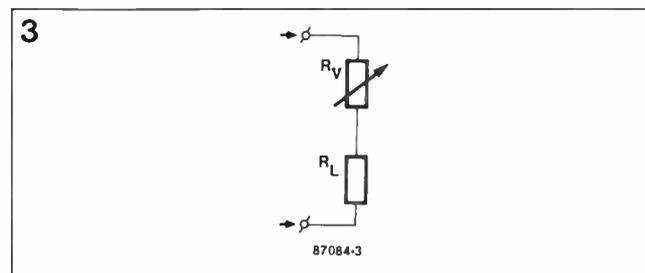


Fig. 3. Stabilisation.

* Peter Bardos is with Advance Power Supplies

electricity may need to be stored, for example, for use with portable equipment. A.c. is much easier to generate and distribute than d.c. but d.c. is required by almost all electronic equipment and is much easier to store. A.c. electricity is more suitable for motors. Heaters are the only sort of equipment that is equally suitable for a.c. and d.c. use.

Power supply

Consequently, the obvious step is to generate and distribute a.c. and then convert it into d.c. for electronics. This is, in fact, one of the functions of a power supply. Other things that a power supply has to do include isolation, changing of the voltage level, and storing energy. Each of these will be considered in greater detail.

The mains supply is "live" and thus has a potential with respect to earth and will give a severe shock to any operator who happens to touch it. Therefore, for the safety of the operator, the power supply has to provide isolation from the mains. The component which does this is a transformer and this will only operate on a.c.

The power supply then has to change the level of the supply since 240 V may be suitable for motors and heaters but electronics like to operate off a much lower voltage, which is normally 5 V-12 V. The component which changes the voltage level is, again, a transformer and, as mentioned previously, will only operate off a.c.

The power supply must also convert the a.c. supply into d.c. as demanded by the electronics load. This action is called 'rectification' and is performed by the rectifier diode which converts a.c. into d.c. with a lot of ripple on it.

Finally, the power supply must be able to store energy. This is needed for two reasons. First, since the a.c. supply alternates continuously it will actually go through zero (i.e. disappear completely) twice every cycle. During these times, when instantaneously there is no input voltage, power to the load will have to be supplied by some other means, i.e., from a store of energy. Second, energy storage is also required to decrease the ripple level that is present after rectification to a low level ac-

Table 1

LOAD WANTS 5 V
INPUT 5 V WORST CASE, BUT
VARIES UP TO 10 V

INPUT	REGULATOR	OUTPUT	O.K.?
10 V	5 V	5 V	
9 V	4 V	5 V	
8 V	3 V	5 V	
7 V	2 V	5 V	
6 V	1 V	5 V	
5 V	0 V	5 V	
4 V	0 V	4 V	x
3 V	0 V	3 V	x
2 V	0 V	2 V	x
1 V	0 V	1 V	x

ceptable by the load. The component which stores the energy is called a "reservoir capacitor" which operates off d.c.

Having established that to supply an electronics load off an a.c. supply a transformer, a rectifier and a capacitor are required, and bearing in mind that some operate off a.c. and some off d.c., the only way these can be fitted together is shown in Fig. 2, which is a circuit diagram of a power supply.

Stabilisation

For most electronic loads, stabilisation is necessary because the supply is subject to variation in voltage due to input changes and changes in loads. Any power supply is also subject to changes in its output voltage because of variations in temperature and component ageing. In other words, the output voltage of the power supply in Fig. 2 is subject to random changes. With changes of voltages, changes of the performance of the load will occur.

Loads are normally quite sophisticated pieces of equipment

(maybe a computer or a TV receiver, or some telecommunication equipment) and so it will be well worthwhile to stabilise the voltage in order to maintain the performance of the load irrespective of the changes mentioned.

The most obvious way to stabilise is to derive from the source more power than needed by the load even under worst case conditions, and then throw away the surplus power when conditions are not worst case. The electronic circuit which does this is illustrated in Fig. 3 and its action is shown in the table. As an example, the table shows what happens when the input to this stabiliser varies from 0 to 10 V when the load actually demands 5 V. Clearly, if the input is less than 5 V, there is not much the regulator can do about it and the load will not operate correctly. Should the input be 6 V however, the regulator will take 1 V leaving the output with 5 V which is what the load demands. Should the input be 10 V, the regulator will take 5 V, still leaving the output with 5 V, and so the regulator

will maintain the correct voltage on the load for any input voltage between 5 V and 10 V.

Energy conversion

It all looks very easy but the problem is what to do with the energy which is now put in the regulator. To return to basic physics, energy cannot be created or destroyed but only converted from one form to another. Therefore, the power put into the regulator needs to be converted into mechanical, chemical, potential, kinetic or some other form of energy.

Most users do not like the power supply moving about (mechanical energy), or exploding (chemical), and therefore this energy is converted into thermal energy (heat). In addition, in most processes the conversion of energy from one form into the desired form is inefficient. This inefficiency manifests itself as an unwanted energy conversion into some form other than the desired form (usually heat), which leads to additional increase in temperature. The total increase in temperature is kept to an acceptable level by dissipating the heat. Examples of this imperfect conversion are, for example, converting electrical energy into light (a light bulb) where the unwanted conversion gives rise to heat. Or, for example, in a car where the conversion of chemical energy into kinetic energy gives rise to an unwanted conversion into heat which heats up the engine.

Heat and temperature

The quantity of heat does not equate with temperature. For example, a drawing pin glowing red hot is at an extremely high temperature, but if it is dropped into a bath of water it would not increase the water temperature by a noticeable amount because the quantity of heat in the pin is very small despite its high temperature. In fact, the temperature rise above ambient temperature of a piece of equipment is proportional to the power dissipated by it divided by the surface area. Heat can be dissipated in three ways: radiation, conduction and convection. Radiation, the method by which the sun warms the earth, warms up the

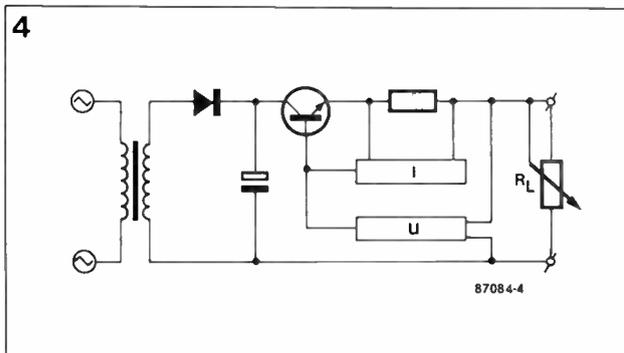


Fig. 4. A linear stabilised power supply unit.

recipient direct without warming up the intermediate material. Such a method is only effective at very high temperatures.

The next method is conduction where heat is conducted to the recipient from the source through a thermally conductive material. This is what happens when you burn your finger on the teaspoon, having left it in the cup. The heat is conducted to your finger through the spoon.

The last method, and that which is most applicable to power supplies, is convection, which operates through the movement of some medium, usually air. Central heating operates in the same way but, unfortunately, the heater is called, popularly, a "radiator", although what it actually does is to convect the heat rather than radiate. Such convection takes place by the source heating the air and the air warming the recipient through circulating from the source.

Efficiency

To return to the regulator in Fig. 3 when the input voltage is 10 V and the output is 5 V the power in the regulator is actually equal to the power in the load. (They both have 5 V across them and they both have the same current through them). Hence, the efficiency of this regulator is 50%. In other words, the power supplied to the system is twice as much as the power required by the load. The implications of this, regarding temperature rise and electricity bills, are quite horrendous.

Taking a closer look at the stabiliser in order to stabilise, three elements are required.

- A control element which does the stabilising.
- a reference which does not alter at all, and
- a comparator which compares the quantity to be stabilised with the reference and then derives a signal which tells the control element what to do to keep the quantity to be stabilised as constant as the reference.

So, in order to stabilise the output voltage a voltage control element, a voltage reference, and a voltage comparator are required.

The signal derived from the

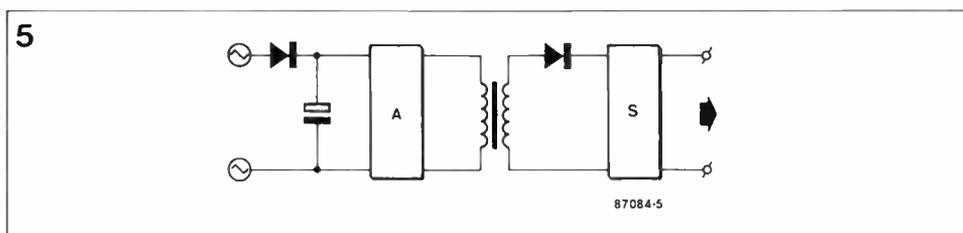


Fig. 5. Direct-off-line switched mode stabilised power supply.

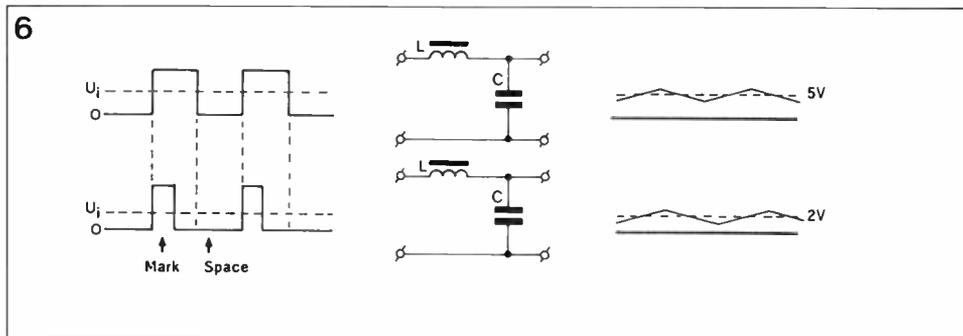


Fig. 6. Lossless regulator: changes in mark/space ratio.

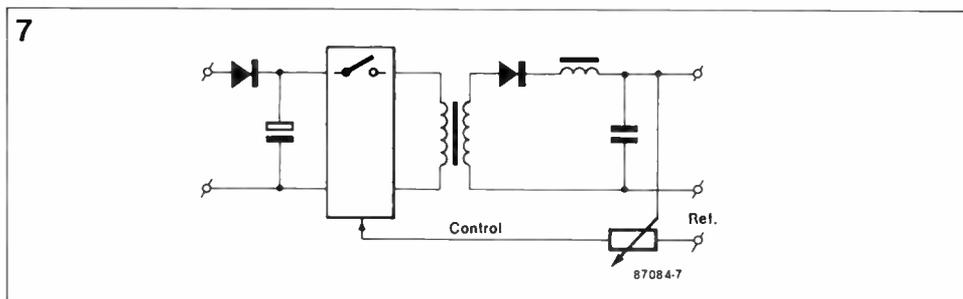


Fig. 7. Direct-off-line switched-mode stabilised power supply incorporating a switching device.

comparator is normally quite small and insufficient to operate the control element and, hence, the need for a final item, an amplifier.

Linear stabiliser

The circuit diagram of such a system is illustrated in Fig. 5. However, there are some problems with this stabiliser. Bearing in mind that the stabiliser will try to maintain a constant output voltage under any conditions, should an overload condition occur, such as a short circuit, the stabiliser will destroy itself. In addition, as the stabiliser's input power is a lot higher than that demanded by the load, should there be a fault condition in the stabiliser it will destroy the load.

One other problem which needs to be considered is the problem of oscillation which, typically, manifests itself as a howl in a public address system.

To avoid self-destruction of the

stabiliser, it is necessary to detect when the overload condition occurs and override the original control signal. This function is called a current limit circuit in power supplies.

The solution to the problem of load destruction is to detect the effect of a fault condition and control the output completely independently. In power supplies this is known as an over-voltage circuit.

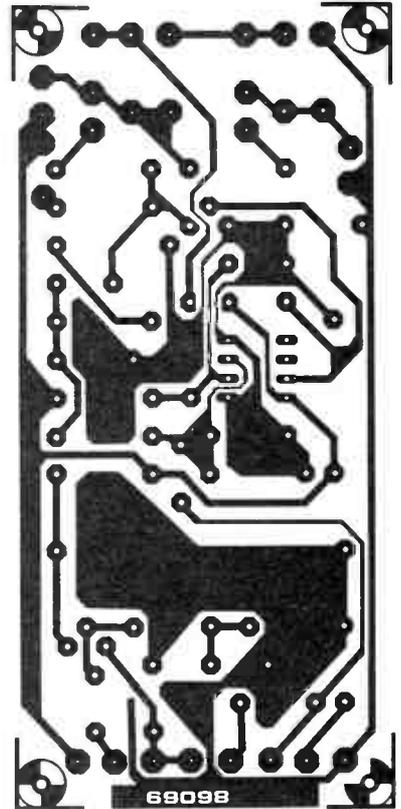
The instability problem is solved by correct design but this is more difficult than it sounds as any design necessarily involves a compromise between the achievement of good performance and good stability. Fig. 4 shows Fig. 2 modified with current limit and over-voltage functions, which represents a linear stabilised power supply.

Having designed a particularly good linear power supply with current limit and over-voltage, how could it be improved?

The performance of the linear stabilised power supply is per-

fectly adequate. In fact it is probably better than is required in a large number of applications. However, the power supply is rather large, heavy and inefficient.

The power supply has a large transformer operating at the mains frequency at 50 Hz. According to theory, the size of a transformer for a given power level is inversely proportional to frequency. Hence, to make the transformer smaller we need to operate it at a high frequency. The size of the capacitor used in a power supply is determined by the amount of energy that needs to be stored. For the sort of electrolytic capacitors normally used for energy storage, the size of the capacitor is proportional to its CV product. But the energy stored is equal to half CV², so the capacitor size for a given amount of energy is inversely proportional to the square root of the voltage. Therefore, to decrease the size of the capacitors the capacitor needs



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SECONDARY BREAKDOWN IN POWER TRANSISTORS

by Sue Cain & Ray Ashmore *

This article examines the different types of secondary breakdown that occur in power transistors, and investigates the phenomena that cause them. It concludes that secondary breakdown is a function of transistor technology, and cannot always be improved without some trade-off in other parameters.

One of the basic failure mechanisms in power transistors is second breakdown. This term includes various physical phenomena which are completely different. They depend on the different use of transistors in the circuits and have in common the electrical and thermal instability inherent in transistors themselves.

The conduction behaviour of an emitter base junction and the current gain of a transistor depend significantly on the temperature and increase as a function of the temperature. Electrical and thermal instabilities may act simultaneously within the device, thereby giving rise to destructive second breakdown mechanism.

An understanding of this mechanism is of great importance for a safer optimum application of a power transistor.

A distinction should be made between direct second breakdown ($I_{s/b}$) which is distinguished by a normal direction of base current I_B (entering into an NPN transistor) and inverse second breakdown ($E_{s/b}$), when I_B is in the opposite direction (extracted from an NPN transistor). The limits to which a transistor may be used without entering into $E_{s/b}$ are defined by the reverse bias safe operating area (RBSOA).

Direct second breakdown

It is important for the power circuit designer to know the locus of the I_C - V_{CE} points defining the boundary between stable and unstable operation of forward biased transistors. This locus defines the SOA safe operating area, that is, the area

of the $\log I_C$ - $\log V_{CE}$ plane which may be used without any risk in DC current conditions or with different width pulses at a known temperature. A typical SOA is shown in Fig. 1. The limits of this area are as follows:

1) The A-B section represents the upper limit of the collector current that may normally be used, generally limited by wire bonds. Operation at higher currents may cause damage to the wires of their bonding.

2) The B-C section is the -1 slope curve section (i.e. the section with constant dissipation) defined by:

$$V_{CE} I_C = P_{max} = (T_{jmax} - T_o) / R_{\theta} \quad [1]$$

This section therefore indicates the maximum dissippable power of the device. T_{jmax} is the maximum temperature which the collector-base junction may reach, over which the device reliability may be compro-

vised. In power transistors, T_{jmax} varies between 125 and 200 degrees Celsius and generally depends on the metallurgy and the type of package. R_{θ} is the thermal resistance between the collector-base junction and the case, including all the silicon and package system. The increase in the maximum dissippable power when the pulse width decreases (Fig. 1) corresponds to the decrease of Z_{θ} with respect to R_{θ} .

3) Section C-D corresponds to the second breakdown phenomenon (or $I_{s/b}$) and limits the maximum power that the transistor can dissipate. This may occur even at relatively low V_{CE} voltages.

4) Section D-F is the limit due to the transistor's BV_{CE0} .

Second breakdown is generated by the electrical and thermal instability of the transistor. The main causes of this instability are:

1) The V_{BE} of a directly biased base-emitter junction, at constant current, decreases linearly with temperature, with a $\phi = 2$ to 2.5 mV/ $^{\circ}$ C slope. The base current of the transistor may therefore be expressed by:

$$I_B = I_o [\exp(eV_{BE} / kT)] \quad [2]$$

and, when V_{BE} is kept constant, it increases with temperature.

2) The h_{FE} at the relevant voltage values increases as a function of temperature according to the law:

$$h_{FE} = h_{FE0} \{ \exp(\Delta E_g / kT) \} \quad [3]$$

Where ΔE_g is an activation energy which is a feature of the transistor.

3) The thermal conductivity of silicon decreases when temperature rises, causing a worsening of the thermal resistance of the transistor.

When these three phenomena are taken into consideration, it may be observed that a pulse of power $P = V_{CE} I_C$ generates:

a) an increase of the junction temperature, giving rise to an increase of I_B and h_{FE} , and therefore to an increase of I_C with a following increase of P and, therefore, a further temperature increase.

b) a dissipation to the external environment, controlled by the thermal resistance $R_{\theta} = dT/dP$ which tends to stabilize the device.

The situation evolves towards stability when:

$$\frac{\Delta I_C}{I_C} = \frac{\partial I_C}{\partial T} V_{CE} R$$

is smaller than 1, or instability if > 1 .

In this way, a stability factor, S , may be defined that will be a function of V_{CE} and I_C :

$$S = R_{\theta} V_{CE} \frac{\partial I_C}{\partial T} \quad [4]$$

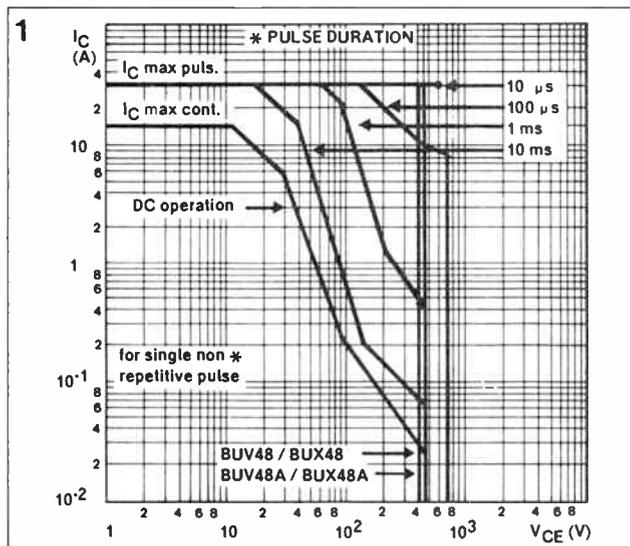


Figure 1. Safe operating areas which may be used without any risk in DC current conditions or with different width pulses at a known temperature.

When $S > 1$, so called "thermal runaway" occurs and the junction temperature increases without any limit, thereby degrading and possibly damaging the transistor. The failure generally occurs when the surface temperature becomes greater than the eutectic temperature between silicon and the contact metal (front aluminium) with a consequent melting of the alloy. A localized temperature increase may also damage the crystal, or the inner temperature of the device may reach values high enough to melt the silicon.

To understand $I_{s/b}$ phenomena which give rise to a reduction of the maximum power that the transistor can dissipate as V_{CE} increases (zone D-E), it is necessary to take into account that device operation is not homogeneous on all the dice area. There are disuniformities in the emitter base current density that may be due to junction disuniformities, crystal defects and, most of all, to the emitter edge concentration phenomenon.

The voltage drop due to the base current flowing through the cross resistance $r_{bb'}$ gives rise to a disuniformity of V_{BE} at the junction, and therefore to the disuniformity of the current density J_E (see Fig. 2).

A side drop of 26 mV reduces the injected emitter current by a factor $1/e$, where e is the base of the natural system of logarithms ($= 2.71828 \dots$).

A concentration of the current at the emitter periphery is therefore generated, so the active silicon area is reduced and hot spots occur, leading to an effective increase of the thermal resistance. As a result, the maximum dissipable power is decreased.

When V_{CE} is increased, the effect of the base-collector electric field is to increase the base current concentration.

Different techniques may be adopted to limit the $I_{s/b}$ phenomenon. Fundamentally, these consist of minimizing the mechanisms that trigger electrical and thermal instabilities in the transistor. The basic techniques are:

- 1) minimization of crystal damages, metal impurities, and doping disuniformities;
- 2) optimization of package and die attach techniques to minimize the thermal resistance

on which the stability factor S depends. Disuniformities of silicon die bondings to the case may give rise to adverse variations of R_{θ} as a macroscopic parameter for the dice as a whole, but also to significant variations between different points, giving rise to premature second breakdown;

3) increase of the base thickness to reduce the high current densities (due to emitter crowding) flowing through the collector base junction (where the electric field is localized), so that the density of the dissipated power is decreased. High base thicknesses, however, will result in lower cut off frequencies and slower switching times;

4) optimization of the horizontal geometry;

5) introduction of distributed ballast resistances connected in series with the base, the emitter or both, which tend to give a negative feedback to thermal runaway, therefore stabilizing the device.

The introduction of a ballast resistance in series with the base of the emitter may reduce from J_1 to J_2 the current density in the hot spot. The emitter ballast re-

sistance is generally obtained by opening emitter contacts thinner than the emitter strip. In this way it is possible to limit the current density at the boundaries of the emitter. These resistances show the drawback of increasing the saturation voltage of the transistor by the amount $V_{CE(sat)} = REIC(sat)$.

On the other hand, the base ballast resistance is obtained through a " N^+ pocket" (in the case of NPN), around the emitter area. This N^+ diffusion, being unbiased, cannot be traversed by the base current, so this is forced to flow below the N^+ through a small section and, in the case of a diffused base, encounters a higher resistance on the way to the edge of the emitter. In this way it is possible to improve $I_{s/b}$ significantly.

It should be noted that the SOA limits are temperature dependent and suitable derating must be applied.

Reverse second breakdown

The reverse breakdown phenomenon ($E_{s/b}$) is also due to thermal and electrical in-

stability of the transistor. As already mentioned, it is distinguished from $I_{s/b}$ by the presence of a reverse I_B (i.e. with a direction opposite to the normal direction of a transistor operating in the active zone) and by high V_{CE} values of the transistor. The device may be in these working conditions during turn-off with an inductive load.

In Figure 3 the common emitter characteristic curves for a transistor are shown.

It is easy to understand the behaviour of these curves when the common emitter gain expression is considered:

$$h_{FE} = A_F / (1 - A_F) \quad (5)$$

for high V_{CE} values, A_F is replaced by MA_F .

For low V_{CE} values, M is an insignificant factor, being very close to 1: it increases when V_{CE} is increased according to the following expression:

$$M = 1 / [1 - V_{CE} / BV_{CBO}]^n \quad (6)$$

From expressions (5) and (6) it is clear that h_{FE} depends on V_{CE} , becoming infinite when $MA_F = 1 / BV_{CEO}$.

The negative slope section, which is a feature of the curves with $I_B < 0$, is due to the fact that A decreases at low values of the emitter current.

During turn-off with an inductive load, the transistor has to operate with negative base current and a high value of I_C . It often has to reach a working area above V_{CEO} , remaining there all the time required for the inductance to be discharged. Fig. 4 shows the behaviour of I_C , V_{CE} , I_B and the power dissipated by the transistor during turn-off.

The area of the dissipated power corresponds to the energy stored by the inductance, $\frac{1}{2}LI^2$, which is discharged into the transistor and this is called second breakdown energy ($E_{s/b}$).

Like $I_{s/b}$, the voltage drop due to the reverse I_B flowing through the side resistance $r_{bb'}$ makes the centre of the emitter strip more biased than its periphery. In this way, a current concentration occurs at the emitter centre.

Let us analyse the case of an NPN transistor with diffused base and epitaxial collector, i.e. with constant concentration ND of donors doping particles.

Poisson's equation is:

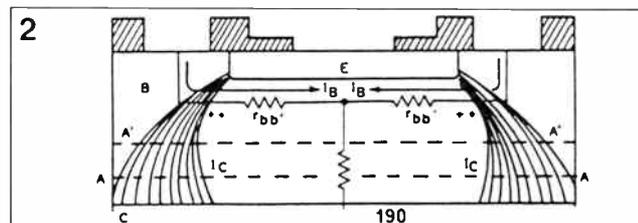


Figure 2. The voltage drop resulting from the base current flowing through the cross resistance $r_{bb'}$ gives rise to a disuniformity of V_{BE} at the junction, and so to the disuniformity of the current density J_E .

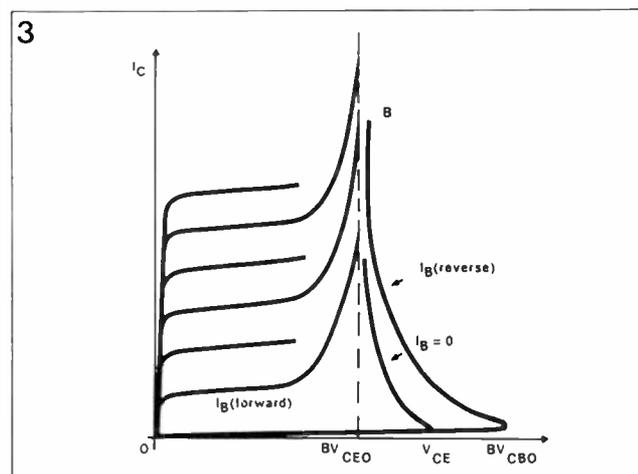


Figure 3. The common emitter characteristic curves for a transistor.

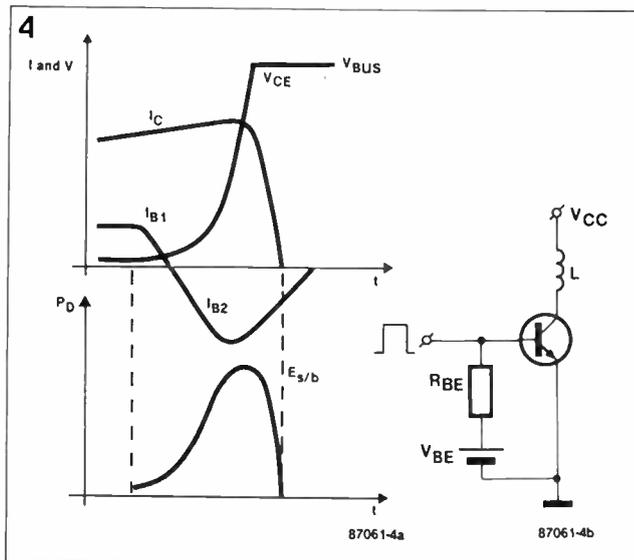


Figure 4. The behaviour of I_c , V_{CE} , I_B and the power dissipated by the transistor during turn-off.

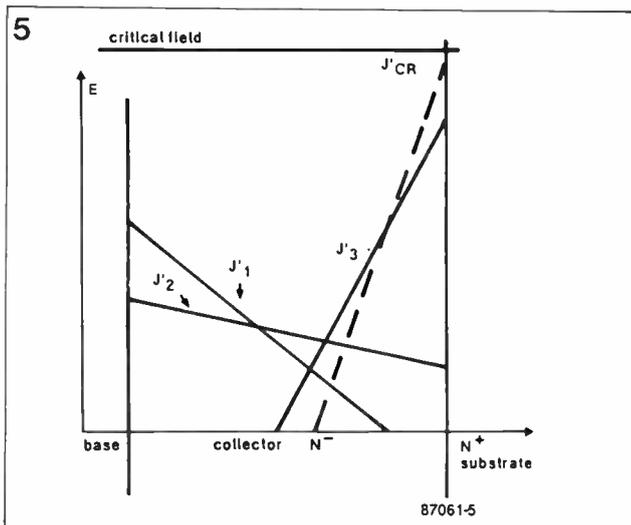


Figure 5. Typical electric field behaviour when the collector current is limited to low values.

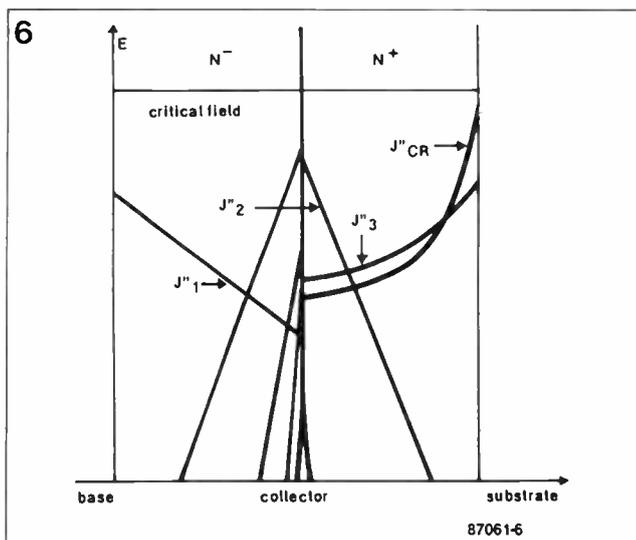


Figure 6. The condition created by the intermediate layer inserted between the collector and the substrate in order to obtain high $E_{s/b}$ values.

$$dE/dX = dV/dX = p(x)/\epsilon \quad [7]$$

The X axis is normal to the silicon dice surface, (x) is the charge per unit volume, E is the dielectric constant of silicon. When the collector current is limited to low values, expression [7] becomes (q being the electron charge):

$$dE/dX = qNo/\epsilon \quad [8]$$

and the electric field behaviour is similar to that shown in figure 5 for $J_c = J'_1$.

The voltage V_{CB} ($= V_{CE}$) is given by the area of the $E-X$ graph and is smaller than primary breakdown voltage due to the reaching of critical field E_{cr} . In the presence of significant values of current density J_c , the expression [8] is modified due to the n concentration of electrons flowing at the speed V through the depletion layer.

$$dE/dX = [q(ND-n)]/\epsilon \quad [9]$$

$$\text{where } n = J_c/qV$$

At constant V_{CB} , the area limited by E has to remain constant. When J_c increases, the $E-X$ slope varies ($J'2$) until its sign is changed ($J'3$) and E_{cr} is reached (J'_{cr}). At this point avalanche local multiplication of electrons occurs with an uncontrolled current increase—and so a strip is formed with a very high temperature that gives rise to either crystal damage or silicon melting. Possible crystal defects, metal ions, and junction disuniformities further exaggerate this phenomenon. The avalanche multiplication is very fast and very localized so the device remains externally cold. The $E_{s/b}$ behaviour is not influenced by the die bonding quality. High $E_{s/b}$ values can be obtained with a proper geometric design to limit the current crowding and, most of all, by inserting a second epitaxial layer N of intermediate doping between the collector and the substrate.

The intermediate layer creates the condition shown in Fig. 6. When the current density increases ($J''2$) the electric field at the interface N^-/N is increased. Before the critical field E_{cr} is reached at the interface, the contribution of layer N becomes significant in sustaining the voltage. A further density increase ($J''3$) reduces the electric field at the interface

N^-/N and the breakdown is not triggered until the critical field is reached at interface N/N^+ . For a good power transistor with $V_{CE(sus)} = 450V$, the current density J'_{cr} corresponding to E_{cr} is of the order of $20A/mm^2$, i.e., greater by a factor 10 when compared to the average current density given by the ratio between maximum saturation current and emitter area.

The $E_{s/b}$ behaviour is also influenced by the conditions outside the transistor, R_{BE} , V_{BE} , L . The base conditions are especially important, as they regulate the crowding phenomenon.

The system most commonly used by power designers to reduce the $E_{s/b}$ effect during turn off with inductive load is a clamping or 'snubber' circuit, that limits the voltage peak between collector and emitter.

The presence of the clamping circuit allows only a minimal amount of the energy stored in the inductance to be absorbed by the transistor, and $E_{s/b}$ becomes independent of the value of L and practical RBSOA limits may be defined.

The presence of high V_{CE} and negative base current, I_B , may give rise at high current to the previously described $E_{s/b}$ phenomenon, even in the presence of the clamping circuit. The multi-epitaxial transistors show a better behaviour even in the presence of a clamp.

The reverse bias safe operating area establishes the maximum switchable current with inductive load versus clamping voltage in very harsh base conditions that simulate the real base driving conditions in the circuits.

The temperature is not a major factor in the $E_{s/b}$ and so the RBSOA rating can be considered to be independent of temperature.

Conclusion

Second breakdown performance is a function of transistor technology and cannot always be improved without some trade-off in other parameters. The application conditions have a considerable effect on both $I_{s/b}$ and $E_{s/b}$ capability.

* Sue Cain is with BA Electronics and Ray Ashmore is with SGS.

RETAIL ROUNDUP



Two stores for Jaycar in Melbourne

It's getting hard to keep up with those people at Jaycar! Last month we brought you news of their new A'Beckett Street store, pictured above. This month they are at it again with another new store in Springvale.

Jaycar has taken over the well known Active Electronics store at the corner of Springvale and Dandenong roads in Springvale. All of Jaycar's wide range of stock and specials will be available and I'm sure the staff will be eager to give you the usual Jaycar service.

Capacitors

Sheridan Electronics has some great bargain on a range of brand-name electroly-

tics right now. Values range from 500 uF to 100,000 uF and all are brand new stock.

Mounting clips and hardware are available for just 75c a set and the capacitors are priced between \$5.00 and \$15.00 each. Voltages available range from 10 volts for the larger capacities to 250 volts for the smaller sizes.

Sheridan Electronics are located at 164-166 Redfern St, Redfern NSW. (02)699 5922.

New Force in Adelaide

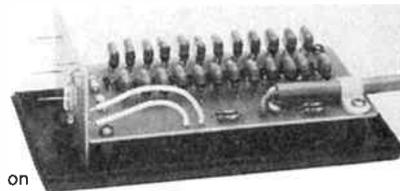
The major retailer in Adelaide, Force Electronics, has announced the opening of a new store at 129 Findon Rd, Findon. The doors will open on the

AEM Printed Circuit Service

Clear the air! — build our **AEM5501 Negative Ion Generator**. Providing around 8 kV output for best results, it's simple to build and low in cost. All parts readily available (Described Sept. '85)

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Copies of the relevant articles cost \$4.00 each post-paid.

first of July but you may have to visit one of their other stores before that if you want to pick up some of the bargains before they run out.

If you are in the market for some "D" type connectors, Force has a range of male and female types at very attractive prices.

The DB15s and DB37's are only 99c each or 79c for 10 up, and DB25s are \$1.95 each or \$1.75 for 10 up. Certainly worth grabbing some at these prices.

Force Electronics has stores at 203 Wright st, Adelaide; 24 Beach Rd, Christies Beach; 445 Main Nth. Rd, Enfield and 504 Brighton Rd, Brighton. 

PROJECT BUYERS GUIDE

This month's feature project, the AEM4622 Bit Stream Flyer modem, is available as a special offer through the magazine in cooperation with Maestro Distributors. See the offer following the project.

The AEM6508 Clipping and Fault Indicator should be built-in to all modern amps in this "digital era", to save your ears, if not your speakers! All the components in this project are commonly available from electronics suppliers. We understand Jaycar will be stocking this project as a kit, so check with your nearest Jaycar store, or order via their toll-free line (008)022 888.

The AEM2000 Lab. Standard Power Supply has attracted a great deal of attention. This issue the construction starts, so now you get down to the nitty gritty! Force Electronics have done all the hard work in getting the specialised components together, ready-punched chassis, front panel etc. And all for a cost well under \$500!

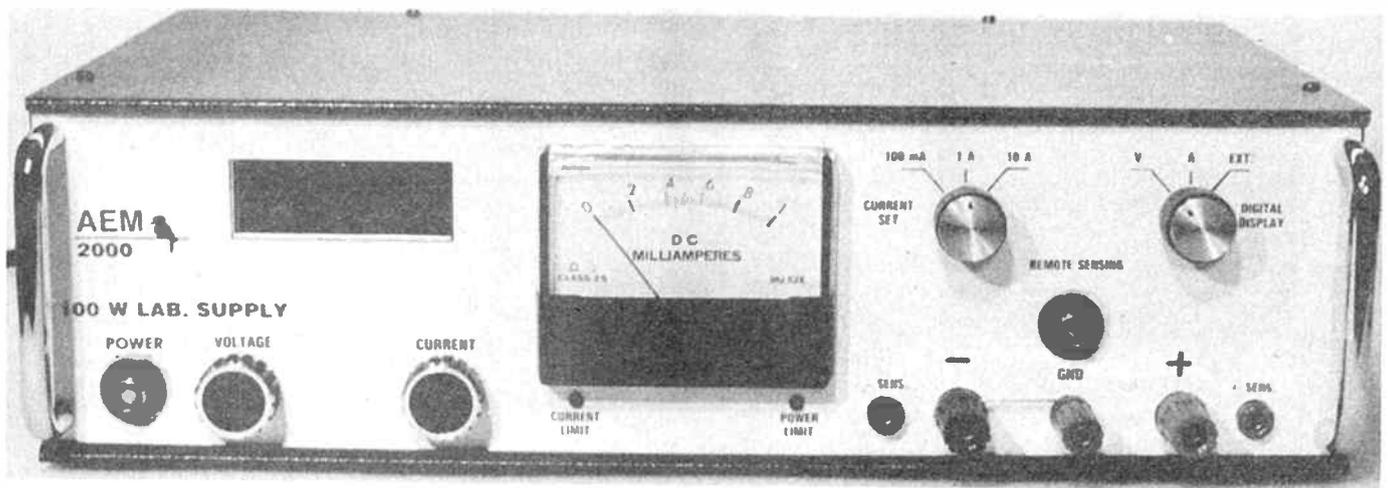
This month's Elektor In AEM section contains some interesting, and useful, projects.

The Elektor Midi Redistribution Unit employs components which are, in the main, widely stocked by electronics retailers. The 6N135 fast optocoupler is recommended by the project's author, M. Eller. It is obtainable from Stewart Electronic Components Pty Ltd, PO Box 281, Oakleigh 3166 Vic. (03)543 3733. You might also try Force Electronics in Adelaide, who tends to stock a wide range of semiconductors, or Geoff Wood Electronics in Sydney. The 800 mA slow-blow fuse could be replaced by a 750 mA type here (they're more common in Australia). You'll find 250 V Varistors stocked by Dick Smith Electronics (cat. no. R-1802) and All Electronic Components, 118 Lonsdale St, Melbourne. Any suitable 9 V transformer may be used, e.g. the '2155' type, a widely stocked item. The heatsink used on the 7805 in this project is of the "universal U" type. Jaycar stock them,

cat. no. HH-8511. Any small bridge rectifier rated at 1 A/40 V or more could be used for B1 as the B40C1000 specified for B1 may be hard to get.

The Metal Detector project is relatively straightforward, electronically — but you'll need some mechanical skills to get it together! However, it should not be beyond the average home "handyperson". In general, the components specified are readily obtainable. While a 22k and a 2k2 pot are specified for P1 and P2, you could readily substitute a 25k and 2k5, respectively. Capacitors C5 and C7 are styroseal (polystyrene) capacitors. In the values specified, you'll find them a little scarce. You can parallel lower values (as suggested), but it's a little impractical with values under 22n for C5, a 100n! However, try All Electronic Components and Stewart Electronic Components, both in Melbourne, or Sheridan Electronics in Sydney. Jaycar and Dick Smith Electronics both stock a range of styroseals, but in the lower value range. The tuning capacitor, C6, may be difficult to root out. But, you could use one of the common 60-160 pF dual-gang types, sold as "replacement" tuning capacitors for transistor radios, and connect the two gangs in parallel. You may need a 180 pF or 220 pF styroseal capacitor connected in parallel to "pad-out" the tuning gang to the required capacitance. As regards the semiconductors, the BC560 (T1) can be obtained from Geoff Wood Electronics in Sydney and Active Electronics in Melbourne. For the AA119 diodes, you could substitute OA202s which are widely stocked.

The Capacitance Meter should prove fairly straightforward to get together. Most of the semiconductors are widely available. However, for the BS170 FETs, try the semiconductor specialists such as Geoff Wood Electronics in Sydney or Force Electronics in Adelaide. The switch used is a standard Lorlin rotary type, widely stocked.



A true 'laboratory standard' 0-55V, 10A max. output power supply

Gerald Reiter

OK, here comes the bit where you get your hands dirty! This month we describe the assembly of the pc boards, with the exception of the panel meter which is to follow. Shortly, you can look forward to 'firing up' your lab. standard power supply, and you won't believe it cost you around \$500!

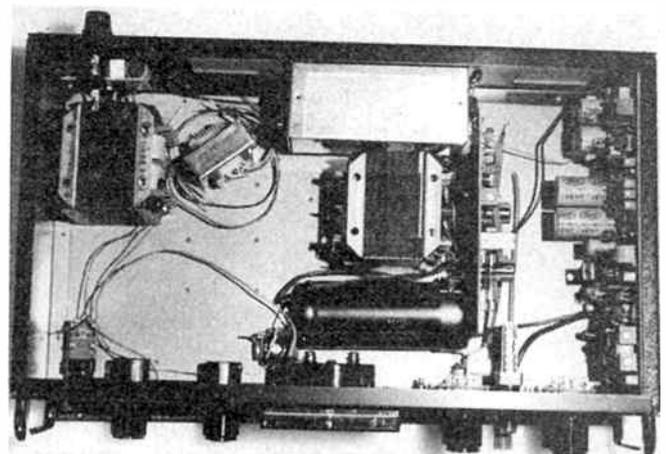
ALL THE CIRCUITRY described in Part 2 is contained on four printed circuit boards, with the exception of the main rail bridge rectifier and 10 000 uF filter capacitor. As detailed earlier, the digital panel meter is a self-contained item and we'll be describing that later.

All the boards are "maximum copper" designs to provide good current carrying capability where it's needed and so that the "common" or 0 V line can provide something of a "groundplane". This technique lowers the impedance of connecting lines and greatly reduces noise on supply rails. Generally speaking, the boards are not "crowded", even though I have stood resistors on end in a number of places, and only a very few links were necessary.

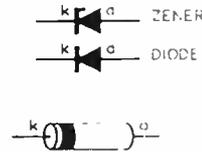
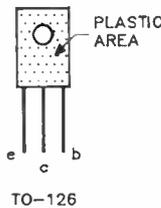
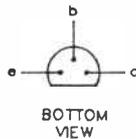
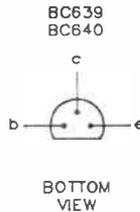
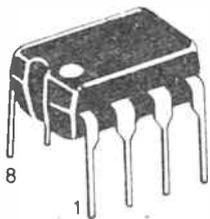
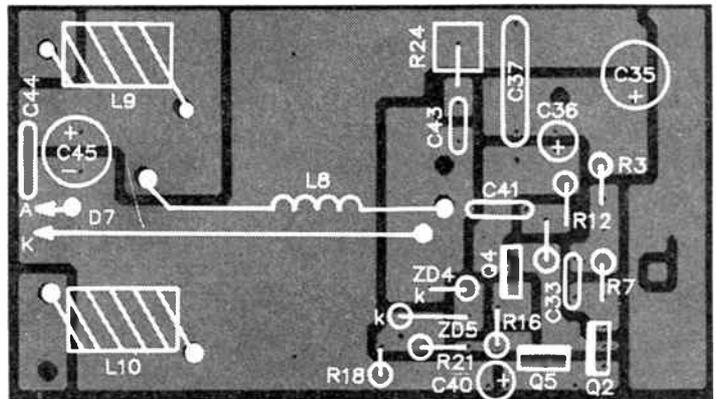
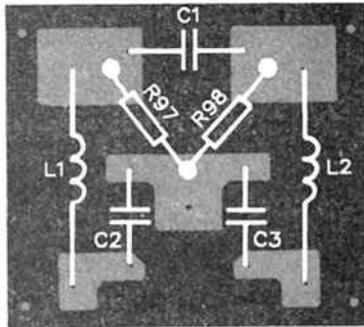
The four boards are designated A, B, C and D. Board A, the largest, contains the low voltage dual supply rails and rectifiers (D1 through D4 and associated components), the linear regulator, its input filter, plus the voltage and current control circuitry – pretty well everything on the right hand page of the circuit last month, except for those few components that necessarily have to be mounted off-board, like the series-pass transistor (Q12) and current sense resistor (R73)! Board B contains the switched-mode pre-regulator. This board eventually mounts inside a small aluminium box with feedthrough capacitors linking it to the "outside world".

All the switched-mode pre-regulator control circuitry is

housed on board C, including the internal supply fuse. This provides protection for the electronics in the event of some circuit failure. This board is the second largest of the four. The smallest is board D which contains the mains input filter components. Surprisingly, this is the only board on ▶



A view inside the cabinet, just prior to completion of the final wiring. The small aluminium box on the rear panel houses the switched-mode pre-regulator.



Semiconductors

B1	BR104
D1-D6	1N4002
D7	MUR1515
D8	1N914, 1N4148
D9	1N4002
D10	1N5404
D11-D14	1N914, 1N4148
D15	1N5404
IC1	4011
IC2-IC5	TL081
IC6	LM301
IC7	LM555
LED1	HLMP-M301
LED2	HLMP-1301
LED3	HLMP-M201
LED4, 5	5 mm R or Y
Q1	BC549
Q2	BF469
Q3	BC559
Q4	BF469
Q5	BF470
Q6	MTP15N15
Q7, Q8	BC549
Q9, Q10	BC559
Q11	MJE2955T
Q12	MJ15003
Q13	BC639
Q14, Q15	BC549
Q16	BC640
Q17	BC559
ZD1, 2	8V2/1 W or 5 W
ZD3-ZD5	18 V/1 W
ZD6	6V2/1 W
ZD7	3V3/400 mW
ZD8	6V8/400 mW
ZD9	LM336/2V5
ZD10	LM336/5V

Resistors

C = carbon, 5% or 10%
 W = wirewound, 5% or 10%
 all others 1/4 W, 1% metal film.

AEM2000 PARTS LIST

R4	560R/1 W, C
R5	100R
R6	0R33/5 W, W
R7	1k8
R8, R9	10k
R10	68R/1 W, C
R11	100R/0.25 W, NTC*
R12	1k/1 W, C
R13	5k6/1 W, C
R14, R15	10k
R16	120R/1 W, C
R17	10k
R18	47k/1 W, C
R19	1k
R20	3k3
R21	150R/1 W, C
R22	150k
R23	470R
R24	6R8/5 W, W
R25	47k
R26, R27	3k9
R28	680R
R29	11k
R31	2k05
R32	9k1
R33	2k05
R34	11k
R35	1k2
R36	82k
R37	1k8
R38	2k2
R39	680R
R40	4k7/5 W, W
R41	10k
R42	47R
R43	820k
R44	27k
R45	10k
R46	470R
R47	330R/1 W, C
R48	47R
R49	10k

BOARDS A, B, C, D

R50	3k3
R51	390k
R52	56R/1 W, C
R53	47R
R54, R55	2k2
R56, R57	10k
R58	39k
R59	470R
R60	3k3
R61	15k
R62	4R7/1 W, C
R63	10k
R64	1k2
R65	1k8
R66	47k
R67, R68	1k5
R69	820R
R70	10k
R71	1k2
R72	4k7
R73	0R05/15 W Arcol HS15
R74, R75	10k
R76	470k
R77	3k9
R78	2k2
R79, R80	1k2
R81	1k
R82	910R
R83	2k2
R84	100R
R85	1M
R86	100k
R87	10k
R88	100k
R89	10k
R90	4k7
R91	6k8
R92	2k2
R93	5k6
R94	102k (or 100k & 2k)
R95	1M
R96	9M1

R97, R98	1M/0.5 W, C
R99	10R
RV1, RV2	1k single turn trimpot
RV3	100k 3/4 multi-turn trimpot
RV4	500k single turn trimpot
RV5	20k single turn trimpot
RV6	2k single turn trimpot
RV7	1k 10-turn trimpot
RV8	500R 3/4 multi-turn trimpot
RV9	100k 3/4 multi-turn trimpot
RV10	50k 3/4 multi-turn trimpot
RV11	5k 3/4 multi-turn trimpot
RV12	1M 3/4 multi-turn trimpot
RV13	10k 10-turn trimpot
RV14	50R single turn trimpot

Capacitors

C = ceramic,
 E = electrolytic
 G = greencap,
 M = monolithic,
 P = polystyrene
 MKT = metallised poly.

C1-C3 100n Class Y poly.
 C4-C7 10n/50V; C or M or MKT
 C8-C11 10n/250V or 630V; C or G
 C12-C15 2200u/16 V; E
 C16 10,000u/100 V, E
 C17-C24 100n/50 V; C or M

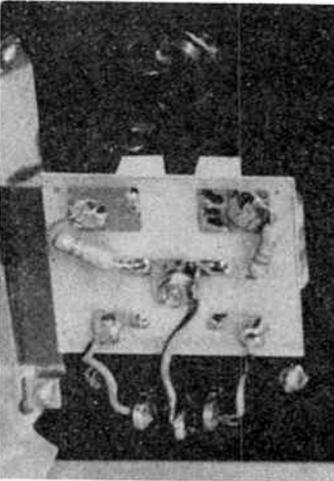
which components mount on the copper side.

A full parts list is given here, even though you don't get to use some of the components and hardware in this part.

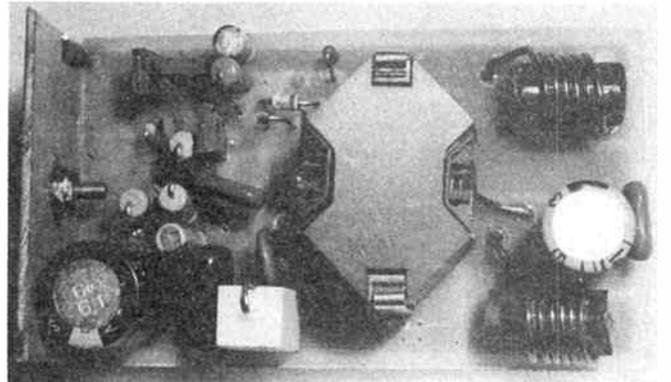
Assembling the boards.

First, make a visual examination of all the boards. See that all holes are correctly drilled and of the right diameter. Check that there are no solder bridges between closely spaced pads or tracks. Then you can proceed.

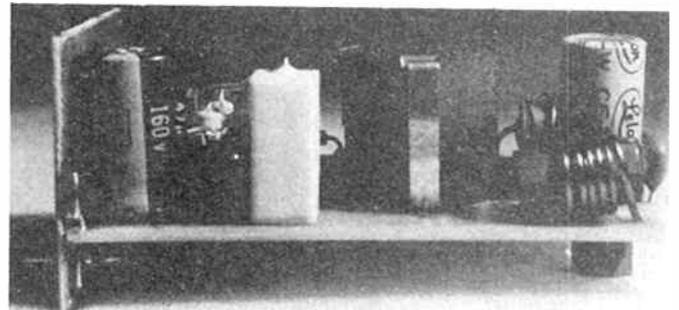
Commence by winding all the inductors. The accompanying box gives the basic winding details. Notice that the



Here's a view of the mains filter board (board D), which ends up mounted on the rear panel of the cabinet, between the IEC mains input socket and the mains fuse.



A top-down view of the switched-mode pre-regulator assembly. The board mounted at right angles at the end is used to mount the assembly to the small aluminium box used to screen it.



Side-on view of the switched-mode pre-regulator assembly.

majority are wound on 20 mm lengths of 10 mm diameter ferrite "aerial" rod. Inductors L3 to L7 are actually ferrite beads slipped over the appropriate leads. Inductor L8 is the pre-regulator's "storage" choke. This is wound on the bobbin of a Siemens RM12 core which afforded the best efficiency. With all the wound inductors, the number of turns IS NOT REALLY CRITICAL, except that the number of turns specified for L8 is a minimum. For the windings on the short lengths of aerial rod, it is best to first wind them on a 9 mm (3/8 inch) drill shank, or something of a similar diameter, then slip the coil off and let it 'spring' open, which increases its internal diameter a little. Then you should be able to slip it on the ferrite piece for a snug fit. I secured the windings with nail polish, but a quick-setting glue such as "Superglue" is equally as good. Always leave plenty of wire for terminating leads. Once all the inductors are complete, set them aside until you need them.

The first board you assemble should be the simplest – board D, the mains filter. First mount the three capacitors. Sit them flush down to the board. The inductors should be mounted next. These too, should be sat down on the board. Determine how the leads will lay and the length required, then cut them, leaving a few millimetres over for trimming later. Carefully scrape off the insulation on the ends, but only back far enough to properly terminate the leads on the board. Tin the leads with a hot iron, but don't leave any sol-

NOTES & ERRATA

The resistor numbering got a little out of sequence in the circuits given last month. The two 1M resistors across C2-C3 in the mains filter (page 68) should be numbered R97 (shown as R1) and R98 (shown as R97). Then, R2 in the +8.2 V rail becomes R1, and R3 in the -8.2 V rail becomes R2. Then R98 (on page 71), connected to the positive output terminal, becomes R99. Its value is 10R, not 10k, as shown.

On page 72, last paragraph in the first column, the second last sentence should read "The gate swing is clamped to 19 V by two 18 V zeners connected back-to-back, ZD4-ZD5."

der "blobs" behind. Fold the leads over against the solder pad after mounting the coil, to mechanically secure it, then solder them. The two 1M resistors, R97-R98, are mounted on the track side. Bend the leads so the resistor bodies stand off the board a few millimetres. Having finished that, you can put the board aside until you come to assemble it in the chassis.

Board B, the switched-mode pre-regulator can be tackled next. The accompanying photographs show another small piece of pc board mounted at right angles on one end. This board holds the feedthrough capacitors and serves to mount the assembly in a small aluminium box which screens the pre-regulator assembly. The end piece board we'll get around to in the next part when we come to assemble the

INDUCTORS

All use enamelled copper wire.

L1, L2

60 turns in three layers of 20 turns each, 0.4 mm dia. wire, on 20 mm length of 10 mm dia. ferrite rod. Wind on thin insulation tape or plain adhesive tape between layers.

L3-L7

Ferrite beads, 4 mm dia. by 10 mm long with 2 mm axial hole.

L8

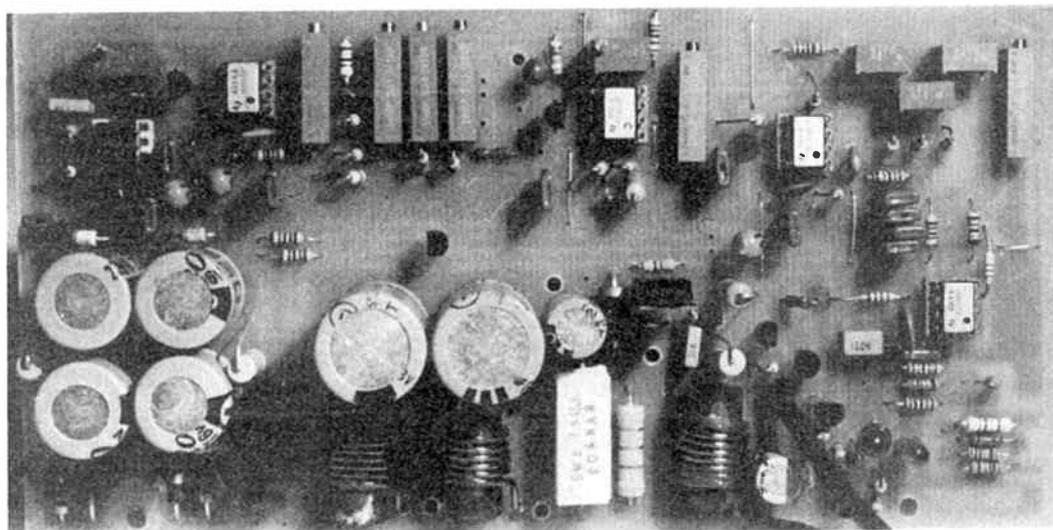
Siemens RM12 core, B65815-5-X2; 30 turns (minimum) of 1.25 mm dia. wire (requires approx. two metres of wire). Wind it carefully and neatly, else you won't fit 30 turns. It is possible to fit up to 36 turns when wound carefully.

L9-L12

Each 5 turns of 1.25 mm dia. wire on 20 mm length of 10 mm dia. ferrite rod. Wind L9-10 LH thread, L11-12 RH thread.

L13

7 turns of 1.25 mm dia. wire on 20 mm length of 10 mm dia. ferrite rod, wound RH thread.



This is board A, the largest. While it contains the most components, it is not difficult to assemble. Note the orientation of all the trim pots and that all the ICs have pin 1 facing the same direction.

power supply in the cabinet. For now, we can just assemble the electronics on this board.

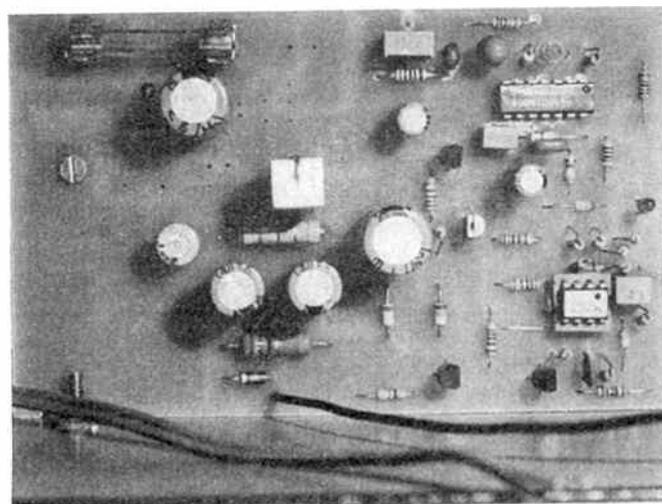
Start with the small components, the resistors, capacitors and diodes, leaving the 5 W wirewound resistor (R24) and the 47 μ electrolytic capacitor (C35) till last. Note that all the resistors and the diodes stand upright (although ZD5 could lay down on the board). Set the capacitors right down on the board. Transistors Q2, Q4 and Q5 can then be soldered in place. Seat them as far down on the board as they will go. You will need to bend out the centre (collector) leg of Q4 and Q5 a little. Make sure all the semiconductors and polarised capacitors are correctly oriented as you insert them, and make a double check when you have finished the board, just to make sure. Now you can mount the inductors L9 and L10. These should be seated down on the board, so prepare the leads accordingly. Trim them to the appropriate length, then scrape off the insulation only as far back as necessary, then tin the exposed copper. Fold each lead end over against the solder pad to mechanically secure the coils, then solder them. Last off all, mount L8. Two spring clips secure the assembly. Solder these in place first. Trim the coil leads to the appropriate length, scrape the insulation from the ends and tin them. Put the assembly in position on the board, placing the coil leads through their holes and snap the spring clips in place. Now solder the coil leads. Do a final visual check of the board, then put it aside.

Now for board C. This one's quite simple and should proceed quite quickly. First, locate the position of the link and solder a length of tinned copper wire in place. This may be made from a cut-off component lead. If you are using IC sockets, mount these next, although they aren't essential. The two fuse clips could be soldered-in next, followed by the passive components, ensuring you get the polarised capacitors the right way round, as always. Leave the 5 W 0R33 resistor, R6, till last, though. The trimpot, RV1, must be mounted with its adjusting screw facing the nearby edge of the board. Also, note which components stand on end and bend the leads accordingly before you mount them. The semiconductors can now be mounted. Seat the transistors and the LED well down on the board, it is not good practice to stand them up on their lead ends. Check, as you put them in, that you have the semiconductors correctly orientated. Do a final visual check of the board then put it aside to tackle the last one (at this stage), board A.

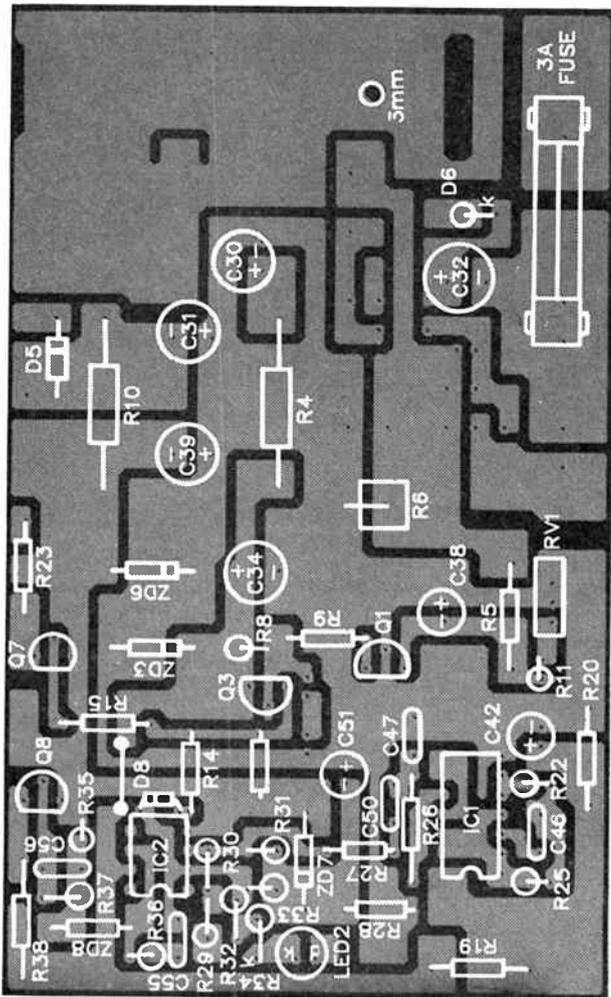
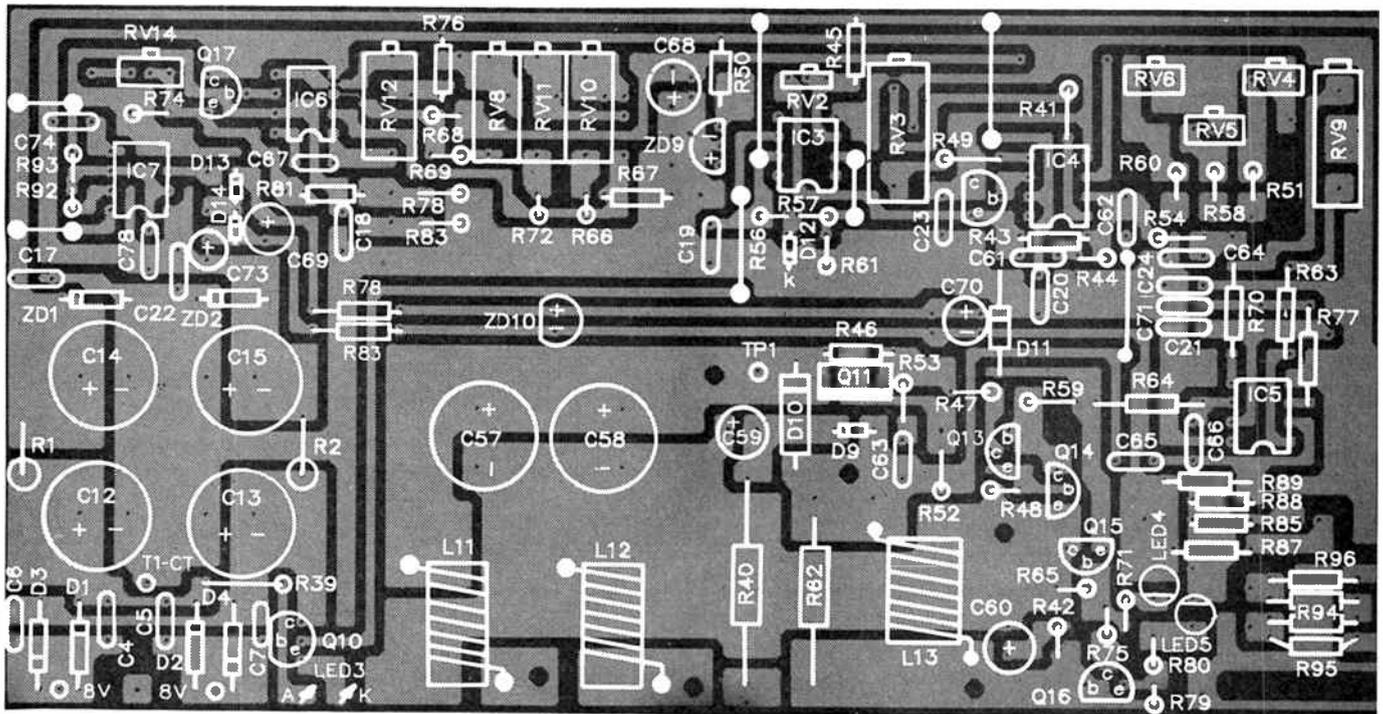
This board has a number of links. Locate these first, cut some tinned copper wire to the appropriate length for each and solder the links in place. If you're using IC sockets,

mount these next, ensuring you get them the right way round. The resistors, diodes, LEDs and transistors can be soldered in place next, as always ensuring you get the semiconductors correctly orientated. Note that the 5 W wirewound resistor, R40, should be mounted a few millimetres proud of the board to aid cooling. Mount the trim pots next. Trimpots RV2 and RV14 have 'topside' adjusting screws, as can be seen in the accompanying photograph. Note that ALL have their adjusting screws adjacent to the nearest edge of the board. This is to provide easy access to all adjustments after the board is assembled in the cabinet. The capacitors can be soldered in place now, ensuring you get the polarised types the right way round. I know this repetition gets boring, but it will save you a lot of headaches and frustration later. Finally, mount the inductors, first preparing the leads as I have described before. The ICs can be placed in their sockets before you make a final visual check of the board.

That's it for now. Next month comes the digital panel meter board and the final assembly. ♣



This is board C, seen here as it is mounted in the cabinet. Note that the two ICs each have pin 1 facing in the same direction.



► C25-C29

- 1n or 2n2/ 200-600 V feedthrough
- C30 22u/63 V; E
- C31 1000u/16 V; E
- C32 1000u/25 V; E
- C33 10n/50 V; C
- C34 1000u/25 V; E
- C35 47u/160 V; E
- C36 10u/25 V; E
- C37 470n/100 V; G
- C38 100u/16 V; E
- C39 1000u/16 V; E
- C40 10u/16 V; E
- C41 10n/100 V; C; G
- C42 100u/16 V; E
- C43 2n2 - 2n7/630 V; C
- C44 10n/630 V; G
- C45 220u/63 V; E
- C46 68p/63 V; MKT, P; G
- C47 5n6/63 V; MKT, G
- C48-C49 .. 1n - 2n2/200 V; C feedthrough
- C50 100n/50 V; MKT, C, M
- C51 100u/16 V; E
- C52-54 470n/100 V; G
- C55, C56 10n/50 V; C, M, MKT
- C57, C58 1000u/63 V; E
- C59 47u/63 V; E
- C60 22u/63 V; E
- C61 10n/50 V; C, M, MKT
- C62 33p/160 V; MKT, C, P
- C63 10n/50 V; MKT, C, P
- C64 100n/50 V; C, M
- C65 100p/160 V; MKT, P
- C66 68p/50 V; MKT, C
- C67 100p/50 V; MKT, C
- C68 22u/16 V; TAG tant.
- C69, C70 .. 10u/35 V; TAG tant.
- C71 100n/50 V; C, M
- C72 100n/63 V; MKT, G, C, M
- C73 10u/50 V; TAG tant.

- C74 10n/50 V; MKT, C, M
- C75, C76 10u/63 V; E
- C77 1u/63 V; G; C
- C78 2n2/63 V; MKT, G
- C79, C80 470n/63 V; C; G
- C81 10u/63 V; E

Miscellaneous

- F1 1.5 A 3AG fuse.
- F2 3 A 3AG fuse.
- M1 1mA, MU65 meter
- SW1 .. DPDT Schadow push switch, 240 Vac rated, with indicator.
- SW2, SW3 4-pole, 3-pos. rotary
- SW4 4PDT Schadow switch, with indicator.
- T1, T2 240 V to 32 V 2 A, 2 x 8.2 V.
- T3 240 V/12 V, No. 2851.

AEM2000 A, B, C, D pc boards; IEC chassis mount power socket; Horwood case; small aluminium box 100 x 60 x 45 mm; meter scale; six lengths of 10 mm dia. ferrite rod 20 mm long; Siemens RM12 core, B6518-5-X2; 200 x 100 mm heatsink; 60 x 100 mm heatsink; 1 x chassis mount fuseholder; pair of 3AG fuse clips; insulator kits for MJ15003, MTP15N15, MUR1515; 4 x knobs; 2 x large banana sockets; 1 x medium banana socket; 4 x small banana sockets; bolts and nuts; lengths of heavy duty, medium duty and light duty hookup wire; solder, thermal paste, etc.

Estimated cost: \$600

A clipping and fault indicator for audio amps

Anthony Tilbrook

Technical Systems Australia Pty Ltd

An audio amplifier driven into heavy clipping will readily damage loudspeakers, apart from sounding frightful. A dc fault on an amplifier's output stage can spell disaster, also. Add-on this simple project to almost any audio amp and it will tell you when the "wick's" up too far and/or why the speaker protector operated.

SINCE THE PUBLICATION OF the AEM6504 Power Amplifier Status Monitor we have received numerous requests for a "universal" fault indicator for audio power amplifiers. It seemed that the most common need was for a unit which could indicate, firstly, when a power amplifier has been pushed into clipping and secondly, some kind of indication of dc fault conditions, such as when one supply rail is "down".

Clipping occurs when the output of the power amp is driven against its supply rails. The effect, if viewed on an oscilloscope, is that the waveform is clipped at the top or bottom corresponding to the maximum output power capability of the amplifier. The output voltage swing simply "runs into" the supply rails. Clipping causes severe distortion and is more likely to occur with lower power amplifiers as one attempts to get more loudness by winding up the volume control, or "wick" (a term that pre-dates public electricity or gas supplies, when kerosine lamps were used which had a burning fabric wick. Light output was controlled by mechanically exposing more or less wick.)

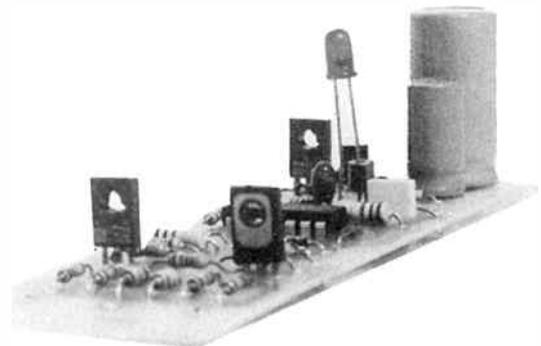
A power amplifier driven into heavy clipping can damage your loudspeakers. The clipping of the waveform produces a large number of harmonics at high frequencies which add, giving increased energy at these frequencies which will damage the tweeters in your loudspeakers as tweeters generally have a much lower power rating than the bass or mid-range drivers. In the case of high-powered amplifiers, the damage which can be done to your ears with prolonged or repeated exposure to heavily-clipped sounds results from the same cause. The ear can withstand fairly horrendous treatment, but can be damaged when subjected to very large continuous sound pressure levels, even for only relatively short periods. Damage can result after only approximately 30 seconds to one minute of continual exposure to sound pressure levels of 120 dB, for example.

LEVEL

We expect that constructors of an

INTERMEDIATE

level, between beginners and experienced persons, should be able to successfully complete this project.



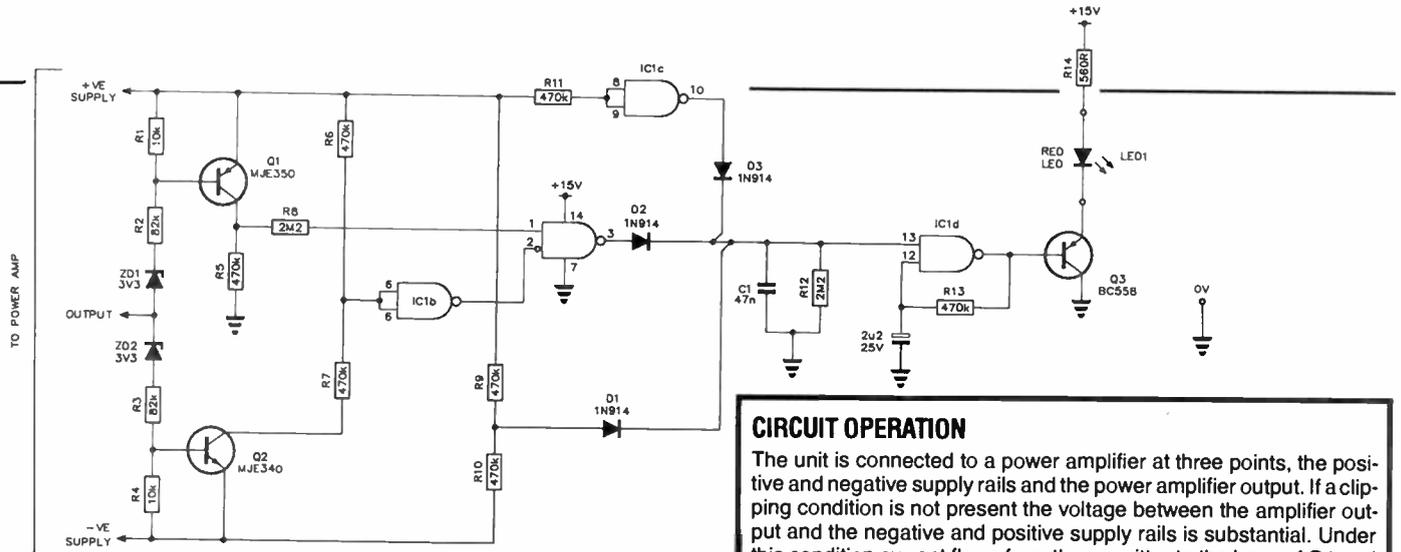
The board is long and narrow and should be readily fitted into almost any amplifier, tucked away in some corner or other where space permits.

It is continual exposure which seems to be the problem that creates the damage. An amplifier rated at about 350 W output, of moderate proportions when one considers the number of amps around these days rated at 500-1000 watts, when not clipping can produce sound pressure levels on the order of 120 dB or more, but only on transients, making the time your ears are exposed to the damaging levels short enough for them to cope. This same amplifier however, when pushed extremely heavily into clipping, could produce these levels through distortion and for extended periods. In professional applications, such as sound reinforcement for concerts etc, it is important that a sufficiently powerful amplifier system is used. In this way the desired sound pressure levels can be reached without driving the amplifier(s) into clipping with consequent serious degradation in sound quality.

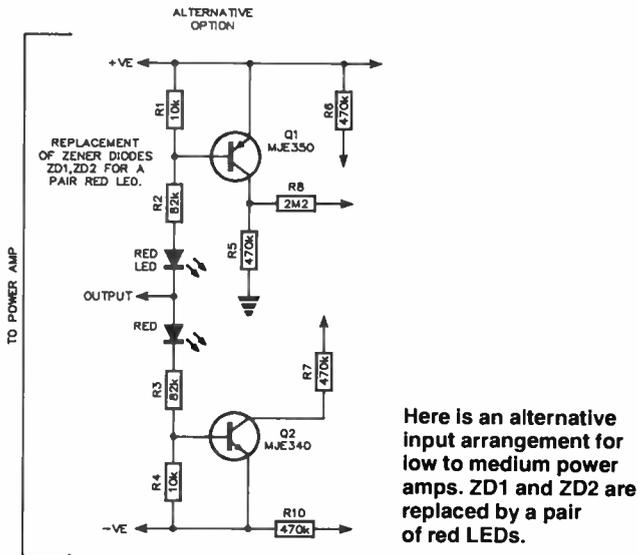
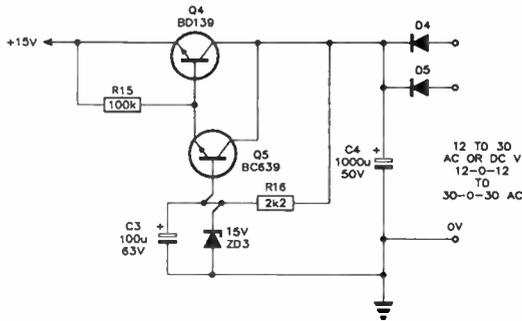
The main use, however, for the clipping and fault indicator will probably be for home hi-fi gear where owners have an interest in sound quality and not just volume.

Project overview

The AEM6508 was designed to be used in almost any amplifier. The unit provides a visual indication that clipping has occurred by turning on a LED. Although a clip can occur for a very short time, the circuit stretches this to a minimum of 100 milliseconds to ensure that the clipping condition will be easily seen. The project also provides indication if either of the supply rails fails. Many amplifiers employ fuses in the positive and negative supply rails to provide protection for the output devices in the event of connection to a short cir-



Above: clipping and dc sensing circuitry.
Below: power supply for the circuit.



Here is an alternative input arrangement for low to medium power amps. ZD1 and ZD2 are replaced by a pair of red LEDs.

cuit. If either of these supply fuses blows, one or both of the supply rails is removed from the amplifier. In this circumstance the 6508 will warn of this condition by flashing its LED indicator at a rate of about two flashes per second. The circuitry enables these two conditions to be indicated using a single red LED.

The 6508 detects a clip by monitoring the instantaneous voltage between the output of the power amp and the supply

CIRCUIT OPERATION

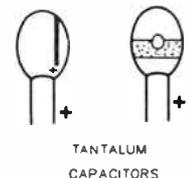
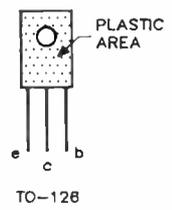
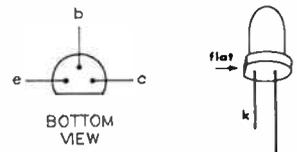
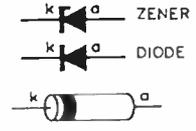
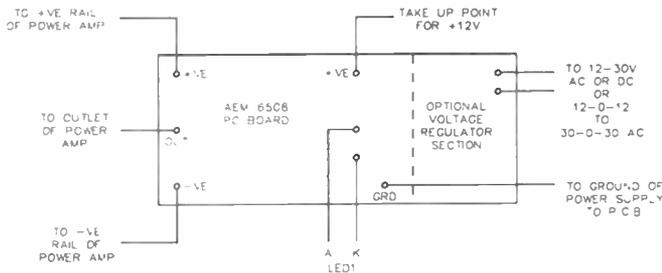
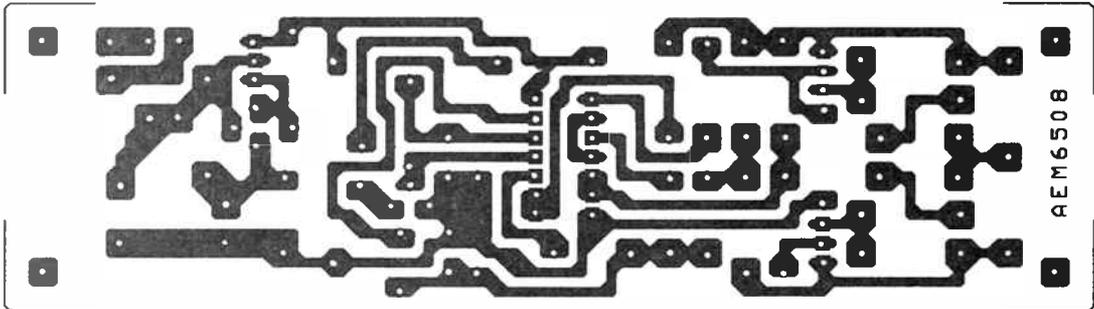
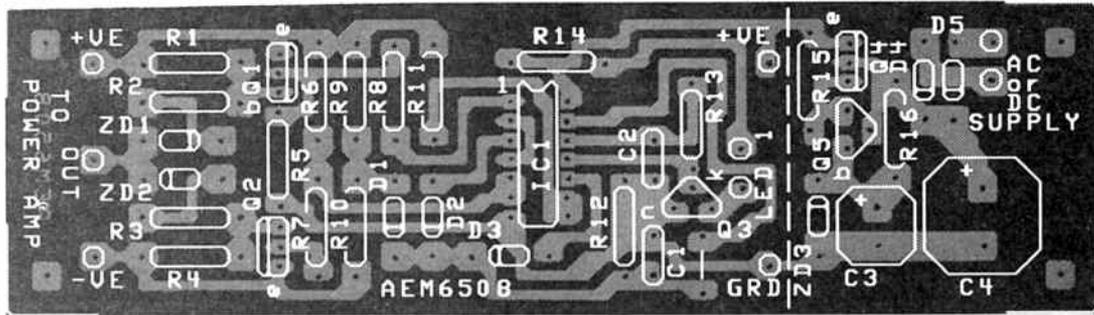
The unit is connected to a power amplifier at three points, the positive and negative supply rails and the power amplifier output. If a clipping condition is not present the voltage between the amplifier output and the negative and positive supply rails is substantial. Under this condition current flows from the emitter to the base of Q1 and via resistor R2 and zener diode ZD1 of the power amplifier output. Current also flows from the power amplifier output via ZD2 and R3 to the base of Q2. Under these circumstances both Q1 and Q2 are biased on.

When Q1 is biased on the voltage across R5 will be approximately that of the positive supply of the power amplifier. Resistor R8 provides current limiting and applies this positive voltage to pin 1 of the 4093, a CMOS quad NAND Schmitt trigger. Since Q2 is also biased on, current flows from R6 via R7 to the collector of Q2. These two resistors provide a potential divider between the positive and negative supplies so that under these circumstances the voltage at the centre of this potential divider should be around zero volts. This voltage is applied to pins 5 and 6 of the 4093 which are connected together so that this gate forms an inverter, the output of which is applied to pin 2, the input of a second gate. As long as the output is not too close to either supply rail, which would indicate a fault condition, then the levels on pin 1 and pin 2 of the 4093 will both be high and consequently the voltage on pin 3 will be low. Under these conditions the voltage on pin 13 of the 4093 is held low by R12 and consequently, pin 11 of IC1d will be high and the red LED, LED1 will be off.

If a clipping fault occurs, however, either pin 1 or pin 2 will be taken low and pin 3 will be correspondingly taken high. Capacitor C1 is charged via diode D2, taking pin 13 of IC1d high and correspondingly, pin 11 low. Transistor Q3, which functions as an emitter follower, is then biased on as is LED 1. If a very short clip occurs, capacitor C1 will still be charged by the 1N914 and will take approximately 100 ms to discharge via resistor R12. This provides a 100 ms monostable which ensures that the LED will be on for a sufficient period of time to be noticed.

The condition of the positive and negative supplies is also sensed. The positive supply is monitored by IC1c, configured as an inverter. Current limiting is provided by R11. Provided that the positive supply is intact, the voltage applied to pins 8 and 9 of IC1c will be high and consequently, pin 10 will be low. If the positive supply is removed, then the voltages on pins 8 and 9 of IC1c will drop and pin 10 will be taken high. Capacitor C1 is charged by D3 in this case, and the red LED is turned on. Similarly, if the negative supply is intact, resistors R10 and R9 form a potential divider between the positive and negative supplies so the resulting voltage on their output is approximately zero. Diode D1 is therefore reverse biased. If the negative supply rail fails then the positive supply forward biases D1 and charges C1, turning on the red LED. As long as either of these conditions remain for longer than approximately one and a half seconds, the RC time constant formed by resistor R13 and capacitor C2 converts IC1d into an oscillator with a repetition rate of around about two Hertz. Hence, supply rail faults are indicated by flashing the LED about twice a second.

The power supply regulator for the circuit is simple and consists of diodes D4 and D5 to rectify an incoming ac voltage and capacitor C4 to provide filtering. The BD139 and BC639 transistors Q14 and 15 provide a simple emitter follower circuit which are biased on by 15 volt zener diode ZD3. Capacitance multiplication is provided by C3, a 100µ electrolytic capacitor, to ensure a smooth supply rail.



rails. With the components specified, a clip will be indicated when the output reaches within 3.9 volts of either supply rail. This will be close enough to indicate the onset of clipping for most power amplifiers, especially higher power ones. However, the smaller power amps with greatly reduced supply rail voltages may require a smaller voltage differential. This can be accommodated by replacing the 3.3 volt zener diodes seen in the circuit with a device which provides a smaller voltage drop. To prohibit clipping indication until the output reaches within 1.2 volts of the supply these zeners can be replaced with 1N914 or 1N4148 small-signal diodes. If you intend to do this, remember that the LEDs need to be oriented the opposite way to the zeners, as shown in Figure 1.

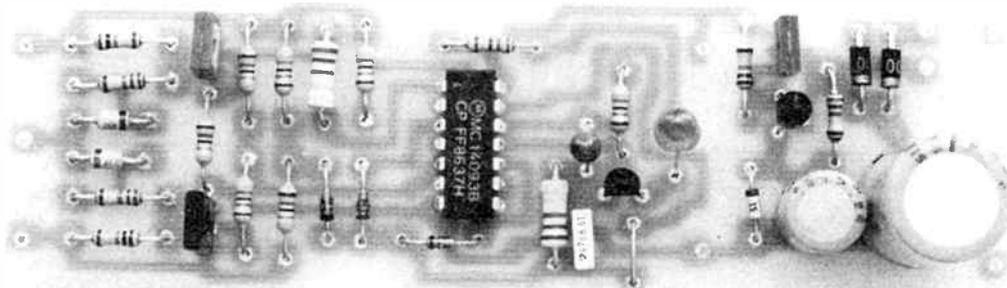
Red LEDs have a voltage drop across them of approximately 1.65V so these can be used in place of the zeners to generate a voltage differential of around 2.25 volts, which is suited to medium power amplifiers.

The power supply

The power supply for the 6508 can be achieved in two ways. For convenience, the board has been designed so that a voltage regulator is provided if required. If this is not necessary and the correct supply voltage is already available, then this part of the circuitry can be omitted. The component overlay shows a dotted line down the board. To the left of this line is the fault condition circuitry with a take-off point for +12 V and ground. To the right of this line is the optional voltage regulator circuitry. Using the voltage regulator circuitry, the board can be run from 12 V to 30 V dc or ac, or indeed from 12-0-12 or 30-0-30 Vac.

AEM6508 PARTS LIST

Semiconductors	
IC1	4093
Q1	MJE350
Q2	MJE340
Q3	BC558
Q4	BD139
Q5	BC639
D1-D3	1N914
D4, D5	1N4002
ZD1, ZD2	1N746 3V3/400 mW
ZD3	1N4744 15 V/1 W
LED1	TIL220R red LED
Resistors	
	all 1/4W, 5% unless noted
R1	10k
R2, R3	82k
R4	10k
R5-R7	470k
R8	2M2
R9-R11	470k
R12	2M2
R13	470k
R14	560R
R15	100k
R16	2k2
Capacitors	
C1	47n MKT
C2	2u2/25 V tant.
C3	100u/63 V RB electro.
C4	1000u/50 V RB electro.
Miscellaneous	
AEM6508 pc board; 14-pin IC socket; spacers, nuts and bolts for mounting; hookup wire.	
Estimated cost: \$25-\$30	



Construction

Construction of the AEM6508 is a relatively simple task as all the components, with the exception of the red indicating LED (LED1), are contained on the pc board. Before beginning construction, check the pc board closely to ensure there are no copper bridges between closely-spaced tracks or pads and that all holes are drilled. I will describe the construction with the assumption that the power supply is external and that all of the voltage regulator components are used. If the optional components are not necessary you can either leave the components off or cut the board along the dotted line shown on the overlay diagram.

Begin by soldering the resistors and link onto the pc board. The link is positioned close to C1, readily identified on the overlay diagram. The next components to be positioned should be the smaller non-polarised capacitors. Do not position the electrolytic capacitors at this stage as their physical size will restrict the positioning of surrounding components. Next should come the transistors, diodes and zeners. All of these components are polarised and therefore need to be oriented according to the component overlay. Be especially careful not to confuse the transistors nor to position the flat pack devices backwards. To ensure they are correctly positioned, refer to the overlay and to the component pinouts.

The larger electrolytic capacitors can now be positioned and soldered onto the board. However, be sure to orient these according to their polarity. In the case of electrolytics this is

essential because a reversed polarity will almost surely result in a breakdown of the dielectric within the capacitor when powered up, usually rendering them useless. The final component to be placed onto the board should be IC1, the 4093 CMOS device. I would recommend the use of a 14-pin DIP socket here as it facilitates easy removal should it be necessary at any time in the future.

The board should now be complete. However, make a final check of the orientation of all of the polarised components and of the solder side of the pc board for any solder bridges that have occurred during construction.

Powering up

Before connection to the power amplifier the board can be checked by connecting it up to a suitable power supply. With the input leads disconnected, the module should indicate the supply failure condition i.e: the LED should flash.

If you follow the wiring diagram given here, along with the overlay diagram, wiring the unit into an amplifier should represent no real problems. The board is a relatively compact design and should be readily fitted inside most amplifiers. The LED may be mounted in any convenient place where it is readily seen. When making the connections to the pc board be careful not to confuse the connection points intended for the power amplifier.

This unit should prove its worth in short order, saving your speakers from damage, if not your ears.

AEM PRINTED CIRCUIT SERVICE

6010 ULTRA-FIDELITY PREAMP

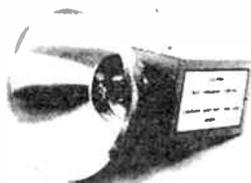
The 'digital era' preamp, featuring low-level cartridge input, CD input, two tuner inputs and one aux input. There are four boards in the set — 6010LL (cartridge pre-preamp), 6010f, 6010r and 6010ma — the front, rear and main boards. (Oct-Nov-Dec '85).

6010LL — \$19.10
6010f — \$16.40
6010r — \$16.40
6010ma — \$23.10
Set of four \$74.90

6501 4-INPUT MIXER

A versatile mixer/preamp for a guitar amp or stage amp. Select resistors to select the input impedance of the channels (Sept '85)

\$20.40



9500 BEAT-TRIGGERED STROBE

Just the thing for discos and parties! Project can act as a manually variable strobe or, coupled to an audio source, flash in time with the beat (July '85)

\$11.30

6102 2-WAY CROSSOVER

Crossover board for our popular 2-ways using the Vifa drivers (Aug '85)

\$21.75

AEM6500 MOSFET AMP MODULE

A 'universal' amp module using the Hitachi MOSFETs and able to deliver 60 W with one pair or 120 W with two into 8 ohms (July '85)

\$9.70

9501 DUAL-RAIL SUPPLY

A utility power supply module that can deliver dual rails from 2.6 V to 26 V at currents up to 560 mA — depending on choice of 5 VA pc-mount power tranny (Aug '86)

\$19.30

6503 ACTIVE CROSSOVER

Here's a high performance four channel (use as many as you need) active crossover that's just right for that active speaker project! (Feb '86)

\$34.40

6504 POWER AMP STATUS MON.

This project prevents dc fault conditions or excessive clipping from exterminating amps and speakers alike. Handles amps up to 300 W and powers from the amp's supply rails (Aug '86)

\$19.40

HOW TO ORDER

Order pc boards by the project number and title • All prices include post and handling • New Zealand purchasers add \$1.00 to these prices • Photostats of the pertinent articles cost \$4.00 each, post paid • With out-of-stock boards there may be a delay in delivery.

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The "Bit Stream Flyer", a stand-alone V.22 modem



Design – Chris & Dan Darling
Article – Roger Harrison

Step into the data communications fast lane with this simple, low-cost 1200 bps full-duplex modem! Now you don't have to discard your old V.21/V.23 modem in order to upgrade.

AS PUBLIC DIAL-UP DATA SERVICES and private bulletin board systems proliferate, the demand for more speed in the communications link has grown proportionately. Many now offer 1200 bps full-duplex (V.22) communications, and for good reason – it saves everyone time and money when compared to speeds of 300/300 (V.21) or 1200/75 (V.23). Modems offering V.21 and V.23 operation are legion, and an increasing number of V.21-V.22-V.23 modems are appearing. But this means that if you have an "old faithful" V.21 or V.21-V.23 modem, in order to gain the advantage of 1200 bps V.22 communications you have to buy another modem that duplicates what you already have! This project provides the solution to that dilemma.

Project overview

The project is based around the Thomson-CSF EF7515 Single Chip DPSK and FSK Modem IC, a dedicated Bell 212/Bell 103/V.22 A-B modem chip described in detail in the data sheet reproduced elsewhere in this issue which was originally published in our November 1986 issue. We have republished the data sheet again for the sake of convenience and easy reference. The unit is remarkably simple

for such a "high-tech" project, due in no small part to the features of the 7515.

The circuitry "borrows" somewhat from the AEM4611 V.22 Add-on for the Supermodem described in the February 1987 issue of AEM. The line interface circuitry, involving a 4558 dual op-amp, is virtually identical. Configuration of the 7515 is here handled by panel switches and a little simple logic employing buffers from IC2, a 7404 hex inverting buffer. Bell/CCITT mode selection is effected with an on-board jumper, though a single-pole double-throw switch could be employed if you required it.

The RS232 interfacing employs a 1488/1489 pair to provide level shifting and buffering for the TXD input (1489), RXD output and DCD (data carrier detect) lines (1488). The clear to send (CTS) line is permanently pulled high so that any data terminal equipment (DTE) attached that implements this line will "know" the modem is always "ready".

The project is powered from a common 12 Vac plugpack. Simple half-wave rectifiers and 7805 and 7905 three-terminal regulators are employed to produce positive and negative 5 V rails. A zener is used to derive an additional regulated +12 V rail. ►

CIRCUIT OPERATION

Heart of the unit is the EF7515, IC1. As the data sheet is included elsewhere in this issue, there's no need for a detailed rundown of its operation here.

IC1's on-board clock is used, XTAL1 providing the required frequency. The 7515's receive filter output is coupled to its receive demodulator input via C2. CCITT or Bell operation is selected by bridging pin 3 to -5 V or +5 V, respectively, at jumper J1.

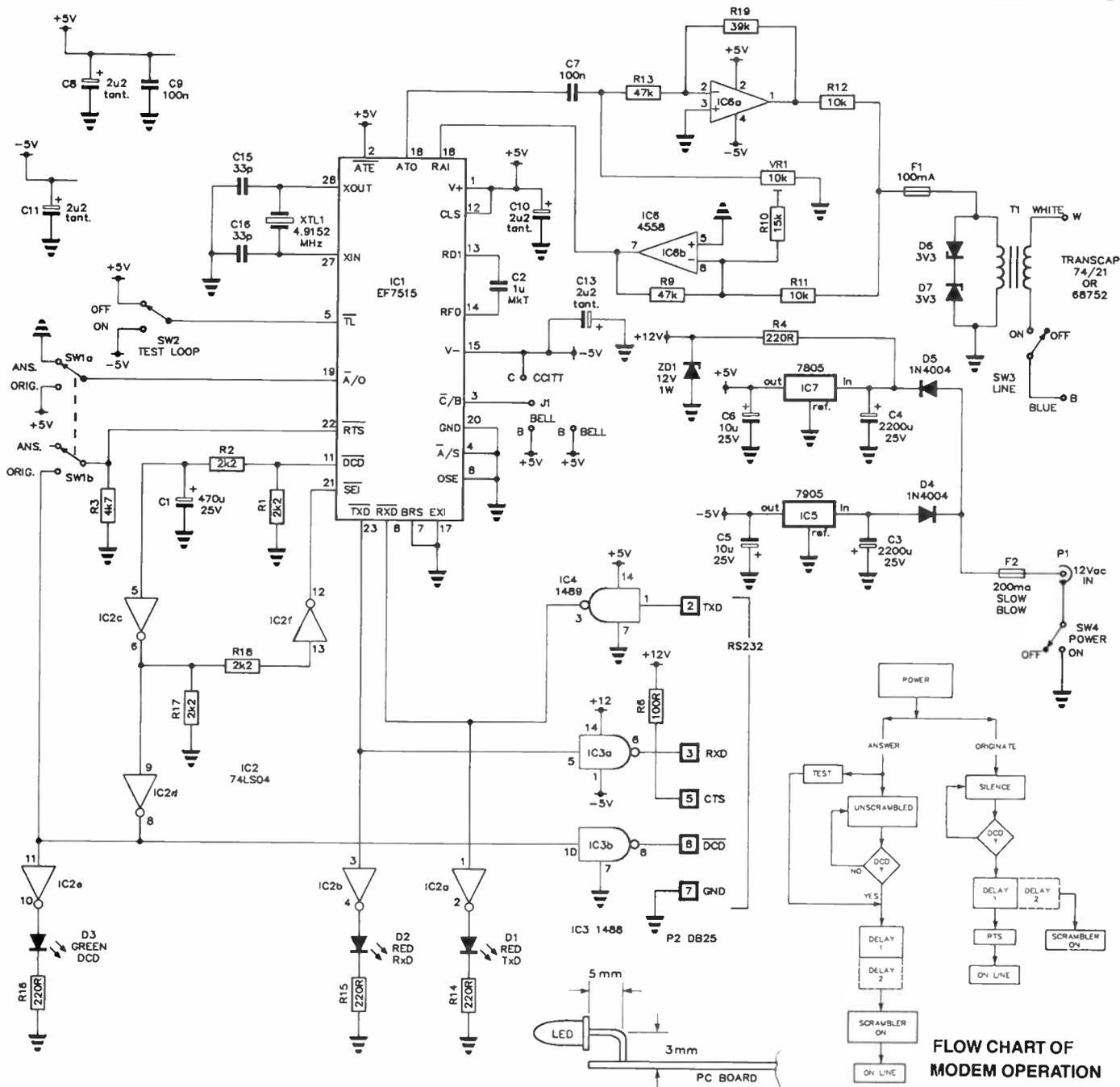
Data to be transmitted enters the modem via pin 2 of P2, the RS232 connector, thence to IC1's RXD input, buffered and level-shifted by IC4, one buffer from a 1489 RS232 line receiver which also inverts the signal sense as required by the 7515. Data received and demodulated by the 7515 is conveyed to pin 3 of the RS232 connector from pin 23, IC1's TXD line, buffered by

IC3a, one buffer from a 1488 RS232 line transmitter which also converts the TTL-level signal to RS232 levels.

Incoming data is indicated by means of LED D2 which is driven by buffer IC2d from the TXD output of IC1. Data being sent is indicated by LED D1 which is driven by buffer IC2a from IC4's output. The 7515 is set to 'answer' or 'originate' mode by SW1. The IC's internal test loop, which links the transmit carrier back to the receive analogue input, is selected by SW2.

Interfacing to the line is accomplished by IC6, a 4558 dual op-amp. IC6a buffers the transmit signal from IC1's analogue transmit output (ATO) fed to the line via T1.

Zeners D6-D7 ensure the level transmitted to the line does not exceed a swing of 3.3 V peak. Signal from the line is amplified by IC6b via its inverting input (pin 6) and fed to IC1's analogue receive input (RAI). Some of the transmit signal is fed to IC6b's



non-inverting input via VR1 so that any transmit signal present on the inverting input will be cancelled at IC6b's output, depending somewhat on how the reflected line impedance from T1 affects the transmitted signal's phase at pin 6 of IC6.

The 7515 has an internal 'scrambler' which ensures transmissions to and fro are 'locked'; it is disabled during handshake procedures. The receive and transmit sequences are apparent from the flow chart here. In originate mode, the IC looks for a data carrier. If there's silence on the line, the DCD output (pin 11) goes high, initiating DELAY 1, which initiates DELAY 2, activating the scrambler and setting RTS low through the two buffers IC2c and IC2d and SW1b. The RS232 DCD line (pin 8 of P2) is set high. The modem is then set on line. In answer mode, the 7515 checks for successful data carrier detection, sets its DCD output high, initiating DELAY 1 and DELAY 2, activating the

scrambler and then setting the unit on line. In TEST mode, the DCD check is bypassed.

The required delay is simply effected by R2-C1. In practice, it was found that DELAY 2 was unessential, although provision has been made to add a capacitor between the input of IC2f and common (C14) to provide it. A 220u/25 V electrolytic is suggested.

Power is supplied from a plugpack having a nominal 12 Vac output at a few hundred milliamps. This comes in via P1, switched on and off by SW4. Fuse F2 provides protection for the plugpack against short circuits within the modem as well as protecting the modem should the plugpack fail and apply 240 Vac to the power input. Note that F2 is a slow blow type. Fuse F1 in the line interface protects the line against the application of mains or high voltage transients to T1 and the line.

Operating status of the modem is indicated by three front panel LEDs: one for the TXD line, one for the RXD line and one for the DCD line.

All the circuitry is contained on a single, double-sided pc board with through-plated holes and measuring 138 mm deep by 127 mm wide. The four switches and three indicator/status LEDs are mounted on the "front" edge, from where they protrude through the front panel. The rear edge has the right-angle pcb-mounting DB25 socket, the concentric power input socket and line terminating pins lined-up along it. The board is quite uncluttered. The largest component aboard is the 600:600 ohm line isolation transformer at the left hand rear corner. Only one adjustment is required – the line interface balance, VR1, a 10-turn pc-mount trimpot.

Since Telecom did away with the requirement for a line isolation capacitor, replacing it with a low-current fuse, cost and bulk of the mandatory line isolation components has decreased, along with the space required on-board.

The physical and electronic/electrical design of the modem complies with all Telecom type-approval requirements, as well as electrical safety specifications. The plug-pack and line transformers recommended in the Parts List both comply with Australian Standard AS3126 and the Transcap line transformer is Telecom approved. Readers are reminded, however, that any device which you intend to connect to a Telecom line must be 'type-approved' as an attachment. It is an offence under the Telecommunications Act 1975 to attach any apparatus to a telephone line which is part of the public switched telephone network, other than an approved device or an appliance leased from Telecom.

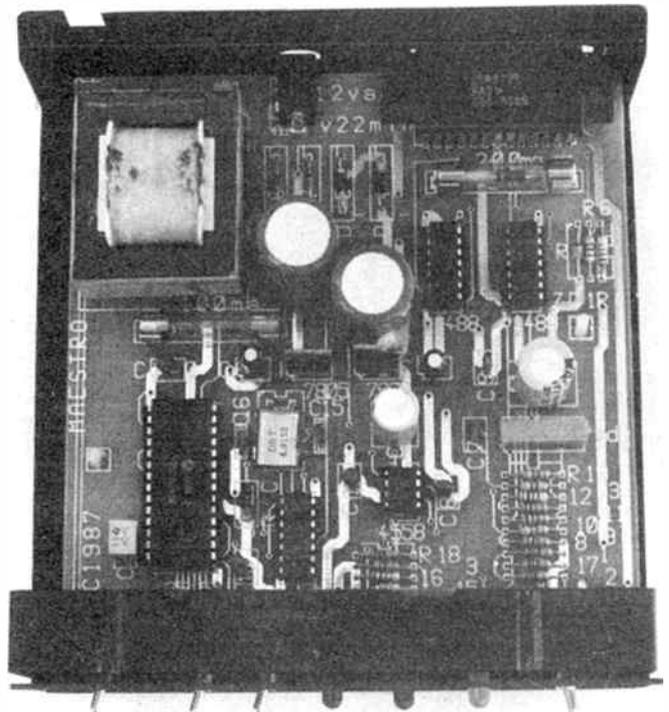
You are at perfect liberty to construct and use the modem described here on an internal intercom line or other private "twisted pair" line in a building, for example. The relevant Telecom specifications relating to modems such as this include documents 1050, 1053, 1222, 1240, 1302 and 1364 and application for type approval must proceed on Telecom's Form TS139 "Data and Non-Voice Equipment Directly Connected to the Telecom Network".

The modem is housed in a metal cabinet designed and manufactured specially for it. The board mounts in the cabinet bottom, secured by four plastic pc standoff pillars. Cutouts in the rear apron provide access to the DB25S

BACKGROUND

This project arose out of reader feedback on the question of how to add 1200 bps full duplex (V.22) operation to an existing modem, such as our popular Dual Speed modem, the AEM4600. Well, after not a little deliberation and research, it turned out that such a proposition is not all that practical. The vast majority of popular V.21/V.23 modems employ the 7910 World Modem chip, as does the 4600. As this cannot operate in V.22 mode, a dedicated V.22 modem chip is necessary, with the addition of line interfacing and data in/out selection and interfacing. Possible with the 4600, but electronically and mechanically quite "messy". Retro-fitting a V.22 facility to a modem where the data and line interfacing details are largely unknown is fraught with difficulties for the individual constructor. The potential for disaster is unbounded. The simplest solution was clear, develop a stand-alone, low-cost V.22 modem.

Having discussed the proposition with the Darling brothers during our research on the question, Dan said he thought he could "knock one up in a flash". He did. It worked first off. He rang with the news a day and a half later. He hadn't even drawn a circuit! The slow part was designing the pc board and proving it, then organising the housing. We organised the documentation. The end result you see here – the Bit Stream Flyer! The Darling brothers, better known as Maestro distributors, are marketing the project both as a kit and in built-up form.



The board fits snugly in the bottom of the case. No hardware is actually mounted on the case. Access to the power input connector and RS232 socket is via cutouts in the rear apron. The line cable is secured by a grommet which is fastened in the slot cutout in the rear apron visible here above the line transformer.

RS232 serial input socket, the power connector and a securing point for the line cable. The front panel is a rectangular piece of punched and silk-screened plastic held in place by a folded-back lip in the cabinet lid and a U-bracket immediately behind it, visible in the photographs here. It is a simple, functional cabinet that should prove more rugged than a plastic case. It fits neatly beneath a standard Telecom table-top phone.

We have not reproduced the pc board artwork for this project as it is double-sided with through-hole plating and well-nigh impossible, if not uneconomical, to produce in the sort of facilities normally available to constructors. Maestro distributors hold the copyright.

Construction

The printed circuit board for the project was laid-out using a CAD package specially designed for pc board work called "Fastwire". This incorporates a feature that enables you to design a component overlay for the board. One of its idiosyncrasies is that resistors (and other two-lead axial components) are grouped in dual-in-line arrays. You will notice the component overlay here has three such arrays: designated RA1, 2 and 3. The components in each array are individually identified, however.

The component overlay diagram reproduced here has all the component outlines individually identified.

To assemble this project, I recommend the use of a good quality temperature controlled soldering iron or soldering "station". The iron should have an iron-clad copper tip with a fine (2 mm or less) conical point or wedge shape, but not too long a point as this lowers heat capacity and the iron's ability to heat the 'heavier' component leads or termi-



The completed modem is quite sturdy looks very smart. It fits neatly beneath a standard Telecom desk top telephone.

(D4, D5) and the three zeners (D6, D7 and ZD1). Make sure you get them the right way round as incorrect orientation could mean instant disaster at first switch-on.

The three LEDs can come next. These are mounted with the leads bent such that the base of the LED is flush with the edge of the pc board and the leads sit some 3 mm up from the top of the board as shown in the accompanying illustration.

The resistors may be tackled next. They all go in the locations clearly marked on the board "RA1", "RA2" and "RA3". Seat them with the component body against the board. Follow by soldering VR1 in place, ensuring the body sits flush against the board.

The crystal is best mounted now, before any components adjacent to it are mounted as they clutter the area making it a little difficult to place the crystal. It is best to lay the crystal flat on the board, as can be seen in the internal pictures of the modem. This keeps it away from the influence of any heat produced by the 7805 adjacent to it. Using needle-nosed pliers held adjacent to or against the base of the crystal, bend the leads at a right angle to the body about 2-3 mm away from the where they enter the base. Then insert the leads in the appropriate holes and solder them in place.

Now mount the capacitors. Note that the electrolytics and tantalums are polarised and must be inserted the right way round. Observe the note concerning C14.

Last of all, solder T1 in place, here too ensuring that it sits flush down on the board. You can set the jumper at this stage by bridging the middle pin and pin C, or you could do that later, at the check out stage.

Before proceeding any further, make a careful visual examination of the board, looking for any "bodgie" joints, missed-out components or polarised components that are incorrectly oriented. Also check for any solder "bridges" between adjacent joints, particularly around the ICs and switches. Correct any problems now.

Check out

Insert the two fuses. With none of the ICs inserted in the sockets, use your multimeter set to its 'low ohms' range to check the +12 V, +5 V and -5 V rails for shorts to common. Watch out, though - when checking the +12 V line, your multimeter's black (common) lead should be connected to the positive rail, the red lead to 0 V. Otherwise, you'll forward-bias ZD1 and the rail will appear to have a short. Correct any problems before proceeding.

Having passed that test, you can plug in the ac plug pack, or attach some other suitable 12 Vac supply, and power-up. The ON/OFF switch should be on, I should hardly need to tell you, but everyone gets trapped once in a while! Check the voltages across C3, C4 and ZD1. The first two should

show around 16-19 Vdc or so, while the voltage across ZD1 should be in the vicinity of 11-13 Vdc.

Now check that pins 1 and 12 of IC1's socket have +5 V on them. Then go around all the other IC sockets and check that the supply rail pins have the correct voltages applied. If there are any problems, trace the fault and rectify it now.

Power down and discharge the supply rails by bridging them to 0 V. Then carefully insert the ICs, leaving IC1 till last. The 7515, note, is a CMOS device and must be handled with appropriate care. It's expensive, too. Make DOUBLY CERTAIN that the ICs are all inserted correctly with pin 1 facing the rear of the board.

Completion and testing

The four plastic pc standoff pillars, you will note, have sticky pads on the bottom. The pads are covered by a paper layer to protect it prior to use. Leave this in place for now and pop the pillars into the mounting holes on the board. Square them up.

Disassemble the case then mount the board carefully in position. When you have it right, press the pillars into place to secure the sticky pads. Slip the front panel in place. Assemble the line cord and secure its grommet in the notch at the top left of the rear apron and connect it up to the pins on the board below.

Set SW3 to HANG UP (left), SW1 to ORIG (left), SW2 to NORMAL (left). Connect the plugpack, power-up again and quickly check the supply rails. Connect a 470 ohm resistor across the line and set SW3 to ON LINE. Take an oscilloscope or an audio millivoltmeter calibrated in dB and connect it between pin 1 of IC6 and 0 V. Set VR1 to obtain a minimum reading. Disconnect the 470 ohm resistor and connect the modem on line. Readjust VR1 for a minimum reading on the CRO or dB meter. Once set, VR1 seems to need little or no adjustment.

Now you can hookup your computer to the modem. Fire up your communications package. Even a simple terminal program will do. Set SW3 to HANG UP, SW1 to ANS and SW2 to TEST LOOP. The RXD LED will flash for several seconds until the DCD LED lights. Now when you type anything, it will be echoed on-screen. This function is good for a "local" check of the terminal/computer, serial cable and modem hookup, but NOT for adjusting the line balance pot, VR1.

Operation

You use it as you would any other "dumb" modem. It should be connected via a "double adaptor" line connector. Power on and set the modem to ORIG or ANS as required, the TEST switch to NORMAL and the LINE switch to HANG UP. Dial the remote modem's number and, when you hear the carrier switch your modem ON LINE. The DCD light should come on presently, and away you go!

Well, that's it! Note that the Bell/CCITT standards are so close you can go on line in ORIG mode and work either BELL or CCITT, no problems, without the necessity of resetting the jumper. If you need to work Bell in answer mode, then you will have to reset the jumper to link pin B and the centre pin of J1.

To use the TEST function, you first switch the modem off line (HANG UP), then set the TEST switch to TEST LOOP. Anything you now type will be echoed on-screen. You may find that, occasionally the RxD LED stays on when you switch from TEST LOOP to NORMAL. It's OK, the 7515 will right itself when switched back on line. 🐱

Here's a great offer, exclusive to AEM readers.

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Don't miss this opportunity to own a high speed modem and to enjoy the pride and satisfaction that comes from having built it yourself!

By special arrangement with the designers, you can obtain a complete kit to build the AEM4622 Bit Stream Flyer by Maestro for just

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The components alone would cost you over \$200 at retail prices!

An optional plugpack power supply is available for an additional cost of \$14.00.

The kit is complete to the last detail; all components, semiconductors, switches, connectors, IC sockets and cabinet.

This offer is made by Maestro Distributors and the magazine is acting as a clearing house for orders.

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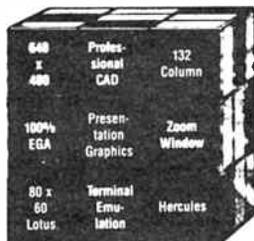
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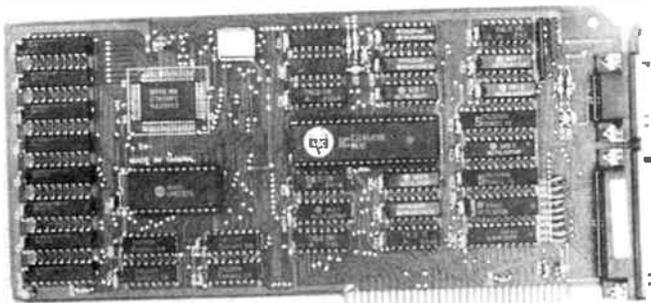
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High speed mono graphics card for PCs and compatibles



A turbo monochrome graphics card from Electronic Solutions improves the performance of PCs and compatibles by speeding up scrolling and writing to the screen by over four times, the company claims. The Turbo Graphics card is fully Hercules graphics compatible and runs all existing graphics-based software, they say.

Slow scrolling is a particular problem with graphics based wordprocessors like Microsoft Word, and with many of the new desktop publishing programs.

The board is very complex electronically but most of the new technology has been built into one powerful gate array chip. As a result, the board will fit in a "short slot" of any PC on

the market, claims Electronic Solutions.

Price is a very reasonable \$175.00 including tax. And for the faint hearted, Electronic Solutions products all carry a 14-day money-back guarantee. A low cost fitting service is also available.

For further information, contact **Electronic Solutions, PO Box 426 Gladesville 2111. (02) 427 4422.**

Banksia boards

Banksia Information Technology (BIT), owned by Australian high-tech entrepreneur David Hartley now living in Hong Kong, has appointed A. J. Distributors as the Australian distributors for their range of PC, XT and AT compatible boards.

Hartley, in response to alleged quality and consistency problems associated with low-cost Asian compatibles, has established a relationship with a Hong Kong manufacturer to produce a range of PC, XT and AT compatible boards which BIT subjects to individual QA tests prior to shipment.

The BIT boards are supplied complete with original DOS package and a manual written in real English, the company claims.

A. J. Distributors also stock a range of other PC compatible products. Further information from **John Williams, A. J. Distributors, 44 Prospect Rd, Prospect 5082 S.A. (08) 269 1244.**

Enhanced graphics adaptor

Data Cable Pty Ltd has added an enhanced graphics adaptor to its range of PC add-on cards. The M-20E Enhanced Graphics Adaptor can be used with IBM PC, XT, AT and compatible computers.

The M-20E has monochrome, colour and enhanced colour modes, the latter able to support 64 colours.

Features of the new M-20E are a 256K dynamic RAM screen buffer on board, light

IBM ships first System/2 from Wangaratta

Shipment of IBM's first new Personal System/2 computers left IBM's plant at Wangaratta, Victoria, in early April, destined for markets in Australia, New Zealand, China, South Korea and South East Asian countries.

Last year, IBM's personal computer exports from Wangaratta were worth \$27 million.

All models of the Personal System/2 family will be produced at the Wangaratta Plant. Shipments of the Model 50 are scheduled to commence this month, Model 60 in July, and Model 80s early in 1988.

Staff levels at Wangaratta have been increased by 48 per cent to develop the production technology for the Personal Systems with nearly 100 people now employed there, IBM say.



pen interface, feature connector and video jack support.

Also available from Data Cable are Enhanced Graphics Adaptor Cards and Enhanced Graphics Colour Monitor packages. The Enhanced Graphics Adaptor has a recommended retail price of \$586.67 (including tax). Contact **Data Cable, 538 Mountain Highway, Bayswater 3153 Vic. (03) 729 0044.**

"I've got MS – but I'm still smiling"

Like most people with MS, my symptoms are mild. They come and go, but in between, I'm fine.

Some people with MS are more disabled than I am. They need the activity therapy centres, the nursing homes and the many other services which MS Societies provide. For their sakes, keep up your donations.

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For more information about multiple sclerosis contact the MS Society in your state.

A VZ-Epson printer patch — the search continues

Larry Taylor

Part 2

IN THE PREVIOUS instalment, printing of the VZ's inverse and graphics characters had been made possible. At this point, the ideal enhancement to our printer patch would be to enable the VZ's COPY command to function correctly when matched with an EPSON type printer. This should be possible, but we must first examine why the usual means for intercepting BASIC key words, during programme execution, won't work in the case of the COPY command.

The VZ's ROM owes much to that used in the earlier TRS-80 computers. The COPY routine, however, is one of a number of additions which greatly enhance the VZ's capabilities. As such, it contains none of the DOS exits, which are to be found in the older sections of the ROM. These exits, or "vectors", are calls to an area in the communications area of RAM, and provide the means by which some BASIC commands may be altered or redirected. Since the VZ DOS makes no use of these vectors, none have been provided in the newer sections of the ROM. My initial hopes dashed, I began to investigate the method used to integrate the DOS into the VZ's operating system. In doing so, I uncovered an alternative vector, one which would make it possible for us to not only intercept the COPY command, but also open the door to further enhancements to the VZ's BASIC.

How so?

It is important to understand, initially, why this type of modification is possible. When we write a BASIC programme, we are creating what we hope will be a precise set of instructions. Unfortunately, before the computer can understand and respond to our commands, each instruction in turn has to be painstakingly translated or interpreted. This is the reason for BASIC's slowness, and it can really only be effectively overcome by having the programme translated or compiled prior to execution. Yet, because a BASIC programme is interpreted as it runs, it is possible that additional commands may be added to the language, provided they are intercepted and executed prior to reaching the VZ's own interpreter. This is precisely what happens when a disk operating system is added. New commands enabling disk operations to be performed, supplementing the existing BASIC. In the case of the COPY command, we are seeking to redirect it to a routine compatible with EPSON type printers, and on completion, have it return as though all had proceeded normally.

As I undertook to produce this extension to the patch, I found myself venturing much further than I had originally intended. The project involved modifying the existing ROM routine, as well as enhancing the COPY command to provide for a second screen dump routine of my own design. Furthermore, I allowed for a copy of the LO-RES screen without the usual linefeeds. I also sought to eliminate those unfortunate flaws in the inverse character data. Listing 1, which was kindly supplied by Bob Kitch, enables a closer examination of the inverse characters held in ROM, by displaying them on the HIRES screen. By relocating the ROM table to RAM at the top of memory the necessary modifications to the data have been made possible.

VZ ROM, INVERSE CHARACTER SHAPE TABLE

```

@ABCDEFGHIJKLMNO
PQRSTUVWXYZ[\]^_`
!"#$%&'()*+,-./
0123456789:;<=>?
  
```

VZ ROM, PRINTER PATCH MODIFIED TABLE

```

@ABCDEFGHIJKLMNO
PQRSTUVWXYZ[\]^_`
!"#$%&'()*+,-./
0123456789:;<=>?
  
```

(note changes to underlined characters)

The accompanying illustration allows a comparison to be made between the ROM characters, at top, and those in the shape table addressed by the printer patch. Incidentally, should you decide that you still don't like the look of the amended characters, it is possible, using the same approach, to either further refine them, or even custom design a completely new set.

Inspired at having overcome this obstacle, and because I have written a number of programs using an Extended BASIC, I wanted the routine to be able to list those commands, which would not normally be recognised. The final aim was to deal with the printer's unimpressive performance, signalled by a dramatic decrease in speed, each time it had to print a graphics or inverse character. The solution I chose to minimise these delays was to feed the data into a section of RAM, which would act as a collection area or buffer, prior to printing. A discussion in detail of how each of these refinements was implemented would only serve to complicate what is otherwise a relatively straightforward procedure. I have elected, instead, to demonstrate how to intercept and enhance an existing keyword on a smaller scale by using another of the VZ's commands.

Enhanced CLS

Tandy's Colour Computer has an enhanced CLS command which enables the user to clear the screen to any one of nine background colours. The syntax is CLSn, where n may be a number in the range 0-8. To illustrate how enhancements to the existing language can be accomplished, this command will be necessary to examine further how the VZ operates.

When a BASIC program is RUN, control passes to a machine language ROM routine, the Execution Driver at 1D5AH, which scans each line of the BASIC programme as it comes to it and begins to translate it. Part of the translation process involves looking for tokens. These are values in the range 128-250 (80H-FAH) that take the place of BASIC reserved words e.g. CLS = 132 (84H). Once the word has been identified and checked for correct syntax, control is passed to the corresponding ROM routine before returning to continue the translation.

On power-up, the address of the routine which examines each byte in a line of BASIC, is stored at 7804H. This is the vector hinted at earlier, and in a non-disk VZ it will normally contain a pointer to the RST 10H routine at 1D78H. Because this vector is in RAM it can be easily changed. This was done so that at a later stage the DOS could be included.

At least three different versions of the VZ DOS could be included that I am aware of, and two of these display the same version number on power up. Consequently, the only fixed location common to all three versions is a jump table commencing at 4005H. This makes it difficult to refer to an actual address within the DOS, where command processing is carried out. However, since all processing must be channelled via the above-mentioned vector, a peek at this address will uncover the whereabouts of the DOS interpreter. A close examination of this region of the DOS will reveal how the added disk commands are interpreted and implemented. This information will enable us to introduce into the system an enhanced command of our own choosing. The trick is to ensure that, as far as the VZ's interpreter is concerned, nothing unusual has happened.

The accompanying assembly language programme in Listing 2, with its associated comments, shows in greater detail how this is accomplished. If you do not have access to an Editor Assembler, Listing 3 is a BASIC version, which pokes the routine into memory. Having adjusted the top of memory pointer, the address at 7804H is stored and replaced by our own. The programme then locates the new routine at the top of the memory. Now each time a byte is to be examined during execution it must first pass through our checkpoint. Once the origin of the call is established, the routine looks for the CLS token, 132 (84H).

Only when it has been located does the routine proceed to examine the next byte. This is checked to see if it lies in the range 0-9. Once it has passed this test, the clear screen routine is implemented, after first calculating the appropriate value, with which to fill the screen. You will notice that not only is it necessary to check for the new command, but also to provide the routine which implements it. In this case a simple block load to the screen has been used. Control is then returned to the ROM processing routine, which prepares to examine the byte following our new command. So, as far as the VZ knows, everything is continuing normally. Tricky isn't it?

The VZ will now respond to the CLSn command, when entered, either directly from the keyboard, or from within a program, with one exception. For some unexplained reason, during IF-THEN-ELSE processing the ROM accesses the byte examine routine at 1D78H directly, instead of via a RST 10H call. This means there is no efficient method for our programme to intercept the new command, when it is used in an IF-THEN-ELSE statement. The problem can best be

LISTING 1

```

10 .....
20 *** DISPLAY INVERSE CHARACTER ***
30 *** SET IN ROM ***
40 *** AS USED BY DOT MATRIX ***
50 *** PRINTER ***
60 *** R. B. KITCH 27/1/B6 ***
70 .....
80
100 WHEN INVERSE CHARACTERS ARE SENT TO A DOT MATRIX PRINTER
110 THE PRINTER SHIFTS TO GRAPHICS MODE AND REQUIRES A ROUTINE
120 TO SUPPLY THE APPROPRIATE SHAPES TO THE HEAD. (NORMAL
130 CHARACTERS ARE HELD IN THE PRINTERS ROM)
140 IN THE VZ COMPUTER A TABLE OF SHAPES IS LOCATED AT
150 3B94H TO 3CD3 IN ROM. THERE ARE 64 CHARACTERS, EACH USING
160 5 BYTES TO DEFINE THEIR GRAPHIC SHAPE. THE SHAPES MAY BE
170 DECODED AND OUTPUT TO THE SCREEN AS IS DONE IN THIS
180 PROGRAM. NOTE THAT THERE ARE SOME ERRORS IN THE ROM.
190 THE 5 BYTES DEFINE A 5 BY 8 DOT MATRIX WHICH IS THE SHAPE
200 OF THE CHARACTER, WHICH INCIDENTALLY ARE NOT ORDERED
210 ACCORDING TO THE ASCII CODE.
220 THE FIRST BYTE DEFINES THE LEFT HAND EDGE OF THE CHARACTER-
230 WHICH IS THE FIRST PRINTED DURING A PASS OF THE PRINTER
240 HEAD. IN TANDY PRINTERS THE MSB IS THE LOWERMOST PIN OF THE
250 HEAD AND THE LSB IS THE UPPERMOST PIN. THE PINS ON EPSON
260 PRINTER HEADS ARE ARRANGED IN THE OPPOSITE SENSE. THIS
270 REQUIRES THAT THE BITS IN EACH BYTE BE REVERSED.
280 .....
290
300 DIM MK%(7) : ***VECTOR OF BIT MASK VALUES - POWERS OF 2
310 DIM BT%(7) : ***VECTOR OF DECODED BITS FROM ROM VALUE.
320
330 ***FILL MASK VECTOR WITH POWERS OF 2 FOR DECODING.
340 FOR I%=0 TO 7 : MK%(I%)=2^I% :NEXT I%
350
400 ***INITIALIZE PARAMETERS - MAY BE CHANGED TO VARY SCREEN.
410 CC%=4 : ***CHARACTER COLOUR. (1-4)
420 BC%=2 : ***BACKGROUND COLOUR. (1-4)
430 CS%=0 : ***COLOUR SET. (0-1)
440 CW%=3 : ***COLUMN WIDTH BETWEEN CHARACTERS.
450 SP%=16 : ***ROW SPACING FOR CHARACTERS.
460 HS%=0 : ***STARTING HORIZONTAL POSITION ON HI-RES SCREEN.
470 VP%=3 : ***STARTING VERTICAL POSITION ON HI-RES SCREEN.
480 HM%=127 : ***MAXIMUM HORIZONTAL POSITION. (0-127)
490
600 ***SET UP MAIN LOOP TO STEP THROUGH ROM FROM 3B94H-3CD3.
610 BK%=0 : ***BYTE COUNTER FOR EACH CHARACTER.
620 HP%=HS% : ***SET HORIZONTAL POSITION TO START
630 MODE(1) : COLOR,CS% : ***SET HI-RES SCREEN AND COLOR SET.
640 SM%=15252 : ***START OF SHAPE TABLE
650 EM%=15571 : ***END OF SHAPE TABLE
660 FOR AD%=SM% TO EM% : ***ADDRESSES FOR SHAPE TABLE.
670 DV%=PEEK(AD%) : ***DECIMAL VALUE READ FROM TABLE
680
700 ***DECODE THE INDIVIDUAL BITS OF DV% AND STORE IN BT%().
710 ***THE MASK VALUES IN MK%() ARE "AND" WITH THE VALUE.
720 ***THE RESULT STORED IN BT%() IS THE "COLOUR" OF THE BIT.
730 FOR I%= 0 TO 7 : ***PROCEED FROM LSB TO MSB.
740 IF DV% AND MK%(I%) THEN BT%(I%)=BC% ELSE BT%(I%)=CC%
750 NEXT I%
800
810 ***CHECK THAT THERE IS ENOUGH ROOM TO PLOT CHARACTER.
820 IF BK%=0 AND HM%-HP%<4 THEN HP%=HS% : VP%=VP%+SP% : ***NEW ROW
830 BK%=BK%+1 : ***INCREMENT BYTE COUNTER.
840
900 ***OUTPUT BYTE TO SCREEN.
910 FOR I%=0 TO 7
920 COLOR BT%(I%) : ***SET COLOUR OF BIT.
930 SET(HP%,VP%+I%) : ***PLOT BIT.
940 NEXT I%
950
1000 ***PREPARE FOR NEXT BYTE.
1010 HP%=HP%+1 : ***INCREMENT HORIZONTAL POSITION.
1020 IF BK%=5 THEN BK%=0 : HP%=HP%+CW% : ***NEW CHARACTER.
1030 NEXT AD%
2000 GOTO 2000 :END

```

LISTING 1A

```

100 THIS SHORT LISTING CAN BE USED BY OWNERS OF THE PRINTER
110 PATCH TO CALCULATE THE START AND END LOCATIONS OF THE
120 REVISED INVERSE CHARACTER SHAPE TABLE IN THE COMPLETED
130 VERSION. BY SUBSTITUTING THE NEW VALUES FOR THOSE WHICH
140 APPEAR IN LINES 640 AND 650 OF LISTING 1, THE MODIFIED
150 CHARACTERS CAN BE DISPLAYED ON THE HIRES SCREEN.
160 .....
170
180 ***CALCULATE THE TOP OF MEMORY
190 TM=PEEK(30897)+256*PEEK(30898)
200 IF TM>32767 THEN TM=TM-65536
210
220 ***ADD OFFSET TO TOP OF MEMORY TO LOCATE START OF TABLE
230 SM%=TM+666 : ***START OF SHAPE TABLE.
240
250 ***ADD 64 CHARACTERS x 5 BYTES TO LOCATE END OF TABLE
260 EM%=SM%+64*5-1 : ***END OF SHAPE TABLE
270
280 ***PRINT START AND END ADDRESSES
290 PRINT"START - SM%=";SM%
300 PRINT"END - EM%=";EM%

```

overcome, by means of a minor change in syntax, when entering the programme line. Using the line,

```
100 IF X=4 THEN CLS4
```

should clear the screen to red, when X=4.

What actually happens is that the screen clears normally, followed by a SYNTAX ERROR message, indicating the routine at 1D78H has not recognised our enhanced command. ▶

Using the Microbee in your amateur station

G.J. Wilson.

2) Printing QSL cards

QSL CARDS are an essential part of the hobby for any active radio amateur as they are usually the only acceptable evidence which can confirm that a given two-way QSO has taken place.

Many overseas operators are now producing their QSLs on printers and the JAs in particular seem to have some very suitable stationery on which to do it. With the ever increasing costs of printing, home printed QSLs offer a real cost saving alternative, even more so if you do a lot of contesting and QSL each new station worked.

The programme described here will print the QSO data side of a QSL card. Whether your printer will handle the thickness of card acceptable for use through a QSL bureau is something you will have to check for yourself. Apart from testing this programme, please don't produce QSLs on standard printer paper. They won't be accepted by the bureau and because they are so frail would arrive mutilated even if they were accepted. There are numerous sorting processes along the route from the source station to the final recipient and therefore they have to be reasonably robust and easily handled.

The program here is intended for use as a guide to writing your own. This one demonstrates the fundamentals involved and if you study the way the program has been put together it should not be too difficult to include your own ideas to meet any particular needs. No two operators have exactly the same equipment or operating habits and most programmes of this type have to be modified to suit individual situations.

This programme has been condensed from a very much larger version, but even in its present form is quite usable. The number of modes has been limited to CW, FM and SSB for simplicity of operation only — if you need others, they can be added.

The details of your station equipment, antennas, power etc are written into the program and depending upon the band and the mode used, the correct listing of gear will be printed automatically. The input data is printed to the VDU screen as it is typed and can be reviewed, in its entirety, before printing is initiated. If a mistake has been made the entry is simply erased and rewritten.

The screen display also keeps the operator informed of what is happening at the printer by showing: Page number, number of QSLs on the current page, total QSLs printed plus the callsign on the last QSL printed. This saves you from having to constantly keep referring to the printout, particularly if you are interrupted while printing.

The format is such that three QSLs are produced on a sheet 8.25" x 11". Each QSL is surrounded by a line which determines its total size and can be used as a guide for trimming.

The demonstration programme is based upon a hypothetical station having the following equipment:

Confirming 2x QSO with Amateur Radio: JH7ZYI Date Worked... 10.07.1987 Hours U.T.C... 0455 Frequency MHz: 21.236 2x Mode..... SSB Report RS..... 589	JH7ZYI
RIG: IC-760, FL-2100B 400W ANT: 1H6-DXX @ 20 M.	To: Amateur Radio JH7ZYI
TNX FB QSO * PSE QSL * 73 [X] ---	
William Sykes, VK0AAA 3 Penguin Street, Hometown, 3000, Victoria, AUSTRALIA	
VK0AAA Print	
Confirming 2x QSO with Amateur Radio: GM6IRJ Date Worked... 20.03.1987 Hours U.T.C... 0729 Frequency MHz: 7.021 2x Mode..... CW Report RST.... 589	GM6IRJ
RIG: IC-760, FL-2100B 400W ANT: Dipole @ 15 M.	To: Amateur Radio GM6IRJ
TNX FB QSO * TNX QSL * 73 [X] ---	
William Sykes, VK0AAA 3 Penguin Street, Hometown, 3000, Victoria, AUSTRALIA	
VK0AAA Print	
Confirming 2x QSO with Amateur Radio: VK7EWD Date Worked... 25.03.1987 Hours U.T.C... 0951 Frequency MHz: 144.117 2x Mode..... SSB Report RS..... 5x5	VK7EWD
RIG: IC-275H 100W ANT: 2x 9 el. yagi @ 16 M.	To: Amateur Radio VK7EWD
TNX FB QSO * PSE QSL * 73 [X] ---	
William Sykes, VK0AAA 3 Penguin Street, Hometown, 3000, Victoria, AUSTRALIA	
VK0AAA Print	

Dipole antennas for 1.8-10 MHz; TH6-DXX for 14-29 MHz; a common transceiver and linear for all HF operation. Stacked 6 el. yagis for 50 MHz with a transceiver and linear. Stacked 9 el. yagis for 144 MHz with a transceiver. A separate ground-plane antenna and transceiver for 146 MHz FM.



```

00010 GOSUB 60: PRINT CHR$(27);"@": PRINT CHR$(27);"G": GOSUB 70: A0:=KEY: A1:=
KEY: A2:=KEY: A3:=KEY: A4:=: A5:=KEY: A6:=KEY: A7:=KEY
00020 B4:=KEY: B5:=0: B6:=1: B7:=1: C0:=1: C1:=0: C2:=KEY: GOTO 120
00030 REM PROGRAM DESIGNED TO BE USED WITH 16 / 32 MICROBEE AND EPSON RX-80 PR
INTER. OTHER EQUIPMENT MAY REQUIRE PROGRAM MODIFICATIONS. COPYRIGHT G.J. Wilson 1
987.
00040 REM TO OPERATE WITH PRINTER DELETE "CLS: RETURN: REM " FROM START OF LINE
60
00050 PLAY 24: 0: 24: RETURN
00060 CLS: RETURN: REM OUT#0 OFF: CLS: OUT#1 ON: RETURN
00070 OUT#1 OFF: CLS: OUT#0 ON: RETURN
00080 PRINT TAB (13) " ": CLS: RETURN
: RETURN
00090 PRINT TAB (41) " !To: Amateur Radio " A1# TAB (69) " !": RETURN
00100 PRINT TAB (41) " ": RETURN
00110 PRINT TAB (41) " " TAB (69) " " : RETURN
00120 CLS: CURS 1,8: INPUT "IS THIS THE FIRST OSL TO BE PRINTED ON THE PAGE ? (Y
/N) ", A0$: IF A0$="Y" OR A0$="n" THEN 160
00130 IF A0$="N" OR A0$="n" THEN 140 ELSE GOSUB 50: GOTO 120
00140 CLS: CURS 1,8: INPUT "HOW MANY OSLs HAVE BEEN PRINTED ON THE CURRENT PAGE
?", B5: C0=C0+B5
00150 IF B5>3 THEN CLS: GOSUB 50: CURS 1,8: PRINT "START A NEW PAGE.": PLAY 0,1
2: CLS: GOSUB 50: GOTO 10
00160 CLS: CURS 1,1: UNDERLINE: PRINT "AMATEUR OSL PRINTING PROGRAM: COP
YRIGHT G.J. Wilson 1987.": NORMAL
00170 CURS 1,3: PRINT "Page No.": B7: CURS 2,5: PRINT "OSL No.": B6: CURS 2,7: PRI
NT "OSL No.": C0: CURS 2,8: PRINT "This page."
00180 IF C1=0 OR B4$="" THEN 190 ELSE CURS 15,13: UNDERLINE: PRINT "LAST OSL PRI
NTED": NORMAL: CURS 29,13: PRINT "": B4$
00190 CURS 16,3: INPUT "CALLSIGN ?": A1$: CURS 28,3: PRINT " "
00200 IF A1$="" THEN CURS 30,3: PRINT [A9 32]: GOSUB 50: GOTO 190 ELSE CURS 31,3
: PRINT A1$: CURS 1,13: PRINT [A6 32]
00210 CURS 16,4: INPUT "DATE OF OSL ?": A2$: CURS 28,4: PRINT " "
00220 IF A2$="" THEN CURS 30,4: PRINT [A9 32]: GOSUB 50: GOTO 210 ELSE CURS 31,4
: PRINT A2$
00230 CURS 16,5: INPUT "TIME U.T.C. ?": A3$: CURS 28,5: PRINT " "
00240 IF A3$="" THEN CURS 30,5: PRINT [A9 32]: GOSUB 50: GOTO 230 ELSE CURS 31,5
: PRINT A3$
00250 CURS 16,6: INPUT "FREQ. MHz. ?": A4: CURS 28,6: PRINT " "
00260 CURS 16,7: INPUT "2x MODE ?": A5: CURS 28,7: PRINT " "
00270 IF A5$="" THEN CURS 30,7: PRINT [A9 32]: GOSUB 50: GOTO 260 ELSE CURS 31,7
: PRINT A5$
00280 IF A5$="C" OR A5$="CW" OR A5$="c" OR A5$="cw" THEN LET A5$="CW": GOTO 310
00290 IF A5$="F" OR A5$="FM" OR A5$="f" OR A5$="fm" THEN LET A5$="FM": GOTO 310
00300 IF A5$="S" OR A5$="SSB" OR A5$="s" OR A5$="ssb" THEN LET A5$="SSB"
00310 CURS 31,7: PRINT [A9 32]: IF A5$="CW" OR A5$="FM" OR A5$="SSB" THEN CURS 3
1,7: PRINT A5$: GOTO 320 ELSE GOSUB 50: GOTO 260
00320 CURS 16,8: INPUT "REPORT SENT ?": A6$: CURS 28,8: PRINT " "
00330 IF A6$="CW" THEN 340 ELSE 350

```

```

00340 IF A6$="9" THEN LET A6$="599": GOTO 360 ELSE 360
00350 IF A6$="9" THEN LET A6$="5x9"
00360 IF A6$="" THEN CURS 30,8: PRINT [A9 32]: GOSUB 50: GOTO 320 ELSE CURS 31,8
: PRINT A6$
00370 CURS 16,9: INPUT "PSE/TNX OSL ?": A7$: CURS 28,9: PRINT " "
00380 IF A7$="PSE" OR A7$="P" OR A7$="pse" OR A7$="p" THEN LET A7$="PSE": GOTO 4
00
00390 IF A7$="TNX" OR A7$="T" OR A7$="tnx" OR A7$="t" THEN LET A7$="TNX"
00400 IF A7$="PSE" OR A7$="TNX" THEN CURS 31,9: PRINT A7$: GOTO 410 ELSE CURS 30
,9: PRINT [A9 32]: GOSUB 50: GOTO 370
00410 CURS 1,11: UNDERLINE: PRINT [A6 32]: NORMAL: CURS 49,8: PRINT "To ENTER p
ress": CURS 52,4: PRINT " [RETURN]"
00420 CURS 49,6: PRINT "To ERASE press": CURS 52,7: PRINT "[E] then": CURS 52,8:
PRINT "[RETURN]": CURS 54,10: INPUT " ", C0$: IF C0$="E" OR C0$="e" THEN 160 EL
SE GOSUB 60
00430 IF B5=0 THEN GOSUB 80
00440 PRINT TAB (13) " ! Confirming 2x OSL with " TAB (69) " !":
00450 PRINT CHR$(14): PRINT CHR$(8): CHR$(8): CHR$(8): CHR$(8): CHR$(8): CHR$(8)
: CHR$(8): CHR$(8): PRINT A1$: PRINT CHR$(29):
00460 PRINT TAB (14) " ! Amateur Radio: " A1# TAB (42) " " TAB (76) " " : PRINT TA
B (17) " ! Date worked... " A2#: GOSUB 110
00470 PRINT TAB (13) " ! Hours U.T.C... " A3#: GOSUB 110: PRINT TAB (13) " ! Freq
uency MHz. " A4: GOSUB 110
00480 PRINT TAB (13) " ! 2x Mode..... " A5: GOSUB 110: IF A5$="CW" THEN PRINT
TAB (13) " ! Report RST... " A6#: GOSUB 110: GOTO 500
00490 PRINT TAB (13) " ! Report RST... " A6#: GOSUB 110
00500 IF A4=50 THEN LET B1$="IC-750, FL-210MHz": B2$="400W": GOTO 510 ELSE 520
00510 IF A4=11 THEN LET B1$="Dipole @ 15 M.": B2$="500 ELSE LET B1$="The-10X @
20 M.": GOTO 560
00520 IF A4=54 THEN LET B1$="IC-575, HL-120MHz": B2$="400W": B3$="A 9 el. ant. @
22 M.": GOTO 560
00530 IF A4=148 THEN 540 ELSE 550
00540 IF A5$="FM" THEN LET B1$="FT-270RH": B2$="100W": B3$="GROUND PLANE @ 10 M.
": GOTO 560 ELSE LET B1$="IC-275H": B2$="100W": B3$="9 el. ant. @ 10 M.": GO
TO 560
00550 REM 420 MHz. & ABOVE DATA GOES HERE.
00560 PRINT TAB (13) " !: GOSUB 110: PRINT TAB (13) " !: GOSUB 110: GOSUB 110
0: PRINT TAB (13) " ! ANT: " B3#: GOSUB 110: PRINT TAB (13) " !: GOSUB 110
00570 PRINT TAB (13) " ! TNX FB OSL " TAB (28) A7# TAB (31) " OSL " 75 " TAB (
69) " !:
00580 PRINT TAB (13) " ! TAB (28) " [X] " : GOSUB 160: PRINT TAB (13) " !: GO
SUB 110: PRINT TAB (13) " ! William Byrnes, VK3AAR: GOSUB 100
00590 PRINT TAB (13) " ! 3 Penguin Street, " GOSUB 110: PRINT TAB (13) " ! Mo
nterona, 5000.": GOSUB 100: PRINT TAB (13) " ! Victoria, " GOSUB 110
00600 PRINT TAB (13) " ! AUSTRALIA": GOSUB 100: PRINT TAB (13) " !: PRINT DHR
# (15): PRINT TAB (56) " VIOAAA Print": PRINT CHR$(18): TAB (92) " !: GOSUB 60: G
OSUB 70
00610 B4$=A1$: B5=B5+1: B6=B6+1: C0=B5+1: C1=C0+1: IF B5=0 THEN GOSUB 60: PRINT
CHR$(12): GOSUB 70: B5=0: B7=B7+1: C0=1: GOTO 160 ELSE 160

```

PROGRAM LISTING

This selection enables a fairly comprehensive range of operating to be covered but can of course be expanded if required. For example, you may have a different transceiver for 1.8 MHz, a beam for 18 MHz, 70 cm gear etc.

As the program runs it selectively picks the type of equipment in use by sorting, using the mode and frequency is greater than 54 MHz, but less than 148 MHz, the equipment will be listed as an IC-275H transceiver feeding 2 x 9 el. antennas. If the mode is FM within the same frequency range it selects the FT-270RH and groundplane. The way this is done is entirely in the hands of the person writing the program,

vary the idea as suits your situation best.

Copy the program (including all spacing) exactly as it is listed and it will run 100% OK. When you are familiar with the workings of it you can then add your own variations as required. If other spacings are used the QSL won't appear in a normal format. Watch particularly the TAB spacing when using condensed print etc as the spacing will be quite different to that used for normal, or pica, size.

The program can be run either with or without a printer. See details in line 60.

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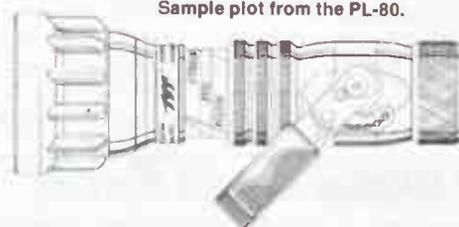
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Step size	: 0.2mm
Pen types	: Ballpoint type (water soluble) OHP type (oil soluble)
No. of pens	: 4 (black, red, green, blue)
Panel Control	: Up, Down, Left, Right, Pen Select, On line
Indicators	: Power, On Line
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Power supply	: DC 10V/1.3A adaptor
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LISTING 2

```

0001 ;*****
0002 ;# ENHANCED CLS COMMAND #
0003 ;# BY LARRY TAYLOR 1986 #
0004 ;*****
0005 ;
0006 ;THIS SECTION RELOCATES
0007 ;THE PROGRAM TO THE TOP
0008 ;OF AVAILABLE MEMORY.
0009 ;
0010 VCTR EQU 7A2BH ;SET VCTR AS 7A2BH
0011 LD SP,7700H ;LOAD STACK POINTER
0012 LD HL,(7BB1H) ;GET THE TOP OF MEMORY
0013 LD BC,ENDP-NVCT ;GET LENGTH OF PROGRAM
0014 PUSH BC ;SAVE PROGRAM LENGTH
0015 XOR A ;RESET ALL FLAGS
0016 SBC HL,BC ;TAKE LENGTH FROM TOP OF MEMORY
0017 LD (7BB1H),HL ;LOAD NEW TOP OF MEMORY
0018 PUSH HL ;SAVE NEW TOP OF MEMORY
0019 XOR A ;RESET ALL FLAGS
0020 LD BC,33H ;RESERVE 50 BYTES STRING SPACE
0021 SBC HL,BC ;TAKE SPACE FROM TOP OF MEMORY
0022 LD (7BA0H),HL ;LOAD START OF STRING SPACE
0023 POP DE ;RETRIEVE TOP OF MEMORY
0024 INC DE ;INCREASE BY ONE
0025 LD HL,(7B04H) ;GET CURRENT RST10H VECTOR
0026 LD (VCTR),HL ;STORE IT IN 7A2BH
0027 LD (7B04H),DE ;LOAD NEW VECTOR
0028 LD HL,NVCT ;GET START OF PROGRAM TO MOVE
0029 POP BC ;RETRIEVE PROGRAM LENGTH
0030 LDIR ;MOVE TO NEW LOCATION
0031 CALL 1B4DH ;DD A NEW
0032 JP 1A19H ;JUMP TO READY MESSAGE

0033 ;
0034 ;START OF THE PROCESSING
0035 ;ROUTINE FOR NEW COMMAND.
0036 ;
0037 NVCT EXX ;SAVE ALL REGISTERS
0038 LD HL,1D5BH ;CHECK TO
0039 POP DE ;SEE IF THE
0040 OR A ;RETURN
0041 SBC HL,DE ;ADDRESS
0042 PUSH DE ;IS 1D5BH
0043 EXX ;RESTORE ALL REGISTERS
0044 JP NZ,1D7BH ;IF NOT GO TO NORMAL PROCESSING
0045 PUSH HL ;SAVE STRING ADDRESS
0046 CALL 1D7BH ;GET NEXT VALUE FROM STRING
0047 JR NZ,CDNT ;IF NOT ZERO THEN CONTINUE
0048 POP POP HL ;ELSE RESTORE STRING ADDRESS
0049 LD DE,(VCTR) ;RETRIEVE ORIGINAL VECTOR
0050 PUSH DE ;AND JUMP
0051 RET ;TO IT
0052 CONT CP B4H ;CHECK FOR CLS TOKEN
0053 JR NZ,POP ;IF NOT FOUND RETURN TO CALLER
0054 INC HL ;MOVE TO NEXT VALUE IN STRING
0055 LD A,(HL) ;GET NEXT VALUE AFTER CLS TOKEN
0056 SUB 30H ;REDUCE IT TO RANGE 0-B
0057 JR Z,EXEC ;IF ZERO THEN EXECUTE COMMAND
0058 LD B,B ;LOAD B REG WITH UPPER LIMIT
0059 CMPR CP B ;CHECK IF A=B
0060 JR Z,EXEC ;IF YES THEN EXECUTE COMMAND
0061 DJNZ CMR ;REDUCE B AND CONTINUE CHECK
0062 JR POP ;NO MATCH SO RETURN TO CALLER
0063 EXEC POP DE ;RETRIEVE OLD STRING ADDRESS
0064 POP DE ;RETRIEVE OLD RETURN ADDRESS
0065 LD DE,1D1EH ;LOAD NEW RETURN ADDRESS
0066 PUSH DE ;SAVE NEW RETURN ADDRESS
0067 INC HL ;MOVE TO NEXT VALUE IN STRING
0068 PUSH HL ;SAVE CURRENT STRING ADDRESS
0069 ADD A,A ;MULTIPLY CLS
0070 ADD A,A ;VALUE BY 16 TO
0071 ADD A,A ;CALCULATE THE
0072 ADD A,A ;COLOUR OFFSET
0073 JR NZ,SKIP ;IF RESULT NOT ZERO THEN SKIP
0074 INC A ;IF ZERO INCREASE TO ONE
0075 SKIP ADD A,7FH ;ADD 127 TO GET GRAPHICS BLOCK
0076 ;
0077 ;CLEAR SCREEN ROUTINE
0078 ;
0079 LD HL,7000H ;LOAD START OF SCREEN ADDRESS
0080 LD (7820H),HL ;SET CURSOR POSITION
0081 LD DE,7001H ;LOAD START OF SCREEN PLUS ONE
0082 LD BC,01FFH ;NUMBER OF BYTES TO MOVE
0083 LD (HL),A ;LOAD GRAPHICS BLOCK INTO HL
0084 LDIR ;DD A BLOCK FILL OF THE SCREEN
0085 POP HL ;RETRIEVE STRING ADDRESS
0086 RET ;RETURN TO 1D1EH TO CONTINUE
0087 ENDP DEFB 0 ;END OF PROGRAM MARKER

```

LISTING 3

```

100 REM *****
110 REM # ENHANCED CLS COMMAND BY LARRY TAYLOR 1986 #
120 REM *****
130 REM # CALCULATE THE NEW TOP OF MEMORY POINTER
140 REM *****
150 NB=79;TM=(PEEK(30B97)+PEEK(30B9B)+256)-NB
160 HB=INT(TM/256);LB=TM-HB+256
170 POKE30B97,LB;POKE30B9B,HB
180 REM *****
190 REM # RESET THE BASIC STACK POINTER
200 REM *****
210 CLEAR50
220 REM *****
230 REM # LOCATION OF SET UP PROGRAM
240 REM *****
250 EB=31274
260 EH=INT((EB+1)/256);EL=EB+1-EH+256
270 REM *****
280 REM # LOAD USER EXECUTION PROGRAM POINTER
290 REM *****
300 POKE30B62,EL;POKE30B63,EH
310 REM *****
320 REM # LOAD 23 BYTE SET UP PROGRAM
330 REM *****
340 FOR T=1TO23
350 READD
360 POKEEB+T,D
370 CS=CS+D
380 NEXT
390 REM *****
400 REM # GET NEW TOP OF MEMORY AND MOVE TO NEXT LOCATION
410 REM *****
420 TM=PEEK(30B97)+PEEK(30B9B)+256
430 IF TM>32767 THEN TM=TM-65536
440 REM *****
450 REM # LOAD 79 BYTE ENHANCED CLS ROUTINE
460 REM *****
470 FOR T=1TO79
480 READD
490 POKETM+T,D
500 CS=CS+D
510 NEXT
520 REM *****
530 REM # IF DATA CHECKSUM VERIFIES EXECUTE SET UP PROGRAM
540 REM *****
550 IF CS<>10968 THEN PRINT " ERROR IN DATA ENTRY -":END
560 X=USR(0)
570 REM *****
580 REM # SET UP EXECUTION ROUTINE DATA IN DECIMAL FORM
590 REM *****
600 DATA 243,49,0,119,42,4,120,34,40,122,42,177,120,35,34,4,120
610 DATA 205,77,27,195,25,26
620 REM *****
630 REM # ENHANCED CLS ROUTINE DATA IN DECIMAL FORM
640 REM *****
650 DATA 217,33,91,29,209,183,237,82,213,217,194,120,29,229,205
660 DATA 120,29,32,7,225,237,91,40,122,213,201,254,132,32,245
670 DATA 35,126,214,48,40,9,6,8,184,40,4,16,251,24,230,209,209
680 DATA 17,30,29,213,35,229,135,135,135,135,32,1,60,198,127,33
690 DATA 0,112,34,32,120,17,1,112,1,255,1,119,237,176,225,201

```

To have the command function properly, insert a colon between the THEN and the new command as below,

100 IF X = 4 THEN:CLS4

Now, when X = 4 the THEN part of the statement will be executed, including, as is usual, any additional commands in the remainder of the line. However, once the colon is reached, the BASIC ROM returns to its usual processing, via the RST 10H routine, and the CLS4 command is then interpreted on its own and not as part of the IF-THEN statement. This is the same solution suggested in the VZ-DOS manual, when using disk commands, which are affected in exactly the same way.

This is essentially the approach I have used to produce a

VZ-EPSON Printer Patch, which enables all the normal printer functions for Epson or Epson-compatible printers. As well as providing the ability to LLIST and LPRINT all inverse and graphics characters, the COPY command is intercepted by the patch. As a result, its function has been enhanced to allow a proper dump of both the LO-RES and HI-RES screens. Corrections have been made to the flawed inverse character data, and when listing, the routine is capable of recognising all the hidden commands, which may have been entered using an Extended BASIC. The patch relocates to the top of available RAM and can be used with Steve Olney's EXTENDED BASIC, already resident in memory, enabling ready access to the functions of both. I hope that the techniques used here to produce what I have found to be an extremely useful utility will encourage others to attempt further such developments.

Perhaps additional enhancements to the VZ's BASIC could be explored. The Commodore 64 is served by a number of enhanced BASICs, why not the VZ? Programs which make use of such BASICs require that the language be loaded before they will function properly. However, this is little different to programs using disk commands needing the DOS to be interpreted correctly. Certainly, the opportunity exists to endow the humble VZ with a brand new bag of tricks.

For anyone interested, copies of the completed VZ-Epson Printer Patch, may be obtained on tape for \$15, from:

J.C.E. D'Alton
VSOFTWAREZ
39 Agnes St
Toowong
Qld 4066

General communications – 2

THIS MONTH'S COLUMN continues the discussion of communication protocols, starting with the well known Kermit protocol, developed at Columbia University in the USA in 1980, mainly to handle file transfer between microcomputers and mainframes, Kermit was subsequently placed in the public domain. The name is DEFINITELY derived from the Jim Henson character of the same name, as there is a "baby version" of the program (for connecting two DEC-20's) called "PIGGY". I will quote a small section from the extensive documentation (80-odd pages) – "Kermit transfers data by encapsulating it in 'packets' of control information. This information includes a synchronisation marker, a packet number to allow detection of lost packets, a length indicator, and a 'checksum' to allow verification of the data. Lost or corrupt packets are detected, and retransmission is requested. In addition, various special control packets allow co-operating Kermits to connect and disconnect from each other and to exchange various kinds of information. Very few assumptions are made about the capabilities of either computer, so the Kermit protocol can work between many different kinds of systems."⁽¹⁾

As can be seen from the above quotation, Kermit introduces another new concept in communications terminology. The concept of the variable length data block, or "packet" as it is known, allows transmissions to optimise the transfer of data. Unfortunately, Kermit only allows for checksum error correction, so it suffers from the same problems that all other protocols using this method do – compensating errors (see my last column for a more detailed explanation). Proposed enhancements to Kermit will allow for CRC checking as well as extensions to the checksum method of error correcting. Kermit also allows for the users to temporarily switch Kermit off, return to the operating system and play around, then return to the package, all without breaking off the transmission. Kermit can also send and receive control characters without having them interfere with either the local or remote operating systems. It does this by preceding them with a special "lead-in" character called a "quote" character. This enables the control characters to be displayed in incoming messages.

Kermit implementations are available for a large number of computers, ranging from micros to mainframes, with the IBM PC, Apple II, TRS-80, DEC Rainbow, PDP-11, VAX and IBM 370 series being just a few. Kermit can also run under TOPS (on the DEC-20) and Unix. Because of the large number of "user configurable" operating parameters, initial installation of Kermit can take a reasonable amount of time. However, once installed, there should be no need for any further modification. The file "KERMIT.ARC", containing a full implementation and extensive documentation can be found on bulletin boards almost anywhere.

Sliding window file transfer

A version of Kermit (called SuperKermit) is available that implements the "sliding window" method of file transfer. Sliding window is a means of transferring packets on a continuing basis, which permits blocks N+1, N+2, N+3 etc to be transmitted BEFORE THE 'ACKS' or 'NAKS' of blocks N, N-1, N-2 etc. have been received. This feature may not seem particularly important, however, with satellite transmissions costing large amounts of money, anything that reduces transmission time also reduces the cost.

One of the protocols that implements sliding window transfer is SEALINK, developed in 1986 by System Enhancement Associates in the USA I will also quote a paragraph from the introductory documentation of this package. "... SEALINK is capable of virtually eliminating propagation delays and turnaround delays. File transfers between New Jersey and Hawaii, which normally suffer a degradation of 50% of more due to satellite relays, proceed as fast as local transfers. Even transfers within the local exchange are speeded up by up to 20% at 2400 bps by the elimination of turnaround delays. Large volume tests show that SEALINK is capable of coming within 2% of the theoretical minimum time for data transfer."⁽¹⁾ WOW! How does this brilliant technique actually work? The concept is fairly easily explained with the aid of the diagram below⁽²⁾:-

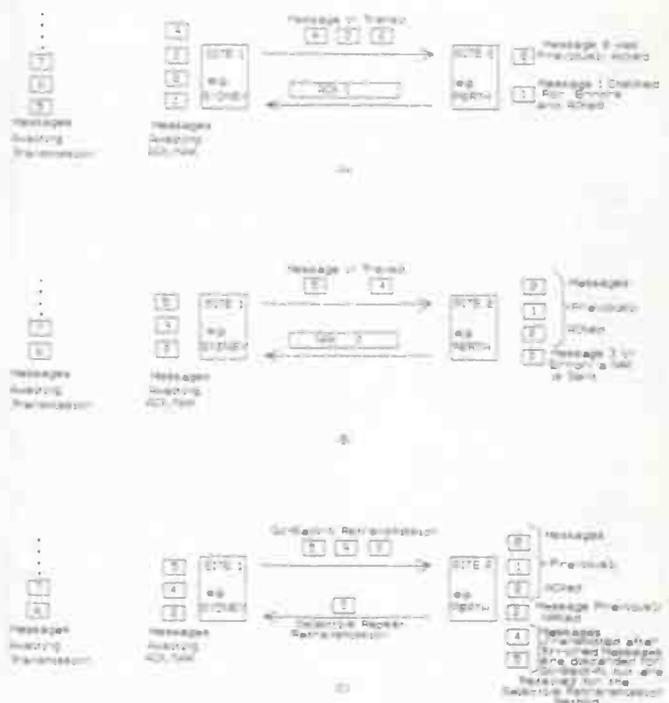


Figure 1.(2)

The "Sliding Window" effect is illustrated in diagram (A). The three packets in transit (numbers 2, 3 and 4 in the diagram) form the "window", the size of which is usually predetermined by the comms package in use. When packet 3 arrives at its destination, it will be checked and 'ACK' returned to Site 1. As packet 3 is removed from the transfer path, so packet number 5 will be added to the path. This is where the term "sliding" comes in – the packets slide to the right as the transfer progresses.

Part (B) of the diagram illustrates the procedure followed when an error occurs. In this case, packet number 3 has been flagged as being "in error", for whatever reason (CRC doesn't match or hasn't arrived etc).

In part (C) of the diagram, two different sliding window techniques are illustrated – "Selective Re-transmission" and "Go-Back-N" Re-transmission." The Selective Retransmission method of error correction is by far the most efficient of the two (this method is used by Superkermit), however it is far

more complex to program into a comms package, and a fairly large buffer is also required – you won't get much change out of 512K. In this case, the block in error is "re-requested" by the remote site (lower part of the diagram) and it is re-transmitted by the original site. When it is received and checked, it is inserted into the correct position in the buffer. The Go-Back-N method is easier to program and doesn't require such a large buffer capacity, but its efficiency is considerably less than that of Selective Retransmission. On a particularly noisy transmission path, Go-Back-N can be just as slow as XMODEM.

ZMODEM protocol

The ZMODEM protocol is the latest issue of the "supersets" of MODEM/XMODEM. There has been extensive design work go into the package to ensure that a high throughput is maintained, particularly with satellite links. Some details extracted from the extensive ZMODEM documentation (3) will illustrate the point – "Between two single task PC/XT computers sending a program image on an in house Telnet link, SuperKermit provided 72 c/sec throughput at 1200 baud. YMODEM-k yielded 85 chars/sec, and ZMODEM provided 113 chars/sec. XMODEM was not measured but would have been much slower based on observed network propagation delays.

Recent tests downloading program images to an IBM PC (4.77 MHz V20) running YAMK 15.68 with table driven CRC calculation yielded a throughput of about 17 Kb on a 19.2 Kb direct connection."

Fairly impressive throughputs.

A tabular comparison of ZMODEM operation over a packet switched network (PSN) showed ZMODEM to only be slightly behind YMODEM-g, about 20% in front of SuperKermit and about 400% in front of XMODEM. The documentation for this package (See reference 2) runs to about 40 pages, with extensive comparisons of throughputs under varying conditions.

For those people thinking of investigating satellite transfers, the message is fairly clear. You must use a Sliding Window file transfer protocol, preferably with the capacity for Selective Retransmission, in order to minimise on-line costs. Unless, of course, you happen to work for OTC!

This ends the introduction to file transfer protocols. If any readers have specific questions they would like answered, please drop me a line C/- Dial Up at AEM.

I have been asked by the Editor to carry out a review on the CrossTalk clone "Mirror". I replied (tongue-in-cheek) that "I'll look into it and reflect on its possibilities." The review should appear in next month's issue of the magazine.

Letters

One of the letters in this month's batch is covered in the details on the Novix NC4000 chip. the other is from a Mr Z. in W.A., who wishes us not to publish his name. One of his com-

ments concerned 'non-standard' Telecom plug compatibility and 'non-standard' wiring of the plug. All we can say is that the whole of the wiring conforms 100% to Telecom specifications. If persons are annoyed by the "tinkling" of the bells when they dial out, they should ask Telecom to come and re-wire the phone and socket to accommodate a Type 3 connection mode.

Some more of Mr Z's comments have been covered in previous errata issues of Dial Up and Maestro apologise for not including a copy of these in their modem kits. However, ALL errata of which they and I am aware, have been published over the last eight issues of this column. Mr Z also commented on the power pack phono plug, and the lack of LEDs and switches on the front panel. We agree wholeheartedly with Mr Z that there were some deficiencies in the the SuperModem. However, it was a first attempt at such an ambitious project, and it was designed as a LOW COST expandable modem, but we will consider ALL suggestions made for improvements, if it is considered economical to produce an updated model. It is still the cheapest modem available in its class.

Mr Z asked about the 'link' on the SuperModem board when the V.22 option is installed. Should it come from Pin 34 of IC10, or should it come from Pin 25 of IC9? In fact, it doesn't matter which of the points are used to derive the signal for the expansion connector. The 7805 regulator is also designed to be bolted through a heat sink to the V.22 board. This may mean that the bolt covers one or two 'feed-through' pads, but as these pads only feed through to the ground plane (to which the case of the 7805 is connected), once again it doesn't matter. Mr Z also uses a SuperModem with his Apple, and wonders why the software is not compatible with DOS 3.3 or PRODOS. This is because the software was written in Forth, mainly to speed development of the package and thereby keep its cost to a minimum. The copy protection is placed on the package for the reason that any software is protected. A well known Sydney pirate was one of the first to complain about the copy protection.

We thank Mr Z for pointing out that the bit patterns for the V.22 expansion board are incorrect. A revised list is shown below:

Pin Number	Signal	Binary Value	Equivalent Voltage
2	PA0	1	+5
3	PA1	1	+5
10	PB0	0	0
11	PB1	0	0
12	PB2	1	+5
13	PB3	0	0
14	PB4	0	0
15	PB5	0	0
16	PB6	0	0
17	PB7	0	0

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Novix 4000 chip

Chris Darling has taken the bit between his teeth and is off to invest in a dozen Novix chips and a similar number of 80386 chips. I am trying hard to interest him in the Immos Transputer chips as well. He is going to compare them all for complex processing tasks and then decide which is the most economically feasible for a single chip computer board. This will be a rather lengthy evaluation, so Chris has decided to bite the bullet and proceed with the Novix 4000 project. He has passed some of the specifications over to me and the possibilities are really staggering.

At the same time as we were investigating the specs, we received a letter from a Mr L. McKeon of Nundah in Queensland, asking for a general article on the processor chip, whilst we are waiting for the actual project. I will present some of the details in Dial Up over the next few months, starting with this issue.

The whole concept of the chip relies on throwing out the conventional ideas on chip architecture and micro-coding Forth onto the chip, instead of normal micro-code. The reason for doing this is not apparent until we do some comparisons of conventional assembly languages written for micro-coded processors, versus the Novix 4000. In most assembly language programs, particularly those written for operating systems, compactness of programming is usually the main criterion. This is due to the fact that assembly language programmers (Chris and I have both done our time in this computer purgatory) tend to write general purpose subroutines and re-use these over and over again. For example, I/O calls are much easier to use as subroutines. Now, depending on the processor being used, subroutine calls may take anything from four to 10 clock cycles to jump to the subroutine and a similar number to return (the 8086 for example, requires 15 clock cycles to pass control to a subroutine and another 15 to return from it).

The Novix 4000 was designed to optimise subroutine calls (Forth spends 90% of its time entering and leaving subroutine-type calls) and the chip can enter a subroutine in one clock cycle and return in zero clock cycles. The chip also runs at higher clock speeds than all 8-bit micros and can run as fast the 80286. One should, however, remember that chips like the 80286 require many more clock cycles to execute a micro-coded instruction (called a Machine Cycle) than does the NC4000. The old RCA 1802 microprocessor takes 16 clock cycles for every Machine cycle, compared to a one/one ratio for the NC4000.

The Novix chip is externally "micro-coded" by the programmer using the chip, simply by writing Forth instructions (words). The normal Forth DO...LOOP construct performs its range checks on the loop limit in one clock cycle as well and by using a careful selection of Forth words, one can almost emulate parallel processing. A special word called 'TIMES' allows any other operation to be repeated the number of times the value on top of the data stack specifies. The Novix 4000 also optimises communication buses, by having separate

buses for main memory, stack memory (usually VERY FAST static RAM) and return stack memory (ditto). A diagram of the overall architecture is shown below in Figure 2. It is the parallel bus structure of the chip that allows instructions to execute multiple operations simultaneously.

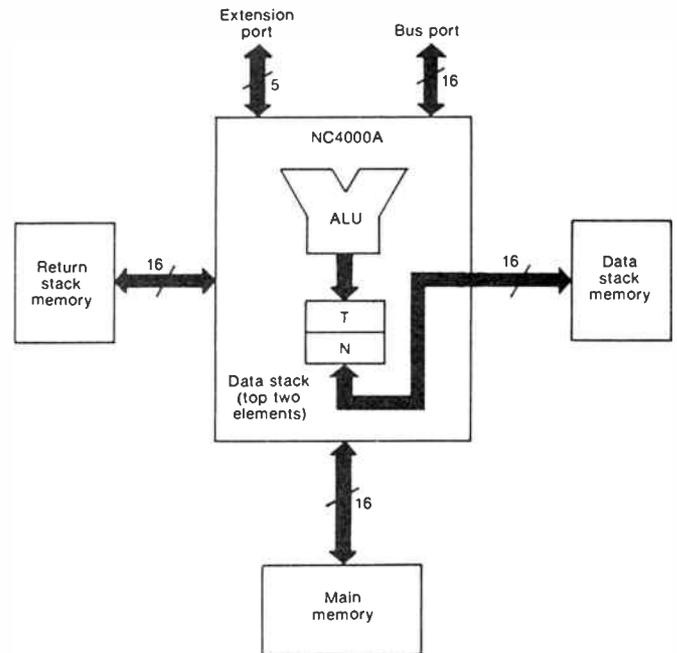


Figure 2. Bus Structure of the NC4000.⁽⁴⁾

By the time you read this a stand-alone V.22 modem will be available as a kit from Maestro, through this magazine. Roger is taking care of the write-up on this one. He has thrown enough work at me to keep fully occupied for some time. Keep those letters coming.....

REFERENCES:

1. SEALink information kindly provided by Software Tools of Australia (Bill Bolton) on his BBS. (02)449 2680.
2. Black, Uyless D. "Data Communications and Distributed Processing", Reston Publishing (Prentice-Hall), 1983, p192.
3. The complete ZMODEM package, including documentation, is available on the Central Coast BBS, operated by John Caine (known as "The Premier"). (043)69 3658. Thanks to John for providing the service and the information.
4. Electronic Design (reprint) "Forth Language Shapes the Structure of a 10-MOPS Chip," Hayden Publishing, March 21, 1985.

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"Novice 2m proposal" stirs heated debate among radio amateurs

A proposal that Novice amateur radio licencees be given operating privileges on the 144 MHz amateur band (two metres) has stirred up quite a heated debate since news of it surfaced since the WIA's annual Federal Convention.

The debate prompted Jim Linton VK3PC and Roger Harrison VK2ZTB (your editör), co-authors of the award-winning 1986 paper "Amateur Radio — Future Direction", to examine the issues and suggest specific action on restructuring in a "specifics document" issued last month, the text of which follows:

"The need for restructure of Australia's amateur licence system has been ignored by the 1987 WIA Federal convention proposal to give Novice licencees access to the entire two metre (144 - 148 MHz) band. The proposal generated at the convention and supported by Federal councillors from all divisions except VK1, arose out of two considerations.

"The first was the desirable "common band" for all grades of licence. The second, which was the major factor in intense lobbying at the convention, was the impact of the JA/VK reciprocal licencing agreement.

"That agreement, effective from February 1987, has serious consequences for the Novice licencee, and Australia's licence structure generally. Japan has a long-established telephony licence with an exam of a lower level than the Australian Novice and with no telegraphy test. The JA telephony licencees operate using low power on the HF bands with the exception of 10 MHz and 14 MHz.

"Under the JA/VK reciprocal agreement, that grade of licence has been given the status of a telephony licence using 10 watts FM on all bands 50 MHz and above.

"How the agreement was reached, the WIA's involvement and the full story concerning the exercise is unclear. What is plain is that the agreement now has a direct influence on the licence structure in Australia. The agreement has brought about a de-facto telephony licence in Australia, access to which is denied to Australians.

"In hindsight, a two year tenure should have been placed on the JA telephony licencees operating in Australia under the reciprocal agreement. It is es-

sential that this agreement be renegotiated to include a fixed tenure.

"To attract the "bottom rung"

beginner interested in radio, and to expose them to the broad scope of the hobby of amateur radio, a "Telephony" licence should be introduced in Australia. The theory syllabus for this licence should include the necessary elements of basic electricity, magnetism, radio frequency generation, modulation, propagation and interference.

"This grade of licence could have FM telephony privileges on 52.500 - 54 MHz and a seg-

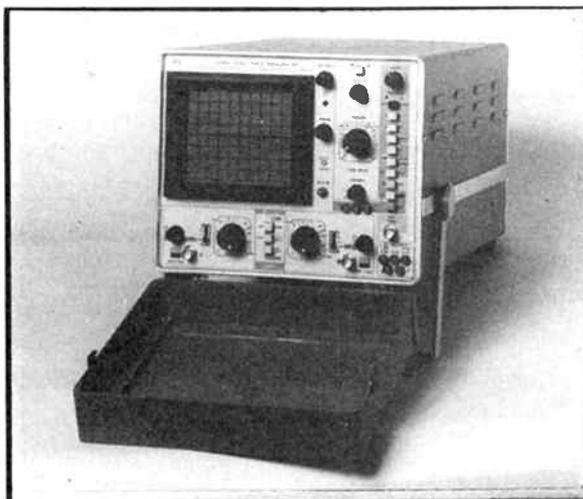
ment of 70 cm at a maximum power level of 10 watts. The Australian Telephony licence must have a tenure of two years.

"An integral part of restructuring the licence system is restoration of the Novice licence syllabus which no longer adheres to it's original intention or definition. The Novice licence should be given additional privileges identical to the Telephony licence on 6 metre and 70 cms, but with a maxi-

— to page 91.

OSCILLOSCOPES

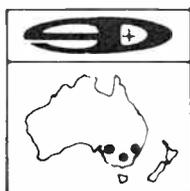
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A guide to digital radio communications

Part 1

Andy Keir VK2AAK

Radio communications all started with "digital" transmission – that is, transmitting information by means of a coded form of modulation. In the beginning, it was Morse code. In the 1920s, the "teletype" was born for transmitting printed text over wire circuits, later being adapted for radio using the Murray/Baudot transmission code. But it was the advent of the digital computer, and more specifically the personal computer in recent times, that brought off a marriage between computers and radio that is right now undergoing explosive growth and development.

Here's a perspective view of the subject, from Morse to modern times. If you were ever curious about getting into RTTY, AMTOR or packet radio, start right here!

WHEN YOU THINK of digital communications over radio, an image probably springs to mind of esoteric computer-controlled gadgetry that's as modern as tomorrow. If you look at the subject in the broadest sense however, you will find that digital communication techniques were established before the radio was even invented!

Whilst the main thrust of this article will be concerned with those modes which have become popular with the advent of the personal computer, we should put the subject in perspective by examining the historical development of digital communications commencing with the mode that started it all.

Morse code

The familiar telegraphic code developed by Samuel Morse in the nineteenth century was the only method which could be used to communicate when radio was in its infancy. Inventors had not yet learned how to modulate a radio wave in order to transmit voice signals. In fact, all that could be done was to turn the radio wave on or off. Morse code by virtue of its on-off nature was well suited to the application, proving a simple and reliable method of conveying intelligence.

In the early years, various methods were devised to use machines for automatically converting the dots and dashes into letters and words. For the most part these were cumbersome mechanical devices and were usually very slow in their

operation. Morse code is not particularly well suited to automatic decoding, being predominantly intended for reception by human senses. Even today, using computers to decode Morse is not always successful. It is fairly simple to get a computer to read Morse code in which the dots and dashes forming the characters are of consistent length and spacing, but most machines and programs will not cope reliably with a human operator using a manual key unless he has a good "fist".

The situation is somewhat different if the sending operator is using one of the new breed of electronic keyers. These devices are usually used in conjunction with a "paddle" rather than the familiar Morse key. The paddle may have two levers, one of which will produce dots and the other which produces dashes, or it may have a single lever which produces dots or dashes depending upon which direction it is moved. The switch contacts associated with the paddle levers only need to be closed momentarily as the electronics in the keyer will create character elements which are perfectly spaced and timed. Electronic decoding systems will usually have no difficulty with Morse generated by this method.

Whilst computer-based Morse code systems can be interesting, particularly to shortwave listeners not wanting to learn the code by ear, most purists would be aghast at the prospect and consider anything other than a good manual key and

The ultimate digital communicator?

In part 2 of this article we intend to discuss some of the hardware commonly used for digital communications but there is one unit which has recently become available in Australia, about which we could not contain ourselves.

The Pakratt PK-232 from Advanced Electronic Applications Inc. represents what must surely be the most versatile interface ever produced for the digital communications modes. Whilst there have been interfaces in the past which could be used for the individual modes, the PK-232 combines them all in a single unit. Not only will the Pakratt allow you to send and receive morse, but also Baudot and ASCII RTTY, FEC and ARQ Amtor and AX-25 packet. The unit includes a high quality modem for HF, VHF and CW as well as an eight pole bandpass filter and a discriminator type tuning indicator.

Connecting the PK-232 to your computer is accomplished by means of a standard RS-232 interface and all the functions are controlled by simple commands. No special software is required in the computer except for a dumb terminal program as all the operating software is supplied in on-board ROM. Changing modes is as simple as a few keystrokes and the unit even has two sets of connectors and a switch to allow changing transceivers from the front panel.

We will be describing the PK-232 in detail in part two of the digital communications article next month but if you would like to find out more in the mean time you could try contacting Emtronics who have units in stock. Emtronics are based at 92-94 Wentworth Ave, Sydney and have stores in both Melbourne and Brisbane.

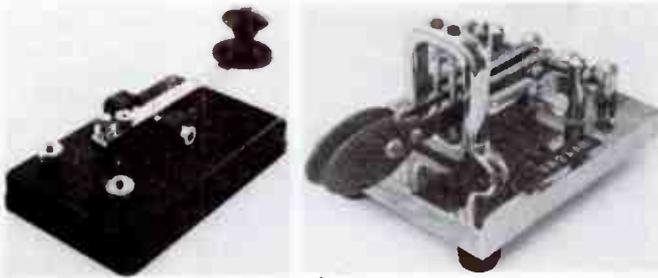
a trained ear as something akin to putting a Ford motor in an FJ Holden.

Radioteletype

In the latter years of the nineteenth century, a Canadian by the name of Frederick Creed developed the teleprinter out of a desire to overcome the limitations of the then current mechanical Morse encoding machines. His first machine was based on a converted typewriter and was designed to allow an operator to encode a character by simply pressing a typewriter key. A teleprinter is basically a typewriter with additional parts which change the mechanical motion of the typist's fingers into electrical pulses for transmission over radio or wire circuits. At the receiving end these pulses are again changed back into mechanical motion and the message is printed automatically on the special typewriter. Radioteletype (abbreviated RTTY) is the term to describe communication between teletype machines over a radio circuit.

In the 1920s a machine was produced in America by the Morkrum company which later became the Teletype Corporation. These days the term Teletype is used as a generic term to describe all such devices but in fact it is a registered

The standard Morse key will be familiar to many. Although these keys are available in a variety of sizes and permutations, most examples follow similar lines to this one.



The modern equivalent of the Morse key, this paddle would normally be used in conjunction with an electronic keyer. Generally manipulated with the thumb and forefinger, one lever produces dots and the other dashes. Well engineered examples such as this one are often the treasured possessions of Morse code devotees and can be a real pleasure to use.

trademark of that corporation. To be perfectly correct, these machines should be referred to as a "teleprinter". Many radio amateurs will be familiar with the cumbersome mechanical teleprinter, good numbers of which are still readily available on the surplus market. A good example of this style of machine is the older type of Telex machine. A few of these clanking monsters are still in service but are largely being replaced in the business world by more modern electronic machines.

A similar trend towards electronic teletype is taking place amongst radio amateurs, due mainly to the ready availability of cheap personal computers which provide a clean solution to the encoding and decoding of characters. Anyone who has operated a mechanical teleprinter will attest to the attractions offered by a computer based system. You can carry on a normal conversation in the same room as a computer and you don't need to stand over it with the oil can at the ready!

The Baudot/Murray code

The classic teleprinter machines employed a system of coding based on permutations of a five-unit binary code developed by Jean Emil Baudot and Donald Murray around 1874. This code is still in wide use today, not only for amateur teleprinter use but also in the International Telex network. The code uses a "start" bit and a "stop" bit to mark the beginning and end of each character and five information or data bits to identify each character. The use of start and stop bits allows a character to be identified correctly, regardless of



This illustration shows a very early example of the teleprinter or "printing telegraph" made by the Morkrum Company of the USA. Despite becoming more streamlined, modern machines still use the same basic method of operation.

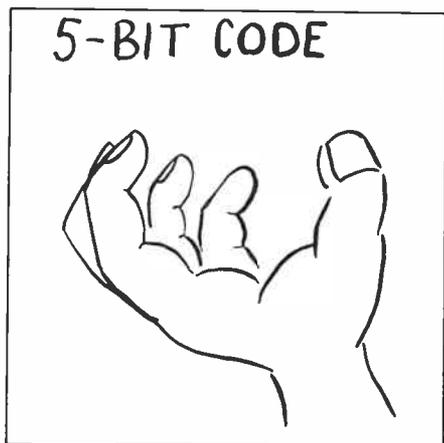
when it occurs in relation to other characters. This method is known as asynchronous transmission.

With only five information bits, the total number of possible combinations is 32. The English alphabet has 26 characters, ten numerical digits and around nine commonly used punctuation symbols which gives us around 45 characters as a bare minimum. The method used to overcome this anomaly is the same one used on the old electro-mechanical typewriter – you shift to FIGS or UPPER CASE. Now you can have the numerical digits and punctuation symbols because with the extra 32 "shifted" characters your total is 64.

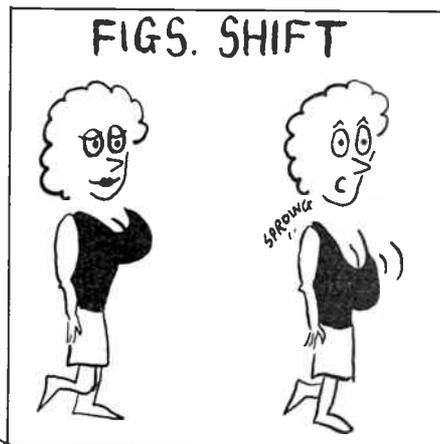
In the teleprinter, two unique 5-bit codes are used to send the FIGS and LTRS characters. All those characters which follow a FIGS character will be printed as the "shifted" symbol and will continue to be so printed until a LTRS character comes along. This scheme has its drawbacks when used over a radio circuit where a noise pulse can cause a FIGS or LTRS character to be missed or erroneously detected. Because the code makes no provision for detecting transmission or reception errors you can end up with lines of unintelligible gibberish until a correctly detected FIGS or LTRS arrives to put the machine back in the correct sense.

Baud yet?

The standard speed for amateur radioteletype, as well as many commercial systems, is 60 words per minute (WPM) ▶



5-BIT CODE



FIGS. SHIFT



LTRS. SHIFT

and at this speed the data bits will be 22 milliseconds long. In order to make detection easier, the stop bit is often made longer. In the standard 60 WPM system, the stop bit occupies 31 milliseconds which is 1.41 times as long as a data bit. In other systems the stop bit may be the same length as the data bits, it may also be 1.5 times as long or even twice as long. This is frequently referred to as one, one-and-a-half and two stop bits.

When speaking of the speed of a system, the more familiar term "baud" or "baud rate" is generally used. There seems to be widespread confusion over this term, with many people confusing "baud" and "bits per second". A baud is a unit of keying rate and the baud rate is found by dividing the shortest pulse length into unity. In the case of the 60 WPM system described above, the shortest pulse is 22 milliseconds in duration. The baud rate of this system is thus $1/0.022$ which equals 45.45 bauds.

Another popular misconception involves the rate at which information is transferred. In the 60 WPM system all the characters are sent at 60 WPM, but the actual transmission speed will depend on how fast the operator can type if using the keyboard directly. Many operators of mechanical RTTY machines pre-record messages on punched paper tape so that they can be retransmitted at the maximum speed of which the system is capable. The computer-based systems usually make provision for recording messages either in a memory buffer or on a floppy disk for subsequent transmission.

AMTOR

As pointed out above, a major failing of the standard teletypewriter system is its inability to detect and correct transmission or reception errors. To overcome this shortcoming, a commercial system called SITOR (Simplex Telex Over Radio) was developed which makes use of a 7-bit information code to achieve essentially error-free communications. This commercial standard was adapted for amateur use in 1977 by J. Peter Martinez G3PLX, and the result has become known as AMTOR (Amateur Teleprinting Over Radio).

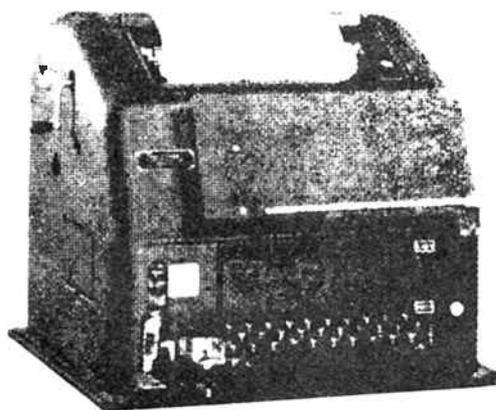
Like SITOR, AMTOR uses synchronous transmission of a seven-bit information code. There are two basic AMTOR modes known respectively as ARQ and FEC. In the ARQ mode (Automatic Repeat Request, also known as mode A), the transmit function encodes individual characters with a mark to space polarity ratio which is always four ones and three zeroes, and sends the characters in groups of three. The receiving station can thus check for the four to three ratio and if not seen correctly will send a command back to the transmitting station requesting that it re-transmit the group of invalid characters. If the group of characters was received correctly, the receiving station transmits an acceptance code and the transmitting station will send the next group of characters in the message.

Many will be familiar with the characteristic "chirp-chirp"

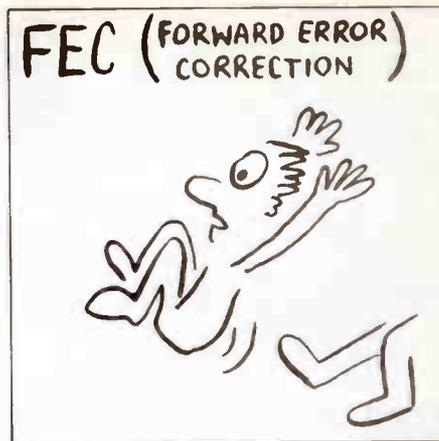
of AMTOR signals heard on the air. The "bursty" nature of the signals is due to the synchronous transmission method employed. Data transmission takes place at 100 baud which corresponds to a character length of 70 milliseconds. The overall cycle time for a three-character block and the subsequent control signal reply is 450 milliseconds. The fast switching between transmit and receive places great demands on the transceivers in use and some models may require slight modifications in order to be suitable for AMTOR operation.

An interesting anomaly can occur with synchronous transmission methods such as ARQ where the data is transmitted in precisely timed bursts. When communication is attempted over great distances such as some "long path" or satellite circuits, the propagation delay will cause the transmitting station to miss the reply control code from the receiving station.

A further difficulty arises with synchronous communications in that two stations in contact are effectively "locked" together, one station operating as the "master", the other as the "slave". In ARQ, the stations need to know each others identity in order to communicate. AMTOR stations identify themselves by means of a selective calling code or "selcall". The selcall is usually derived from the stations callsign and amongst amateurs generally consists of a four character code comprised of the first letter and the last three letters, e.g. VK2AAK would become the selcall VAAK. It is not possible to initiate a contact in ARQ unless the selcall of the other station is known and it is also not possible to "break-in" to a contact in progress. It is widely recognised that ARQ is the better of the two modes, but in cases such as just described the second AMTOR mode, FEC, has its advantages or may even be essential.



The Teletype model 15 is a sturdy workhorse well known amongst amateur radio operators. Although they are being largely replaced with computer based systems these days, they still have a sort of romantic appeal and many a good example can still be found in the amateur's "shack" or on the surplus market.



The FEC mode (Forward Error Correction) is also known as mode B and provides the means for transmitting to several stations simultaneously. FEC is a synchronous mode that transmits an uninterrupted stream of characters and does not operate in a "handshake" situation as does ARQ. In FEC, the transmitting station sends each character twice. The first transmission of a specific character is followed by the transmission of four other characters, after which the re-transmission of the first character takes place. The receiving station searches the inbound characters and validates them by checking for the 4:3 mark-to-space polarity ratio. The probability of both occurrences of the character being mutilated are quite low and the result is improved reliability when compared to normal RTTY.

When using FEC, there is no master or slave station and in use, it's operation is similar to normal asynchronous RTTY. Unlike ARQ mode, where the duty cycle is quite low, FEC operates at 100% duty cycle and transmitters should be rated accordingly. The FEC mode is the one to use when calling "CQ" or engaging in a "net" where more than two stations are involved. FEC should also be used for extremely long distance communications where the propagation delay precludes the use of ARQ.

Packet radio

Since its introduction in the early 1970s, packet radio has become probably the fastest growing mode since two metre FM. When we consider the enormous growth in the popularity of personal computers and the potential offered by the packet mode, it is easy to see why it has such an appeal.

Much of the early work on amateur packet radio took place in Canada where, in 1978, Doug Lockhart VE7APU began experimenting with bit-oriented protocols based on the International Organization for standardization (ISO) high-level link control (HDLC) protocol. Doug Lockhart designed a special-purpose computer called a terminal-node controller

(TNC) and also founded the Vancouver Amateur Digital Communications Group (VADCG) who were responsible for much of the pioneering work on packet systems. In 1984, Doug Lockhart was awarded a certificate of merit by the Canadian Amateur Relay League (CRRL) in recognition of his efforts.

The original VADCG packet protocol had some shortcomings in that it only provided a one-byte address field. This meant that the number of stations which could be addressed was quite small. Many amateurs were of the opinion that the addressing should be based on amateur callsigns and meetings took place in the USA to see whether the CCITT X.25 public packet-switched network could be used as the basis for a suitable protocol. The result of these discussions was the AX.25 protocol (Amateur X.25) which used amateur callsigns in the address field.

A good deal of controversy has arisen over the use of the two incompatible protocols and although both the VADCG and AX.25 systems have gone through some major changes

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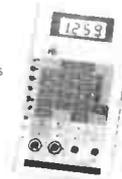
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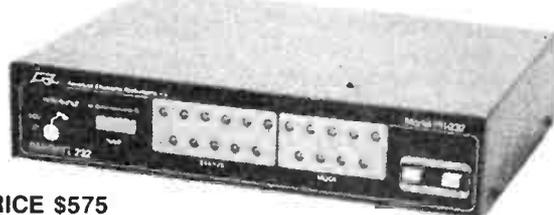
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and enhancements, both are still popular. In Australia, the Department of Communications has directed that any protocol used in the packet system should include callsigns in the address field. This decision has ruled out the use of earlier versions of the VADCG protocol but more recent versions have been introduced which comply with those requirements. The AX.25 protocol has gained considerable popularity due in part to the fact that the ARRL has adopted it as the "official" system and that it is also the system used in several current and planned amateur satellites which support packet communications.

Whilst packet is a digitally encoded signal like RTTY, it incorporates error detection and handshaking to ensure data integrity, much like AMTOR. A computed value called the "frame check sequence" is sent with each transmission which allows the receiving end to check for errors. The receiving end computes its own FCS and compares it with the one sent. If they are identical, the transmitted packet is acknowledged and the next packet is sent by the transmitting end. If the FCS values at each end fail to agree, no acknowledgement is sent and the transmitting end will re-send the same packet after a short wait and will keep doing so until it gets an acknowledgement.

A packet is simply a collection of ASCII data. Inside the packet is the message or information to be sent as well as a number of "fields" which include the source and destination addresses as well as protocol control codes. The data within the packet is sent synchronously, i.e. there are no start or stop bits. Synchronization is ensured by a number of "sync" bytes at the start of the packet. The actual protocol is quite complex and would require several pages just to give a brief description. We will confine ourselves to how the packet mode can be used and what advantages it can offer the user. If you are insatiably curious about the intricacies of the protocol, some sources of further information are given at the end of this article.

A basic packet radio station consists of three major parts: a computer or terminal on which to type and view messages, a terminal-node controller and a transceiver which operates on the band required. The terminal does not need to be a complex device, almost any device which provides an RS-232 serial port can be used with the majority of TNCs. Many operators do choose to employ a personal computer of some sort as it can enhance operation as well as being useful for other things beside packet. There exist many simple terminal programs suitable for use in small computers and these are quite suitable for use with packet radio. If you already have a communications program which you use with a telephone modem, you will find that this will usually work just as well with a TNC.

The TNC is really the heart of the whole system and takes care of all the hard work involved in assembling your messages into packets and sending them to the transmitter, as well as extracting the information from received packets for

display on your terminal. The TNC is essentially a self-contained computer, often based around a microprocessor such as the Z80 and generally has quite a large complement of on-board memory. The software in EPROM which controls the operation of the TNC and takes care of the protocol may be as large as 256k and the on-board RAM may be 16k or more.

Most current types of TNC include an internal modem thus producing a self-contained unit which is straightforward to connect and use. The only connections that need to be made are: the serial cable from the computer or terminal to the TNC, the audio output of the radio to the TNC, the audio input to the microphone connector of the radio from the TNC and the press-to-talk connection from the TNC to the radio.

There are a number of characteristics which are unique to the packet mode and foremost among these is its ability to share a common channel with other users. Because the packets are only sent in short bursts, there is more than enough time for another set of stations to send their packets to each other in the spaces between your transmissions. Although your TNC will hear the other packets, it will not respond to them because they are not addressed to you. It is possible to configure your TNC to see these other packets if you wish, but if you are carrying on a conversation with another station, your screen may get somewhat cluttered. If you are not "connected" to another station, it is quite easy to configure your TNC to see all the packets flying to and fro on the frequency.

It is this "unconnected" mode which is used to call CQ or to "read the mail". If by chance one of your packets is sent at exactly the same time as one from another station, they will collide and thus be corrupted. The error correcting protocol in the receiving TNCs will not acknowledge the corrupted packets and so the transmitting units will re-send the same packets. To prevent the same collision occurring again, the sending TNCs will wait for a random time before transmitting. All TNCs are arranged so they will not transmit whilst activity is detected on the channel and thus the TNC which transmits first will grab the frequency and all the others will wait until its packet has been sent.

Another very useful feature provided by packet radio is the ability for any TNC to act as a repeater at the operator's discretion. If you are not within range of a packet station whom you wish to contact but there is a third station located between you who is able to hear you both, it is possible to "connect" to the distant station "via" the intermediate one. All this happens quite automatically as far as the intermediate station is concerned and the operator will not even see your packets unless he configures his TNC to display them.

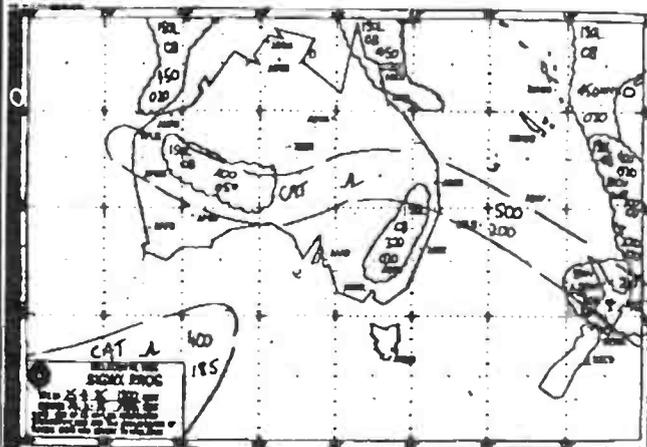
The whole concept of packet radio is based upon the ability to form a network of interconnected stations. As indicated above, it is quite possible to contact stations well out of your normal range by making use of intermediate "digipeaters". Many stations now operate bulletin-board systems which allow other packet equipped stations to leave messages for later retrieval by a third party. Most of these bulletin boards ▶

The AUSTRALIAN ELECTRONICS Monthly

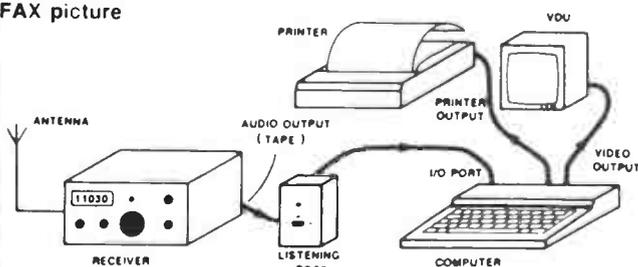


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▶ DIGITAL COMMUNICATION

also have a range of programs and files of interest to amateur radio operators which can be downloaded over the air straight into your computer.

The majority of packet radio activity takes place on the VHF bands but some stations are also capable of operation on the HF bands. Some of the bulletin-board stations provide "gateway" facilities so that local users who connect on VHF can have their signals automatically retransmitted on HF thus providing world-wide communications. A number of current and planned amateur satellites also carry the packet mode. Imagine being able to send a message from a simple, low-cost VHF station to an orbiting satellite which stores your message for later retransmission on the other side of the globe!

As you can see, packet radio has a great potential for providing a global network in which any suitably equipped amateur can participate. By combining the power of the low-cost personal computer, with the sophistication of the modern transceiver, we can have a communications system of unparalleled versatility and reliability.

In part two of this article we will take a closer look at the hardware for the digital modes, as well as details about how to get going on the air and who to talk to for advice. 📌

— from page 83.

mum power output of 30 watts and SSB on the segment 52.050 - 52.200 MHz.

"The enhancements for the Novice proposed above are designed to be greater than those given to JA telephony licencees under the reciprocal agreement and to meet the common band requirement, yet are not a disincentive to upgrading as allowing use of the entire two meter band would be.

"A third aspect of the licence restructure is the introduction of an "Intermediate" class of licence. The intermediate licence serves two purposes. Firstly, to bridge the gap between the Novice and the AOCPLimited licencees, and secondly, to provide an avenue to those people who aim an interest in electronics through computers and computing.

"It is an essential step if the Amateur Radio Service is to survive by making the hobby more attractive to people of all ages.

"The Intermediate licence would require a candidate to have passed the Novice theory, plus a supplementary exam or set of questions on elementary digital subjects and FM. This grade of licence would have the 6 metre privileges afforded to the novice licencee plus 70 cm segments 433-435 and 438-440 MHz covering FM simplex, repeaters and digital modes. Those segments are selected to avoid the satellite band.

"A candidate who passed the Intermediate theory exam(s) as well as the Novice telegraphy exam, would have the Novice HF privileges, plus be permitted to use RTTY, AMTOR, ASCII, FAX, SSTV and Packet on the segment 28.2 - 28.3 MHz.

"The data mode privileges would enable Australian Intermediate licencees to communicate with USA Novices who have those privileges on that band segment. Being examined on FM, the Intermediate licencee should either be permitted into the FM international segment 29.000 - 29.700 MHz and/or FM repeaters be allowed in Australian within the current Novice band.

"Intermediate licencees should be allowed access to the 1.2 GHz band in the future. Holders of the combined Novice/Limited licence (K calls) would automatically be given the digital and other HF privileges of the Intermediate licence.

"The above restructure of Australia's amateur licence system would make the hobby appropriate to today's technology and improve its attractiveness to potential radio amateurs. It sets out new entry points into the hobby and a logical upgrading path leading to increased numbers of licencees with AOCPLimited and Limited Licence qualifications.

"The particular privileges proposed in this document represent a balance between a number of conflicting considerations including the consequences of the JA/VK reciprocal agreement. The privileges are set to encourage upgrading by those who have the motivation to attain the skills.

"The aim is to give newcomers an attainable entry into the hobby, and the Intermediate licence gives a taste of digital modes to entice them to upgrade to the higher licence classes." 📌

EXAR XR-2206 Monolithic Function Generator

GENERAL DESCRIPTION

The XR-2206 is a monolithic function generator integrated circuit capable of producing high quality sine, square, triangle, ramp, and pulse waveforms of high stability and accuracy. The output waveforms can be both amplitude and frequency modulated by an external voltage. Frequency of operation can be selected externally over a range of 0.01 Hz to more than 1 MHz.

The circuit is ideally suited for communications, instrumentation, and function generator applications requiring sinusoidal tone, AM, FM, or FSK generation. It has a typical drift specification of 20 ppm/°C. The oscillator frequency can be linearly swept over a 2000:1 frequency range, with an external control voltage, having a very small affect on distortion.

FEATURES

Low-Sine Wave Distortion	0.5%, Typical
Excellent Temperature Stability	20 ppm/°C, Typical
Wide Sweep Range	2000:1, Typical
Low-Supply Sensitivity	0.01%V, Typical
Linear Amplitude Modulation	
TTL Compatible FSK Controls	
Wide Supply Range	10V to 26V
Adjustable Duty Cycle	1% to 99%

APPLICATIONS

- Waveform Generation
- Sweep Generation
- AM/FM Generation
- V/F Conversion
- FSK Generation
- Phase-Locked Loops (VCO)

ABSOLUTE MAXIMUM RATINGS

Power Supply	26V
Power Dissipation	750 mW
Derate Above 25°C	5 mW/°C
Total Timing Current	6 mA
Storage Temperature	-65°C to +150°C

SYSTEM DESCRIPTION

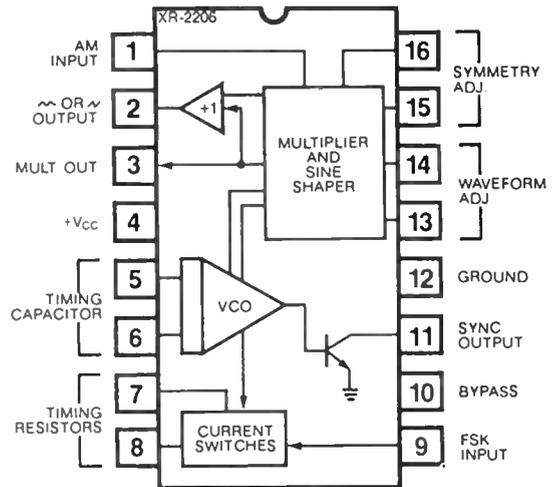
The XR-2206 is comprised of four functional blocks, a voltage-controlled oscillator (VCO), an analog multiplier and sine-shaper, a unity gain buffer amplifier, and a set of current switches.

The VCO actually produces an output frequency proportional to an input current, which is produced by a resistor from the timing terminals to ground. The current switches route one of the timing pins current to the VCO controlled by an FSK input pin, to produce an output frequency. With two timing pins, two discrete output frequencies can be independently produced for FSK Generation Applications.

Frequency-Shift Keying:

The XR-2206 can be operated with two separate timing resistors, R₁ and R₂, connected to the timing Pin 7 and 8, respectively, as shown in Figure 12. Depending on the polarity of the logic signal at Pin 9, either one or the other of these timing resistors is activated. If Pin 9 is open-circuited or connected to a bias voltage $\geq 2V$, only R₁ is activated. Similarly, if the voltage level at Pin 9 is

FUNCTIONAL BLOCK DIAGRAM



Part Number	Package	Operating Temperature
XR-2206M	Ceramic	-55°C to +125°C
XR-2206N	Ceramic	0°C to +70°C
XR-2206P	Plastic	0°C to +70°C
XR-2206CN	Ceramic	0°C to +70°C
XR-2206CP	Plastic	0°C to +70°C

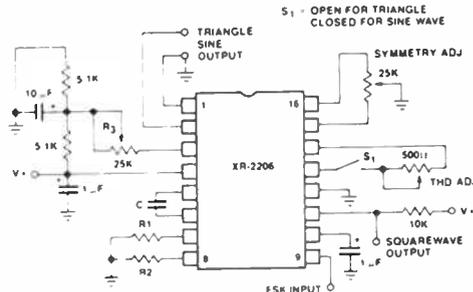


Figure 1. Basic Test Circuit.

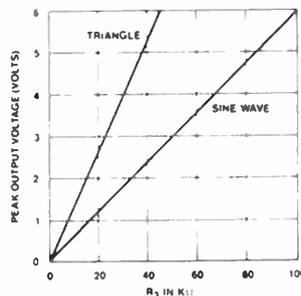


Figure 2. Output Amplitude as a Function of the Resistor, R₃, at Pin 3.

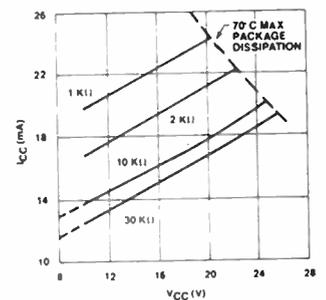


Figure 3. Supply Current versus Supply Voltage, Timing, R.

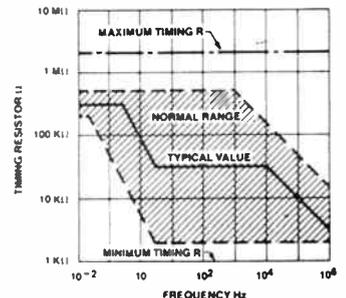


Figure 4. R versus Oscillation Frequency.

ELECTRICAL CHARACTERISTICS

Test Conditions: $V^+ = 12V$, $T_A = 25^\circ C$, $0.01 \mu F$, $R_1 = 100 k\Omega$, $R_2 = 10 k\Omega$, $R_3 = 25 k\Omega$
 unless otherwise specified. S_1 open for triangle, closed for sine wave.

PARAMETERS	XR-2206M			XR-2206C			UNITS	CONDITIONS
	MIN	TYP	MAX	MIN	TYP	MAX		
GENERAL CHARACTERISTICS								
Single Supply Voltage	10		26	10		26	V	
Split Supply Voltage	+5		+13	+5		+13	V	
Supply Current		12	17		14	20	mA	$R_1 \geq 10 k\Omega$
OSCILLATOR SECTION								
Max. Operating Frequency	0.5	1		0.5	1		MHz	$C = 1000 pF$, $R_1 = 1 k\Omega$
Lowest Practical Frequency	0.01			0.01			Hz	$C = 50 \mu F$, $R_1 = 2 M\Omega$
Frequency Accuracy	+1		± 4	± 2			% of f_0	$f_0 = 1/R_1 C$
Temperature Stability	+10		± 50	± 20			ppm/ $^\circ C$	$0^\circ C \leq T_A \leq 70^\circ C$ $R_1 = R_2 = 20 k\Omega$
Supply Sensitivity		0.01	0.1		0.01		%/V	$V_{LOW} = 10V$, $V_{HIGH} = 20V$ $R_1 = R_2 = 20 k\Omega$
Sweep Range	1000:1	2000:1		2000:1			$f_H = f_L$	$f_H @ R_1 = 1 k\Omega$ $f_L @ R_1 = 2 M\Omega$
Sweep Linearity							%	$f_L = 1 kHz$, $f_H = 10 kHz$
10:1 Sweep		2		2			%	$f_L = 100 kHz$, $f_H = 100 kHz$
1000:1 Sweep		8		8			%	$\pm 10\%$ Deviation
FM Distortion		0.1		0.1			%	
Recommended Timing Components								
Timing Capacitor C	0.001		100	0.001		100	μF	See Figure 4
Timing Resistors R_1 & R_2	1		2000	1		2000	k Ω	
Triangle Sine Wave Output								
Triangle Amplitude		160		160			mV/k Ω	See Note 1, Figure 2
Sine Wave Amplitude	40	60	80	60			mV/k Ω	Figure 1, S_1 Open
Max. Output Swing		6		6			V p-p	Figure 1, S_1 Closed
Output Impedance		600		600			Ω	
Triangle Linearity		1		1			%	
Amplitude Stability		0.5		0.5			dB	For 1000:1 Sweep
Sine Wave Amplitude Stability		4800		4800			ppm/ $^\circ C$	See Note 2
Sine Wave Distortion								
Without Adjustment		2.5		2.5			%	$R_1 = 30 k\Omega$
With Adjustment		0.4	1.0	0.5	1.5		%	See Figures 6 and 7
Amplitude Modulation								
Input Impedance	50	100		50	100		k Ω	
Modulation Range		100		100			%	
Carrier Suppression		55		55			dB	
Linearity		2		2			%	For 95% modulation
Square Wave Output								
Amplitude		12		12			V p-p	Measured at Pin 11
Rise Time		250		250			nsec	$C_L = 10 pF$
Fall Time		50		50			nsec	$C_L = 10 pF$
Saturator Voltage		0.2	0.4	0.2	0.6		V	$I_L = 2 mA$
Leakage Current		0.1	20	0.1	100		μA	$V_{11} = 26V$
FSK Keying Level (Pin 9)	0.8	1.4	2.4	0.8	1.4	2.4	V	See section on circuit controls
Reference Bypass Voltage	2.9	3.1	3.3	2.5	3	3.5	V	Measured at Pin 10

Note 1: Output amplitude is directly proportional to the resistance R_3 on Pin 3. See Figure 2.
 Note 2: For maximum amplitude stability, R_3 should be a positive temperature coefficient resistor.

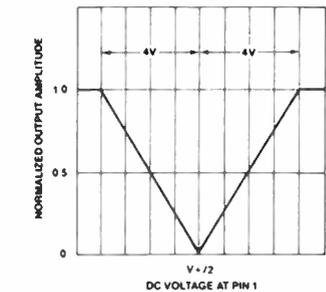


Figure 5. Normalized Output Amplitude versus DC Bias at AM Input (Pin 1).

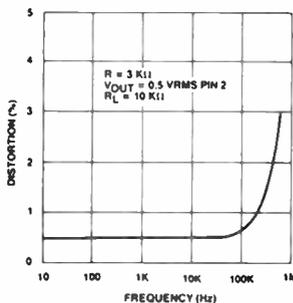


Figure 7. Sine Wave Distortion versus Operating Frequency with Timing Capacitors Varied.

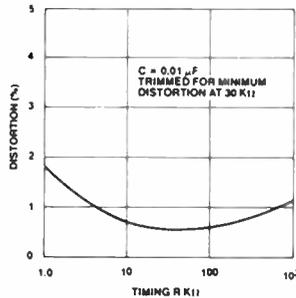


Figure 6. Trimmed Distortion versus Timing Resistor.

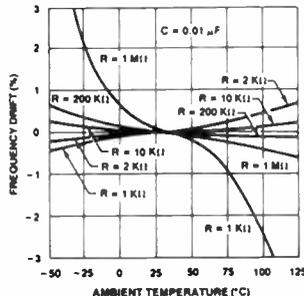


Figure 8. Frequency Drift versus Temperature.

$\leq 1V$, only R_2 is activated. Thus, the output frequency can be keyed between two levels, f_1 and f_2 , as:

$$f_1 = 1/R_1 C \text{ and } f_2 = 1/R_2 C$$

For split-supply operation, the keying voltage at Pin 9 is referenced to V^- .

Output DC Level Control:

The dc level at the output (Pin 2) is approximately the same as the dc bias at Pin 3. In Figures 10, 11 and 12, Pin 3 is biased midway between V^+ and ground, to give an output dc level of $\approx V^+/2$.

APPLICATIONS INFORMATION

Sine Wave Generation

Without External Adjustment:

Figure 10 shows the circuit connection for generating a sinusoidal output from the XR-2206. The potentiometer, R_1 at Pin 7, provides the desired frequency tuning. The maximum output swing is greater than $V^+/2$, and the typical distortion (THD) is $< 2.5\%$. If lower sine wave distortion is desired, additional adjustments can be provided as described in the following section.

The circuit of Figure 10 can be converted to split-supply operation, simply by replacing all ground connections with V^- . For split-supply operation, R_3 can be directly connected to ground.

With External Adjustment:

The harmonic content of sinusoidal output can be reduced to $\approx 0.5\%$ by additional adjustments as shown in Figure 11. The potentiometer, R_A , adjusts the sine-shaping resistor, and R_B provides the fine adjustment for the waveform symmetry. The adjustment procedure is as follows:

1. Set R_B at midpoint, and adjust R_A for minimum distortion.
2. With R_A set as above, adjust R_B to further reduce distortion.

Triangle Wave Generation

The circuits of Figures 10 and 11 can be converted to triangle wave generation, by simply open-circuiting Pin 13 and 14 (i.e., S_1 open). Amplitude of the triangle is approximately twice the sine wave output.

FSK Generation

Figure 12 shows the circuit connection for sinusoidal FSK signal operation. Mark and space frequencies can be independently adjusted, by the choice of timing resistors, R_1 and R_2 ; the output is phase-continuous during transitions. The keying signal is applied to Pin 9. The circuit can be converted to split-supply operation by simply replacing ground with V^- .

Pulse and Ramp Generation

Figure 13 shows the circuit for pulse and ramp waveform generation. In this mode of operation, the FSK keying terminal (Pin 9) is shorted to the square-wave output

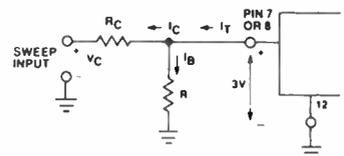


Figure 9. Circuit Connection for Frequency Sweep.

XR-2206

(Pin 11), and the circuit automatically frequency-shifts itself between two separate frequencies during the positive-going and negative-going output waveforms. The pulse width and duty cycle can be adjusted from 1% to 99%, by the choice of R_1 and R_2 . The values of R_1 and R_2 should be in the range of 1 k Ω to 2 M Ω .

PRINCIPLES OF OPERATION

Description of Controls

Frequency of Operation:

The frequency of oscillation, f_o , is determined by the external timing capacitor, C, across Pin 5 and 6, and by the timing resistor, R, connected to either Pin 7 or 8. The frequency is given as:

$$f_o = \frac{1}{RC} \text{ Hz}$$

and can be adjusted by varying either R or C. The recommended values of R, for a given frequency range, as shown in Figure 4. Temperature stability is optimum for 4 k Ω < R < 200 k Ω . Recommended values of C are from 1000 pF to 100 μ F.

Frequency Sweep and Modulation:

Frequency of oscillation is proportional to the total timing current, I_T , drawn from Pin 7 or 8:

$$f = \frac{320 I_T \text{ (mA)}}{C \text{ (\mu F)}} \text{ Hz}$$

Timing terminals (Pin 7 or 8) are low-impedance points, and are internally biased at +3V, with respect to Pin 12. Frequency varies linearly with I_T , over a wide range of current values, from 1 μ A to 3 mA. The frequency can be controlled by applying a control voltage, V_C , to the activated timing pin as shown in Figure 9. The frequency of oscillation is related to V_C as:

$$f = \frac{1}{RC} \left(1 + \frac{R}{R_C} \left(1 - \frac{V_C}{3} \right) \right) \text{ Hz}$$

where V_C is in volts. The voltage-to-frequency conversion gain, K, is given as:

$$K = \frac{\partial f}{\partial V_C} = - \frac{0.32}{R_C} \text{ Hz/V}$$

CAUTION: For safety operation of the circuit, I_T should be limited to ≤ 3 mA.

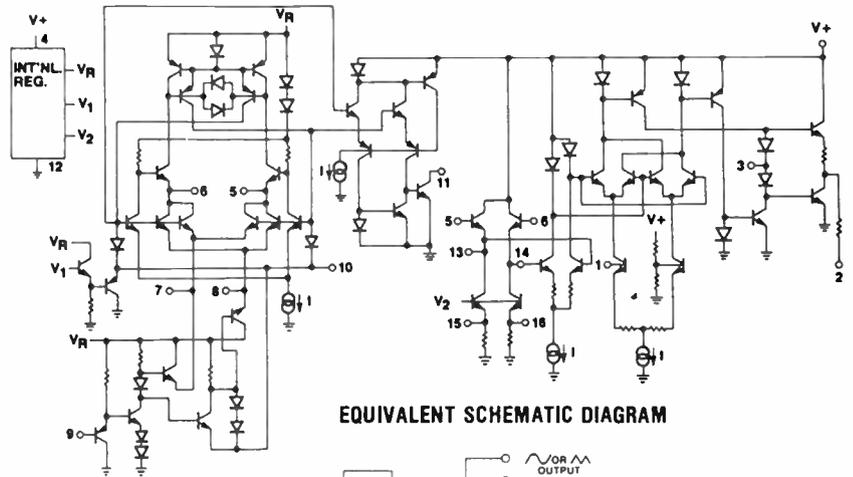
Output Amplitude:

Maximum output amplitude is inversely proportional to the external resistor, R_3 , connected to Pin 3 (see Figure 2). For sine wave output, amplitude is approximately 60 mV peak per k Ω of R_3 ; for triangle, the peak amplitude is approximately 160 mV peak per k Ω of R_3 . Thus, for example, $R_3 = 50$ k Ω would produce approximately ± 3 V sinusoidal output amplitude.

Amplitude Modulation:

Output amplitude can be modulated by applying a dc bias and a modulating signal to Pin 1. The internal impedance at Pin 1 is approximately 100 k Ω . Output amplitude varies linearly with the applied voltage at Pin 1, for values of dc bias at this pin, within ± 4 volts of $V^+/2$ as shown in Figure 5. As this bias level approaches $V^+/2$, the phase of the output signal is reversed, and the amplitude goes through zero. This property is suitable for phase-shift keying and suppressed-carrier AM generation. Total dynamic range of amplitude modulation is approximately 55 dB.

CAUTION: AM control must be used in conjunction with a well-regulated supply, since the output amplitude now becomes a function of V^+ .



EQUIVALENT SCHEMATIC DIAGRAM

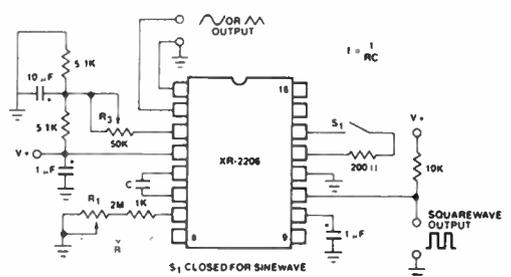


Figure 10. Circuit for Sine Wave Generation without External Adjustment. (See Figure 2 for Choice of R_3 .)

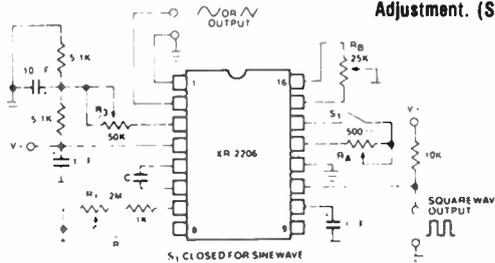


Figure 11. Circuit for Sine Wave Generation with Minimum Harmonic Distortion. (R_3 Determines Output Swing—See Figure 2.)

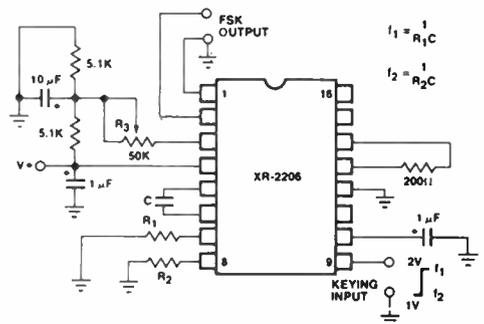


Figure 12. Sinusoidal FSK Generator.

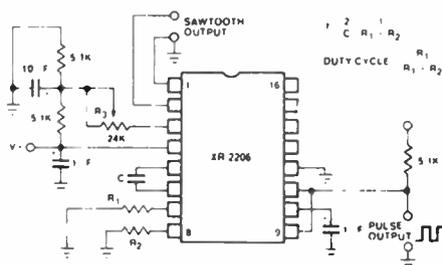


Figure 13. Circuit for Pulse and Ramp Generation.

EFG7515 CMOS SINGLE CHIP DPSK AND FSK MODEM (BELL 212A - BELL 103 - V22 A/B)

The EFG7515 is a single chip DPSK and FSK voiceband modem, compatible with the applicable BELL and CCITT recommended standards for 212A sets including BELL 103 and V22 A-B type modems.

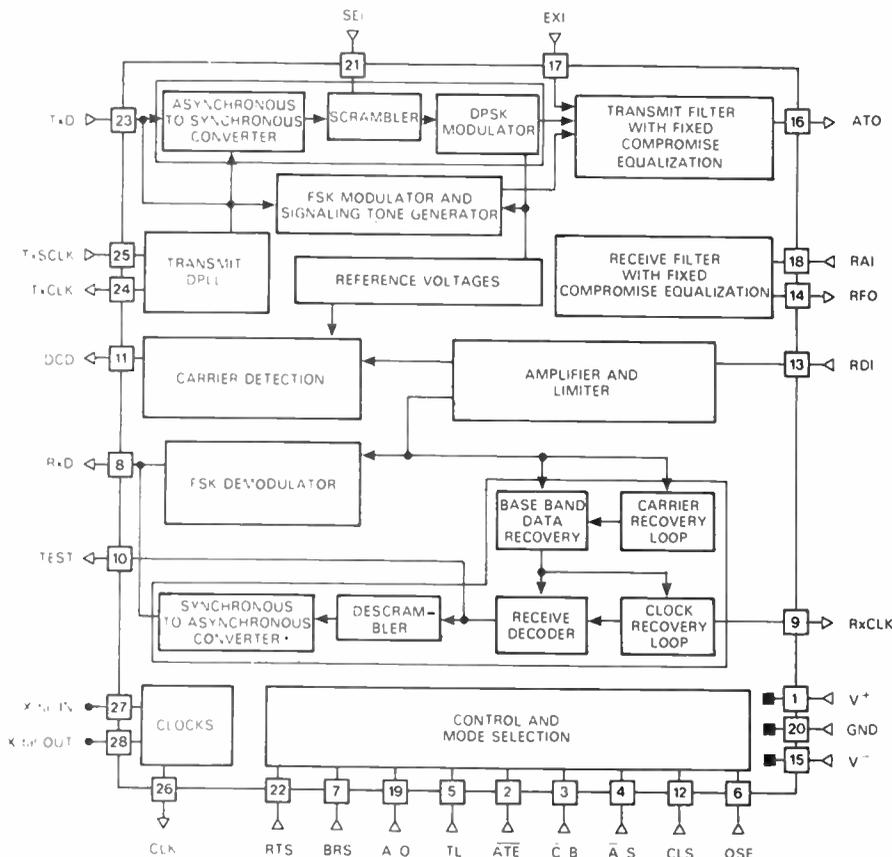
- Monolithic device includes both transmit and receive filters.
- Mixing analog and digital techniques.
- Standard low cost crystal (4.9152 MHz).
- Available clock for microprocessor at 4.9152 MHz.
- Low power consumption - CMOS technology.
- Sharp adjacent channel rejection.
- Fixed equalization in transmitter and receiver.
- Test loops.
- Carrier detect output.
- CCITT and BELL signaling tone.
- 1200 bps and 600 bps bit synchronous format in DPSK.
- 1200 bps and 600 bps +1%, -2.5% or +2.3%, -2.5% character asynchronous format (8, 9, 10 or 11 bits) in DPSK.
- 0 to 300 bps in FSK.
- Break signal supervision.

- External voice band tone filtering available (i.e. 550 Hz or DTMF).
- CMOS and TTL compatible.
- Direct interface to THOMSON SEMICONDUCTEURS microprocessor family.
- Special line monitoring facility.

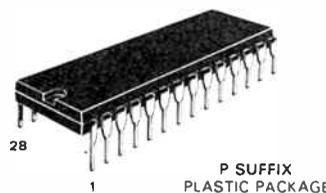
MAIN OPERATING MODES

- Standard selection (BELL 212A/BELL 103/V22).
- Answer tone selection.
- Low speed mode selection.
- Channel selection (Answer/Originate).
- Synchronous/Asynchronous mode selection.
- 8 bits to 11 bits word length selection in character asynchronous format mode.
- Overspeed selection in character asynchronous format mode.
- Scrambler selection.
- 1800 Hz guard tone selection in V22.
- Test loop selection (Digital/Analog).

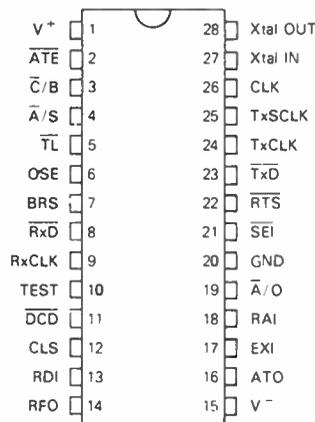
BLOCK DIAGRAM



CASE CB-132



PIN ASSIGNMENT



GENERAL DESCRIPTION

The EFG7515 is a general purpose monolithic DPSK and FSK modem implemented with double poly CMOS process. It is capable of generating and receiving phase modulated signals at data rates of 1200 bps or 600 bps as well as frequency modulated signals at data rates up to 300 bps on voice-grade telephone lines. It is offered in a 28 pin package capable of operating full-duplex according to three pin selectable standards:

- CCITT V22 A-B.
- Bell 212A with its low speed mode.
- Bell 103.

All filtering functions required for frequency generation, out-of-band noise rejection and demodulation are performed by on-chip switched capacitor filters. In phase modulation the modem provides all data buffering and scrambling functions necessary for bit synchronous format and asynchronous character format modes of operation. Internal frequencies are generated from a 4.9152 MHz crystal reference.

SUMMARY OF THE DIFFERENCES BETWEEN BELL 212A AND V22 A-B

Feature	BELL 212A	V22
Low speed mode	0-300 bps FSK	600 bps DPSK
Guard tone	No	1800 Hz optional*
Answer tone	2225 Hz	2100 Hz
Character length in asynchronous mode in DPSK	9, 10 bits	8, 9, 10, 11 bits**
Over speed mode in asynchronous mode in DPSK	No	Yes**
64 spaces detection	No	Yes

Table 9

- * 550 Hz may be externally generated and added to the transmit signal through EXI
- ** Features of V22 are available in BELL 212A on the chip

All these differences are taken into consideration inside the EFG7515

aem data sheet

PIN DESCRIPTION

Common section (supply, clock, handshaking and mode selection)

Name	Pin Type	No	Function	Description
V ⁺	I	1	Positive power supply	-5 V
V ⁻	I	15	Negative power supply	5 V
GND	I	20	Ground	0 V
XIN	I	27	Oscillator input	This pin corresponds to the input of the oscillator. It is normally connected to an external crystal but may also be connected to a pulse generator. The nominal frequency of the oscillator is 4.9152 MHz.
XDOUT	D	28	Oscillator output	This pin corresponds to the output of an inverter with sufficient loop gain to start and maintain the crystal oscillating.
CLK	D	26	Clock	This pin delivers a clock signal, the frequency of which is the crystal frequency. It may be used as a buffered clock for a microcontroller.
C/B	I	3	CCITT/BELL selection	This three-state input selects the features corresponding to CCITT or BELL recommendation.
A/S	I	4	Synchronous/asynchronous selection	This three-state input selects the synchronous bit format or the asynchronous character format mode in DPSK transmission. This input allows also character length selection (refer to table 7).
CLS	I	12	Character length	This input selects the character length in conjunction with A/S input (refer to table 7).
OSE	I	6	Over-speed selection	This input selects the over-speed in asynchronous character format mode required by CCITT recommendation (refer to table 7).
BRS	I	7	Binary rate selection	A logic "0" on this input turns the chip on 1200 bps rate. A logic "1" turns the chip on 600 bps or 0-300 bps according to C/B selection.
A/D	I	19	Answ./Orig selection	A logic "0" on this input turns the chip on answer mode. A logic "1" turns the chip on originate mode.
TL	I	5	Test loop selection	This three-state input, selects the test loops mode (refer to table 5).

Transmit section

Name	Pin Type	No	Function	Description
TxD	I	23	Transmit data	Data bits to be transmitted are serially presented on this input. A mark corresponds to a logic "1" and a space to a logic "0". This data determines which phase or frequency appears at any instant at the ATO pin in DPSK or FSK modes.
ATO	O	16	Analog transmit output	The analog output is the modulated carrier or the answer tone to be conditioned and sent over the phone line mixed with the filtered signal from EXI.
EXI	I	17	External tone input	This analog input allows external tone to be filtered by an internal low pass filter. Filtered signal appears at ATO whatever RTS.
ATE	I	2	Answer tone enable	A logic "0" on this input instructs the chip to enter answer signaling tone mode according to C/B selection. A logic "1" turns the chip on transmit data mode (refer to table 8).
SEI	I	21	Scrambler enable input	A logic "0" on this input enables the internal scrambler. A logic "1" instructs the chip to bypass the scrambler.
TxCLK	O	24	Transmit clock from modem	This output delivers a transmit bit clock generated by the chip in synchronous mode. This output generates a logic "1" in asynchronous mode. When TxSCLK is used, TxCLK is locked on TxSCLK.
TxSCLK	I	25	Transmit clock from terminal	This input receives a bit clock supplied by the DTE. This clock synchronizes the internal transmit clock of the chip in synchronous mode.
RTS	I	22	Request to send terminal	When a logic "0" is present on this input, the chip delivers on ATO a modulated signal or a signaling tone and the filtered signal from EXI. When a logic "1" is present on this input, ATO delivers only the filtered signal from EXI. When a logic "1" is present on this input, the receive section may be used for line monitoring and ATO delivers only the filtered signal from EXI.

Receive section

Name	Pin Type	No	Function	Description
RAI	I	18	Receive analog input	This input receives the analog signal from the hybrid. It corresponds to the input of the receive filters.
RFO	O	14	Receive filter output	This analog output is the signal received on RAI once filtered. The receive filter also equalizes the signal for adaptation to most existing lines. This output must be connected to RDI through a capacitor to meet the level detection conditions.
RDI	I	13	Receive demodulator input	This pin is the input of the carrier detection logic and of the demodulator.
DCD	O	11	Data carrier detect	A logic "0" on this output indicates that a valid carrier signal is present on RAI. A logic "1" means that no valid signal is being received. The hysteresis meet standards recommendation.
RxD	O	8	Receive data	Data bits demodulated are available serially at this output.
RxCLK	O	9	Receive clock	This output delivers a receive bit clock generated by the chip. In asynchronous mode this clock is 16 times the modulation rate. In synchronous mode the clock is equal to the bit rate.
TEST	O	10	Test	This output is an intermediate demodulator output intended for handshake and test purposes.

FUNCTIONAL DESCRIPTION

TRANSMITTER

The transmitter consists of two analog signal generators followed by switched capacitor and continuous filters. In phase modulation operation mode the DPSK signal generator is preceded by a selectable scrambler and an asynchronous to synchronous converter is included in character asynchronous format mode.

Tone allocation: the modem on the end of the line which initiates the call is called the originate modem. In normal transmission operation it transmits in low channel and receives in high channel. The other modem is the answer modem which transmits in high channel and receives in low channel.

Modulators

DPSK modulator: the phase modulation type is differential quadrature four phase shift keying (see table 1). The 1200 bps data stream to be transmitted is converted into two 300 dibits per second streams which modulate alternatively two independent carriers. Consequently the base band shaping is included is a 5 bit address ROM which generates samples for a 8 bit switched capacitor DAC at a frequency equals to 8 times the carrier frequency.

FSK modulator and tone generator: a frequency synthesizer provides accurate clocks to a switched capacitor sine wave generator (see table 3). Phase continuity is maintained when a frequency shift occurs.

Transmit filters

To avoid unwanted frequency components to be echoed by the hybrid in the reception path, to maintain the level of spurious out-of-band signals transmitted to the telephone line below the limits specified by administrations (see figure below) and to complete statistical amplitude and phase equalization, the analog signals are processed by ten poles sharp pass-band switched capacitor filters. The response of these filters depends on the selected channel (Answer/Organize) and the selected standard (BELL 212-V22/BELL 103). A continuous filter eliminates parasitic sampling effects. An additional low-pass filter input is provided. This allows to mix and filter such tones as DTMF signals or special guard tones (550 Hz) to the transmitted signal.

Scrambler

The scrambler used during phase modulation ensures the transmission of a continuously changing pattern. This avoids the receiving modem to drop out of lock on certain continuous repetitive data patterns. This scrambler may be disabled during handshaking procedures. In V22 a special unlocking sequence is performed on 64 spaces pattern at scrambler output.

Asynchronous to synchronous converter

The DPSK signal is synchronous in nature but the modem has both an asynchronous as well as a synchronous mode of operation in DPSK. So a data buffer is necessary to convert variable rate asynchronous character data to an equivalent bit oriented synchronous data stream. This is done by inserting or deleting stop bits. In addition this converter is able to recognize and format the break signal.

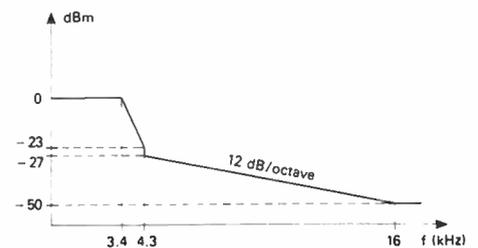


Figure 1: Transmit filters characteristics

BRS	TxD		Phase shift
	n-1	n	
0	0	0	+90°
		1	0°
	1	0	+270°
		1	+180°
1	0	+90°	
	1	+270°	

Table 1: DPSK modulation

A/O	TxD	Standard frequency
0	0	2025 Hz
	1	2225 Hz
1	0	1070 Hz
	1	1270 Hz

Table 3: FSK modulation (BELL 103)

RECEIVER

The receiver includes two band-pass filters followed by an amplifier and a hard limiter. Depending on selected standard, the detector output is passed through a DPSK demodulator or a FSK demodulator. The DPSK demodulator is followed by a descrambler and a selectable synchronous to asynchronous converter. In addition a carrier detector monitors the level of the received signal.

Tone allocation: in normal transmission operation the originate modem receives in high channel and transmits in low channel. The answer modem receives in low channel and transmits in high channel.

Receive filters

The signal delivered by the hybrid to the receive analog input is a mixture of transmitted signal, received signal and noise with a level in the range from -48 dBm to -6 dBm. Depending on the operating mode and the selected standard the 20 poles receive switched capacitor band-pass filter selects the frequency band of the low channel or the high channel. A ratio of 14/15 is applied on the sampling clock frequency between FSK and DPSK in the same operating mode (Answer / Originate). These filters reject out-of-band transmission noise components and undesirable adjacent channel echo signals which can be fed from the transmit section into the receive section. Fixed equalization is included in order to assure low error rate.

Amplifier and hard limiter

Once filtered the received signal is amplified and fed to the carrier detector. In order to limit analog parts in the design all the demodulator techniques used in the EFG7515 are based on zero crossing detection. So the received signal is just limited before entering demodulator.

Demodulators

DPSK demodulator: a DPLL is used to recover the carrier signal. This DPLL has a lock range of ± 2 Hz but as the incoming carrier may present an offset of ± 7 Hz a second loop allows the first DPLL to lock on the exact frequency of the carrier with an accuracy of ± 1 Hz and to follow its slow variations. Then the limited received signal is mixed through exclusive-Or with the recovered carrier and with the 90 degrees phase shifted recovered carrier. The results are processed through four poles Bessel filters which provide a good amplitude propagation time compromise. The received sampling clock is recovered from these base band data with a simple DPLL. The received data are sampled by this clock and then converted into a serial synchronous bit stream.

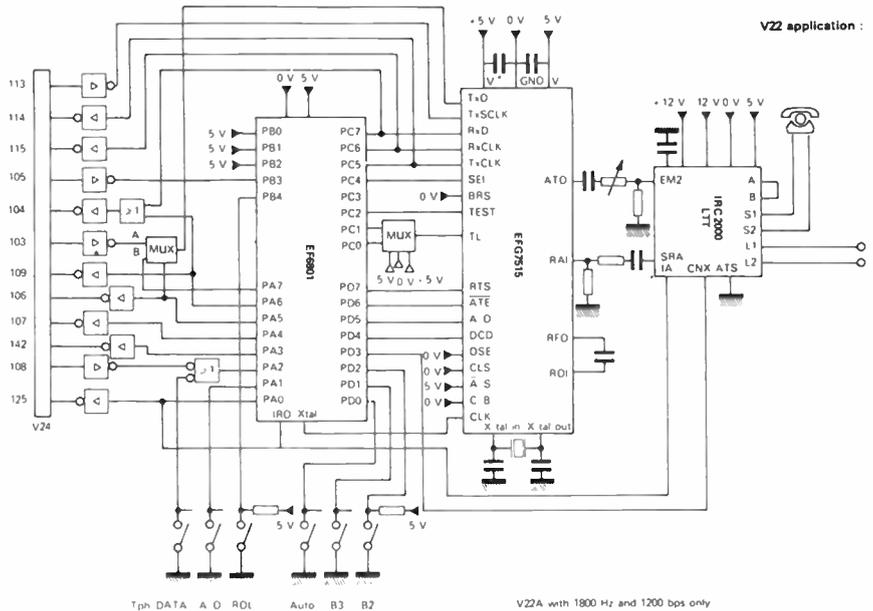
FSK demodulator: the zero crossing detector output is passed through a shift register whose length depends on the operating mode (Answer / Originate). The output of the shift register and the detector are mixed into an exclusive-Or. Then they are processed through a four poles Bessel filter and a slicer.

Test output

Once demodulated DPSK data are generally processed (cf next paragraph) but during call set-up procedures or data set testing it is of importance to monitor the demodulator output. So in DPSK mode demodulated data are available on TEST pin.

Descrambler and synchronous to asynchronous converter

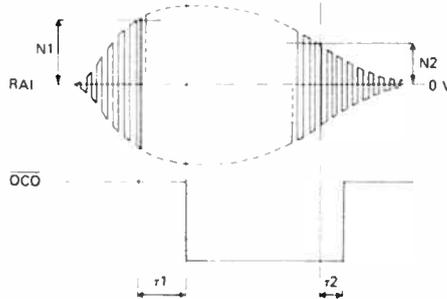
Data coming from the DPSK demodulator are unscrambled. In V22 the unlocking sequence is detected at descrambler input and the original data are decoded before descrambling. In asynchronous character format mode of operation a data



buffer is able to detect missing stop bits and reinsert them. The converter is able to recognize the break signal and transmits it without modification.

Carrier detector

Whenever valid signals are being received at the input of the demodulator and are acceptable for demodulation, carrier detect output is pulled down. A delay is timed out before the carrier received or carrier lost signal changes carrier detect output to provide immunity against noise bursts. The modem also provides at least 2 dB of hysteresis between the carrier ON and the carrier OFF thresholds (see diagram below).



In DPSK mode $105 \text{ ms} < t1 < 205 \text{ ms}$ $10 \text{ ms} < t2 < 24 \text{ ms}$
 In FSK mode $215 \text{ ms} < t1 < 315 \text{ ms}$ $25 \text{ ms} < t2 < 75 \text{ ms}$

LOOP TESTS

LOOP 3

This loop is called the analog loop. When it is selected the receive filters and the demodulators are configured to process the same channel as the transmit section. The transmit carrier has to be looped back externally to the receive analog input. This loop allows the user or the DTE to check the satisfactory working of the local DCE.

LOOP 2

This loop is called the digital loop. When it is selected received data, receive clock and data carrier detect signals are respectively and internally looped back on transmit data, transmit clock from terminal and request to send. This loop allows the user or the DTE to check the satisfactory working of the line and the remote DCE.

CLOCKS

In synchronous mode of operation TxCLK, TxSCLK and RxCLK are respectively working as the V24 circuits C114, C113 and C115. In asynchronous mode of operation RxCLK can be used as baud rate clock to synchronize the transmit and the receive sections of a UART. See table below.

OSCILLATOR OUTPUT

The buffered master clock (4.9152 MHz) is made available at output CLK. It can be used as a clock for a microcontroller.

VOLTAGE REFERENCE

A temperature compensated voltage reference build with a zener is included in the chip. This voltage is used to calibrate transmit levels and to generate the carrier detection thresholds.

LINE MONITORING

A special mode has been included in the EFG7515 to monitor the line during an automatic call. When this mode is selected receive filters clock is directly derived from TxSCLK which allows the user to precisely observe broad frequency bands. Furthermore the DCD performs a fast carrier detection equivalent to an envelope detection. As the center frequency of the receive filters is proportional to TxSCLK frequency in this mode it is possible to tune the passband according to the frequencies to be detected (see next table).

We would like to acknowledge the kind permission granted by Promark Electronics to reproduce this data sheet.

APPLICATIONS INFORMATION

In a typical application a microcontroller provides control and interface to the Data Terminal Equipment (DTE), and a Direct Access Arrangement provides connection to the telephone line. Then the EFG7515 can communicate with the most popular modems (BELL 103 and BELL 212A) in countries under BELL standards and popular modems (V22) in countries under CCITT recommendations.

Standard frequency	Frequency using 4.91 MHz	% deviation from standard	Mode
1070 Hz	1066.7 Hz	-0.3%	BELL 103 Originate
1200 Hz	1200 Hz		BELL 212A or V22, Originate
1270 Hz	1269.4 Hz	-0.05%	BELL 103 Originate
1800 Hz	1807.1 Hz	+0.4%	Guard tone V22
2025 Hz	2021 Hz	-0.2%	BELL 103 Answer
2100 Hz	2104.1 Hz	+0.2%	Answer tone CCITT
2225 Hz	2226.1 Hz	+0.05%	BELL 103 Answer or Answer tone BELL
2400 Hz	2400 Hz		BELL 212A or V22, Answer

Table 2: Output frequency deviation

A/S	C/B	BRS
-1	-1	0
ou 0	ou 0	1
	1	0
		1
1	-1	0
	ou 0	1
	1	0
		1

TxCLK	RxCLK
1	19.2 kHz
1	9.6 kHz
1	19.2 kHz
1	4.8 kHz
1200 Hz	1200 Hz
600 Hz	600 Hz
1200 Hz	1200 Hz
1	4.8 kHz

Mode
V22 asynchronous
BELL 212A asynchronous and BELL 103
V22 asynchronous
BELL 212A synchronous and BELL 103

Table 4: Clocks operation

The Last Laugh



These klystrons are like women. You have to dip the final at least once a week and touch up the bias every so often!

IT WAS TRULY SAID by the Last Laugh's correspondent in the March issue that "The noble art of public telephony is not without its moments of mirth." Prompted by the stories detailed in March's Last Laugh, one reader rang to relate an intriguing tale of the perversities of inanimate objects he'd experienced as an employee of our grandest public utility in the days when it was truly a utility and certainly less grand.

Tone signalling has long been used in

the telephone system for the automatic and semi-automatic control of line equipment. A system in use during the time of our latter correspondent's experience was called "TVF", for twin-voice frequency, signalling. It employed dual tones in the 600-700 Hz region, according to our caller.

One fine day, a lady was using a public phone box beside the local railway line. A steam train approached (this occurred some time ago!) and, just as it drew nigh

the occupied phone box, the engineman sounded the whistle. The train's speed and the resultant Doppler effect swept the whistle tone through the TVF frequencies and "cleared-down" the line, cutting off the unfortunate lady's call!

Although vaguely blaming the train for her mishap, the poor lady probably never knew she was a victim of incompatible technologies and the perversity of nature! 🐦

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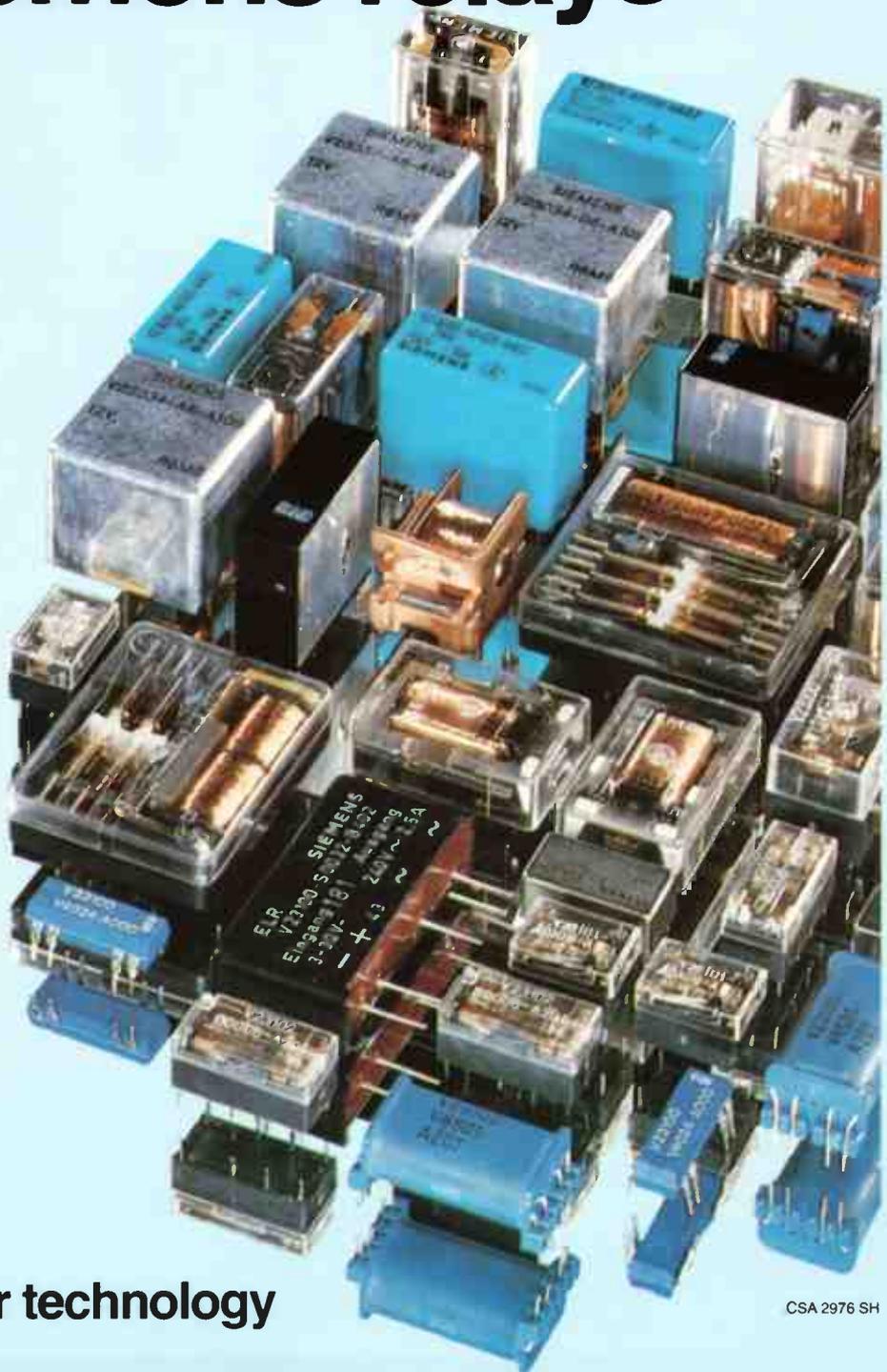
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