AUSTRALIA'S TOP ELECTRONICS MONTHLY
OCTOBER 1986 $4.75 NZ$6.50

The Australian Electronics Monthly

Incorporating Elektor Electronics

10 PROJECTS +!

Simple car alarm

Variable output electric fence

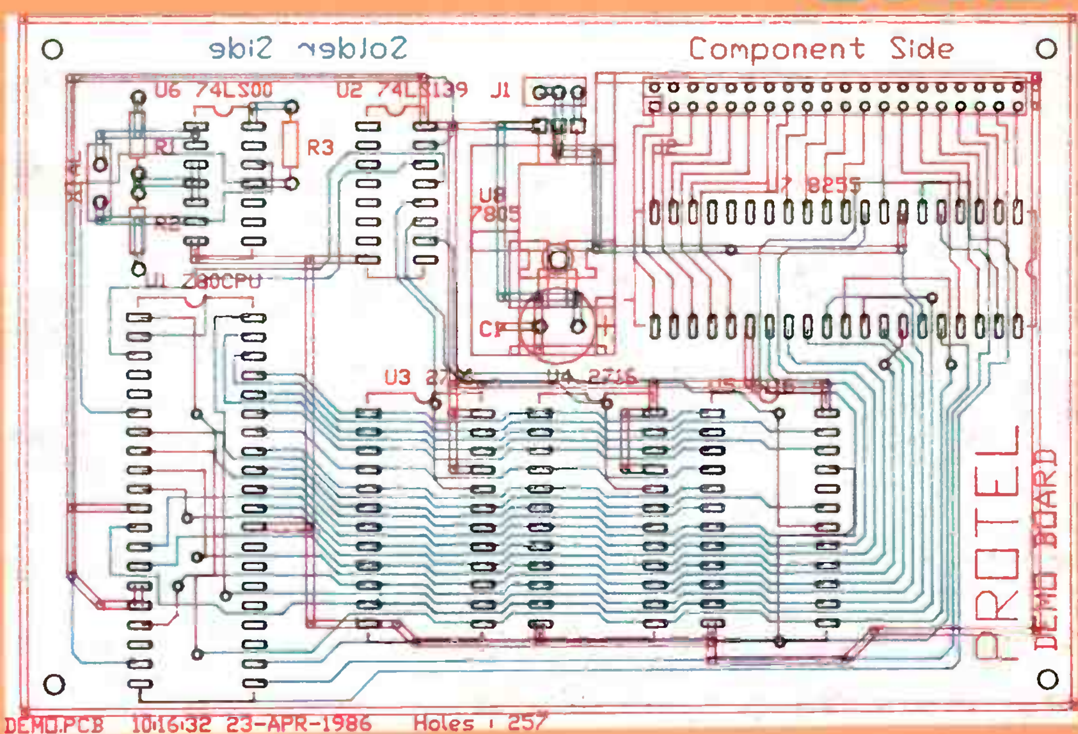
Headphone amp.

RF field strength meter

3-way Vifa speakers revisited

Serial digitizer

CAD



audio • video • computing • communications • projects • engineering • technology

"With my HP CAD sail a boat that

Ask Ben Lexcen what his most valuable design tool is and he'll tell you it's his Hewlett-Packard Computer Aided Design system. Here he talks about his experience with the HP system and offers some salient advice to the new generation of designers who will follow in his wake.

Have you always felt at ease working with computers?

"No way! Really I was a latecomer to computers because I didn't have any formal training and I was frightened of them. In fact, I used to dream up some wonderful excuses to avoid getting involved with them.

"But, of course, I realise now that if you're going to be a leader in any field, not just design, you've got to utilise the leading technology. And really this HP stuff is so easy to use, I'm not sure what I was frightened of."

Which parts of a boat do you design with the help of the computer?

"Virtually the whole lot, with the exception of tiny mechanical things. But we use it to design the shape and structure of the boat, and the sails.

"We use it to do all the hydro-dynamic considerations such as the total drag of the hull unit. Plus we use the computer to test different hull shapes."

What aspect of your involvement with Hewlett-Packard strikes you as being particularly beneficial?

"Well, once you become involved with HP, you'll soon realise that apart from their technical excellence and innovation, one of their major strengths is that they have the people to help you get the best results from CAD.

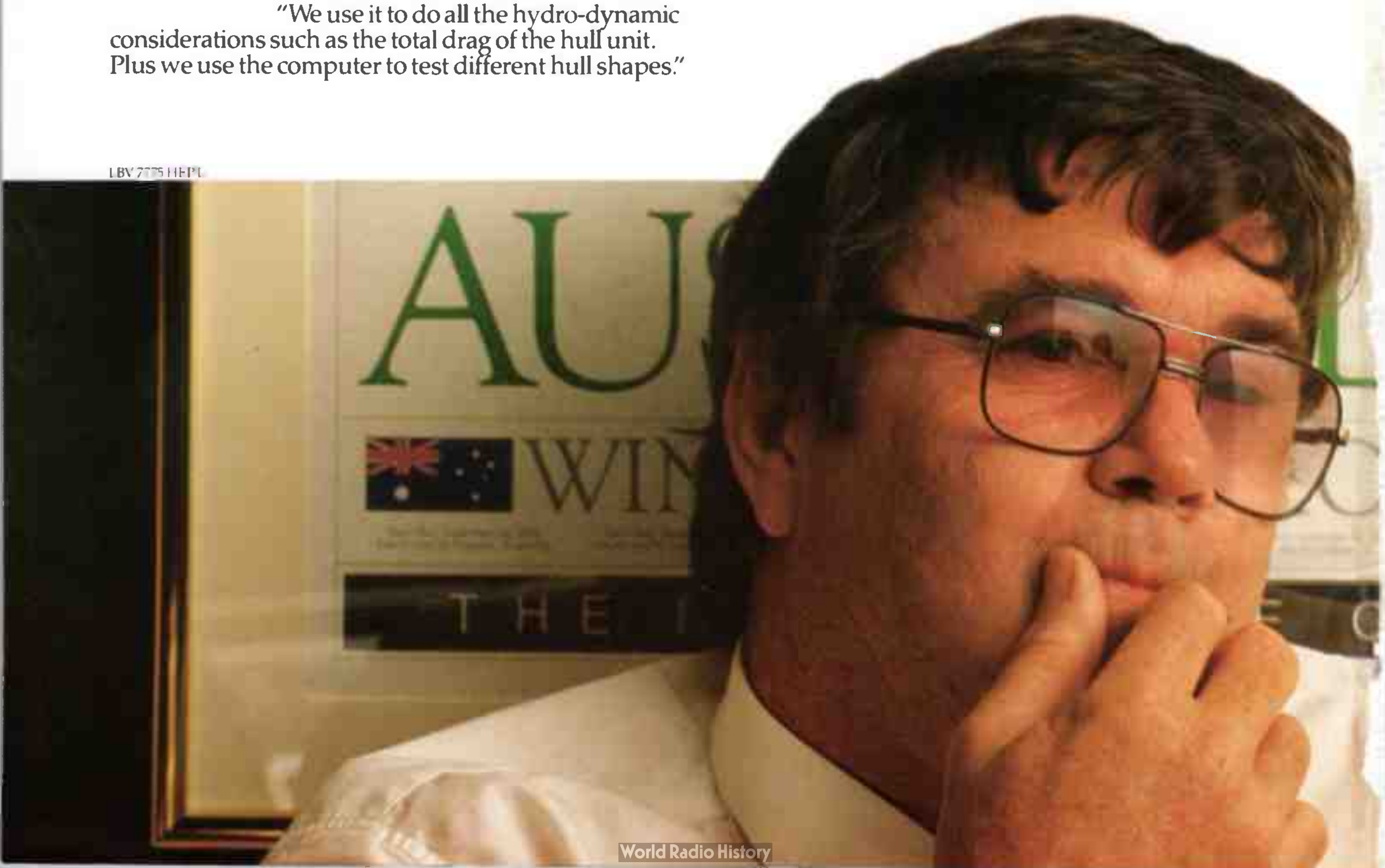
"Because HP supply the hardware and the software, you've got a terrific advantage over the guy who tries to work with a lot of different suppliers. I mean it counts for a lot when the person who writes the software understands the workings of the processor.

"If you've got questions or problems, you can get answers and solutions from the one place. And believe me, that can save a lot of time and worry."

How has the HP equipment assisted in the day-to-day running of your office?

"Well, it's staggering how much faster we can get things done since we plugged into HP. This is mainly due to the fact that the computer does so much of the calculation which we used to labour over manually.

LBV 7775 HEPL



system I can virtually doesn't exist."

"For instance, now I can create the basic shape of a boat in a matter of hours whereas it used to take about a month. It might take me about ten minutes to do a keel whereas before it might have taken a week."

Does saving so much time mean that you have to compromise on quality or accuracy?

"Absolutely not. The equipment is dead accurate and I can do a more thorough job for far fewer man-hours.

"In fact, we are so confident in the HP equipment that when we've settled on the design of the boat to defend the America's Cup, we won't tank test it in Holland, we'll test it here in the computer. And when you're talking about a million dollar boat, you've got to be damn sure you've got the right equipment to do it."

What of CAD in the future?

"Look – I'm sure that if Australian designers don't grab CAD with both hands and run with it, the rest of the world will pass us by. And once we all realise its potential, you're going to see a lot of very happy and satisfied people in all sorts of design offices."

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AUSTRALIAN ELECTRONICS Monthly

Elektor Electronics

WELCOME to AEM incorporating Elektor Electronics!

As we've been telling you over the past few months, from this issue we're incorporating material culled from the British issue of Elektor Electronics. We've made our first 'combo' issue a bumper, with the majority of projects and articles culled from Elektor's September issue, plus some material from earlier issues this year which we judge (or you've told us!) would be of interest.

We've incorporated some 40 pages with projects including things like a headphone amp, a serial digitizer for virtually any computer, a heart monitor, satellite loudspeakers and more. These, together with our own projects this month, presents over 10 projects!

We're confident you'll enjoy our first issue incorporating Elektor, and the many more to come.

Roger

Roger Harrison
Editor

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OFFICE:
Fox Valley Centre, Cnr Fox Valley Rd & Kiogle St, Wahroonga NSW.
POSTAL ADDRESS:
PO Box 289, Wahroonga 2076 NSW

ENQUIRIES
Advertising: Steve Collett (02) 487 2700.
Editorial: Roger Harrison (02) 487 2700.
Technical: Only after 4.30 pm EAST, David Tilbrook (02) 487 1483.

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COVER

Protel output plot, courtesy Tom Moffat and Uni of Hobart. Design by Angelika Koop.

PROJECTS TO BUILD

CIRCUITS & TECHNICAL

ELEKTOR IN AEM

PRACTICALITIES
featuring John East's Modular Music Synthesiser will return next issue.

PRACTICAL COMPUTING

The winner of Weller Crossword Competition No. 12 was

Mike Batty of St Ives in Sydney.

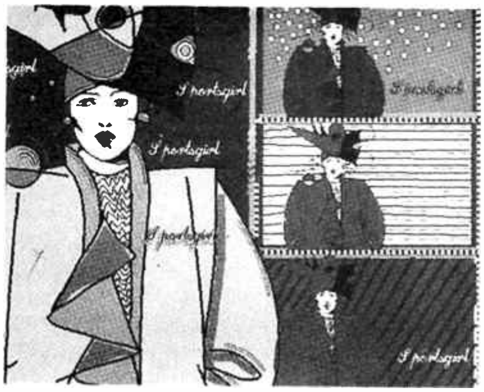
Thanks one and all for your enthusiastic support for this competition over the past year.

NEXT MONTH!

PINK NOISE GENERATOR
A pink noise generator is invaluable for evaluating loudspeaker performance (as discussed in September's letters) audio systems and room acoustics. This project, while a stand-alone unit, will feature as part of an upcoming third-octave analyser.

GUITAR EQUALIZER
Here's an effective parametric equaliser for guitarists, providing four filters: LOW, LOMID, HIMID and HI. The LOMID filter operates more or less over the fundamental frequency range, while the HIMID covers the upper fundamentals well into the harmonics. The other two are standard low-pass and high-pass filters.

COLOUR VIDEO INTERFACE FOR THE ATARI ST
The ST is one of the significant new computers introduced in the past few years. Unfortunately, its SCART video output makes it impossible in many cases for the machine to be readily connected to a colour TV set or monitor. This interface solves that problem.



Conjuring up a graphics revolution

If you can move a felt-tip pen around a pad you're suddenly in the same league as da Vinci, Picasso, Lautrec, Frank Lloyd Wright, Brunel . . . and others of their ilk, according to a Melbourne-based company, vision Control, who has developed a powerful computer graphics system for high quality two-dimensional drawing and 'painting'.

The system, known as "Conjure", runs on the IBM AT and some compatibles. That means it runs on an office desk, unlike most comparable systems claims Vision Control, which are usually housed in some kind of video production house.

Vision Control claim the system will revolutionise a host of enterprises in a wide range of fields — architecture, engineering, advertising, cartography, graphic design, education and marketing.

But the great flexibility of the Conjure system, the company says, creates opportunities for less obvious organisations. For example, Perth firemen now have all the city maps and buillding plans available on computer. When there is a fire, a graphic display shows important information on the site in text and pictures to assist the firemen's knowledge of the target.

The constabulary can use Conjure, too . . . as a 'video identikit'. A variant of Conjure is being developed for this application. To date, research on computer-run identikit systems has been restricted to large mainframe systems.

Images may be called-up from a 'library' or created and manipulated with a digitizing pad. Hard copy output can be obtained with a range of quality imaging devices, such as QCR or PCR high resolution film recorders, Tektronix 4692 or 4696 inkjet printers or the Matrix TT200 thermal transfer printer. A video output option provides true broadcast standard composite PAL video.

Conjure also has a video digitizing input option that provides the capability to capture images of objects, drawings and photographs with a video resolution of eight bits per pixel.

All a small company needs to catapult it into the 'big league', according to Vision Control, is one reasonably sized desk, an AT or compatible, the required options . . . and imagination! Imagine an art department with no paint, pencils, rulers, marker pens, Letraset and virtually no paper; imagine turning Polaroids into simple but stunning TV commercials; imagine adapting new maps (or other complex drawings) from old in less time than it takes to sharpen your red and blue pencils — says Vision Control.

Basically, Conjure is a little 'genie' that releases designers, engineers, artists and creative people from boring, repetitive tasks, the better to achieve more of what they're best at — thinking, drawing and just creating, the company says.

And to further motivate your interest in these parlous times, Conjure is fully Australian designed, developed and manufactured. Further details are available from **Vision Control International Pty Ltd, Miles St, Mulgrave Vic. 3170. (03) 560 2444.**

Dollar bust brings boom for electronics

The falling A$ is bringing some windfalls to the Australian electronics industry. Two local manufacturers have recently won contracts to supply locally designed and manufactured modules to Burroughs Ltd, the world's second largest supplier of computer systems, for their B25 range of business computer systems.

Victorian switchmode power supply manufacturer, Setec Pty Ltd, will supply power modules to Burroughs. They are the first Australian company, and only the second world-wide, to meet the standards set by Burroughs for this product.

The Sydney-based LSE Manufacturing, a division of the James Hardie Group, has already started delivering 256K RAM expansion boards to Burroughs. LSE produce the four-layer board here from go to whoa, beginning with parts procurement, construction, full environmental testing, packing and shipping.

Chalk up two strokes for the home side.

Meanwhile, the Roland Corporation is speeding up feasibility studies into the local manufacture of computer monitors and its top-selling plotter range as a result of the A$ drop against world currencies.

The President of Roland Corporation Japan, Mr Ikutaro Kakehashi, revealed the company's plans at the opening of their new office and warehouse complex in Dee Why West in August.

Digital diary beats FBT car log hassles

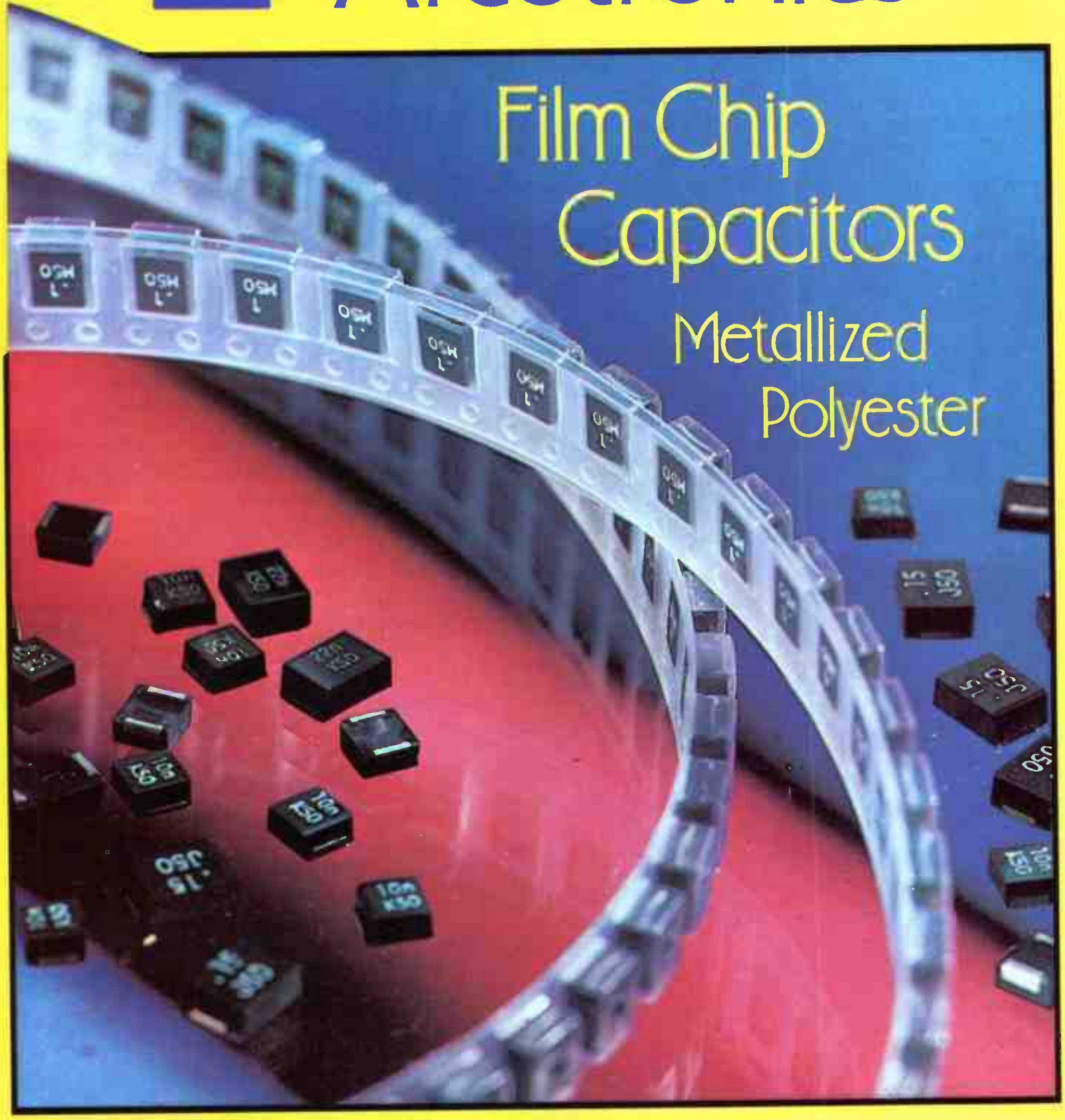
Logging vehicle use to comply with the new fringe benefits tax presents considerable hassles and generates mountains of 'paper warfare'. But a West Australian company, the Beaver Corporation, has come up with what they describe as an automatic electronic system that wipes away the paper piles, log books and the hassles.

Beaver Corp's Digital Diary istalls into any modern vehicle and automatically records the necessary log information — date, time, odometer readings, km travelled vehicle registration, etc. One vehicle with Digital Diary can separately record the usage of different drivers by means of PIN numbers (as with credit card systems).

The Digital Diary is used with any IBM computer or compatible and provides two standard report forms — a vehicle usage report and all individual trip details. Hard copy reports can be made and signed by the users.

Beaver Corp. claim the Digital Diary is easy to use, requiring single keystroke responses to simple on-screen menus. Report generation requires a minimum of user training and computer time, they claim. Demonstrations of the Digital Diary were held at the Perth Electronics Show recently. Further details from **Chris Campbell, Beaver Corp., Unit 7, 24 Thorogood St, Victoria Park 6100 W.A. (09) 361 7766.**

Arcotronics



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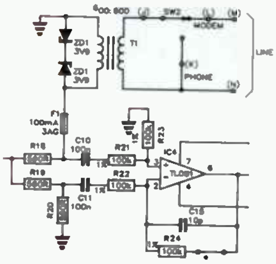

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Relieving the design drudgery with CAD

Roger Harrison

One boon the 'computer boom' has brought electronics engineers is the facility of computer aided design, CAD, at increasingly affordable prices. Where wordprocessing and spreadsheet computer programs are essential tools of modern managers, CAD programs and systems are rapidly becoming essential tools for today's electronics engineers.

FOR THE WORKING ENGINEER, technical officer or technician involved in the design and prototyping of electronic equipment, the low productivity drudgery bit is inevitably pc board draughting and circuit drawing. But, as they are two essential tasks, anything you can do or employ to reduce the time and effort spent reaps obvious benefits.

While computer aided design, or more specifically computer aided draughting, is not new, being originally developed on large mainframe systems, the 'personal computer revolution' has brought it literally to the desktop. Traditional draughting, whether electronic or any other type, involves principally a mental skill allied with a variety of physical skills.

Electronic draughting in particular involves the use of a defined set of symbols placed and interconnected according to a broad set of rules. The object is to embody an inntellectual concept — which is represented by a circuit — in visual form so that anyone "understanding the language" of the ▶

standard, stylised symbols understands the concept.

Printed circuit draughting is somewhat different. Restraints are far more rigidly applied — for sound electrical and mechanical reasons. e.g.: ICs are manufactured according to internationally agreed mechanical standards, and these determine the mechanical restraints on pc board layout.

CAD software packages aimed at, or useful to, someone involved in any aspect of electronic design and/or production are divided into two fundamental types — general 'draughting' or 'line drawing' packages and 'pc board layout' packages. They may be designed for use in typical 'desktop' situations running on something like and IBM PC, or similar, or rather larger systems employing one central computer shared between 'workstations'. Each has distinctive features — and failings — but we don't have the scope to go into those aspects exhaustively in this article.

The draughting process

Typically, circuit drawing commences with a pencil rough on a blank sheet of paper, working from top to bottom, left to right (conventionally). Unless you start with a large sheet, inevitably you end up crowding the drawing on the bottom or right — or somewhere! Such sketches are first working roughs that go through numerous changes involving much application of the eraser and elbow grease. A final draught may then be drawn, usually on squared paper for better planning and placement of the circuit symbols. From this, a final ink drawing on tracing paper is prepared. It may be traced directly from the rough, or laid over squared paper, using this as a guide for placement of the various component symbols, as before. Inevitably, even this drawing will end up being corrected at some later stage.

So, how is it all done on a computer?

There are many similarities and commonalities between computer draughting software packages, so I'll cover the salient features.

Firstly, you're given a grid to work on. The beauty of computer software is, of course, you get to specify the grid parameters to suit yourself. A cursor becomes your pen or pencil tip and you get the facility to move it around employing a convenient peripheral like a mouse or a 'digitizer' tablet. The computer mouse is probably a familiar device, but a digitizer tablet may not be. This gadget is simply a board with sensors that detects the position of a small 'cursor' you move over the tablet. This cursor's position is echoed by the on-screen cursor. Buttons on the digitizer's cursor allow you to mark the cursor placement, as well as serve other functions.

The software will present you with menus of commands suited to a wide range of draughting activities. For example, you can place your cursor at one point, mark the position, then drag your cursor to another position and mark it too, then select a command that draws a line between the two points. You may create a figure, such as a rectangle, and reposition it anywhere on the screen. You may also copy the figure and place the copy elsewhere on your drawing. You can create 'ranks' of symbols in an array, a very handy feature for digital and microcomputer circuitry (e.g: for creating banks of RAM).

Editing commands take the place of eraser and elbow grease. Generally, at least three editing commands are available, letting you erase portions of a drawing, copy symbols or portions of the drawing, as well as move elements of circuit portions.

The grid generated by the software serves the same purpose our squared paper did earlier. Generally, your cursor is confined to move only in increments set down in the grid, "snapping" from point to point. You may, however, have the freedom to move the cursor pixel by pixel, but using the snap facility generally speeds things immensely and permits greater accuracy when joining points and lines, closing circles, etc.

ARE MICROCAD SYSTEMS SUITABLE FOR PCB DESIGN?

Over the last 12 months there has been an extraordinary increase in the use CAD software on microcomputers with such packages as Autocad. The use of such software has been so wide spread that the general term "microcad" has come into use to distinguish them from the larger turnkey CAD/CAM systems. Microcad is being used in a variety of applications, particularly in electronics where there has always been a problem in the drafting of circuit diagrams and the preparation of printed circuit board artwork.

The effectiveness of microcad in electronics has been questioned, especially by those who use the larger turnkey CAD/CAM systems as thhey know how demanding circuit board design is on their machines and could not believe that a system one tenth of the cost could possibly do the job.

Some Microcad vendors claim their systems have similar performance and features to larger systems and at a fraction of the cost. In practice this is clearly not the case but microcad can be an invaluable tool in some applications. Microcad enables companies to achieve consistency, take advantage of repetition in drawings (e.g: repeatedly used symbols) and improve quality for very little capital outlay. In many cases, a 50% improvement in productivity will justify its introduction. A further benefit in adopting the microcad approach is that staff can be quickly trained, typically being productive within a week or so, and they can combine manual PCB design techniques with CAD by digitising manually prepared sketches.

What is frequently overlooked by companies in their eagerness to save thousands of dollars is the limitations of microcad systems. They are very effective on drawings of low complexity, but as complexity increases such factors as screen update times, screen resolution and speed of response to graphic edits begin to effect productivity. Another factor, which is far more difficult to quantify, is the increase in errors with complexity. Errors are easily made and difficult to detect on a low resoltuion screen. Microcad systems often have poor ergonomics both in terms of posture for the operator and due to the low screen resolution.

Microcad systems do not offer the huge potential productivity gains that the more expensive turnkey CAD/CAM systems or engineering workstations offer due to the lack of efficient design automation software such as autoplacement and autoroute. The maximum productivity gain achieveable on microcad systems is around 3:1 whereas, by employing automated design techniques, productivity gains can be up to 10:1. Also, the more expensive systems have comprehensive error checking, high resolution screens and very fast graphics. A possible drawback to the automated design approach is the high level of skill required and the time taken to reach proficiency, which can be from two to six months.

Once a company decides it has a problem which can be solved by using CAD, it must then determine whether microcad will meet their needs. They need to estimate average complexity of their drawings, volume and turnaround required and then decide on the range of systems that meet their needs. If, for example, a company has a requirement for a large number of high density circuit boards which have to be designed within time scales determined by other activities within a project than the turnkey CAD/CAM approach would be most appropriate. At the other extreme, a company that requires low density circuit boards and has occasional requirements for other types of drawings would be well served by the microcad approach. An approach some companies are taking is to do part of their work "in house" on microcad systems and to send the more complex work to a service bureau.

In conclusion, microcad is here to stay and will continue to increase in popularity. Prospective CAD system purchasers should be wary of how the limitations of microcad will affect their application.

Brian Watson
Tron Computer Graphics

When moving the cursor away from a marked point, a line is drawn from that point to the current cursor position, no matter where you place the moving cursor. This line 'stretches' as you move and the facility is called "rubber banding" for obvious reasons, and it allows you to see exactly what you're doing.

Lines of greater width than a single trace are obtained by drawing multiple lines immediately side by side. ▶

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Well, all that's fine, but circuit drawing involves repeated use of standard symbols and repeatedly drawing the same symbol is drudgery — and a right pain in the rectangle, hence "libraries" may be created. Such library symbols are often referred to as 'macros' or 'icons'.

In past years, Letraset created a range of rub-down circuit symbols for this very task. Some packages supply circuit symbol libraries, but any package worth its salt includes a library of what is termed "primitives". These are figures or partial figures, such as circles and arcs, which may be called-up on command and assembled to create another figure according to requirements. Thus, you can create your own library of circuit symbols "to taste".

Once called-up from the library and placed on-screen, your symbol or icon can be moved, rotated, copied or arrayed. In other words, it can be worked on just as if you had created it on-screen from scratch.

An advantage offered by CAD packages is the ability to "zoom" in on any small sector of your drawing so that you can pay attention to the close detail where necessary, as well as the ability to zoom out for an overview.

Some packages provide several "worksheets" which can be accessed from the current drawing. You may also have the facility to copy all or part of a drawing from one worksheet onto another. Another facility often seen in CAD packages is "windowing" — a familiar feature of many wordprocessing packages, but used here for supplementary 'scratchpad' purposes, menu selection, etc.

Inevitably, text has to be added to your drawing. Again, any CAD package worth its salt should provide for text entry to drawings. In general, you place your cursor where you want the text to commence, call up the text mode, then type in your text from the keyboard.

AutoCAD provides several 'layers' to work with, and you

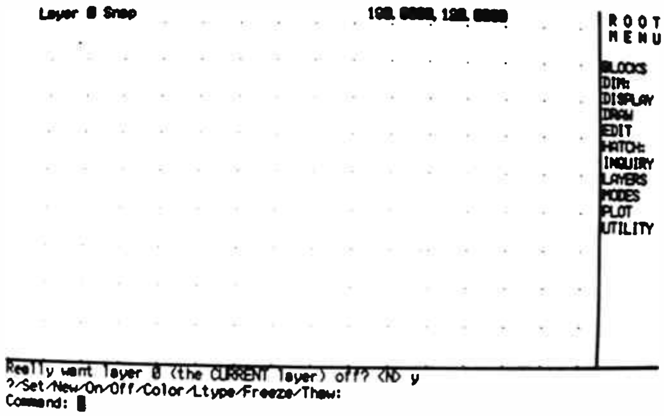


Photo 1. The AutoCAD Drawing Editor and Standard Menu represent the electronic drafting board on which drawings are constructed.

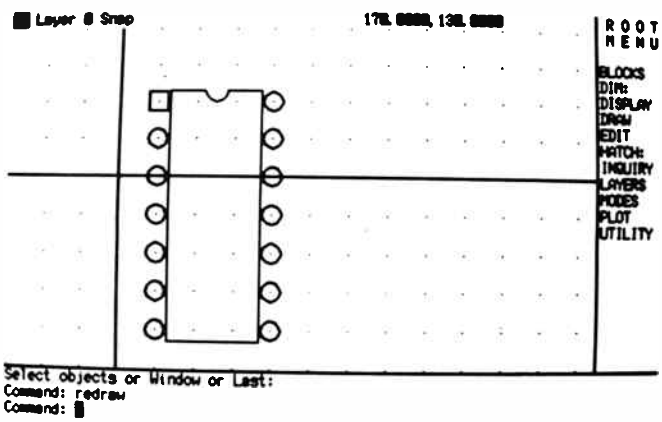


Photo 2. The creation of symbols for repetitive use are possible using simple drawing commands (primatives). A 14-pin IC is created with lines and circles, and is then saved to disk for later recall.

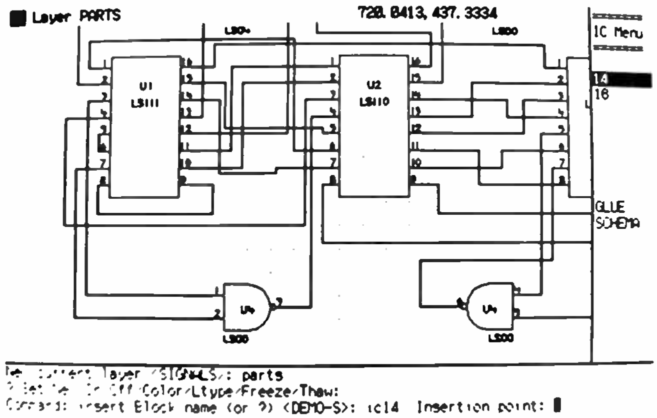


Photo 3. Schematic drawings can be created through a selection of symbols from a user-defined menu.

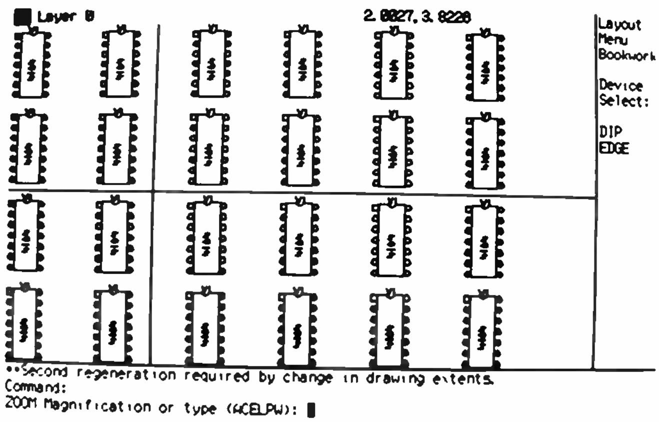


Photo 4. Use of the ARRAY command enables the construction of a memory bank of RAM chips. AutoCAD's editing commands can also move, copy, erase, stretch, scale and rotate.

can have several on-screen at one time. This is akin to working on several sheets of transparent film or tracing paper placed one on top of the other over squared paper in the 'traditional' drawing system. Text to go on a drawing, for example, is entered on one layer, after you've completed a drawing on a 'primary' layer.

All the circuit drawings done here at AEM and reproduced in the magazine from issue one, have been created on a package called "AutoCAD", a US product marketed here under licence by Entercom in Melbourne. AutoCAD runs on a number of popular PCs. The manufacturers recommend as a minimum, a system with a single floppy disk drive, a 10 megabyte hard disk, 640K of RAM and some kind of 'pointing' device, such as a mouse or digitizer, to drive the cursor. An 8087 maths coprocessor is a nicety (for speed), but not a necessity. The display requires a colour monitor screen having, as a minimum, a resolution of 640 x 350 pixels which means something like the IBM EGA colour graphics card or a Techmar card.

We created all the symbols 'from scratch', and they're stored on hard disk for day to day use, backed up on floppies.

What about the drawn result?

It is fundamental that you need acceptable quality hard copy output. Just what "acceptable" means depends on your applications and your pockets! Generally, this means a plotter of some description. Different packages call for differing plotter standards.

Basically, there are two plotter types: the flat-bed X-Y plotter and the "sweet lips" plotter. The former employs an arm that moves across (the X direction) a sheet of paper or film which is fixed to a platten (the 'bed'). This arm carries a pen on a transport which moves the pen up and down the arm (the y direction). The "sweet lips" type takes the paper or film, holding it between rollers on top and bottom which drive the sheet back and forth while a pen is transported to and fro across the paper. Each has its own advantages and disadvantages.

Some packages provide for output to a dot matrix printer for quick "check plots", often a handy facility. In some applications, it may provide 'acceptable' quality output.

Plotters that deliver good quality hard copy do not come cheap, and may push up the cost of your hardware by some 30% to 100%. If you do a considerable number of drawings, the cost may well be justified, but if you only require one or two a month, or fewer, then it's an expensive item to lease or purchase. For this reason, plotting service bureaus have sprung up. Generally, they offer to plot your work direct from disk for a fee. Some can take your drawing file via modem over the telephone network. Handy!

The output from your CAD package may be 'scaled' to size before plotting. This may be necessary to keep the entire drawing on a single sheet or to conform to a size standard.

Storage

The most common form of drawing file storage is the ubiquitous floppy disk. However, drawings can suck up positively huge amounts of memory and you may find drawings occupying a quarter meg of memory not uncommon. In general, we find an issue's worth of AutoCAD drawings require one or two DSDD floppy disks.

It seems most CAD programs require you to save a drawing to floppy or hard disk before it can be plotted. It's a feature that prevents costly and time-wasting "accidents".

Printed circuit design

The process of laying out a printed circuit has many similarities as well as many differences to line drawing of circuits. In pc board design, as in line drawing, one makes repeated use of common standard symbols — lead termination pads, DIL package layouts, etc.

Probably the most common (commercially, anyway) method used to date, and still widely practised, involves the placement of special plastic adhesive pads, pad layouts and tapes on a sheet of draughting film laid over a transparent grid sheet on a light box. These indicate the shape, size and location of conductors, lead terminations etc and are usually scaled at 2 x or 4 x actual size to enable easier manipulation of the adhesive pads and tapes to assist accuracy in the final result. This is necessary because the tape represents electrical conductors which must be laid down according to established design rules setting trace width, minimum spacing, etc. The process often involves delicate cutting of pad shapes and careful laying or redirection of tracks. An actual-size transparent 'phototool' is then made from this master.

Such taped-up artwork is not only laborious and thus time consuming to lay, particularly with large boards employing many components, but it's very fragile with only few corrections possible before the tape loses adhesion or the layout is otherwise damaged. If you later need to make a major change to such a layout, well . . . happy nightmares!

Software for pc board layout is "application specific" and at once both versatile and limited. The appropriate design rules are generally incorporated in such packages, leaving you to concentrate on the necessary major task of layout, a versatility which line drawing packages (which may be used for the same task) generally do not boast, without requiring an additional software 'module'.

Most pc board CAD packages feature multi-layer facilities, some include a facility for draughting component side annotation for the creation of silk-screen overlays during manufacture, solder mask facilities, etc. In addition, they generally incorporate in-built layout rules that ensures you can only place pads and tracks within the set parameters. For example, if a track needs to pass close to a pad, the pad will automatically be 'shaved' to guarantee minimum conductor separation.

As with the line drawing CAD packages, you are presented with a cursor which may be moved around the screen by means of keyboard keys, a mouse or a digitizer. In general, you will be supplied with a library of pads and pad layout icons which can be placed on-screen, rotated, moved, copied or arrayed as desired. ▶

FASTER TURNAROUND TIME FOR PCB PHOTOPLOTTING

The Tennyson Graphics Electronic Laser Plotter combines the versatility of a rotating drum with the speed and precision of laser optics for the rapid exposure of high quality phototools, the company claims.

Printed circuit designs are transferred to the plotting system from a CAD system. Standard Gerber photo plotter input is read into the system from 9-track magnetic tape of IBM compatible diskettes or transferred through the telephone system by modem.

The Tennyson Graphics' plotter is a raster plotter, so it has no aperture wheels. All specifications for tracks, pads, mirroring, step-and-repeats and nesting are entered on an alphanumeric terminal to individual job requirements.

A high speed minicomputer, backed by 9900 megabyte disk memory, runs exclusive conversion software, to turn the xy design into plot ready raster data.

The software interprets draftcodes to tables that can include emulation of both standard and customized apertures. Each set of apertures can include up to 96 different track widths and 96 different pad sizes and shapes.

The plotter's 40 x 73 inch format (1010 x 1850 mm) is the largest in the industry. It produces high quality photo tools up to 10 000 pixels per square mm. The laser exposes at consistently uniform density and causes no pinholes.

The photo plotting of a 200 x 200 mm double-sided PCB with four plots costs only $245.

Tennyson Graphics claim a turnaround time of less than 48 hours. Contact **Tennyson Graphics, 993 North Rd, Murrumbeena, Vic. 3163. (03) 579 0424.**

Tracks are drawn between connection points by one of two methods — manually, or by "auto-routing". In the manual method, you start at one point and move the cursor around the board as you would a pen. Track width may be specified before you start. Some packages allow right angle bends (i.e: Protel-PCB), while others fillet the corners at 45 degrees (e.g: Smartwork).

Auto-routing does the job for you, employing a complex software algorithm. You have to leave your system running for many hours while it completes the task (depending on the software algorithm and the speed of your hardware), but it will prove quicker than you, especially on large boards with many components. Some packages (the more expensive ones!) can auto-route over multilayer boards, while others can only cope with one layer at a time. Nevertheless, it must be pointed out, you will end up with a number of uncompleted tracks because the program cannot find a route and you have to solve the problem youself.

While line drawing CAD packages feature an array function for repeating symbols or sub-drawings, pc board CAD packages may provide a "step-and-repeat" function which enables rapid generation of repetitive board layout sections, such as RAM. You will also see "cut and paste" functions where a layout section or area can be marked out, moved, copied or saved for later use. In this way you can create 'standard' layouts or sub-layouts which can be stored and used over and over again.

A "cleave" function is featured with some pc board CAD software. This allows you to 'stretch' a layout on one axis while maintaining the connections previously established. Just the thing for adding extra devices in a layout without having to start a section, or the whole board, over again.

For obvious reasons, hard copy output for pc CAD packages requires a plotter. Many packages provide the facility of choosing 1:1, 2:1 or even 4:1 format artwork. Most provide for some sort of "checkplot", usually on a dot matrix printer operated in high resolution graphics mode. Such plots may be used on occasion to make prototype boards (we've done it!)

Here at AEM, we've used a program called Smartwork since issue one. It is also a US package, manufactured under licence here by Entertainment Audio of Adelaide. Smartwork features "conductor sensing", which prevents the accidental shorting of tracks.

Smartwork is especially good for pc board layout of digital circuitry, or circuitry which is predominantly digital, although we have used it for all-analogue boards on occasion. AutoCAD we've used principally for analogue circuitry board layouts, but we have employed it for the odd digital board.

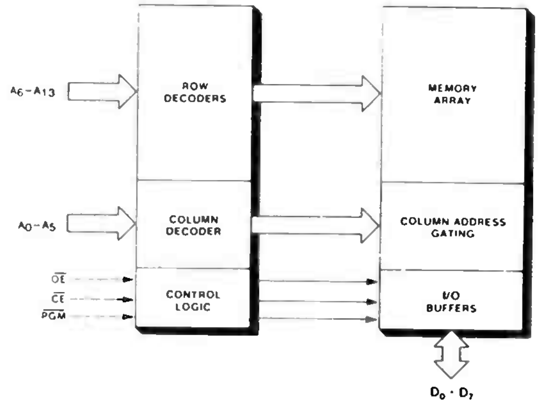
In conclusion

CAD draughting packages can certainly relieve the design drudgery — a fact we can personally vouch for! CAD software for desktop PCs are relatively new and this 'overview' is necessarily limited to a fairly fundamental level. If you're prepared to pay the price, all sorts of bells and whistles are available. The current position has probably been best summed-up by Murray Stein of Entercom, who said: "It's important to remember that CAD hasn't been around all that long. And it certainly hasn't been affordable either. But the increasing sophistication of microcomputers and software is now making possible what could only be imagined a few years ago. The future is indeed bright."

We gratefully acknowledge the assistance of the following people during the preparation of this feature: Peter Messner of Entertainment Audio, Murray Stein of Entercom, Mike Lovell of Quest, Brian Watson of Tron Computer Graphics and John Irving of Penman.

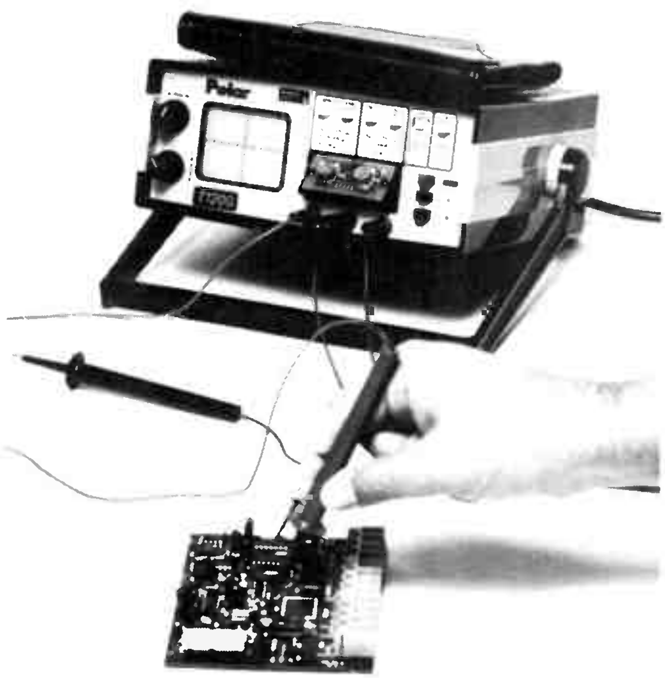
PROM erased in a flash

A new 128K PROM from SEEQ Technology combines both EPROM and EEPROM technologies to give a high density, low-cost, non-volatile Quick Electrically Erasable PROM, or QPROM. As it is bulk-erasable, the 48128 Flash QPROM is an ideal memory device for applications requiring high density PROM and infrequent in-system updates, such as program store, SEEQ claim.



The device features a 200 ns read access time and can be electrically erased in as little as 20 seconds. Once erased, a byte write may be performed. Only a single high voltage supply is required for chip erase or byte write operations.

Full details and data sheets are available from **Arthur Seaton, RAE Industrial Electronics, Suite 203, 109 Alexander St, Crows Nest 2065 NSW. (02/ 439 7599.**



In-circuit faults locator

A powerful new tool from Polar Instruments to help in quickly locating circuit faults, especially those difficult-to-find ones, has been released by Emora Instruments.

Using the model T1200 (or T1000 connected to an oscilloscope in XY) the technician or engineer has a flexible troubleshooting aid. Faults can be located on unpowered electronic boards and quickly isolated to a particular component, according to Polar.

Troubleshooting can often be performed WITHOUT a detailed knowledge of the faulty circuit's action, Polar claim. This method allows the rapid detection of defective components unlike conventional techniques which require a highly trained technician and often lead to excessive fault finding times.

In addition, simple transistor curve tracing features are available, allowing devices to be checked for gain etc, and matched where necessary.

General faultfinding on a wide variety of unpowered boards is achieved using the LO or HI ranges. These product a current-limited ac test voltage across a pair of probes plugged into the front panel. The probes are connected between two points on the faulty board and the display shows the impedance 'signature' seen by the probes, i.e: the current/voltage characteristic of the components between the probes is plotted.

The display can be used to locate faults in two ways: (i) by recognition of a suspect or faulty type of display; (ii) by comparison with a known good board. Comparison between a known good board and faulty one allows the defective component to be rapidly located.

Two channels are provided so that the unit can switch alternately between a good and faulty board to compare the two signatures.

Simple single button selection allows the full output characteristics of most devices to be displayed.

All probes and interconnecting leads are supplied and housed in a pouch on top of the instrument.

Details from **Emona Instruments, PO Box K720, Haymarket 2000 NSW. (02) 212 4599.**

Portable circuit analyzer

A new circuit analyzer tool, developed by Epson Computers to provide easier and faster troubleshooting and product analysis, is now available in Australia.

Based on the company's PX4 portable computer, the compact new tool performs essential diagnostic functions which would normally require expensive, specialised oscilloscopes and logic analyzers, Epson claim.

Epson's technical support manager, Mr Norm Sturdy, said day to day repair work will now be much easier and service staff will appreciate the tool's portability and versatility.

With an input of 16 channels the circuit analyzer displays waveforms of eight channels simultaneously up to 20 MHz.

Timing diagrams can be magnified by up to 32 times and state tables can be displayed in hexadecimal or binary notation. Both can be printed out with either 80 or 136 column printers.

As a digital oscilloscope, the device has a digitizing rate of up to 200 kilo samples per second. Equipped with two A/D converters, two channels can be measured simultaneously without affecting the digitizing rate, Epson claim.

For further information, contact **Norma Flint, Epson Australia Pty Ltd. (02) 452 5222.**

A "STAR" is born

Meltec, Australian distributors of the MES range of equipment from America, announces an SMD removal/replacement machine called STAR (SMD Terminal for Assembly and Rework).

STAR is predominantly robotic, reducing operator skill requirements to a minimum level. Design considerations were, no damage to either the PCB or the component being removed, no damage to adjacent components, used for limited assembly as well as rework, minimum time to complete the job (usually under 20 seconds), and maximum cost effectiveness.

STAR is the only system available that incorporates a feature that breaks the bond between a component and the PCB without the use of external devices or tools, according to the makers.

For further information, contact **Meltec P/L (02) 708 4300.**

Low-cost storage CRO from Parameters

Parameters has released a low-cost 20 MHz, two-channel digital storage CRO from Dynascan Corporation, makers of the B&K Precision range of instruments.

Known as the model 2520, it features a sampling rate of two megasamples per second and 1024 × 8 bit per channel storage. It also features pre-triggering at 0%, 25%, 75% and 100%. Full specifications are obtainable from **Parameters Pty Ltd, PO Box 261, North Ryde 2113 NSW. (02) 888 8777.**

New auto-tranny

Electromark now stocks a 5 kA version of the Matsunaga M-type variable auto-transformer. These slide regulators are suitable for any equipment which is controlled by voltage variation. The range now stocked covers power ratings from 500 VA to 5 kVA.

The M-types, ranging from 500 VA to 10 kVA are manufactured in Japan to Electromark specifications for Australian use. All units up to 20 amps incorporate Australian standard output sockets and are fitted with input cords and plugs. A voltmeter is fitted as standard equipment, and models up to 15 amps have a circuit breaker or fuse.

Further details from **Electromark Pty Ltd, PO Box 184, Mortdale 2223 NSW.**

Handheld sound level meter

A handheld microprocessor-based sound-measuring instrument from Britain offers outstanding accuracy and ease-of-use advantages, the makers claim.

The CEL 493 Precision Integrating Impulse Sound level Meter from Lucas incorporates a 100 dB single measurement span covering the most common sound level range.

A microprocessor is used to provide a custom-built liquid

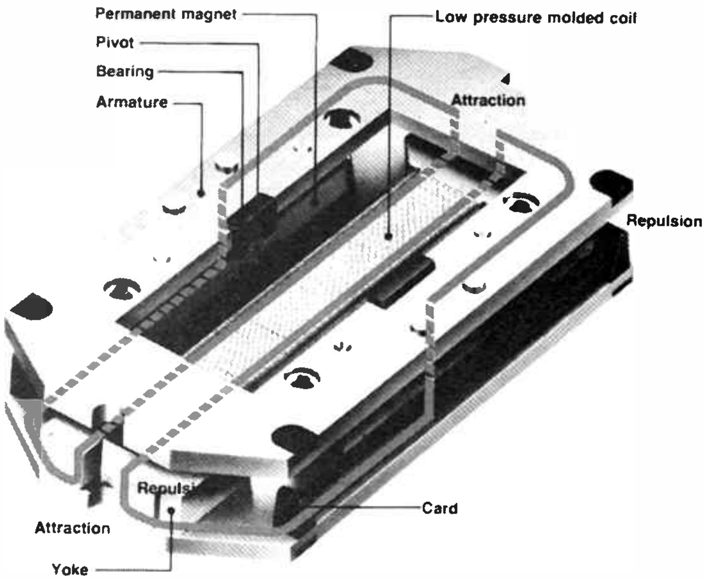
crystal display of the precise digital readout and a simultaneous analogue bargraph display for fluctuating levels. In addition to displaying 'A'-weighted sound level, the meter will also calculate, store and display L_{eq}, L_{max} and measurement duration.

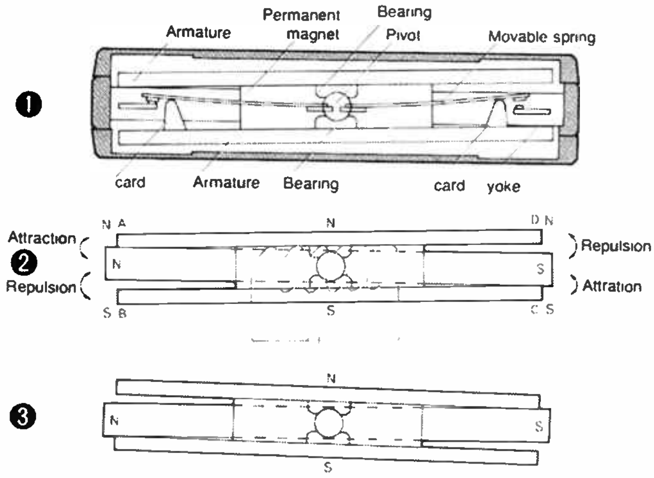
The meter's display indicates overload condition, low battery power, measurement pause and measurement reset in addition to parameter and numerical value. By using the soft-key controls, answers can be brought to the LCD for digital display. Indicators in the display show which parameter is selected, and the pushbutton method adopted eliminates the need for special codes to obtain data display.

A versatile computer interface allows remote measurement parameter selection, remote measurement start and stop and data transfer of measured results. Sound-level samples can be transferred at a rate of two per second.

The meter exceeds the requirements of IEC-651 Sound Level Meters and IEC 804 (proposed) Integrating/Averaging Sound Meters in the Type 1 category.

Details from **Selby Anax, 352-368 Ferntree Gully Rd, Notting Hill Vic 3168.**





This horizontal-mount flat pack polarised relay employs a four-gap balanced armature mechanism featuring a double loop magnetic circuit to achieve high sensitivity. (National SA relay, courtesy RVB).

RELAYS — technology and application techniques

Part 2

Concluding with practical suggestions on contact protection techniques, switching circuitry and coil driving.

Roger Harrison

AS YOU would appreciate from the previous discussion, there's more to employing a relay than just connecting its coil and contacts in circuit. To do the job required, you need to see the contacts are properly operated and that the coil is properly 'driven' and its back-emf dissipated.

Contact protection

For the reasons covered, relay contacts are best operated at or near the manufacturer's ratings. Some loads will cause large currents to flow for very short periods at switch-on and/or switch-off. Filament (incandescent) lamps and capacitive loads cause extremely high currents to flow at switch-on (in-rush current). Typically, for ac-operated lamps, in-rush currents are 10-15 times nominal load current and last up to 350 ms, while for capacitive loads in-rush currents are 20-40 times nominal load current and may last only 30 ms or less. Generally, relays having contacts rated to carry the expected in-rush current are specified. Such relays will have heavy-duty contacts and relatively high contact pressures.

While it has been said that arcing is good for relay contacts, excessive arcing is destructive. In addition, it generates a measure of RF interference, which may be undesirable if coupled into sensitive circuitry or equipment nearby.

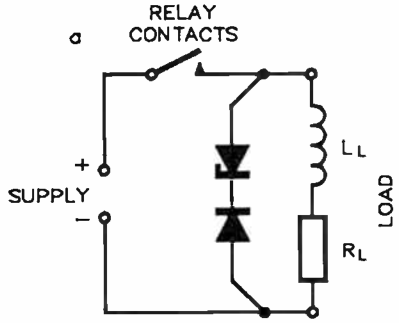
A variety of means are employed to quench excessive arcing, depending on the load and the application. In low voltage applications (under 30 V) where the load is resistive a capacitor connected across the contacts, preferably as physically close to the contacts as possible, will do the job. The capacitor's value is not all that critical — the lowest value that does the job is all that's required, really. That may lie anywhere between 10n and 1u, or so. A resistor in series with the suppression capacitor is necessary in higher voltage applications (and is a good idea anyway). It serves to absorb some of the arc energy during contact breaking and limits the capacitor's discharge current when the contacts close. The series resistor value should be above 10 ohms, but below 2k.

In dc switching applications, inductive loads present special difficulties for considerable contact arcing will result when the relay contacts open. This causes excessive heating and contact erosion. The load inductance's back-emf can be clipped by means of a series diode-and-zener arrangement shown in Figure 5(a). The components should be connected across the load, and as close as physically possible to it. A suitably rated Varistor may be substituted instead of the diode-and-zener.

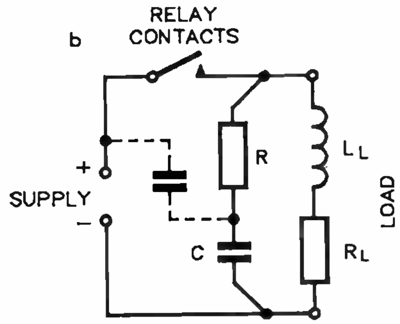
Alternatively, a simple series R-C combination may be used, connected directly across the load and physically close to it, as shown in Figure 5(b). The resistor may be any convenient value under about 2k, but little is gained by using values below 470R. The capacitor may be any convenient value between about 47n and 2u, depending on the magnitude of the back-emf. The higher the capacitor value, the better the suppression. The capacitor should have a voltage rating well above the circuit's expected peak voltage. The R-C combination could also be shunted directly across the relay contacts (as shown by the dotted capacitor position in Figure 5b). For a guide to values, see "R-C Contact Quenching".

The best contact protection is afforded by the combination shown in Figure 5(c), with an R-C shunt across the contacts having a diode in parallel with the resistor. Here, the capacitor charges via the diode when the contacts are open, and discharges via the resistor when the contacts are closed.

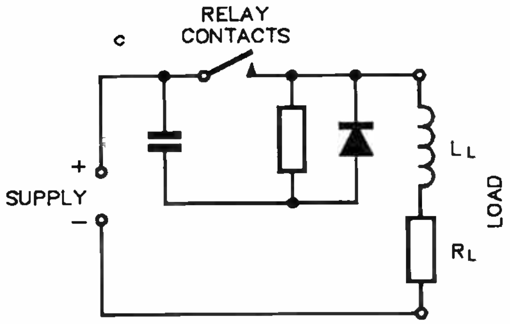
Figure 5. Recommended contact protection schemes when inductive load dc circuits are to be switched. (See text).



(a) A diode and zener across the load clips the back-emf oscillations following switch-off. The zener clamps the large negative swing, the diode clamps any following positive excursions, suppressing any contact arcing from this cause.



(b) Simple R-C protection. You can attach a series R-C combination either across the load or across the contacts.



(c) The most effective protection of all. The contacts are R-C 'quenched', but the capacitor charges rapidly via the diode during the break and discharges via the contacts and resistor during make.

R-C values are obtained from "R-C Contact Quenching". The capacitor and diode should have voltage ratings above the expected peak voltage.

Where the load is located some distance from the relay, the capacitance of the interconnecting line may cause a substantial in-rush current to flow. The relay contacts should be rated and protected accordingly.

In ac circuits, an inductive load will generate a considerable back-emf if the relay contacts open at the peak of the cycle — the back-emf may be thousands of volts! A Varistor across the load can absorb this and relay contacts may be protected as illustrated in Figure 6. The diodes' peak reverse voltage rating should exceed the ac supply's peak-to-peak value, and the capacitors rated above the ac supply's peak value. Capacitor values should be around 1u per amp switched. The resistor should be rated at 1 W or above and may be a fairly high value. e.g: 100k or more.

Simple R-C contact suppression can be effective in low voltage ac circuits (say, under 50 V) with inductive loads. As a guide, the R-C time constant should be similar to that of the load (if known), but the load impedance must be substantially lower than the R-C combination. For this reason, relay contacts in loudspeaker protectors have no contact arc quenching.

Relay driving clues

Relay coil current should be turned on and off abruptly to avoid contact "chatter" and unstable closure and release times.

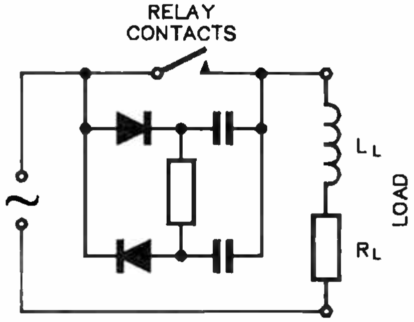
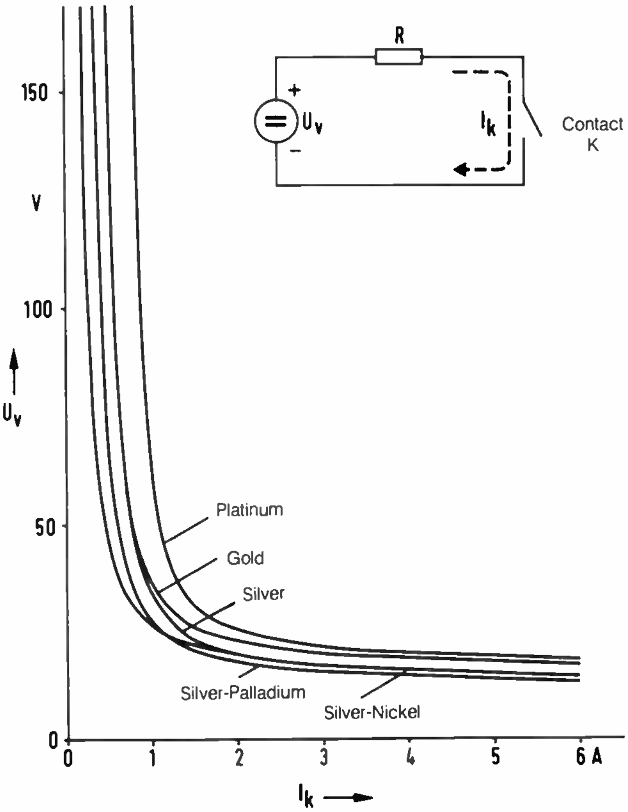


Figure 6. R-C contact arc quenching in ac circuits with inductive loads. In these situations, if the contacts close when the supply cycle is at or near zero and the increasing voltage of the next half wave has the same polarity as the inductor's remanent magnetism, the inductor's likely to saturate, allowing a huge in-rush current that may be 40 times the steady-state current! Apart from generating massive RF interference, such transients can destroy contacts and perhaps circuit components attached.



In some applications, arc-free switching is called for, particularly where a relay must operate in close proximity to sensitive RF equipment. This graph (from Siemens data) shows limiting voltage/current curves for a variety of contact materials. For a given contact material, arcing will not occur if the values of both voltage and current being switched are both below the limiting line for that material.

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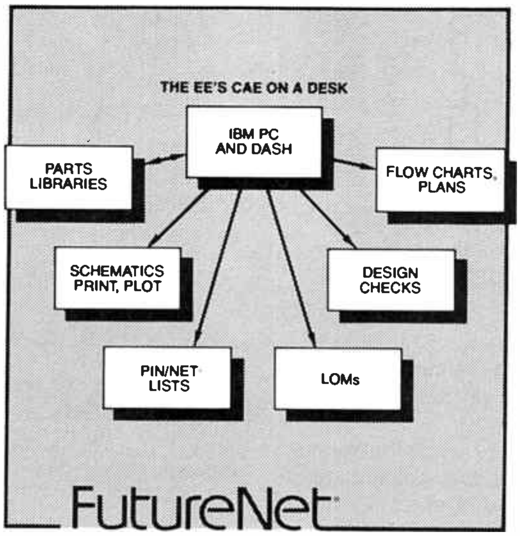

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If you're employing a transistor current amplifer to drive the relay, and require a two-stage circuit to achieve the required current amplification, avoid the use of a Darlington pair circuit because excessive dissipation results in the input transistor, which does not saturate. It is better to employ an emitter-follower input driving a common emitter stage with the relay coil in the collector of this stage.

Where several, separately activated, relays are employed in a circuit sharing a common supply rail, each should have one terminal in common.

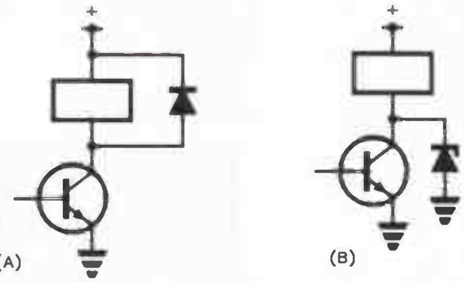
Contact closure time can be sped up considerably by the simple expedient of connecting a lamp in series with the coil, the lamp and relay coil each being rated at half the supply voltage. The lamp's "dark" resistance is considerably lower than its "on" resistance. Thus, the relay coil will be initially driven at about 200% of its rated voltage.

If a relay is located a long way from its driving source, distributed capacitance in the wiring to the coil can slow down closure and release times. It's better to place the drive circuit as close as physically possible to the relay.

Dissipating the back-EMF

Whenever you release the current flowing in a relay coil, the collapsing magnetic field generates a voltage across the coil terminals that's proportional to the coil inductance and opposite in polarity to the energising voltage. This is known as the "back-emf". In some relays, though rated to operate at, say 12 Vdc, the back-emf may be hundreds of volts! If you're using a transistor or IC output to switch the relay coil current, this will almost certainly have disastrous consequences.

The most common method employed to dissipate the back-emf is to connect a diode in the circuit so that it will not conduct during coil energisation, but will conduct when the coil is de-energised and generates the back-emf. This is shown in the circuit (A), here.



Though widely used, this technique has a drawback in that it lengthens the relay release time. If this is important, a better method is shown in circuit (B), here. The zener should have a knee voltage some 20-50% greater than the supply voltage, but less than the transistor's Vceo rating.

Bibliography

(1) "Electronic Inventions 1745-1976", G.W.A. Dummer, Pergammon Press, 1977. ISBN 0 08 0209823.

(2) "The Ultimate in Relay Technology", Hans Sauer, Elektronik Industrie 11/82, pp 35-38.

(3) "Everything You Always Wanted to Know About Relays", Collyn Rivers, ETI 2/84, pp 12-27.

We would like to acknowledge the kind assistance of RVB, Koloona Industries and Promark in the preparation of this feature.

MAGNAVOX SPEAKERS

Jaycar proudly announces in line with our support Australian Made campaign we are stocking quality Magnavox speakers. Magnavox recently undertook a total change with new owners who are striving to bring you world class speakers made right here in Australia.
Over the last few years Magnavox have gradually been improving each of their drivers and we can now offer you much improved specifications with much higher power handling. For instance, the 8.30 replacement, the 8MV will now handle 100 watts RMS, a far cry from the 30 watts RMS of the old version.

8MV-003

8/30 Replacement

If you own a pair of 8/30 woofers, you can now easily upgrade them. Your old 8/30's handle 30 WRMS, the new 8MV's handle 100WRMS. No need to buy new cabinets. 8MV's mount in the same hole.

Power handling: 100WRMS
Resonant Freq.: 32Hz
Freq. Range: fo - 4000Hz
Sensitivity: 95dB
Cat. CW-2110

$89.50 each

AUSTRALIAN MADE

12MV-012

The 12MV is a high power high fidelity woofer utilising a 38mm diameter long throw voice coil wound on an aluminium former and high compliance suspension with a polyurethane foam roll surround, resulting in excellent linearity at very high input powers.

Power handling: 100WRMS
Resonant Freq.: 23Hz
Freq. Range: fo - 3000Hz
Sensitivity: 96dB
Cat. CW-2125

$69.50 each

NEW

8W-020

The 8W Mk 6 is a high fidelity woofer utilising a 25mm diameter long throw voice coil wound on an aluminium former and a high compliance suspension with a polyurethane foam roll surround, resulting in excellent linearity at high power.

Power Handling: 60WRMS
Resonant Freq.: 44Hz
Freq. Range: fo - 4000Hz
Sensitivity: 96dB
Cat. CW-2109

$32.50 each

8WR-020

The 8WR is a high fidelity wide range driver utilising a 25mm diameter long throw voice coil wound on an aluminium former and a high compliance suspension with a polyurethane foam roll surround. An auxiliary cone has been fitted to extend the H.F. response by over 1 octave.

Power Handling: 50WRMS
Resonant Freq.: 44Hz
Freq. Range: fo - 15kHz
Sensitivity: 96dB
Cat. CE-2338

$34.50 each

AUSTRALIAN MADE

8JX

The 8JX is a 8" twin cone speaker suitable for medium power handling applications.

Power Handling: 30WRMS
Resonant Freq.: 44Hz
Freq. Range: fo - 14kHz
Sensitivity: 93dB
Cat. CE-2333

$26.50 each

GORE HILL OPEN UNTIL 4p.m. SAT AFTERNOON

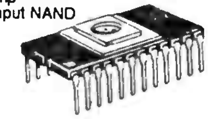
Jaycar's advertisements are now produced totally by computer utilising the lastest in laser technology and desk top publishing.

JAYCAR'S GIANT SEMI SELLOUT

I.C. SALE

Shown below are some incredible bargains in I.C.'s. Some I.C.'s here are now very scarce.
(NOTE: prices INCLUDE sales tax!)

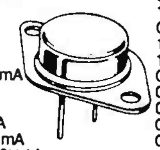
Cat. No.	Description	1-9	10-99	100+
ZZ-8061	6821 MDS PIA	3.00	2.50	2.00
ZZ-8055	6809 CPU	5.00	4.50	4.00
ZZ-8414	2114 RAM	1.50	1.25	0.95
ZS-9500	6810A RAM	2.50	2.00	1.50
ZS-9501	2708 EPROM	3.00	2.50	2.00
ZS-9502	MC14412 MODEM	10.00	6.00	5.00
ZS-9503	MC14411 Bit Rate Generator	8.00	5.00	4.00
ZS-9504	LM370	1.00	0.80	0.50
ZS-9505	4538 Monostable	1.00	0.80	0.50
ZL-3301	LM301 Op amp	0.60	0.50	0.40
ZS-9506	MC1408LS D/A Convertor	4.00	3.00	2.00
ZS-9507	MC14490 Hex CB Eliminator	2.00	1.50	1.00
ZS-9508	75451	1.00	0.80	0.50
ZC-4528	4528 Multivibrator	0.80	0.50	0.40
ZS-9510	74S138 Decoder/Demultiplyer	2.00	1.80	1.50
ZC-4011	4011 NAND	0.40	0.35	0.30
ZC-4049	4049 Hex inverter	0.80	0.60	0.50
ZS-9511	COM2017 VART	2.00	1.80	1.50
ZS-9512	DG201 CJ Interrupt	2.00	1.80	1.50
ZS-9513	74S04 Hex inverter	0.50	0.40	0.30
ZS-9514	74LS352 (Inverting LS153)	1.50	1.00	0.80
ZS-9515	96LS02 Input NOR x 4	0.80	0.50	0.40
ZS-9516	74188	0.50	0.40	0.30
ZS-9517	XR556	1.00	0.80	0.50
ZS-9518	MCI 4411 Bit Rate Generator	5.00	4.00	3.00
ZS-9519	LM317H (TO-5)	1.00	0.80	0.50
ZS-5807	7407	0.50	0.40	0.30
ZS-9520	78M15 Regulator	0.50	0.40	0.30
ZS-9521	6800 CPU	4.00	3.00	2.50
ZS-9522	DG211 CJ Analog switch	1.00	0.80	0.50
ZS-9523	79MO5C Regulator	1.00	0.80	0.50
ZS-5366	74LS366	0.80	0.50	0.40
ZS-5005	74LS05	0.50	0.40	0.30
ZC-4502	4502	1.00	0.80	0.50
ZC-4050	4050	0.50	0.40	0.30
ZS-9524	78M12 TO-220 500mA	0.80	0.50	0.40
ZS-9525	74L04 Hex inverter	0.50	0.40	0.30
ZS-9526	7403 Q 2 input NAND	0.30	0.20	0.15
ZS-9527	4521	2.00	1.80	1.50
ZS-9528	74145	0.80	0.60	0.50
ZS-9529	LM348	1.00	0.80	0.50
ZS-9530	78L05 Regulator	0.80	0.60	0.50
ZS-9531	741TC Op amp	0.50	0.40	0.30
ZS-9532	7410 3 x 3 input NAND	0.40	0.30	0.20
ZS-9533	7426N	0.30	0.20	0.18
ZS-5085	74LS85	0.60	0.50	0.40
ZS-5175	74LS175	0.70	0.60	0.50
ZS-5273	74LS273	1.50	1.20	1.00
ZS-5373	74LS373	1.50	1.20	1.00
ZS-9534	8T26	2.00	1.50	1.00



TRANSISTOR SALE

Shown below are some incredible bargains in semis. BUY IN BULK AND SAVE!!
(NOTE: Prices INCLUDE sales tax!)

Cat. No.	Description	1-9	10-99	100+
ZS-9560	2N5415 PNP200V 1A	0.50	0.40	0.30
ZT-2297	2N2646 Unijunction	0.80	0.75	0.65
ZS-9562	PN3568 NPN 60V 500mA	0.18	0.12	0.10
ZS-9653	BD680 PNP 80V 4A	1.00	0.80	0.70
ZS-9564	2N5416 PNP 300V 1A	0.60	0.45	0.35
ZS-9565	BD650 PNP 100V 8A	1.50	1.20	1.00
ZS-9566	2N6211 PNP 275V 2A	1.00	0.80	0.65
ZS-9568	2N5400 PNP 120V 600mA	0.30	0.20	0.18
ZS-9569	2N4092 FET	0.30	0.20	0.18
ZS-9570	2N2647 Unijunction	0.80	0.75	0.65
ZS-9571	2N1480 NPN 100V 1.5A	0.30	0.25	0.18
ZT-2298	2N2222A NPN 30V 800mA	0.30	0.25	0.18
ZS-9573	MPS4356(MOT) PNP 80V 1A	0.50	0.40	0.35
ZS-9574	2N4036 PNP 65V 1A	0.20	0.12	0.05
ZS-9575	2N4356 PNP 80V 500mA	0.12	0.08	0.05
ZS-9576	SE4010 (FAIR) NPN 25V 300mA	0.08	0.05	0.03
ZS-9577	2N398B (GERMANIUM) 100V 200mA	0.30	0.20	0.15
ZS-9578	2N2905A PNP 60V 600mA	0.20	0.10	0.08
ZS-9579	BC178 TO-18 20V 100mA PNP	0.15	0.10	0.05
ZS-9580	2N2219 NPN 30V 800mA	0.12	0.08	0.05
ZS-9581	PE6021/MPSA06 NPN 80V 500mA	0.15	0.10	0.08
ZS-9582	BC177B PNP 45V 100mA	0.15	0.10	0.05
ZS-9583	BD679 NPN 80V 4A	1.00	0.80	0.70



DIODE SALE

Shown below are some amazing values in rectifiers and diodes.
Get in for your chop now! Once again prices INCLUDE sales tax!

Cat. No	Description	1-9	10-99	100+
ZS-9540	G3010 DO-4 <1000V 6A Rect.	0.40	0.30	0.20
ZS-9541	F22 DO-13 200V 2A Rect.	0.10	0.08	0.05
ZS-9542	FD333 125V 300mA diode		$3/hundred	
ZS-9543	BZX79 & C6V2 400mW Zener	0.20	0.15	0.10
ZS-9544	BZX79 C12 400mW	0.30	0.25	0.20
ZS-9545	RP1020 20A 100V Rect. DO-5 stud	1.50	1.20	1.00
ZS-9546	ZPD39 39V 500mW Zener 5%	0.20	0.15	0.10
ZS-9547	ZPD62 62V 500mW Zener 5%	0.20	0.15	0.10
ZS-9548	ZPD33 33V 500mW Zener 5%	0.20	0.15	0.10
ZS-9549	ZPD47 47V 500mW Zener 5%	0.20	0.15	0.10
ZS-9550	ZPD56 56V 500mW Zener 5%	0.20	0.15	0.10
ZS-9551	ZPD27 27V 500mW Zener 5%	0.20	0.15	0.10
ZS-9552	BZTO3 C62 62V 1.3W Zener	0.20	0.15	0.10
ZS-9553	AAZ18 Diode	0.20	0.15	0.10
ZS-9554	Zener 22V 5% 10 watt	2.00	1.50	1.00
ZS-9555	ZAA119 Diode pair	0.30	0.20	0.15
ZS-9556	1N748A 3.9V 400mW Zener	0.20	0.15	0.10
ZS-9557	1N5062 800V 1A Diode	0.20	0.15	0.10
ZS-9558	PFZD68 68V Surge Supp Zener	1.00	0.80	0.60
ZS-9559	BAT42 uWave Mixer Diode	1.00	0.80	0.60

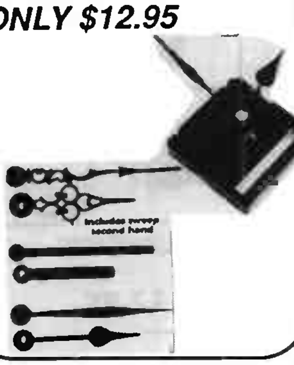
QUARTZ CRYSTAL CLOCK MOVEMENT

• Very compact • Self starting one-second stepping motor has strong torque • Powered by one 1.5V AA battery that lasts for one year • ±15 second/month accuracy • 56mm square, 15mm deep

Fit your own custom clock face. Great for novel applications such as fitting to pictures etc. SUPPLIED WITH 3 SETS OF HANDS

Cat. XC-0100

ONLY $12.95

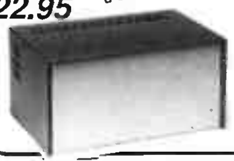


LARGE PROJECT BOX

Another box in our range of Kew Australian made boxes, as used in many projects. Ideal for large projects. Measuers 305mm wide 150mm deep and 200mm high.

Cat. HB-5468 NEW

$22.95



AUTO CABLE

Jaycar now stock 4mm auto cable, for all you weekend car buffs. Perfect for wiring up lights, horns, etc., in cars, trucks, bikes and caravans.

Available in 3 colours. Also great for heavy amp and power supply wiring. 28 strands each 0.3mm.

YELLOW Cat. WH-3070
ORANGE Cat. WH-3071
WHITE Cat. WH-3072 NEW

$18 per 30 metre roll

80¢ metre

MAINS MUFFLERS

This fully approved Electricity Authority unit is the ultimate mains suppression device. It is fitted with a circuit breaker and VDR's for extra suppression capacity. Nothing but clean 240V goes through.

RECOMMENDED FOR:
Computers - Printers - Disc Drives - VDU's - Videos - Medical Equipment

Max load 1000 watts 4 amps 250V.

TWO OUTLET Cat. MS-4040
$149.00
FOUR OUTLET Cat. MS-4042
$249.00 NEW

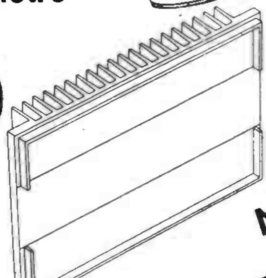
BUY AUSTRALIAN

Heatsink Front Panel

This is the special DIECAST panel as used in the new AEM6000 power amp. It is available separately. It can also be used as the SIDES of a 4 unit rack case for high-power rack mount PA amps!

Cat. HH-8520

ONLY $49.95 each



NEW

NEW MODEM SENSATION!

ANOTHER JAYCAR SCOOP BUY!

We have purchased the entire remaining stock of the famous 'Cicada' 300 Baud modem. The modems are NOT mounted in the case nor do they include a telephone. The PCB is completely ASSEMBLED AND TESTED with all parts in place. You only have to connect 240V, your computer and a phone line and you're away!

FULLY APPROVED. This modem (when mounted in its case) holds Australian Telecom approval No. C83/37/1011. Kit modems - even ones designed to comply with Telecom regulations - are NOT Telecom approved. So why take risks? You can now have an approved modem for far less than the price of a kit!!

SPECS AND FEATURES
- 300 Baud FULL DUPLEX
- Answer originate
- Telecom approval C83/37/1011
- CCITT V.21
- Direct connect
- Double sided plated thru board
- Fully assembled and tested

We only have limited quantities so be quick to avoid disappointment.

Cat. XC-4810

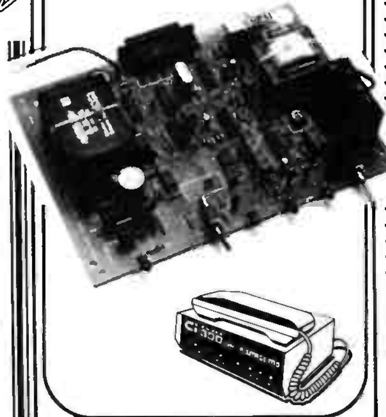
Were selling for $299

ONLY $49.50

Plastic case to suit Cat. HB-5912 **$14.95**

Illustration shows Cicada modem as originally sold. Note that the modem offered is for the assembled and tested PCB only and does NOT include case or telephone. No other electronic components are needed however

TELECOM APPROVED



TURN YOUR SURPLUS STOCK INTO CASH!!
Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.
CALL GARY JOHNSTON OR BRUCE ROUTLEY NOW (02) 747 2022

PHONE TODAY!

MEMOREX 5½" DISCS

Quality discs in a handsome plastic storage box.

Single Sided Double Density - Box 10
Cat. XC-4751 **$27.95**
(includes box worth $4.95)

Double Sided Double Density - Box 10
Cat. XC-4756 **$29.95**
(includes box worth $4.95)

Storage boxes on their own
Cat. XC-4758
$4.95 NEW

SILICON VALLEY POSTER

Normally $9.95 NOW ONLY $4.50

P&P 50¢
Supplied folded

½PRICE

This is a full colour poster measuring 760(w) x 575(h)mm and is a full map of the famous Silicon Valley area south of San Francisco. The poster is full of cartoon characters and statements. You could stand in front of it for an hour and not take it all in. It is printed on very heavy art quality paper.

Cat. BP-9220

TOP VALUE

NEW STUNNING CAPACITOR BARGAINS NEW

We have made a buy of Military/Telecommunications grade Tantalum and Aluminium electros.

Cat. RE-5990 10,000uF 16V axial electro
1-9 $3.00 10 up $2.00

Cat. RZ-6690 15uF/20V axial mil. grade tant.
1-9 $1.50 10 up $1.20

Cat. RZ-6691 22uF/35V axial mil. grade tant.
1-9 $1.75 10 up $1.50

Cat. RZ-6692 47uF/35V axial mil grade tant.
1-9 $2.25 10 up $1.75

REMEMBER! The tantalums are -25 +125°C. Hermetically sealed metal can types - not cheap dipped resin.
*MIL-C-39003

GOT A SWEET TOOTH?

All Jaycar's stores now have a jar full of lollies on the counter for customers to help themselves while they wait to be served.

Judging by your reactions so far we think it's a good move, so have a lolly on us.

PRICE INCREASES

As a result of the continuing depreciation of the $A prices of many goods have inevitably risen. We notice that some competitors have increased their prices already. We wish to ensure our customers that Jaycar will only increase prices as cost increases are forced upon us.

We are not here to rip you off.

Universal TO-3 Transistor Mounting Bracket

Mounts 4 x TO-3 devices on pre-punched heavy duty right angle bracket. Hole pattern conforms to most popular PCB designs for amp kits.

Cat. HH-8500

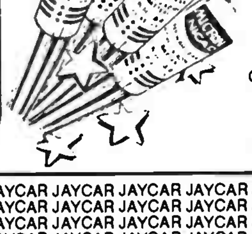
VALUE $2.50

SCART PLUG

This new addition to our plug range is being used more in video and computer applications. 21 pins.

Cat. PP-0910

ONLY $4.75 NEW



PENLIGHT NiCads

Don't keep wasting money buying throwaway batteries - step up to rechargeable NiCads.

SUPERB "ROCKET" BRAND AA PENLIGHT 450mAh

Cat. SB-2452

$2.95 each

SPECIAL 4 for $10

JAYCAR No.1 FOR NEW KITS

RS232 TO COMMODORE
Ref: ETI July 1986
Supplied without Commodore edge connector.
Cat. KE-4722
$14.95 NEW

PHONE CONTROLLER
Ref: EA June 1986
Cat. KA-1672
$55.00 NEW

LIGHT SAVER
Ref: EA June 1986
Supplied without plate and epoxy.
Cat. KA-1670
$14.99 NEW

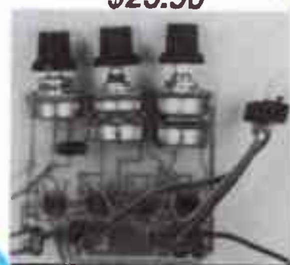
DIGITAL SAMPLER
ETI 142
Cat. KE-4720
$119.00 NEW

SCREAMER CAR ALARM
NEW
Ref: EA August 1986
Incorporates two sensors and utilizes a piezo screamer inside car.
Cat. KA-1675
SHORT FORM
$32.50
Includes Piezo

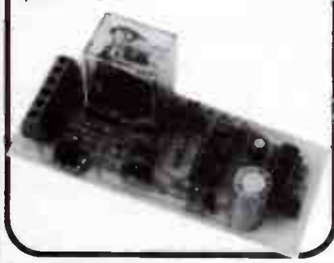
TELEPHONE SCREAMER
See ETI October 1986
If you are bothered by annoying or obscene calls, hit the button and the caller will be deafened by a loud scream. Makes a nice gift for the woman who is perhaps on her own.
Cat. KE-4726
$24.95 NEW
Double Adaptor $7.50

HIGH POWER ELECTRIC FENCE
See EA October 1986
The two previous electric fence projects have been very popular. This high power version is for those big jobs. Works well in conditions where there is a lot of wet grass near fence.
Cat. KA-1678
$229 NEW

PARAMETRIC EQUALISER MODULE
NEW
Ref: ETI August 1986
This module can be used on its own or in gangs as effects units and also in synchronous sweep effects
Cat. KE-4724 **$23.50**



TURBO TIMER
See EA Sept 1986
A simple sensor system to prevent the car ignition being turned off before the Turbo unit has cooled down (approx. 90 seconds). A must for those with turbo charged cars.
GREAT INSURANCE AGAINST A COSTLY TURBO FAILURE!
Cat. KA-1679
$29.95



SOLDERING IRON TEMPERATURE CONTROLLER
See ETI Sept. 1986
A variable control using diodes. No transformer required, soldering iron connects through this to power outlet. Simple to install.
Cat. KE-4725
ONLY $25.00

AEM 6000 POWER AMP
- 240W RMS (total) into 8 ohms!!
- 80,000 uF power supply filtering!
- 2 x 300VA Toroids
- Massive diecast heatsink front panel
- Speaker protection
- Power amp status monitor circuit

Here it is at last, the *ULTIMATE* Hi Fi Mosfet power amp. David Tillbrook's latest creation of genius. This massive power amp is likely to set the standard for other Hi Fi amps to reach.
In keeping with the quality design the Jaycar kit is faithful to the final prototypes. We commissioned a special *DIE CAST* heatsink front panel especially for the project which is exclusive to Jaycar. The prepunched rugged metal cabinet is as per the design. We are totally confident that you will be delighted with this kit, which is absolutely complete!
Cat. KM-3032
P.O.A.

VIFA SPEAKERS
This new Vifa/EA speaker kit is especially designed for use with the new Playmaster 60+60 amplifier. The kit includes 8" woofers, dome tweeters, crossovers and cabinets. Sealed box design of 15 litres volume. Great sounding speakers at a very affordable price. 60 watts rms handling.
See EA Sept. 1986
ONLY $449
Cat. CS-2470
Complete speakers and cabinets

TELEMAIL PHONE NUMBERS

(008) 022 888
TOLL FREE
FOR ORDERS ONLY
(02) 747 1888
HOTLINE

JAYCAR No.1 FOR HI FI KITS

PLAYMASTER 60+60
High quality, low priced stereo amplifier from Electronics Australia.
See EA May, June, July 1986

ONLY $249

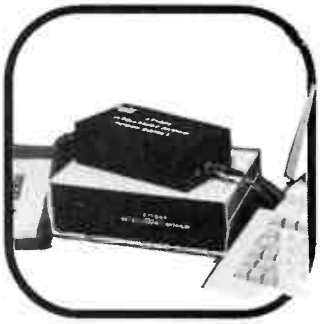
INTELLIGENT MODEM ETI 684

See ETI June, July, August 1986

The Ultimate Modem

Features:
- V21 300/300 full duplex
- V23 1200/75 half duplex
- Automatic baud rate selection on reception (auto bauding)
- Other standards found overseas like Bell 103 and other 600/600 and 1200/1200 standards are supported by the hardware
- Intelligent auto answer
- Intelligent auto dialling
- Fully software driven
- 48K RAM buffer
- Cassette interface under Viatel standard control
- Software controlled loudspeaking
- Responds to industry standard Hayes commands
- Especially tailored for use by both professional and hobby users.

INTRODUCTORY OFFER
BUY BOTH FOR $419



MODEM $379.50
Cat. KE-4716

POWER SUPPLY $49.95
Cat. KE-4715

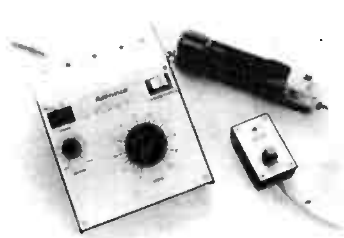
"RAILMASTER" PULSE-POWER TRAIN CONTROLLER

Ref: EA September 1984

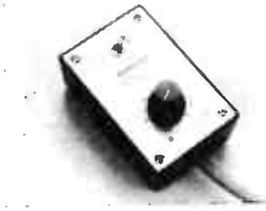
This is a state-of-the-art train controller offering tremendous features:
- Variable simulated inertia
- Full short circuit protection including both audible and visual indicators
- Adequate power for double and triple heading locos
- Fixed 12V DC and 15V AC power for lighting and accessories
- Optional walk-around throttle

Cat. KA-1560

ONLY $99.95



Optional Walk-around Controller
Cat. KA-1559
$11.95



Diesel Sound Simulator
Cat. KA-1561
$22.50

Steam Sound Simulator
Cat. KA-1562
$22.50

ETI 467 MIXER PREAMP

Ref: ETI July 1980

Ideal companion for power amp modules. Mixes up to 4 inputs (high and low level) with individual level controls. High performance 3 band tone controls. Kit comes complete with case. Operates from 2 x 15V AC (use power amp supply or Cat. MM-2008 transformer).
For full specifications check Jaycar's 1986 Catalogue.
Cat. KE-4014

JUST $37.50

8 CHANNEL AUDIO MIXER JAYCAR 8002

A balanced input/output 8 channel mixer with features found in units costing well over $2,000!!
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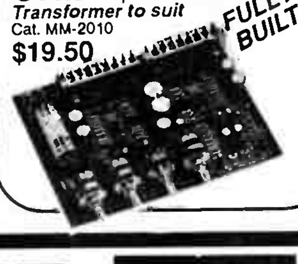

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Technics 'digital' piano simulates 'real' instrument

Technics has released an electronic piano featuring digital PCM (pulse-code modulated) technology that is claimed to faithfully reproduce the acoustic resonance, timbre and touch of a 'real' piano.

Dubbed the PX1, it is the top of the line in a new range of PX-series keyboard instruments from Technics. The key hammer action mechanism of the PX1 closely resembles the actual hammer action of acoustic pianos.

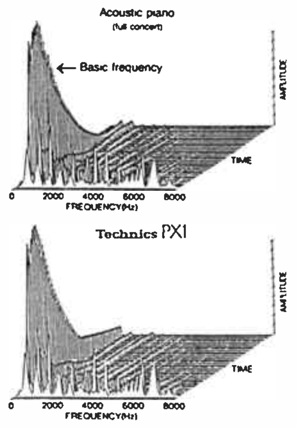
The keyboard is made of wood to give it that 'classical feel', and it employs opto-electronic key touch sensing which provides for the inclusion of attack response dynamics.

The complex harmonic structure of the traditional piano sound is closely matched by Technics' digital PCM sound generating system which employs digitized sounds from an original instrument stored in a ROM.

The PX1 incorporates a two-channel play sequencer that allows you to record and play back you own performance as well as a variety of other performances. You can record complex pieces at a slow pace and replay at the required speed.

So far as effects go, you can choose two piano sounds, two electric piano sounds, plus harpsichord and clavichord. A three-band equaliser permits fine-tuning of the mid-range sound (500 Hz to 4 kHz). In addition, you can add chorus and tremolo with variable depth and rate.

Four tuning modes provide fundamental, equal temperament and what is described as "Werckmiester technique, no. 1 and no. 3". As you'd expect, a MIDI interface is standard.



An optional digital disk recorder, the SY-FD5, can be attached for recording performances or compositions too long to store in the play sequencer. In short mode, 10 or 20 short tunes may be stored, while in professional mode, one or two long tunes are accommodated.

There are four models in the PX range, from the top-line 88-key PX1, through the PX9 and PX7 to the 76-key PX5. Further details from your local music store or **National Technics, 95-99 Epping Rd, North Ryde 2113 NSW. (02)887 5314.**

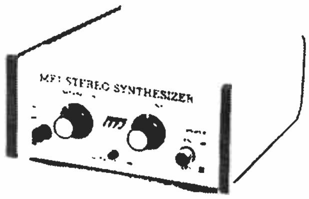
Big Mac in Danish opening

Scandinavian audio importer, Scan Audio, appointed well-known industry identity John McTavish as state manager for NSW and ACT in August.

John's career in hi-fi goes back almost 22 years and spans most facets of the industry, from technician to salesman, professional musician to designer.

Following several years in retail, John returns to his preferred field, wholesale. His brief is to represent and promote Scan Audio's range of Danish hi-fi products — Jamo, Ortofon, Scan-Speak, Vifa and Dynaudio. You can reach **John McTavish on (02)871 2854.**

Special on video stereo sound synthesiser



A special discount of 40% is offered on the MFJ Enterprises MFJ-1501 stereo sound synthesisers this month, available from GFS Electronic Imports in Melbourne.

Normally $399, they're currently discounted to $239. The ac adaptor for it costs $35, and post & packing costs $14 where applicable.

The MFJ-1501 is ideal where you can't justify the outlay on a stereo TV or VCR, GFS say. It simply hooks up between the aduio outlet or speaker of a TV and the auxilliary stereo input of your stereo system.

Contact **GFS Electronic Imports, 17 McKeon Rd, Mitcham 3132 Vic. (03)873 3777.**

NEW TAPE LINE-UP FOR TDK

TDK's "impressive new audio tape line-up" comes out of continued research into the improvement of magnetic particles, binders, solvents and additives, the company says. The new range — MA-XG, MA-X, SA and SA-X, SF, AD-X and AD — was released on September 1.

There are two new metal tapes in the line-up, MA-XG and MA-X. Each employs TDK's "Finavinx" formulation, and feature a bias noise improvement of 1 dB and MOL improvement of 0.5 dB at 10 kHz. TDK claim these new tapes provide "staggering dynamic range" suited to capturing the wide dynamics of digital sound. The MA-XG is housed in their famous Reference Standard II (RF II) two-part, precision diecast metal housing.

The SA-X (Type II) boasts a -63.5 dB bias noise level, while the SA is down to -63 dB, a good 1 dB better than the previous SA tapes, TDK say. The SA's improved MOL gives it an extra 1.5 dB dynamic range while frequency response is quoted as flat to 20 kHz.

A new introduction is the SF ('super fidelity'), a Type II economy tape which offers a -61 dB bias noise. The AD and AD-X normal position (Type 1) tapes offer improved bias noise and MOL for greater dynamic range, and TDK expect a large response to the range.

All cassette cases feature side A and B markings for the visually handicapped, believed to be a world first.

Consumer electronics fights back

Roger Harrison

The eighth Perth Electronic Show this year saw the industry with set jaws, tight belts, tough attitudes and determined optimism – all set to battle for that ever more elusive creature, Mr & Mrs Public's expendable income. But that didn't dampen the traditional hype and the hustle that characterises the largest consumer electronics show in the southern hemisphere.

IF TRAVEL is an education, then four pilgrimages to Perth in four successive years must rate me a university degree! Mind you, I'm not entirely sure what I've learned althoghter (well, I've learned a few things, but I'm not sure I should divulge them here). If I've learned anything, it's that the industry is not short of innovative ideas to keep a product line selling. the concommitant to that is, this year's new product — however 'state of the art' it may be — always has a lot of room left for further development (deliberately)!

Witness video and VCR Developments over the past four years. In 1983, Akai introduced the first two-speed VCR. At the '83 Perth Show, most of the major VCR makers followed suit and launched two-speed machines for release late-'83 early-'84. At the '84 show, it was stereo hi-fi video. In '85 Sony debuted 8 mm video and its "Super Beta" VCR, while National and Akai quietly fielded surround sound VCRs. The latter proved a pre-cursor for VCR Developments, for this year the surround sound processor was BIG. And JVC launched their counterattack on 8 mm video in the PAL market with their first VHS-C "VideoMovie".

The 1983 show was the "year of the digital disc", and Australia shot to third in the world in consumption of imported CD players in early '84. The '84 show saw model proliferation and reformulation and a distinct change to horizontal disc transports by most manufacturers. In '85, "audiophile" CD players arose, featuring over-sampling, separate channel decoding, superior tracking performance and more sophisticated track selection facilities. This year Accuphase went "over the top" with a two-unit CD player that will sell here for a tad under $10,000!

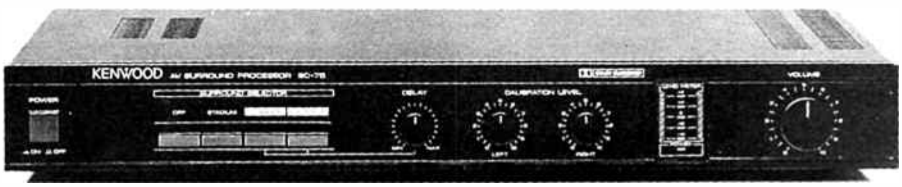
Well, this year, the manufacturers and marketers dragged out as many of those 'marketing innovations' as could be mustered, for there was little really new in product or product changes. Last year we saw released portable CD players, 8 mm video and Super Beta. This year, once again, the primary consumer drawcards were CD And video, but "surround sound" video probably represented the only really new consumer product line.

The video hots

As Malcolm Godfinch told us last month, the war is on between the 8 mm and VHS-C 'camps'. Chief combatants are Sony and JVC, respectively. Sony hired a pavilion of their own this year, while JVC dominated one of the main walkways in the show's largest pavilion with an open-plan stand and a team of disco dancers to attract attention. Focus of that attention was their GR-C7EA VideoMovie VHS-C camcorder weighing just 1.4 kg and featuring 60 minutes continuous recording, a CCD pickup device, HQ picture improvement circuity, auto-focus, full auto-colour tracking for white balance and a 6 × power zoom lens. It can be held and operated in one hand. Their hands-on display centre was always busy.

JVCs new GR-7CEA VHS-C camcorder leads the VHS camp's fight against 8 mm video. It was a popular item at the show.

Philips and Akai also showed VHS-C camcorders, while national and Hitachi made a strong showing with new model ▶



Kenwood's surround sound processor features four channel output and uncomplicated operation.

Philips new top-line 16-bit CD player, the CD-650, features remote control and favoured track selection.

camcorders employing the full-size VHS cassette.

Sony, not to be outdone, had an impressive hands-on display featuring both the 8 mm V8-AF and Handycam camcorders as well as their conventional Beta models. Featured this year was their MPK-M8 Sports Pack for the Handycam, aimed at the outdoors/underwater enthusiast.

It seems there's the glimmer of a TV 'renaissance' underway, but nobody apart from NEC and Philips made a big deal of it. "Flat-square" screens lead the way here, with most of the big names introducing models with barely curved screens and squared corners (hence the name) — with the claimed advantages of wider viewing angle and reduced picture distortion. NEC Showed a big-screen TV featuring PIP & "picture-in-picture". In one corner of the screen, you can display another small image from your VCR or another channel. Just the thing for "channel hoppers"!

I questioned a few company executives about high definition TV (HDTV), which is a hot topic of discussion in Europe and Japan at present. All agreed it would bring a massive revolution to all phases of the TV industry — in manufacturing, production and broadcasting — but it looks to be a fair way off yet.

Surround sound add-on processors for VCRs are tipped to lead to the "home cinema". Surround sound processors are meant to link your hi-fi and your TV/video to create an audio-video entertainment centre in the home. Kenwood, Akai, Pioneer, Luxman, NEC, Nakamichi and Yamaha all had equipment on-show. NEC and Yamaha brought out the 'big guns' — demonstrating the concept with Rambo tapes that made you really feel those choppers flew overhead from behind you!

Yamaha's processor can be added to any audio system and features an 'ambience selector' which allows you to experience Rambo in St Paul's cathedral, for instance (the choppers come down from the dome!)

There are three basic system types: the 'rear ambience' type with small rear speakers, the more sophisticated Dolby type which requries an extra two-channel amp and two speakers, and the special multi-channel extravaganzas with six-channel output. The latter type employ the two front speakers in standard stereo format, a centre-format speaker to be placed beneath or near the screen to provide a 'centre focus' and the other channel to feed side and rear amps and speakers.

Yamaha's processor provides selectable digital delay characteristics, stored in ROM, for the extraneous channels. To do this they measured the acoustic characteristics of various famous venues around the world and stored them in ROM. Innovative! I must say Yamaha's demonstrations proved the most exciting at the show.

Show-stopper of the video displays, though, was Philips' "Vidi-wall", a two metre high by over two-and-a-half metre wide display of screens that had the audience transfixed like so many stunned mullets, showing a phenomenal range of effects with various action scenes — including a roller coaster ride that had them swaying on the dips and corners!

Just a touch of the future to round up; Sony showed a TV with integral VCR at their industry seminar session this year, just launched on the Japanese domestic market and in the US, which is NTSC Standard. A PAL version won't be along for a while, but it's in the pipeline. The one they showed the press and industry reps weighed some 70 kg! Definitely a loungeroom-only item.

CD reaches the upper atmosphere

Compact disc players got bigger and smaller this year! At the 'bottom' end, Sony's Discman comes in an even smaller size this year as it now uses the smaller AA Cells and they've "shaved" the housing and innards. Technics were not to be outdone, either. They launched a tiny new portable against the Sony. Technics' SL-XP7 is just 12.5 cm wide that boasts and anti-mistracking mechanism that is said to prevent the player skipping tracks while it's being toted around, just like the others claim.

At the upper atmosphere end of the market, Hal Wallis's Alberts Hi-Fi launced the Accuphase two-component CD with a starting price just under ten big ones. It comprises the DP-80 transport and DC-81 'precision' digital processor. They are coupled via a fibre optic link said to totally isolate the units and eliminate external interference. The processor, for reasons best known to Accuphase, features discrete circuitry for its dual 16-bit digital-to-analouge converters with 121-stage oversampling filters. I guess that, at the price, you'd hear the difference anyway!

Pioneer showed their six-pack CD player (previewed by Dennis Lingane in our May issue), while Philips had a new range of 16-bit units. Top of the range is their CD-650 remote controlplayer, featuring "favoured track selection" which has received good reviews overseas to date.

Kenwood showed a car CD System where all the bulky electronics mounts in your boot, with a small control module to go on or in your dash or console. Sony also showed a car CD with boot-mounting electronics that features a 10-disc pack — which should provide enough music for most of those long interstate trips. Boot-mounted CD seems a definite trend.

For the audiophiles

Convoy's Geoff Mathews never fails to put on a well presented audio demonstration at the Perth Show. This year he teamed Nakamichi's new preamp and power amp (plus Nak's top-line CD, of course) with B&W's new Matrix line of speakers. I was priviliged to a private session early one morning and, listening to some familiar material on CD, it literally made my hair stand on end!

Mike Henriksen of Scan Audio had his range of Vifa kit speakers on demonstration, along with his other lines of Danish speakers (Jamo, Scan-Speak) in a small pavilion located well away from the "main din". As he's just gained the Ortofon agency, Ortofon cartridges featured prominently — the vinyl record is not yet dead. Apparently, top-end record turntables, arms and cartridges are enjoying a boom at present with audiophiles stocking up so they can play their LPs in ten yers by which time CD (and maybe DAT) is slated to have killed it as LP's killed 78s.

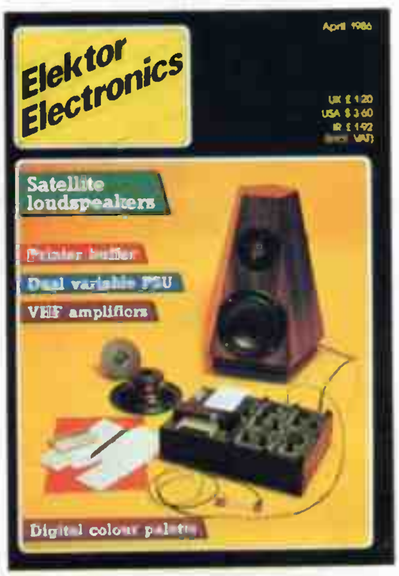
Interdyn released some new Luxman amps, including a new model "Brid", a hybrid valve/MOSFET integrated amp, while Marantz, Kenwood and Pioneer had new models too.

Prices

Big topic of discussion behind the scenes was prices. With the Aussie dollar under 100 Yen, prices are set to hike substantially once current inventory is cleared — 40% was the figure generally bandied about. The message is, buy now.

However, some companies, have been buying inventory at 100 yen to the dollar since earlier this year and will largely maintain their prices. The country is overstocked on some items we hear, CD players in particular, and some stock sellouts may appear at year's end. — to page 84

Elektor Electronics in AEM



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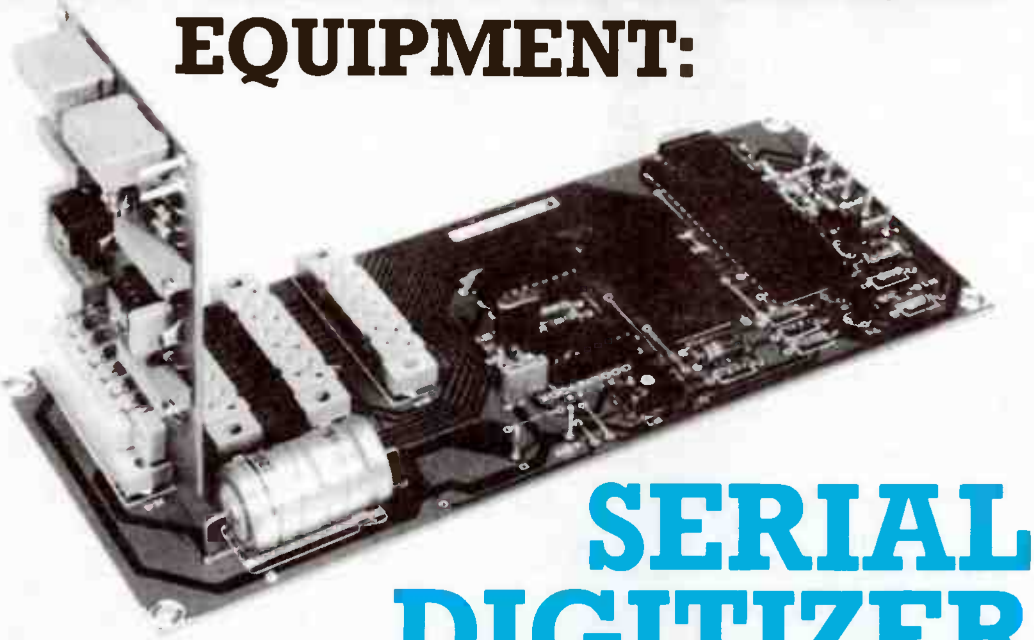


SERIAL DIGITIZER

Have you ever wished it were possible to read analogue voltages on your computer while sighing in dismay at the intricacies of bus connecting the design of your choice?
This design of an eight-channel analogue-to-digital converter board goes round the hardware problems by utilizing the computer's serial I/O port, and so becomes a universal unit for straightforward incorporation in almost any type of computer system.

It is perfectly understandable that many users of home computers are hesitant about embarking on wiring peripheral equipment direct to the internal bus configuration of their expensive computer. Most expansion boards therefore employ the parallel (Centronics) port for communication with the computer. However, when a printer has already been hooked up to this outlet, interfacing becomes a problem in many cases.
For less obvious reasons, the serial communication capability of the home computer's RS232 port is often disregarded as a means for two-way communication with peripherals other than modems.
In the case of the digitizer described here, the computer first sends a 3-bit channel selection code over the serial port, then awaits the byte representing the analogue voltage level at the relevant input channel. Handshaking and special command codes may be dispensed with altogether; input and output data suffice.
The 3-bit output code from the computer enables selection of one of eight (2^3) identical analogue input sections, each of which comprises its own attenuator and amplifier, ensuring the correct handling of a wide span of input voltages.
If, for example, the voltage at channel 4 is to be read into the computer, binary code 3 should be sent to the digitizer, which promptly responds

Technical characteristics of serial digitizer:

- 1 up to 8 multiplexed analogue channels.
- Conversion time ≤ 0.5 ms.
- Variable reference voltage (4 V max.).
- 1 up to 8 separate measuring amplifiers (8 V max.), each with offset compensation and variable gain.
- Serial I/O communication (150. . .9600 baud).
- Option for use of handshaking signals (RS232).
- 5 bits remain available for switching purposes.
- Modular construction allows easy expansion.

▶

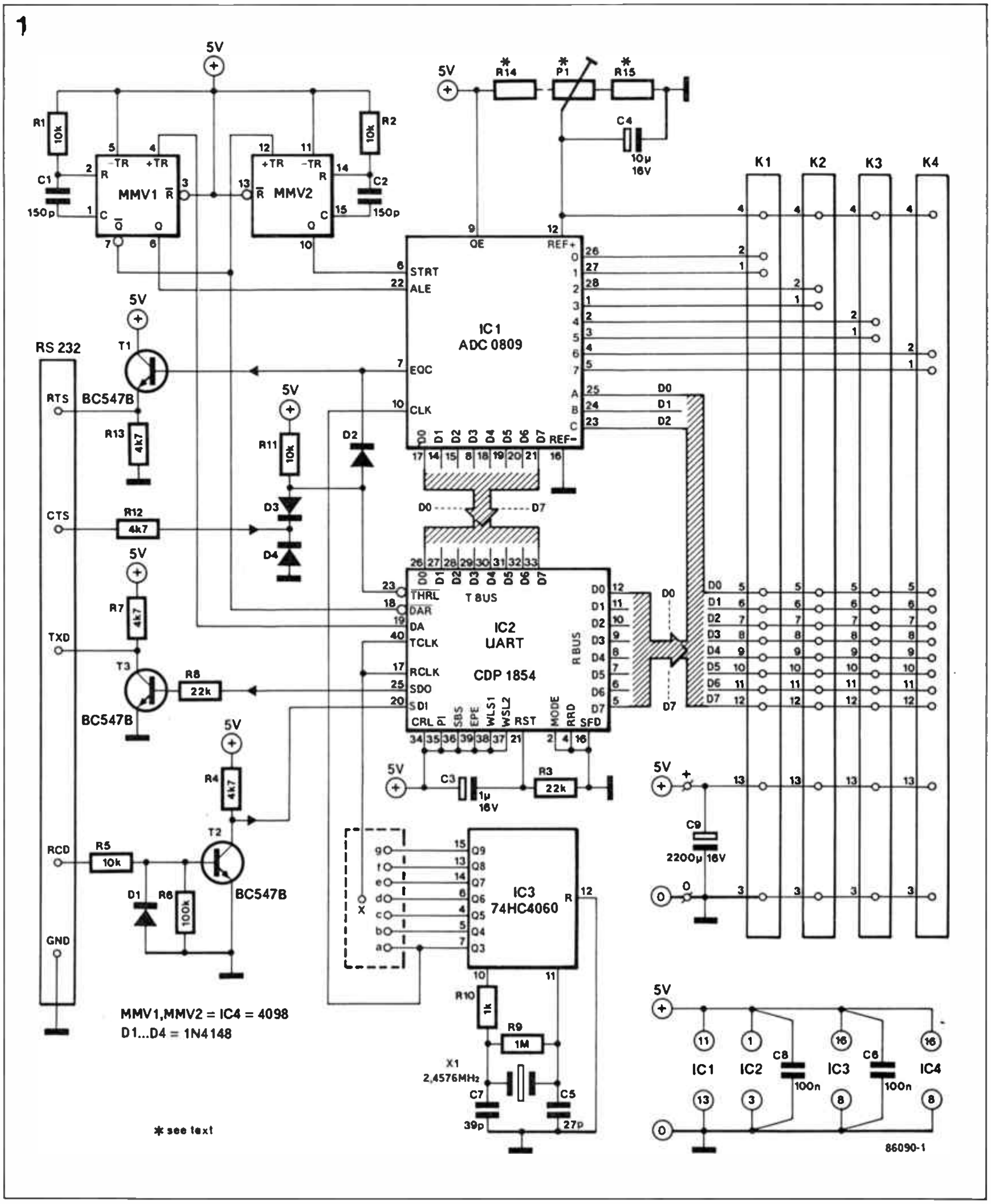


Fig. 1. Circuit diagram of the serial I/O and analogue-to-digital converter sections as part of the universal eight-channel digitizer. Note that all integrated circuits are complementary metal oxide silicon (CMOS) types ensuring low power consumption and a high degree of noise immunity. Consult the parts list for possible UART types other than the RCA CDP1854.

Table 1.

IC_3 output	T_{clock} R_{clock} [kHz]	baudrate	strap
Q_3	153.6	9600	x−a
Q_4	76.8	4800	x−b
Q_5	38.4	2400	x−c
Q_6	19.2	1200	x−d
Q_7	9.6	600	x−e
Q_8	4.8	300	x−f
Q_9	2.4	150	x−g

Table 1. Simply select the relevant strap for the desired serial transmission speed (baudrate).

by returning the converted databyte over the same RS232 port (note that, by convention, the code to a channel is always one less than the channel number, e.g. code 0 selects channel 1).

Serial I/O and voltage conversion

With reference to the circuit diagram shown in Fig. 1, it is seen that IC_3 functions as a crystal-controlled baud rate generator supplying seven strap-selectable transmit & receive clock frequencies of 16 times the requisite baud rate. Consult Table 1 to find which strap you need to have computer and digitizer "listen and talk" at the desired baud rate.

Universal asynchronous receiver/transmitter (UART) IC_2 receives serial data from the computer at the SDI (serial data in) terminal and outputs the equivalent 8-bit word in parallel form at its three-state receiver bus (Rbus) outputs $D_0 \ldots D_7$. Timed by Rclock, incoming serial databits are internally shifted into the receiver register. On completion of receipt, DA (data available) goes high, flagging the presence of stable data on the Rbus datalines. Data will remain latched until $\overline{DAR}$ (data available reset) is pulsed low,

whereafter a new word may be shifted into the receiver register.
Transmission, i.e. conversion of an 8-bit word at the Tbus datalines into a serial pulse train, commences after $\overline{THRL}$ (transmitter holding register load) has been pulsed low. Timed by Tclock, data is shifted out of the transmitter register and output as a pulse train at the SDO (serial data out) terminal. Since terminals Rclock and Tclock have been connected in the present design, serial input and output run at the same speed.
In order to detail the operation of the circuit shown in Fig. 1, it is assumed that computer and digitizer have been set to operate at, say, 4800 baud (baud rate strap b on the digitizer board), and that the voltage at channel 3 is to be measured and converted (digitized) for processing in the computer system.
To begin with, the computer's RS232 port should be programmed to send binary code 2. Upon receipt of the pulse train, IC_2 outputs 0000 0010 ($D_7 \ldots D_0$) at its Rbus terminals, and DA is activated. Monostable MMV_1 is triggered with the rising edge of the DA pulse and supplies analogue-to-digital converter (ADC) IC_1 with a correctly timed ALE (address latch enable) pulse in order that the channel code can be loaded from the A B C address inputs. Output $\overline{Q}$ of MMV_1 is used to activate $\overline{DAR}$ and trigger monostable MMV_2, which supplies IC_1 with a STRT (start of conversion) pulse after a period determined with timing parts R_2 and C_2.
IC_1 is a high precision, 8-bit CMOS ADC featuring an internal eight-channel input multiplexer addressed over the A B C inputs. If code 2 is sent, therefore, the voltage at pin 28 is selected and internally routed to the ADC proper. Next, STRT is activated, causing the conversion process based on successive approximation to be started. The conversion process runs under control of pulses applied to CLK, which, as is seen from the circuit diagram, is connected to the baud rate generator Q_3 output toggling at $2457.6/2^4 = 153.6$ kHz.
After a conversion time of about 0.5 ms, the digital equivalent of the input voltage to pin 28 becomes available at the $D_0 \ldots D_7$ outputs of IC_1, which activates EOC (end of conversion) and so causes the UART to latch the 8-bit word at its Tbus datalines for serial transmission over SDO and therefrom over the TXD driver composed of R_7, R_8 and T_3. Components R_3 and C_3 cause all UART registers to be cleared and output bistables to be reset at power-on.
The Type CDP1854 UART, finally, is an all-CMOS equivalent of the well-known Types AY-3-1015 and TR6402, which may also be used in the proposed circuit.

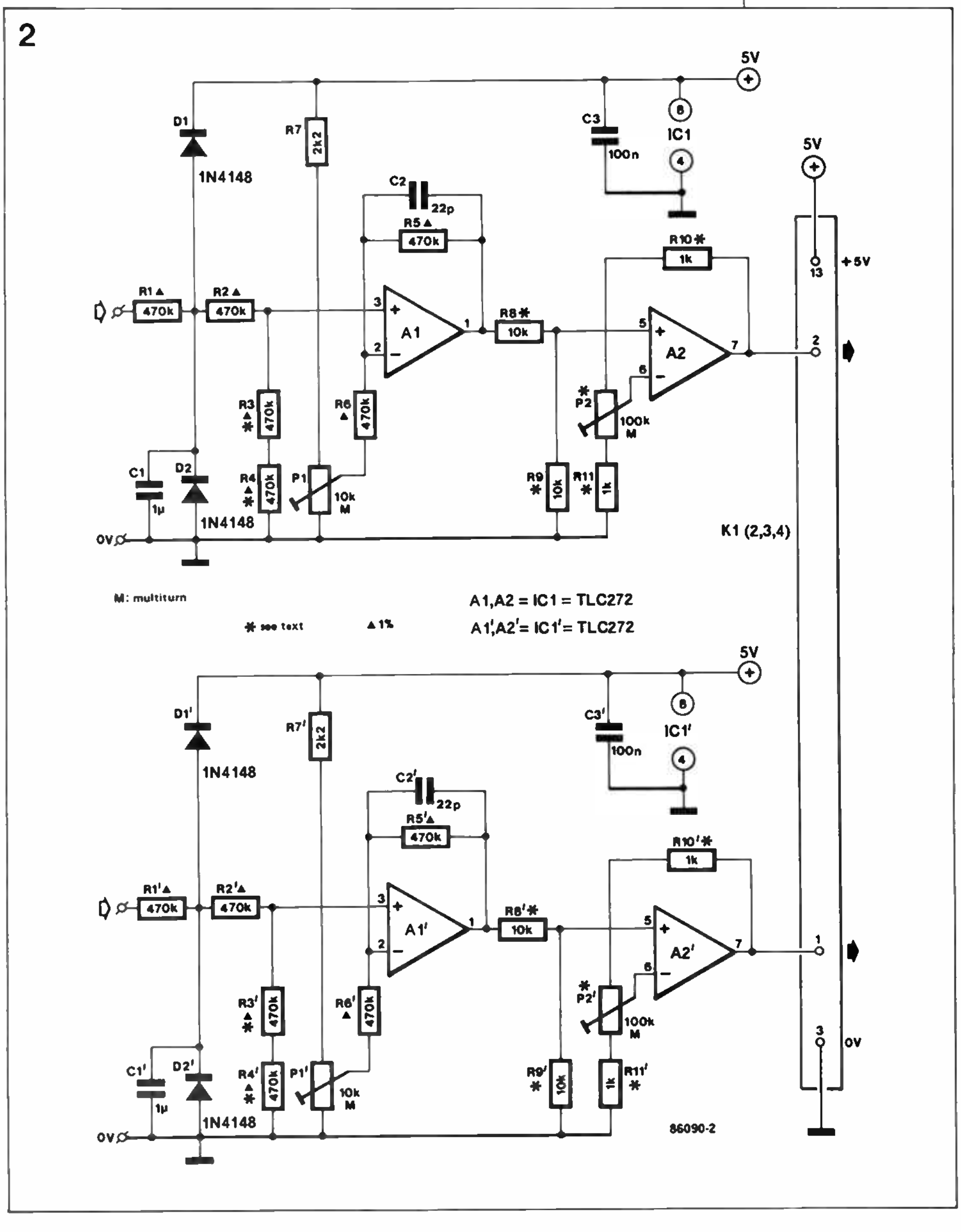
Optional handshaking

To put things right from the start: the computer TXD line should be connected to the digitizer RCD input, and the computer RXD input to the digitizer TXD output.
Provided the computer is not too slow in handling serial I/O data, and that it can be set to work without the need for any particular RS232 port input pins to be hard wired to RS232 supply lines, a three-wire setup, i.e. TXD, RXD and ground, should work satisfactorily at relatively low baud rates. If not in use, RTS (request to send) and CTS (clear to send) connections on the digitizer may be left vacant.
With reference to Fig. 1 it is seen that the EOC pulse from IC_1 drives T_1 and thus causes the computer to be notified, by means of RTS, that converted data is available on the Tbus datalines. However, these data can not be strobed into the UART until $\overline{THRL}$ goes low, i.e., when the computer signals its readiness to receive data by driving CTS high, causing diode OR gate D_2-D_3 to pass a low to high transition to $\overline{THRL}$, whereby the transmitter section in IC_2 is prompted to start parallel latching and serial shifting of output bits.

Eight analogue voltages

The circuit diagram of one of eight identical analogue input amplifiers is ▶

Fig. 2. Circuit diagram of one of eight analogue measuring amplifiers featuring offset adjustment and variable gain. Note that P_1 and P_2 are multiturn presets and that $R_1 \ldots R_6$ incl. are close tolerance (1%) metal film resistors to ensure the highest possible degree of accuracy and stability.



Parts list
(main board; see Figs. 1 & 3)

Resistors:
R_1;R_2;R_5;R_{11} = 10 k
R_3;R_8 = 22 k
R_4;R_7;R_{12};R_{13} = 4k7
R_9 = 1 M
R_{10} = 1 k
R_{14} = 4k7*.
R_{15} = 33 k*
P_1 = 10 k preset

Capacitors:
C_1;C_2 = 150 p
C_3 = 1 μ;16 V electrolytic
C_4 = 10 μ;16 V electrolytic
C_5 = 27 p
C_6;C_8 = 100 n
C_7 = 39 p
C_9 = 2200 μ;16 V

Semiconductors:
D_1 . . . D_4 incl. = 1N4148
T_1 . . . T_3 incl. = BC547B
IC_1 = ADC0809 (National Semiconductor)
IC_2 = CDP1854 (RCA); 6402 (Western Digital); AY-3-1015 (General Instruments)
IC_3 = 74HC4060
IC_4 = 4098 or 4528

Miscellaneous:
X_1 = 2.4576 crystal HC25/U
K_1 . . . K_4 = 13-way PCB socket to DIN41617
PCB Type 86090-1 (see Readers Services)
* see text

given in Fig. 2. However, before detailing the operation of that section of the digitizer, the function of potential divider network R_{14}-P_1-R_{15} at the REF+ input of IC_1 must be gone into (see Fig. 1). Since REF− of IC_1 is at ground potential, the input voltages to the ADC chip must lie between nought and the voltage at REF+, the maximum value being 4 V.

It is possible to have IC_1 convert a limited input voltage span by appropriate setting of P_1; if, for instance, REF+ is set to 2.5 V, the attainable resolution is $2.5/2^8$ = 9.77 mV per step. Resistors R_{14} and R_{15} may be adapted to narrow the span of P_1 as required; the target value for REF+ should then be reached if P_1 is set to about the centre of its travel.

Fig. 2 shows that each analogue input section is based upon the use of the Type TLC272 dual CMOS operational amplifier, which has been chosen in view of its low current consumption (about 1 mA per opamp) and capability to accept an input voltage of nought, whilst the chip can be fed from a single supply voltage.

Diodes D_1 and D_2 protect the opamp input from being driven either with voltages far in excess of the positive supply or with reversed polarity. C_1 has been incorporated to suppress transients on the input voltage; its value of 1 μF gives a period of about 0.5 s, which may have to be adapted to suit the particular application.

Potential divider R_3-R_4-R_1-R_2 keeps the non-inverting input of A_1 at half the input voltage to the circuit. P_1 allows the offset of A_1 to be accurately compensated.

It is seen that half the input voltage less any offset introduced with P_1 is found at the output of A_1; the maximum input voltage to the circuit as shown is about 7.5 V, while measurements up to 8 V may be taken if the input protection diodes are removed. R_3 and R_4 may be left out in case input voltages are not expected to exceed 4 V; however, this modification gives an increase in amplifier input impedance, which is of the order of 2 megohms with R_3 and R_4 in function.

The second opamp stage composed of A_2 is driven over another potential divider network, R_8-R_9, which, dimensioned as shown, gives a voltage division factor of 2, while replacing R_8 with a wire link gives 1, or no division at all. Opamp A_2 has been configured to operate as a linear amplifier whose amplification can be set to any value between unity (remove R_{11}) and about 1000 by means of multiturn preset P_2.

Given he above considerations as to

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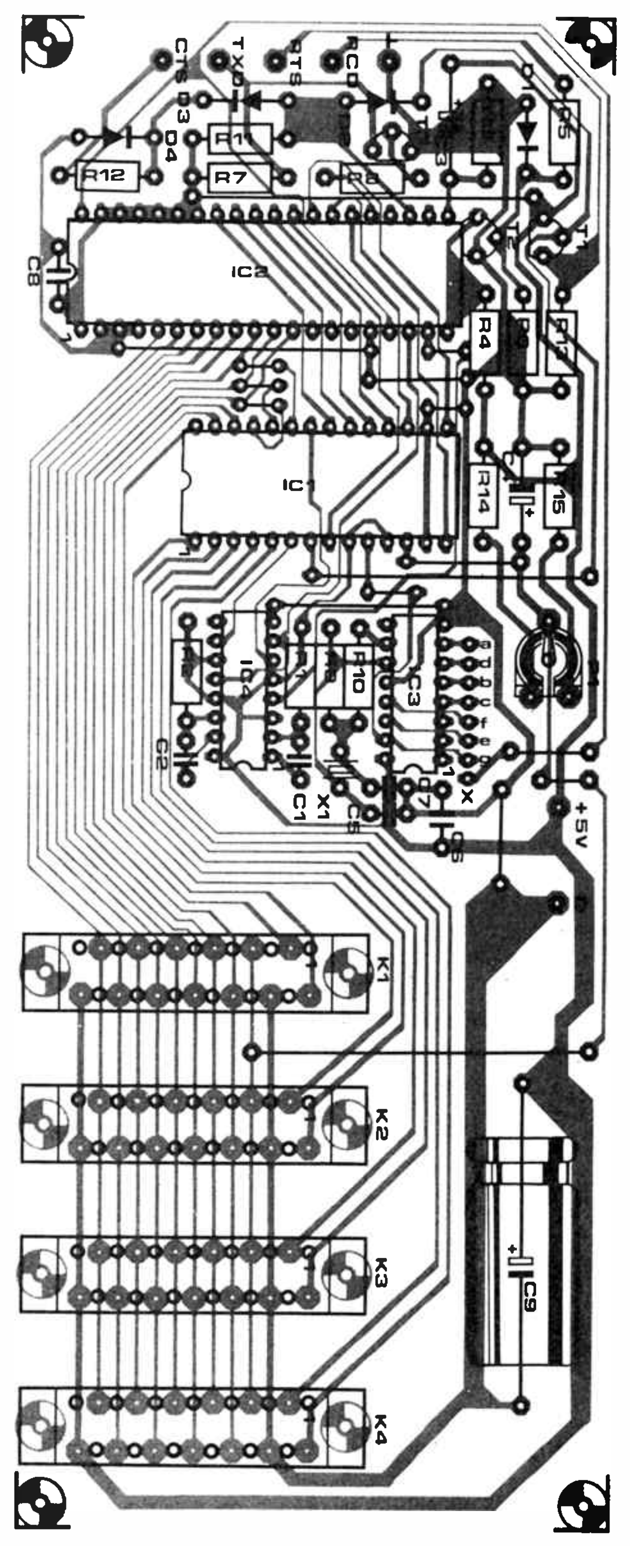

Fig. 3. Component mounting plan for the main PCB; up to four bus connectors may be fitted onto it in order to receive the same number of boards shown in Fig. 4. Unused ADC inputs should be tied to ground.

the potential divider networks and the adjustable gain of A_2, it is readily seen that the proposed input module is versatile in respect of the voltage span that can be applied to its input.

The circuit in practice

Provision has been made to enable users of the proposed digitizer to employ the number of input modules as requisite for a particular application; to this end, up to four plug-in amplifier boards, each comprising of two input channels, can be received on the main board bus connectors. Refer to Figures 3 and 4 for the component mounting plan of main board and amplifier modules respectively.

Rbus databits $D_3 \ldots D_7$ have been bus wired to allow easy expansion of the digitizer with software controlled relays, switching transistors or analogue bilateral switches or (de)multiplexers. A possible application would be an intelligent sample and hold system which supplies the computer with real time data regarding the state of some sensor-controlled process.

REF+ has also been "bused" in order that this voltage can be used as a reference for further analogue circuits. However, due care should be taken not to connect relatively heavy loads to REF+, since it is not intended to actually supply current. Unused inputs of amplifier channels should be tied to ground to minimize induced interference.

UART IC_2 has been hard wired to accept and send serial data organized as 8 databits, 2 stop bits and no parity. Table 1 shows which strap to use for a particular port baud rate, while Fig. 5 may be used as a guide in programming digitizer servicing programs or subroutines without (Fig. 5a) or with (Figs. 5a and 5b) use of RTS-CTS handshaking. The flowchart of Fig. 5a shows that the computer is forced into a wait loop during the ADC conversion process, whilst Fig. 5b indicates how converted data is read after the digitizer has issued an interrupt over the RTS line; Fig. 5c, finally, shows how the computer has the digitizer hold the converted byte until transmission can take place; other methods of programming are, of course, also thinkable.

Setting up

Aligning the completed digitizer should preferably be done with a precision voltage source, a digital multimeter, a computer equipped with a standard RS232 port, and, naturally, at least one input amplifier module plugged onto the digitizer main board.

For an initial test, you should also have a properly working serial controller program which can send keyboard data and display (hexa)decimal data as received from the digitizer.

To begin with, set REF+ to limit input voltage span as required. With REF+ at 4 V, the same input voltage should produce FF_{hex} (255_{10}). Remember that whatever value is set for REF+, 255_{10} is the highest value you can read, corresponding to the level of REF+.

Short-circuit the amplifier's input and set P_1 for a reading of 0 V exactly at the output of A_1. Remove the short circuit and apply a stable input voltage of the level which is to be the maximum for use with the input channel. Align P_2 to give a level of REF+ at the output of A_2. If required, remove R_{11} to achieve unity gain of A_2, or adapt the values of R_8-R_9 for the requisite divide factor, i.e attenuation of the input voltage.

Again, whatever the maximum voltage to the channel, the highest anticipated level in the particular application should give a computer reading of FF_{hex} (255_{10}), the lowest level (0 V) Ø, both hexadecimal and decimal. Finally, it should be noted that the Type ADC0809 achieves an accuracy of ± 1 bit, or about 15 mV at an input voltage span of 4 V.

(Sv)

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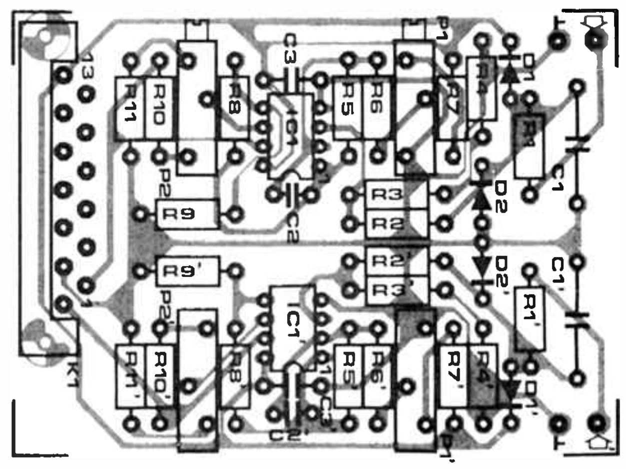

Fig. 4. Component mounting plan of one of four identical add-on boards to plug into the main board bus connectors. Note that an add-on board as shown here holds two measuring amplifiers.

Parts list
(Measuring amplifier board; see Figs. 2 & 4)

Resistors:
$R_1 \ldots R_6$;
$R_1' \ldots R_6'$ = 470 k;
1% metal film
R_7;R_7' = 2k2
R_8;R_9;R_8';R_9' = 10 k
R_{10};R_{11};R_{10}';R_{11}' = 1 k
P_1;P_1' = 10 k multiturn preset
P_2;P_2' = 100 k multiturn preset

Capacitors:
C_1;C_1' = 1 µ;MKT
C_2;C_2' = 22 p
C_3;C_3' = 100 n

Semiconductors:
D_1;D_2;D_1';D_2' = 1N4148
IC_1;IC_1' = TLC272 (Texas Instruments)

Miscellaneous:
13-way angled plug for PCB edge mounting (to DIN41617).
PCB(s) Type 86090-2 (see Readers Services)

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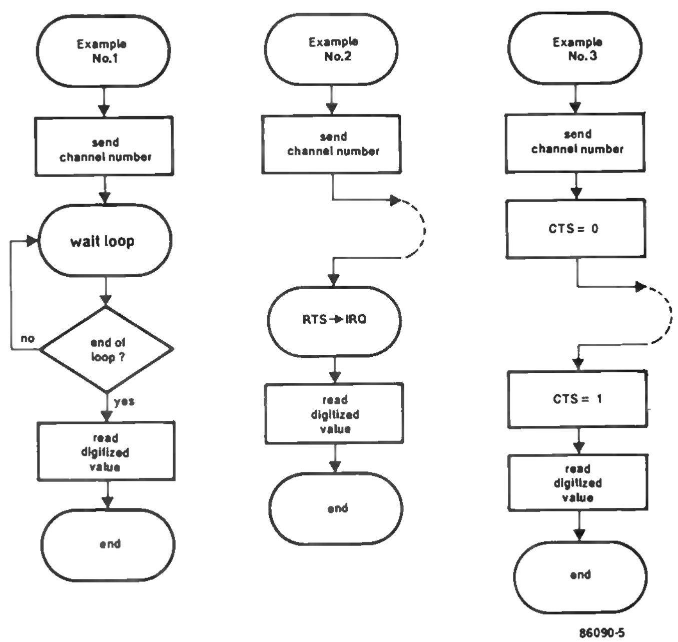

Fig. 5. Three suggested flowcharts for serial I/O subroutines. Example No. 1 is the most rudimentary of the three; No. 2 shows the possibilities for using RTS-generated interrupt requests, while No. 3 illustrates how handshaking signal CTS may be used to effect correctly timed serial communication.

HEADPHONE AMPLIFIER

Anyone with a keen ear for hi-fi sound reproduction should read this article, which details how the Type TEA2025 chip was revisited once more to make a versatile, yet compact and low component count stereo headphone amplifier.

Circuit details

Already incorporated in Elektor's portable mixer (see *Elektor Electronics*, issues of April, May and June 1986) and briefly discussed in the Summer Circuits issue of this magazine (*Elektor Electronics*, July & August 1986, p. 28), the Type TEA2025 stereo amplifier chip is the basis of the present design of a headphone amplifier circuit, details of which are shown in Fig. 1.

The amplifier chip is fed from a 12 V supply which ensures ample output power for use with 30 to 600 ohms impedance headphone sets. Total harmonic distortion at maximum output is of the order of 0.1%, although it must be noted that the amplifier then produces a sound pressure level which may be harmful to the ears.

The TEA2025 is driven by a pair of symmetrically fed (±12 V) operational amplifiers whose output level is monitored by overdrive detection circuit T_1-T_2; the PEAK level LED will light in case the safe driving level for the amplifier chip IC_3 is exceeded. Provision has been made to switch to monaural amplification by means of S_1.

As to the power supply, note that most current is drawn from the positive 12 V rail, so that an 1 A regulator Type 7812 has therefore been incorporated, while a 100 mA Type 79L12 can easily handle the negative supply demand of the PEAK indicator circuit and that of driver IC4.

Where this is desirable, potentiometers P_{1a} and P_{1b} may be replaced with presets, while driver stage gain may be defined as required by adapting feedback resistors R_1 and R_3.

Construction and applications

With reference to the track pattern and component overlay shown in Fig. 2, hardly anything can go wrong in constructing this versatile headphone amplifier. Note that regulator IC_1 should be fitted with a home-made, U-shaped bracket to aid in cooling the device. It is also suggested to fit IC_3 with a small DIP-type heat-sink, although the device is not too heavily loaded and should, therefore, remain relatively cool.

Volume setting potentiometer P_2 as well as gain adjustment potentiometer P_1, if fitted, are mounted direct onto the PCB, but conventional wiring with short lengths of screened cable may also be used with front-panel mount potentiometers.

Testing the completed amplifier is readily done by switching it to monaural mode and setting P_1 and P_2 to maximum (cw) and minimum (ccw) respectively. Do not apply an input signal while verifying that the outputs of A_1 and A_2 are at 0 V with respect to ground. Apply 10 V_{pp} input signal (3.6 V_{rms}), e.g. from the secondary of a mains transformer, and see if the driver stages can produce 20 V_{pp}; LED D_5 should just about remain off at this level. Maximum output power of the circuit should be achieved with 800 mV_{pp} applied to the inputs of IC_3; output voltage at the R and L terminals should be about 12 V_{pp} at $R_L = \infty$, and 8 V_{pp} at $R_L = 15\ \Omega$.

Applications of the present circuit other than a hi-fi stereo headphone amplifier include a general-purpose measuring amplifier, if equipped with a simple faultfinding probe, or a line driver for signal distribution in multi-amplifier PA systems.

(Sv)

Parts list

Resistors:
- $R_1 \ldots R_4$ = 10 k
- R_5;R_6 = 4k7
- R_7;R_8 = 33 k
- R_9;R_{10} = 470 Ω
- R_{11};R_{12} = 2k2
- R_{13};R_{14} = 56 k
- R_{15} = 22 k
- R_{16};R_{17} = 6k8
- R_{18} = 680 Ω
- P_1 = 47 k logarithmic stereo potentiometer*
- P_2 = 25 k logarithmic stereo potentiometer*

*PCB-mount type

Capacitors:
- C_1 = 1000 μ;25 V
- C_2 = 220 μ;25 V
- $C_3 \ldots C_6$ = 100 n
- C_7;C_{17};C_{18}; C_{19} = 100 μ;16 V
- C_8;C_9 = 470 n
- C_{10};C_{11} = 1 μ; bipolar or MKT
- C_{12} = 2μ2;16 V
- C_{13};C_{14} = 220 n
- C_{15};C_{16} = 22 μ;6 V
- C_{20};C_{21} = 150 n
- C_{22};C_{23} = 470 μ;16 V

note: all electrolytic capacitors are radial types.

Semiconductors:
- $D_1 \ldots D_4$ = 1N4001
- D_5 = red LED & panel holder
- T_1;T_2 = BC557B
- IC_1 = 7812
- IC_2 = 79L12
- IC_3 = TEA2025 (Thomson CSF)
- IC_4 = TL072

Miscellaneous:
- F_1 = 100 mA slow
- Tr_1 = 2 x 12 V at 250 mA
- S_1 = SPST switch
- PCB Type 86086
- Clip-on or slide-on DIL heat sink for IC3
- Soldering pins as required

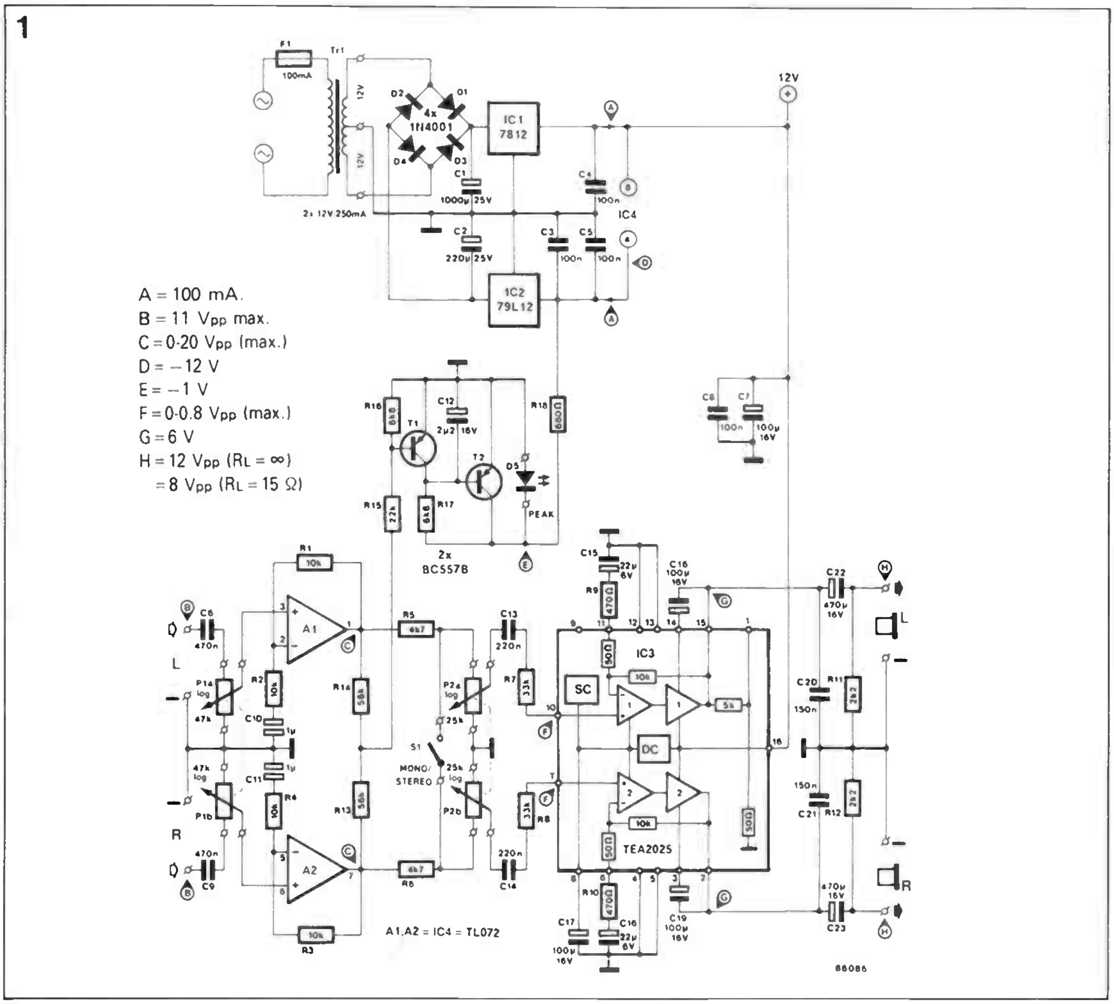

Fig. 1. Not many parts are required to build this high-quality stereo headphone amplifier based upon the Type TEA2025 chip. Measuring values relevant to several points in the circuit are shown inset.

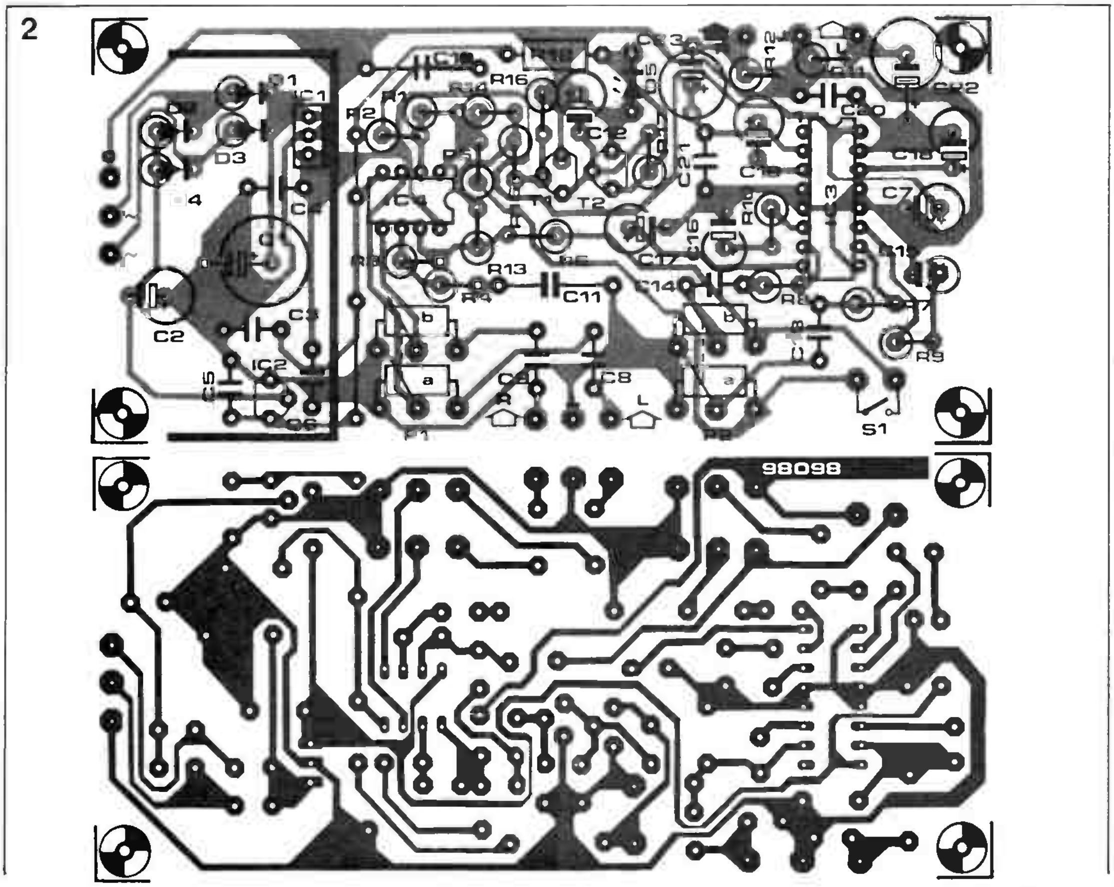

Fig. 2. Showing track pattern and component overlay of the stereo headphone amplifier. Note that stereo potentiometers P1 and P2 are mounted direct onto the PCB for compact mounting in a small-size cabinet.

SATELLITE LOUDSPEAKERS

Following on last month's Active subwoofer, this article deals with the satellite loudspeakers that complement the subwoofer to give complete coverage of the audio spectrum. These satellites are, however, also perfectly suitable for independent use.

Satellite loudspeakers are not a separate category of sound reproducing equipment; any loudspeaker whose bass performance should be improved could be classified as a satellite. So-called bookcase speakers are invariably satellites, because their modest dimensions prohibit proper reproduction of frequencies below about 100 Hz.

If you are planning a new loudspeaker system, you could do worse than to opt for a subwoofer-satellites system. It is then, of course, best right from the start to design the satellites for optimum performance with the subwoofer and vice versa. It is on this basis that the present article has come about: the results are very satisfactory, indeed.

Even those who are not terribly interested in the subwoofer will find that the bass performance of the satellite speakers (—3 dB point at 65 Hz) is perfectly adequate for their requirements.

Although the design of a loudspeaker enclosure is never an easy task, the one proposed here presents the constructor with relatively few difficulties. This is, of course, largely due to there being no need of paying much attention to the bass reproduction. A response down to 100 Hz would be perfectly adequate; true, an octave further down would be very nice, but is, in this case, not necessary.

This immediately removes the problem of choosing the right shape and size of enclosure and deciding how many "ways" the system should have. The enclosure decided on is a normal closed box, while it was felt that a two-way system would be perfectly acceptable, provided that the chosen drive units would allow this. The latter aspect also requires less arithmetic and fewer measurements than, e.g., a three-way system.

These considerations have resulted in a very satisfactory practical realization, both as regards the enclosure and the number of drive units. As a bonus, the bass performance measured is considerable better than that aimed at. In short, the proposed design is compact, easy to build, not expensive, and, even without a subwoofer, gives an excellent overall performance.

The drive units

As said, the design is based on two drive units. Since the majority of

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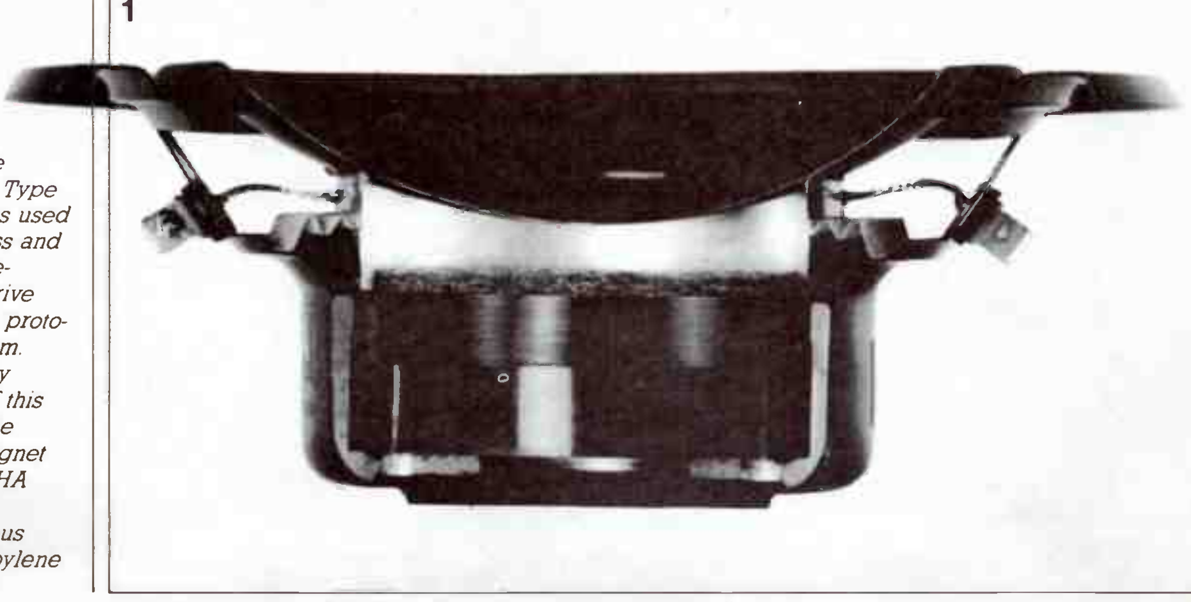

Fig. 1. The Dynaudio Type 17W75 was used as the bass and middle frequency drive unit in the prototype system. Noteworthy aspects of this unit are the centre magnet and the PHA (phase homogenous area) propylene cone.

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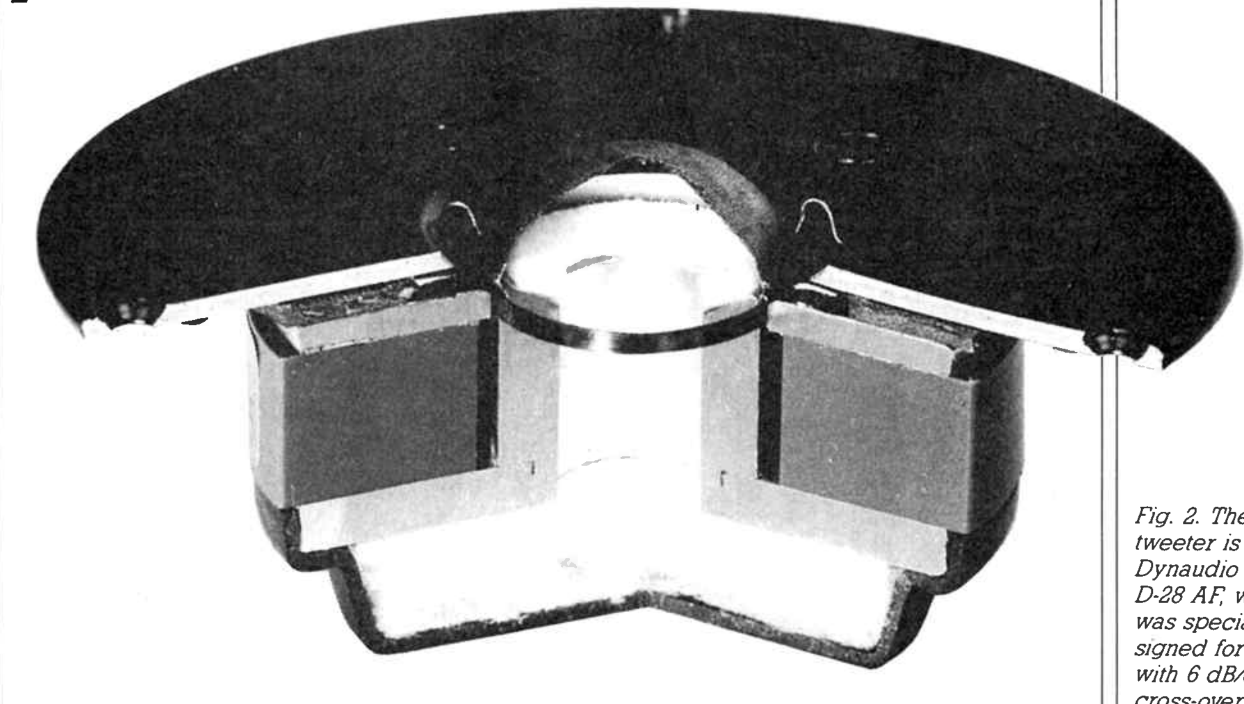

Fig. 2. The tweeter is a Dynaudio Type D-28 AF, which was specially designed for use with 6 dB/octave cross-over filters.

middle-frequency units are not really satisfactory above about 2000 to 2500 Hz, which causes problems in the choice of tweeter, Dynaudio units were used for the prototypes. These units did not only meet the requirements for the present design better than most; they also offer the advantage of an excellent match with the subwoofer (which also uses a Dynaudio drive unit). The units are the Type 17W75, a 170 mm bass and middle-frequency unit, and the Type D-28 AF tweeter.

The 17W75, shown in Fig. 1, is a drive unit with a relatively large voice coil (75 mm) in hexacoil technique, which, in conjunction with the unusual shape of the one-piece cone, gives an ideal transfer of the acceleration force from the coil to the PHA (phase homogeneous area) cone. Another advantage of the big voice coil is the short rise time (fast transient response) of 50 µs. Very low distortion and excellent phase characteristics are a result of the total concave shape of the cone.

The D-28 AF, shown in Fig. 2, is a 28 mm soft dome tweeter. The voice coil is coupled with the aid of ferro fluid. The unit has a noteworthy fast transient response (short rise time) of 12 µs. It offers the great advantage of having been designed specifically for use with 6 dB/octave filters: not many dome tweeters have!

Cross-over filter

Cross-over filters (or networks) are, unfortunately, necessary, because there is not a drive unit that can reproduce the entire audio range satisfactorily. As long as these filters are not to steep-skirted, they do not cause too much harm, but with increasing skirt steepness the flaws they introduce become more and more serious. Steep-skirted filters have particularly bad transient response characteristics.

The design of a cross-over network should therefore be based on 6 dB/octave slopes, provided the drive units used allow this. This is so in the present design as can be seen from the diagram in Fig. 3. Strictly speaking, this circuit contains only two true filter components: L_1 and C2. The remainder of the components perform the correcting functions that are always necessary for good filter operation. Network R_1-C_1 serves to counteract the impedance of the 17W75, which increases with rising frequency. This carefully designed network ensures that the overall impedance of the drive unit remains constant above its resonance frequency. Only because of this can the filter perform as required.

Resistive divider R_2-R_3 serves a twofold function. In the first place, it ensures level matching of the tweeter, whose efficiency is somewhat higher than that of the 17W75. Then, the value of R_2 may be varied between zero ohms and 2.2 ohms without the necessity of changing the value of C. A value of 0 ohms corresponds to a 0.5 dB correction for the tweeter, while 2.2 ohms gives a −1.5 dB correction. Moreover, R_3 smoothes out a small uneveness in the tweeter characteristic: its value must, therefore, not be changed under any circumstances.

The characteristic in Fig. 4 represents the output voltage of the filter, measured across the two drive units. Note that the cross-over point only appears to be at −5 dB; it is actually at the customary −3 dB. The characteristic of the 17W75 has a slight peak at the cross-over frequency, and this has been corrected by a slightly earlier action of the filter. Acoustically, everything is, therefore, as it should be.

Construction of the filter should not give any difficulties if the PCB (Type 86016) shown in Fig. 5 is used. Note, however, that L_1 should be fastened with glue or a brass/nylon bolt: a

Fig. 3. The 6 dB/ octave cross-over network is typified by its simplicity.

▶

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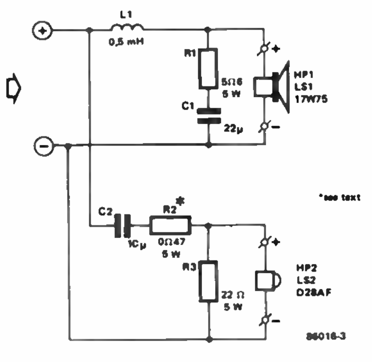

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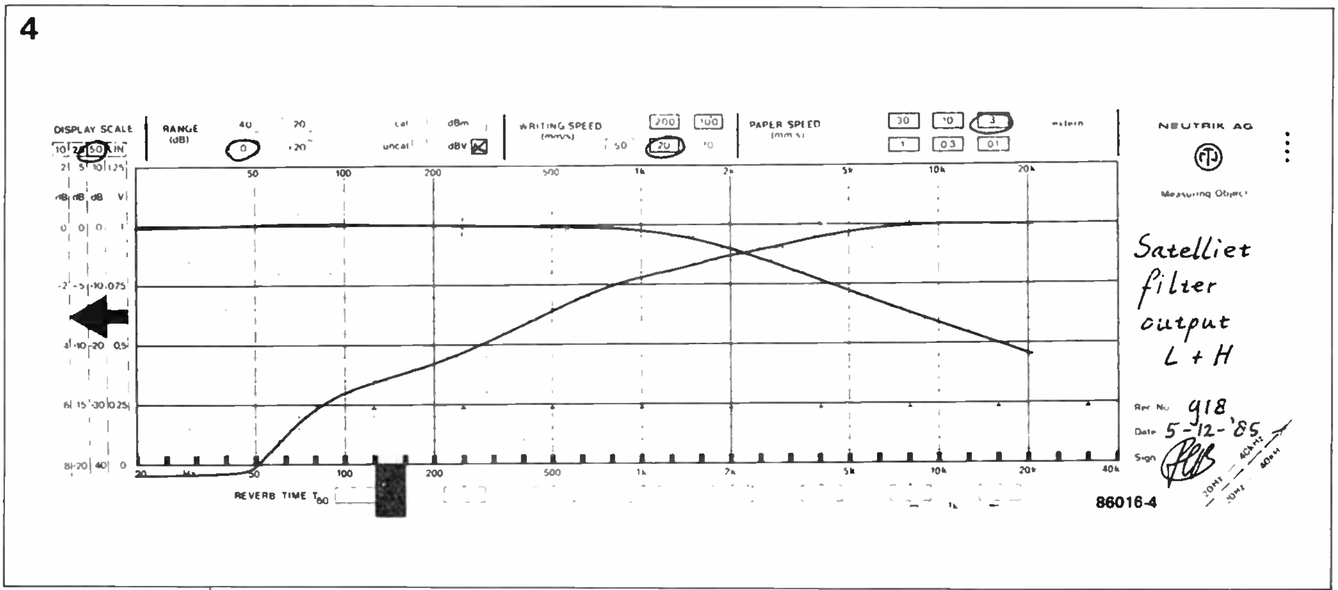

Fig. 4. Characteristic curve of the output voltage of the cross-over filter measured with the drive units connected.

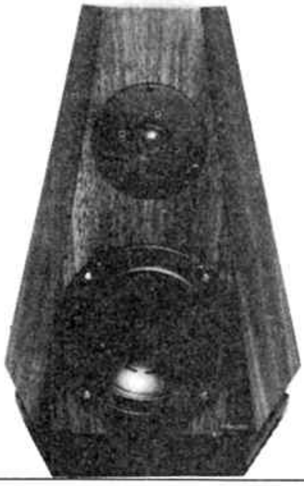

Fig. 5. The printed-circuit board for the cross-over network (Type 86016 — available through our Readers' Services).

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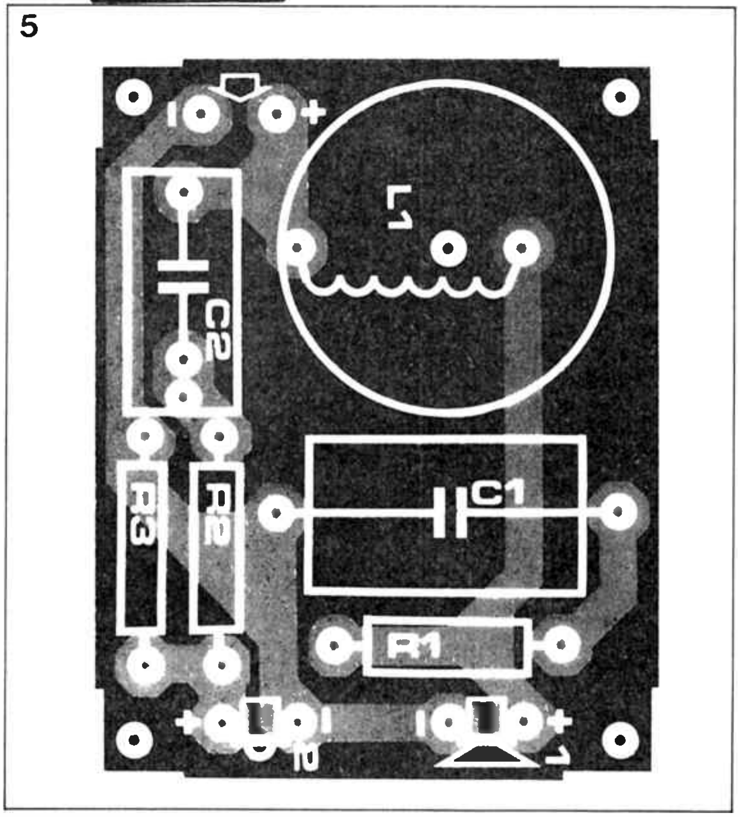


Parts list

L1 = 0.5 mH air-cored inductor; wire diameter 1 mm
C1 = 22 μ bipolar electrolytic or polyester
C2 = 10 μ polyester
R1 = 5 Ω;5 W
R2 = 0.47 Ω;5 W
R3 = 22 Ω;5 W
Dynaudio Type 17W75 drive unit
Dynaudio Type D-28 AF drive unit
chip board or plywood, 18 mm thick, as required (see Fig. 6)
about 0.25 m² rubber-backed floor covering
about 0.25 m² rock-wool
1 variovent; 110 mm; (Dynaudio)
connector terminals as required
wood glue, screws, and nails as required

steel fastening would affect the value of the inductor. Also, observe correct polarity when the drive units are connected to the board. The PCB may be conveniently mounted —on spacers— on the bottom lid or against the back panel of the enclosure.

The enclosure

According to the manufacturer's data, the 17W75 is best housed in a 10 to 15 litre closed box, which has been provided with a so-called variovent (acoustic resistance). Although theoretical considerations point to a somewhat larger volume, in practice the manufacturer's recommendations proved to be correct. In a damped closed box of exactly 10 litres volume, the bass performance of the 17W75 was surprisingly good. The difference between a box with, and one without, a variovent is slight. The variovent only serves to attenuate the resonance peak, and this results in a somewhat more rigid performance at low frequencies.

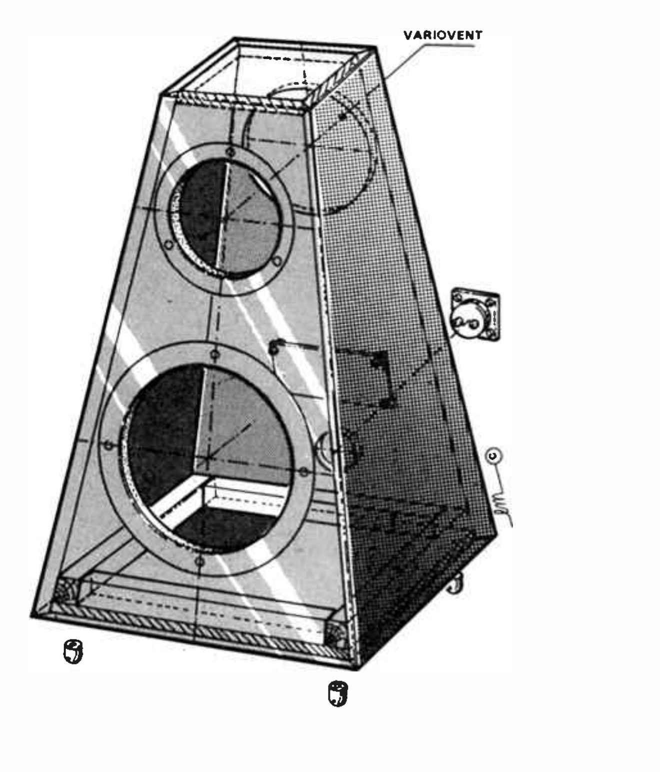
Although some photographs accompanying this article show a beautifully styled pentagonal, pyramid-shaped prototype enclosure (courtesy Dynaudio), the proposed enclosure has been kept rather simpler. Note, however, that the pentagonal enclosure is available from Dynaudio as a kit: it is acoustically excellent, but quite difficult to build. Our own proposal, shown in Fig. 6, offers similar advantages as the Dynaudio design: no parallel side panels; leaning backwards; upward tapering front panel; but does not demand the craft of a furniture maker.

The material is 18 mm fine-chip board; plywood may, of course, also be used, but is rather more expensive. The front, back, and side panels have exactly the same dimensions. If these are sawn very carefully, all four can be glued together in one go. The bottom and top lid must be sawn very carefully to ensure a good, tight fit onto the leaning vertical panels. The top lid may be glued in place, but the bottom panel is best fitted with screws and sealing tape so that access is possible at a later stage, if required. Next, the holes for the drive units, the variovent, and the connector terminals should be cut. The variovent should be glued into

Technical characteristics

System	passive; two-way
Enclosure	closed box
Net volume	about 10 litres
Cross-over filter	6 dB/octave; cross-over point at about 2500 Hz
Frequency range	−3 dB points at 60 Hz and 20 kHz
Amplifier rating	30-100 watts
Sensitivity	89 dB

6a



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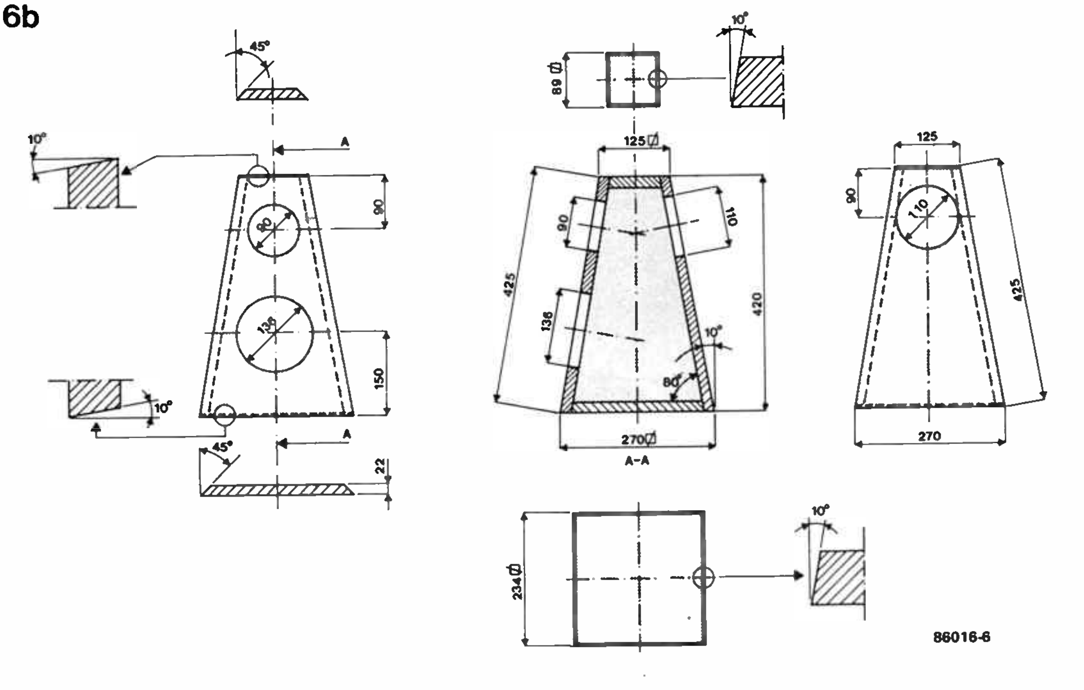


Fig. 6. Construction details of the proposed enclosure. The material may be 18 mm plywood or good quality chip board.

place, while the drive units should be screwed on. Afterwards, the gap between the rim of the drive units and the front panel should be sealed with suitable tape.

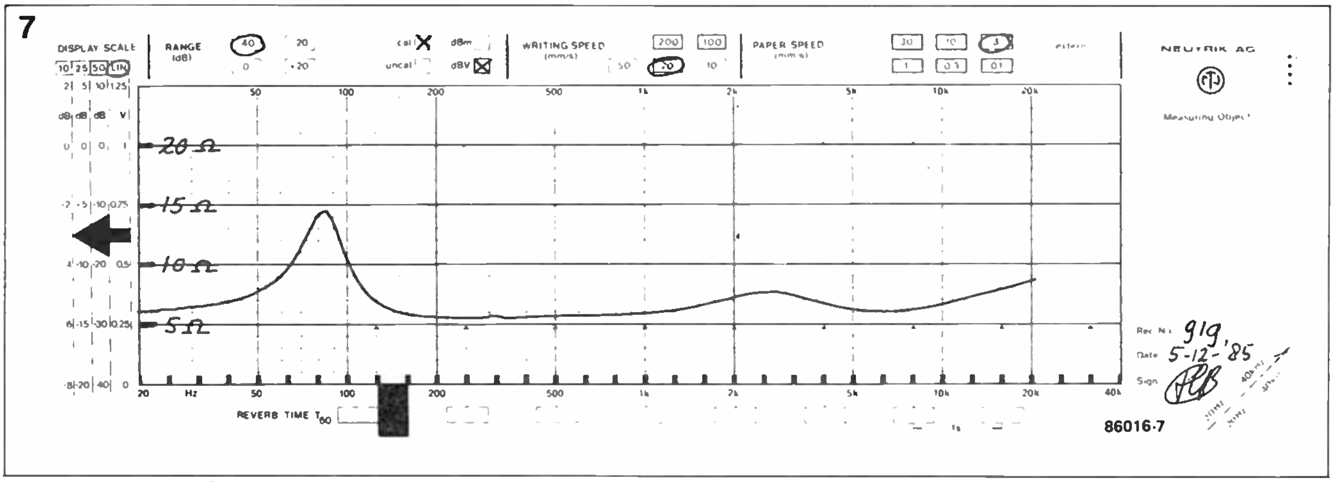
The beste place to fit the cross-over filter is at the back panel between the variovent and the connector terminals.

Panel resonance is further prevented by gluing strips of rubber-backed floor covering at the inside of all panels and then covering these with 30 mm thick rock-wool. If this material is amply cut, the strips will be push-fitt, obviating the need for gluing them into place.

The finish of the exterior of the enclosure is left to your own taste and preference.

Performance

It is, of course, easy (and tempting) for a designer to sing his own praises, so the performance of the system can be gauged from the measured impedance and frequency response characteristics illustrated in Figures 7 and 8 respectively. The smooth impedance curve should not present any problems to a good output amplifier. The frequency response curve was measured with $R_2 = 0.47$ ohms. When this is increased to 2.2 ohms, the characteristic shifts down by about 2 dB above 2 kHz. Response at low frequencies was ascertained by close-proximity (20 mm) measure- ▶



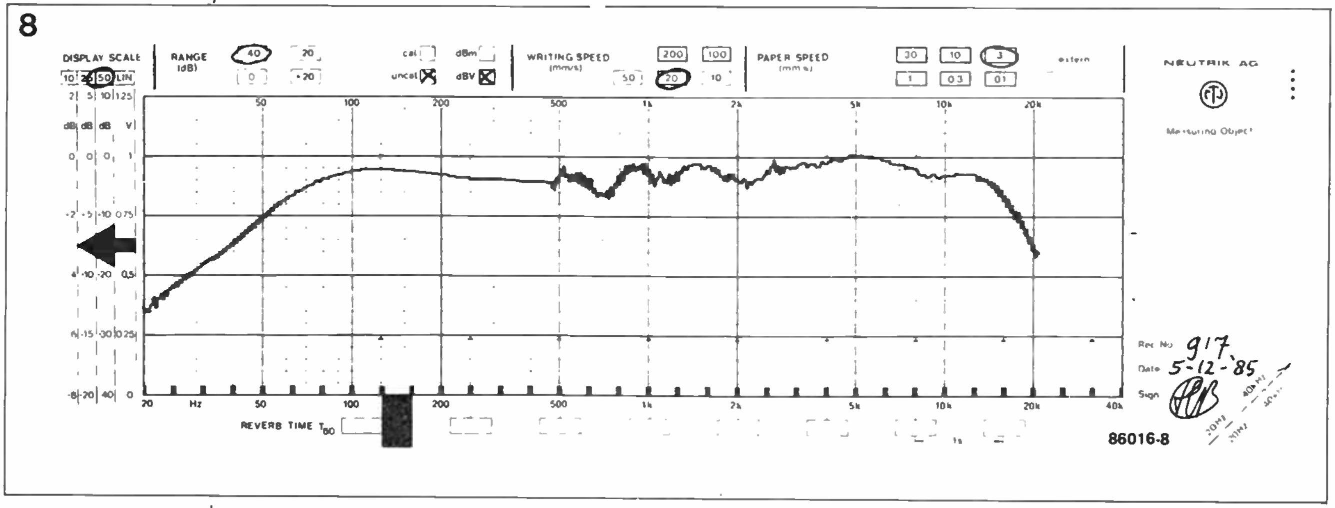


Fig 7. Characteristic impedance curve of the completed satellite system.

Fig. 8. Frequency response curve of the completed satellite system.

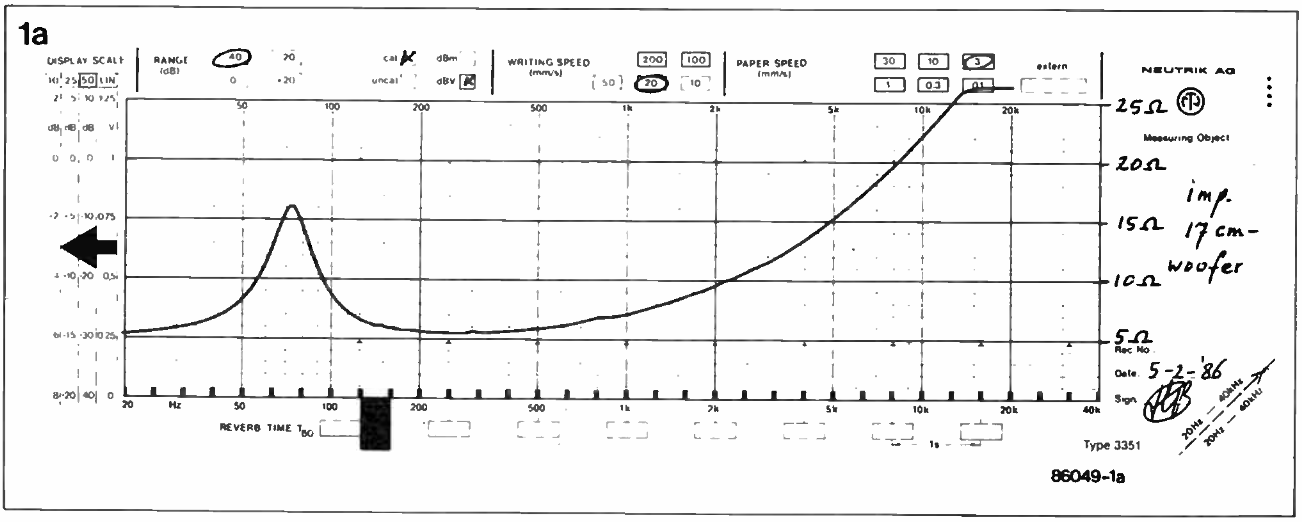
ments. The acoustics of the test room has such an effect that measurements at greater distances give no meaningful information as to the behaviour of the system at low frequencies. For measurements at middle and high frequencies, the test microphone was placed at a distance of about 2 metres at roughly the height of the acoustic centre of the enclosure.

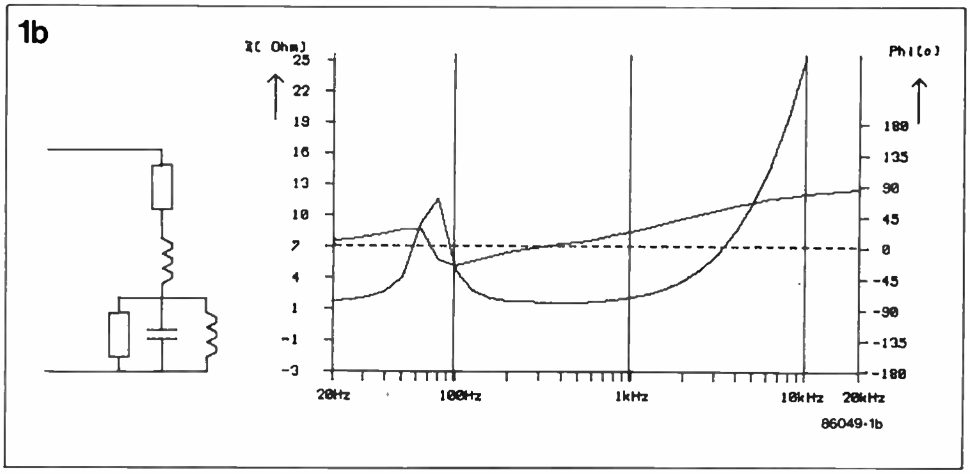
LOUDSPEAKER IMPEDANCE CORRECTION

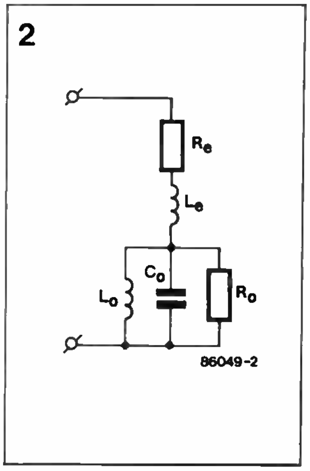
A loudspeaker presents a complex load to the output amplifier and the cross-over network. This load can be measured and any deviation from the nominal impedance corrected. In this manner a multi-way loudspeaker system with a passive cross-over network can be made to function optimally.

A loudspeaker looks a simple enough device: a frame, a coil, a magnet, and a cone of paper or of man-made fibre. Put it in a box and you have a sound reproducer. If only it were as simple as that. . . *Designing a closed loudspeaker box* (*Elektor Electronics*, February 1986) explained the fundamentals of calculating the dimensions of a closed box on the basis of the characteristics of the drive unit used. That thus dealt with the acoustics of the system. The present article takes a closer look at the electrical aspects.

Before reading any further, note that if the cross-over network is of the active ▶







type, the loudspeaker impedance is of no particular importance. With a passive filter, however, it is a prime factor.

Dynamic impedance

A drive unit may be represented by an electrical circuit containing resistance, capacitance, and inductance. Its impedance may, therefore, be inductive, capacitive, or resistive, depending on the frequency of operation. Moreover, the impedance is affected, to some extent, by the type and dimensions of the enclosure in which the drive unit is housed. Figure 1 shows the dynamic impedance of a 17 cm bass unit measured over the frequency range of 20 Hz to 20 kHz. This curve is characterized by the peak around 75 Hz and the slowly rising impedance with frequency. The peak is caused by the resonance frequency of the equivalent circuit, while the rising with frequency results from the self inductance of the voice coil. As the cross-over network has been designed for operation into a constant-value ohmic load, the performance of the system will be adversely affected by this varying impedance.

Equivalent circuit

A (simplified) equivalent circuit of a typical drive unit is shown in Fig. 2. The voice coil has a resistance, R_e, which determines the minimum impedance of the drive unit. From the curve in Fig. 1 it is clear that for the drive unit used here R_e=5.5 ohms. The inductance of the voice coil is represented by L_e. The parallel circuit L_o-C_o-R_o causes exactly the same peak as the drive unit proper. Note that it is in series with the series combination of R_e and L_e.

Impedance calculations

A dynamic impedance characteristic, such as that in Fig. 1, can be determined with the simple set-up of Fig. 3. If the resistance R is large compared with the nominal loud-

Fig. 1. The impedance curve of a typical loudspeaker unit in (a) was measured under controlled conditions. Subsequently, an equivalent circuit was calculated and built: the impedance curve of this is shown in (b). The resemblance between the two characteristics is striking.

Fig. 2. The equivalent electrical circuit of a loudspeaker looks anything but a resistance.

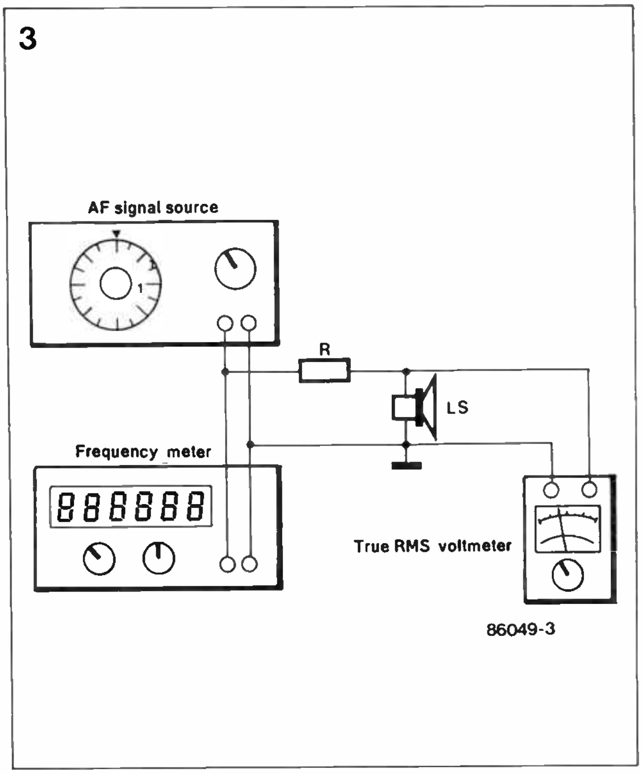
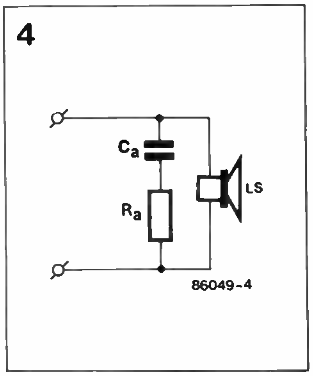
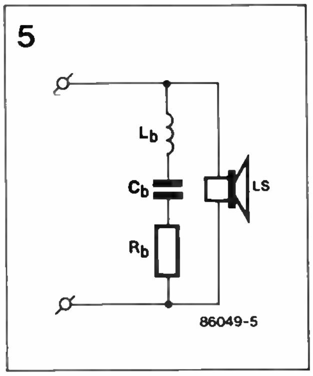


Fig. 3. Typical set-up for measuring loudspeaker impedance over a range of frequencies.

Fig. 4. An RC network across the loudspeaker compensates for the rise in impedance with frequency.

Fig. 5. The resonance peak of a loudspeaker may be negated with a suitable LCR network across the unit.





speaker impedance, the AF signal source functions as a perfect current source. If, for instance, R=3k3, and the output of the signal source is set at 3.3 V r.m.s., the current through the loudspeaker coil is 1 mA. Each millivolt drop across the loudspeaker, therefore, represents 1 ohm. It is clear that the true RMS voltmeter should be a sensitive type. The impedance presented by the loudspeaker can now be measured over a range of frequencies, and the curve plotted from the values measured. It is, of course, essential that the drive unit is housed in its normal enclosure to ensure that the true impedances are measured.
The voice coil resistance, R_e, may be measured with an accurate ohmmeter, or with the set-up of Fig. 3. The latter is not too accurate, but it will do. In this case, the minimum impedance over the frequency range is ascertained.
Next, ascertain the impedance, Z_o, at the resonant frequency, f_o. The true impedance, Z, is

$$Z=Z_o-R_e \qquad (1)$$

Subsequently, calculate the impedance, Z_3, at the −3 dB points from

$$Z_3=R_o+Z\sqrt{2} \qquad (2)$$

Measure at which frequencies above and below f_o, f_a and f_b respectively, the impedance has the value Z_3.
The bandwidth, BW, of the resonance peak is calculated from

$$BW=f_a-f_b \qquad (3)$$

Values of the equivalent circuit components can now be calculated from the following.

$$L_o=BWZ/2\pi f_o \qquad (4)$$

$$C_o=1/2\pi BWZ \qquad (5)$$

$$R_o=Z \qquad (6)$$

For bass speakers, measure at which frequency, f_x, the impedance is equal to $2R_e$. Then,

$$L_e=\sqrt{3}R_e/2\pi f_x \qquad (7)$$

For middle and high frequency speakers, measure at which frequency, f_z, the impedance is equal to $\sqrt{2}R_e$. Then,

$$L_e=R_e/2\pi f_z \qquad (8)$$

Correcting the dynamic impedance

To ensure optimum performance from the passive network and loudspeaker, the impedance presented to the filter by the loudspeaker should remain constant over the frequency range of the system. This is readily effected by an RC combination across the drive unit as shown in Fig. 4, where

$$R_a=R_e \qquad (9)$$

$$C_a=L_e/R_e^2 \qquad (10)$$

Note that the minimum impedance of the loudspeaker remains equal to R_e.
Correcting the resonance peak is normally not necessary, because it usually lies well outside the pass band of the cross-over network. None the less, where it is felt necessary, it can be done with the aid of the circuit in Fig. 5. Here,

$$L_b=L_oR/R_o \qquad (11)$$

$$C_b=C_oR_o/R_b \qquad (12)$$

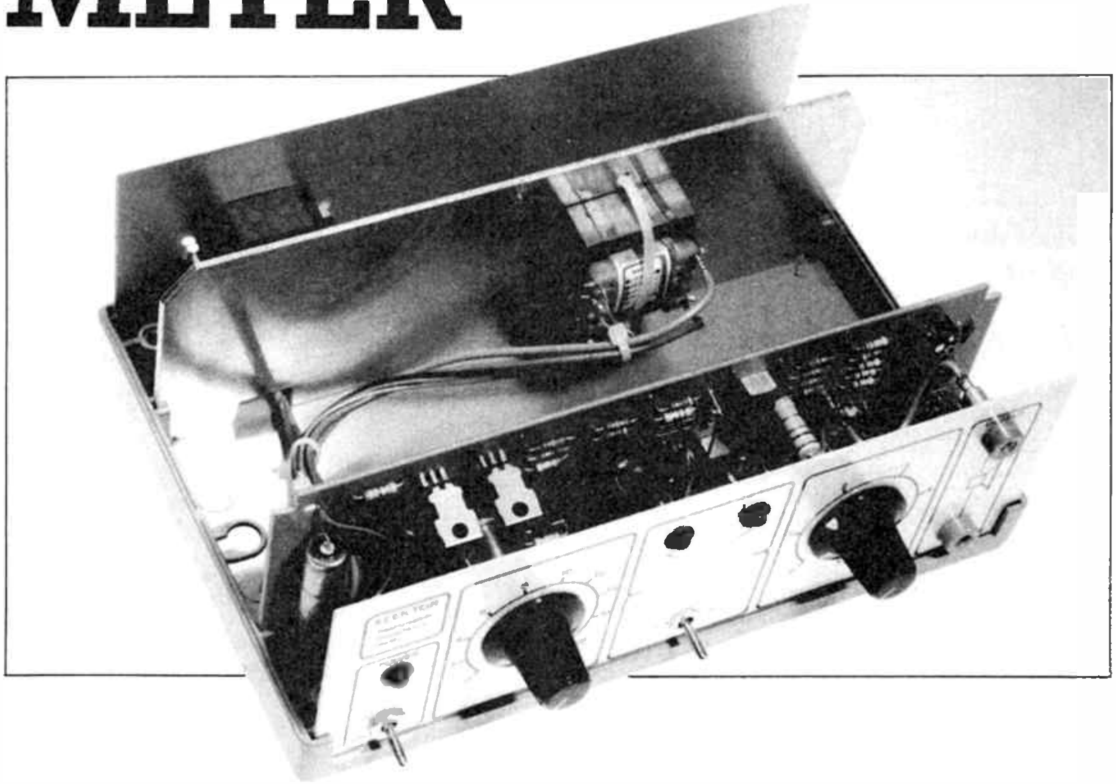
$$R_b=R_e+R_e^2/R_o \qquad (13)$$

These correcting networks ensure that the passive cross-over filter is terminated into a constant-value impedance.

HB

LOUDSPEAKER IMPEDANCE METER

by K. Rohwer



A simple, yet interesting and useful, instrument for measuring the resistance and the inductive reactance of a loudspeaker.

It may be argued that a loudspeaker impedance meter is something that is needed only once in a blue moon, but to many dyed-in-the-wool audio constructors it could be a godsend. Loudspeakers are frequently offered for sale at very low prices by various retailers, but often there is no indication as to their characteristics. The present circuit will at least enable the impedance to be ascertained with a good degree of accuracy. A multimeter will, of course, only give some idea of the resistance. A useful aspect of the present circuit is that the resistance and the inductive reactance can be measured separately. The only limitation of the meter is that all measurements take place at a frequency of 1000 Hz. This is an excellent value for woofers and broad-band drive units, but on the low side for middle frequency units and tweeters. The meter is, therefore, not suitable in the design of a loudspeaker enclosure, because then the impedance at a number of different frequencies needs to be known.

Design considerations

The principle of the impedance meter is almost more interesting than its practical construction. Owing to the inductive reactance, measuring impedances with the aid of a bridge circuit is not as simple as it may appear at first sight. The present meter is, therefore, based on a different design philosophy as shown in Fig. 1.

As the block diagram shows, the meter consists of a quadrature sine wave oscillator, a synchronous rectifier, a voltage source, and a null-point detector. The oscillator provides two signals, $\sin\omega t$ and $\cos\omega t$, that have the same frequency, but are 90° ($\pi/2$) out of phase. The $\sin\omega t$ signal is used to control a voltage-driven current source, the output of which flows through the impedance, Z, to be measured.

The potential drop across Z consists of two voltages, U_R and U_X, which are 90° out of phase (U_R is caused by the pure resistive part of the impedance, whereas U_X is due to the inductive reactance, X_L). The basis of the meter is that the two oscillator outputs can be adjusted accurately to give a compensating potential at the inputs of a differential amplifier that is identical to the composite drop across Z. The output of the differential amplifier is then zero. A synchronous rectifier and a null-point detector facilitate the correct setting of the two potentiometers. When both LEDs are quenched, the value of R and X_L can be read off the scale of the potentiometers once these have been calibrated.

Circuit description

The quadrature oscillator is composed of opamps A_1 and A_2 and generates a signal at a level of about 6.5 V and a frequency of around 1000 Hz. The sine wave voltage appears at A, and the cosine one at B. The voltage-controlled current source is formed by A_3, T_1, and T_2, while R_{12} is the current-determining resistor. ▶

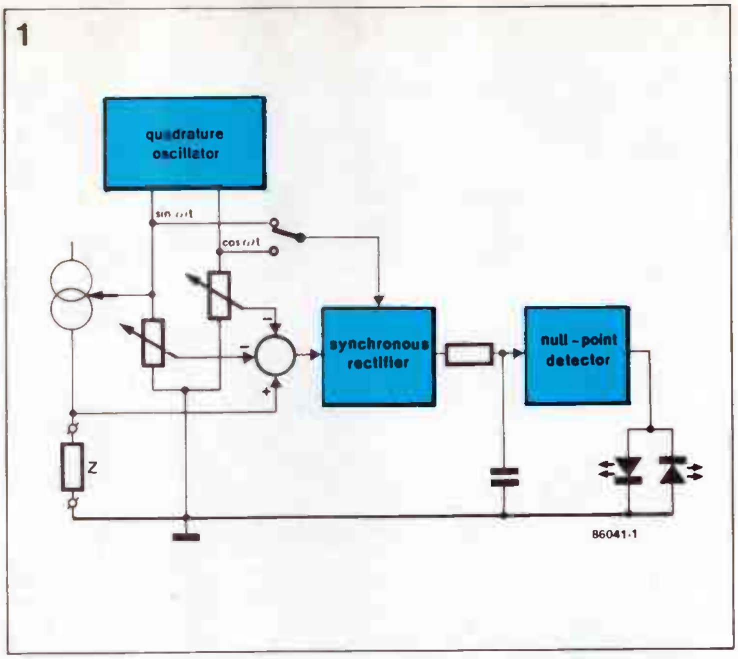
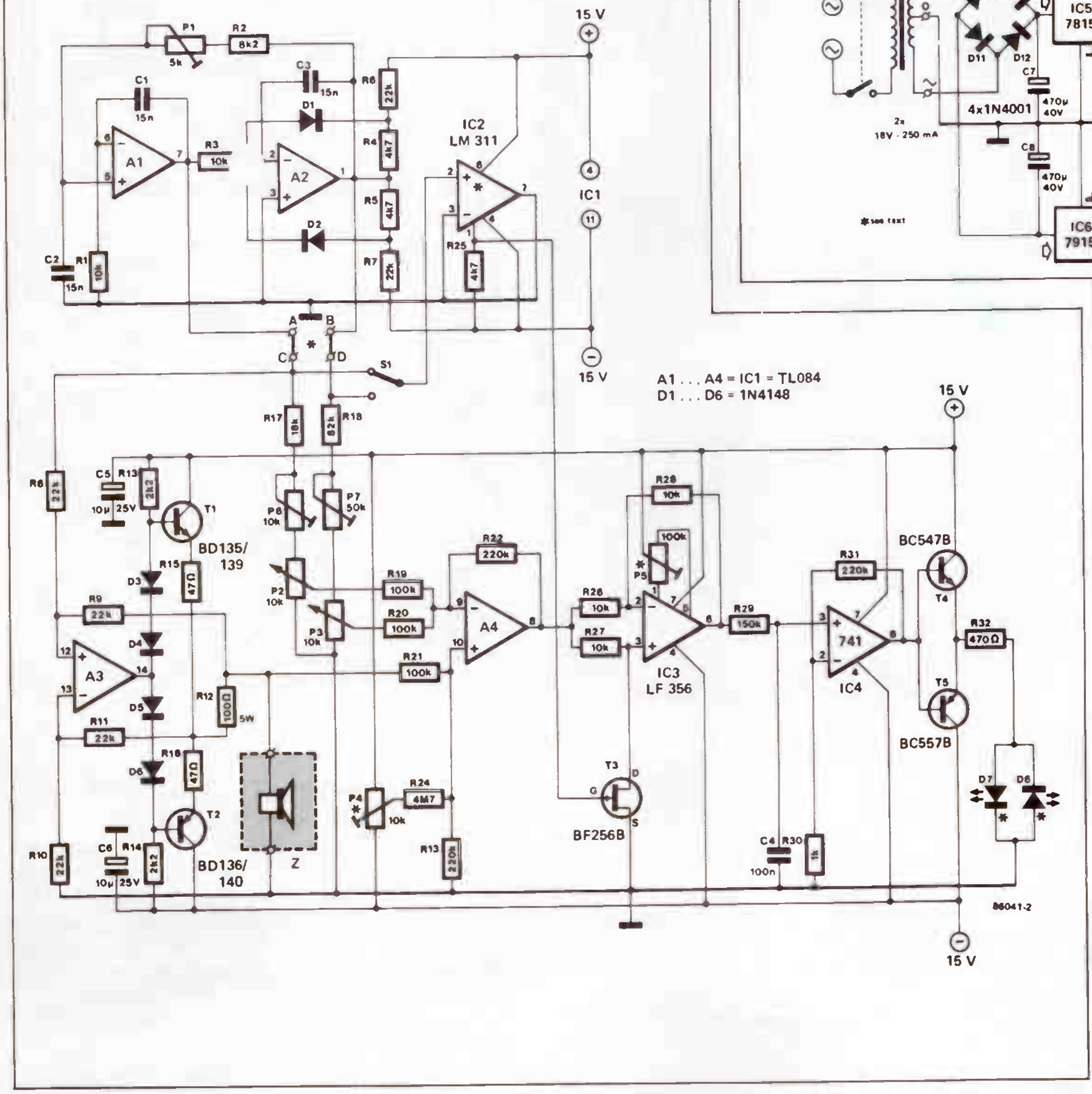


Fig. 1. Block diagram of the meter. The voltage drop across Z is compensated by a composite signal provided by the quadrature oscillator. The values of the resistive and reactive elements can then be read off the scales of the potentiometers.



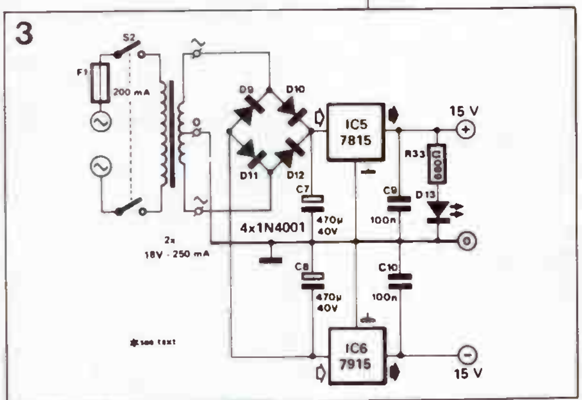


Fig. 2. The circuit diagram of the meter.

Fig. 3. The symmetrical power supply is a conventional unit.

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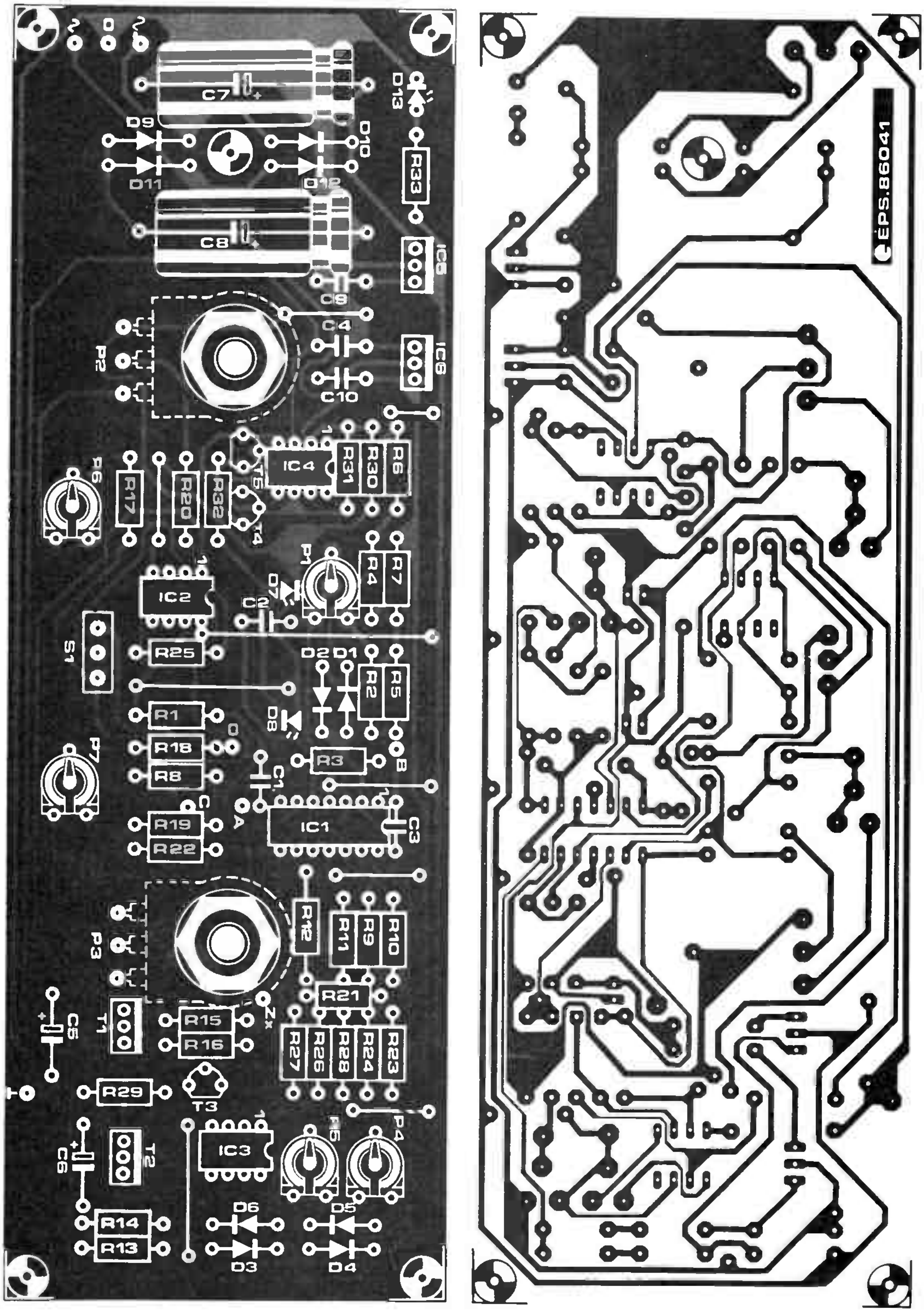


Fig. 4. The printed-circuit board accommodates the entire circuit, including the power supply. Wire links are required between A and C and between B and D.

Parts list

Resistors:

R1;R3;R26;R27;R28 = 10 k
R2 = 8k2
R4;R5;R25 = 4k7
R6 to R11 incl = 22 k
R12 = 100 Ω;1 W
R13;R14 = 2k2
R15;R16 = 47 Ω
R17 = 18 k
R18 = 82 k
R19;R20;R21 = 100 k
R22;R23;R31 = 220 k
R24 = 4M7
R29 = 150 k
R30 = 1 k
R32 = 470 Ω
R33 = 680 Ω
P1 = 5 k preset
P2;P3 = 10 k, linear, wirewound potentiometer
P4;P6 = 10 k preset
P5 = 100 k preset
P7 = 50 k preset

Capacitors:

C1;C2;C3 = 15 n
C4;C9;C10 = 100 n
C5;C6 = 10 μ;16 V
C7;C8 = 470 μ;40 V

Semiconductors:

T1 = BD135/BD139
T2 = BD136/BD140
T3 = BF256B
T4 = BC547B
T5 = BC557B
D1 to D6 incl = 1N4148
D7;D8;D13 = LED
D9 to D12 incl = 1N4001
IC1 = TL084
IC2 = LM311
IC3 = 741
IC5 = 7815
IC6 = 7915

Miscellaneous:

Tr1 = mains transformer 2 × 18V;250 mA
S1 = SPST switch
S2 = double pole mains switch
F1 = fuse; 200 mA; delayed action
fuse holder to individual requirements
two wander plugs and sockets (chassis mounting)
Verobox Type 75-1411D
PCB 86041 (see Readers' Services)
Front panel foil 86041-F (see Readers' Services)

The two compensating voltages are taken from the oscillator via potential dividers R_{17}-P_6-P_2 and R_{18}-P_7-P_3 and C and D (which are linked to A and B respectively). Since the value of the inductive reactance, X_L, is always much smaller than that of the DC resistance, R, the value of R_{18} is considerably larger than that of R_{17}.

The differential amplifier is formed by opamp A_4: potentiometer P_4 provides the necessary off-set compensation.

The synchronous rectifier is composed of T_3 and IC_3. The amplification of the latter is +1 or −1, depending upon the state of T_3. This transistor is controlled by comparator IC_2, the input of which can be connected to the sine or cosine output of the oscillator by S_1.

The somewhat unusual output configuration of the comparator (output pin 7 to ground and earth pin 1 to −15 V via R_{25}) becomes clearer when it is realized that pins 1 and 7 are connected to the emitter and collector respectively of the output transistor in the LM311. Series combination R_{29}-C_4 smoothes the output voltage of IC_3 before this is applied to the null-point detector.

The null-point detector consists of a Type 741 opamp, IC_4, and two complementary transistors, T_4 and T_5. As stated before, if during the test P_2 and P_3 have been set correctly, diodes D_7 and D_8 will remain quenched.

The power supply, which provides symmetrical voltages of ±15 V, is a fairly simple affair as shown in Fig.3.

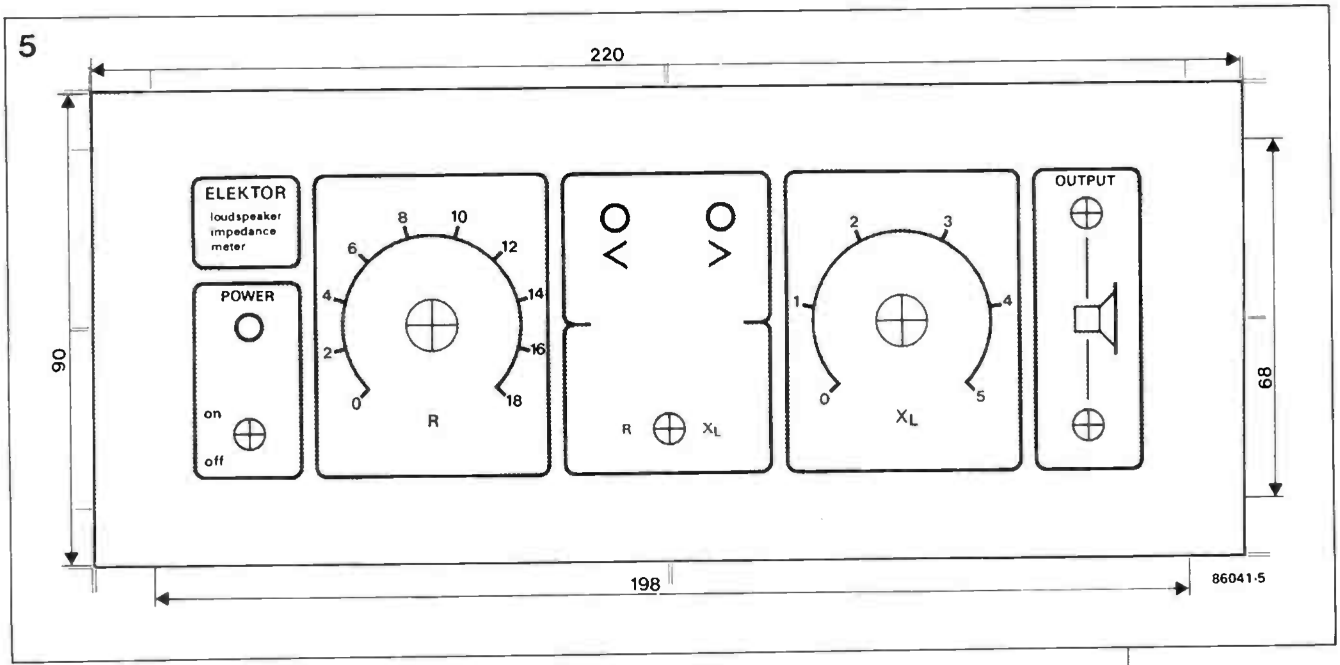


Fig. 5. The front panel of the meter matches those of other instruments in the series.

On/off indication is provided by diode D_{13}.

Construction

The meter is best built on PCB86041 shown in Fig. 4 and housed in a Vero case Type 75-1411D. Note that potentiometers P_2 and P_3 can be mounted direct onto the PCB.
Do not forget wire links A-C and B-D.
Connections between the PCB and input and output terminals should be kept short and made in relatively thick wire.
Do not fit C_4 until the meter has been calibrated.
It is advisable to use LEDs of equal brightness in the D_7 and D_8 positions.
Use of the Type 75-1411D Verobox has two advantages: the meter then fits nicely in the Elektor series of measuring instruments, and use may be made of the front panel foil 86041-F available through our Readers' Services—see Fig. 5.

Calibration

Adjust P_1 so that the oscillator just starts, which is conveniently checked with the loudspeaker under test.
Turn P_2 and P_3 fully anticlockwise (wipers to ground), and short-circuit the output terminals. Diodes D_7 and D_8 should now light.
Adjust P_5 until both LEDs are equally bright, and then turn P_4 till they just go out.
Fit capacitor C_4.
Set switch S_1 on the front panel to position R.
Connect a 10-ohm (1 per cent tolerance) resistor across the output terminals.

Set P_2 (R) to read 10 and slowly adjust P_6 until both LEDs just go out.
Replace wire links A-C and B-D by (temporary) links A-D and B-C. Switch S_1 should remain in position R.
Connect a 3.3-ohm (1 per cent tolerance) resistor across the output terminals.
Set P_3 (X_L) to read 3.3 and slowly adjust P_7 until both LEDs just go out.
Remake wire links A-C and B-D.

Using the meter

Connect the loudspeaker under test across the output terminals.
Set S_1 to position R and turn P_2 (R) until the LEDs just go out.
Set S_1 to position X_L and turn P_3 (X_L) until the LEDs just go out.

The impedance of the loudspeaker is calculated from

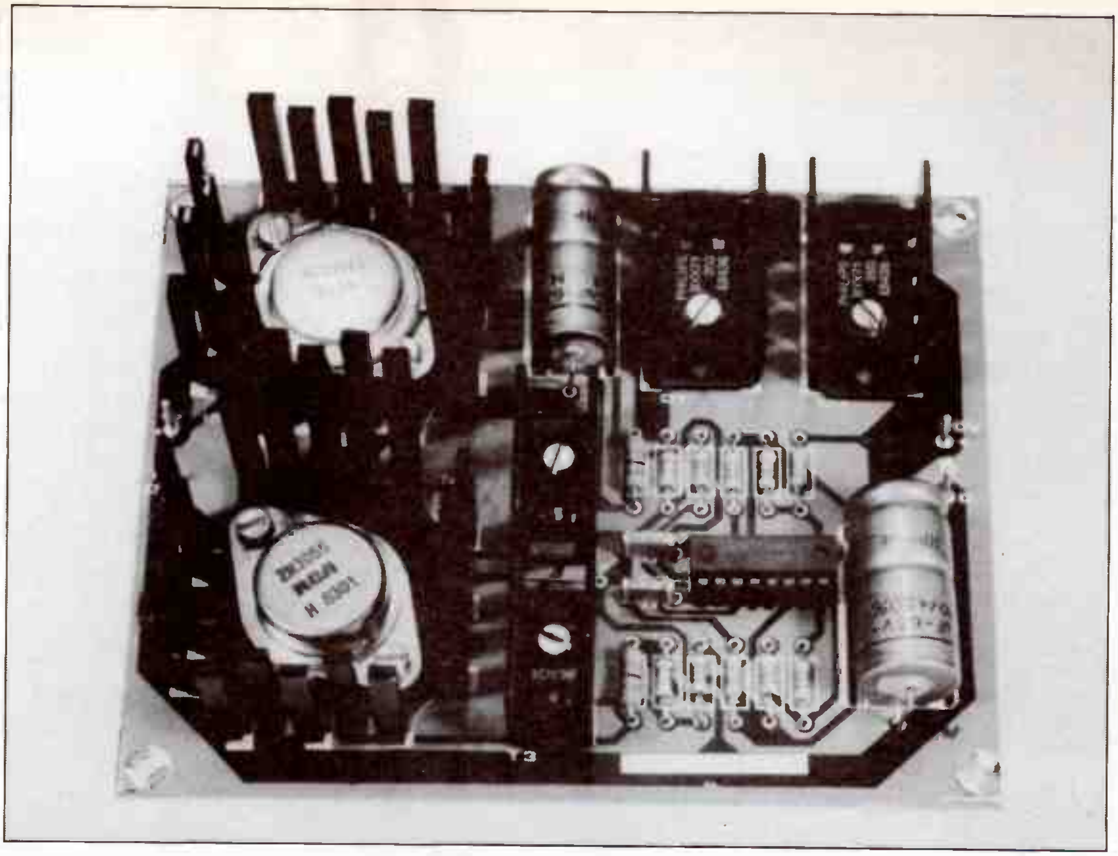
$$Z=\sqrt{(R^2+X_L^2)} \qquad [\Omega]$$

where R and X_L are the values read from the front panel.
The self-inductance of the voice coil may be calculated from

$$L=X_L/2\pi \qquad [\text{mH}]$$

Experimental extensions

Various extensions may be incorporated, although these have not been tested in our own laboratories. For instance, if wire links A-C and B-D are replaced by a change-over switch that enables A to be linked to D and B to C, it becomes possible to measure capacitive reactances (X_C). Again, if the output of the voltage-controlled current source is made switchable, different measuring ranges become available. And finally, the oscillator could be made to provide a number of switch-selected frequencies. But then, this would not be such a simple instrument any more.



Mains-operated NiCd chargers are in plentiful supply, but a NiCd charger that operates from a car battery and enables fast charging is something special. The one described here can charge 9-, 12-, or 15-volt batteries.

DC OPERATED BATTERY CHARGER

Lowering the e.m.f. — electromotive force — of a car battery is easily done with the aid of a resistor, zener diode, or voltage regulator, but raising it is rather more difficult. The method chosen here is the familiar one of voltage doubling. How this is done in this charger is illustrated in Fig. 1.

In Fig. 1a, switch S connects the negative terminal of electrolytic capacitor C_3 to earth, so that both C_3 and C_4 are charged to the (car battery) supply voltage U_b:

$$U_o = U_{C4} = U_{D2} + U_{C3} = U_{D2} + U_b - U_{D1} = U_b \quad (1)$$

In Fig. 1b, switch S connects the negative terminal of C_3 to U_b, so that the output voltage, U_o, becomes:

$$U_o = U_{C4} = U_b + U_{C3} - U_{D2} = 2U_b - U_{D2} \quad (2)$$

When the switch is returned to earth as in 1a, the potential across C_4 remains at U_b, because C_3 cannot discharge. It is clear from this that U_o ($=U_{C4}$) will alternate between U_b and $2U_b - U_{D2}$. If the switching speed is high enough, the output voltage will approach $2U_b - U_{D2}$.

Circuit description

In practice, the switching is carried out by a Darlington pair of transistors: T_1-T_2 and T_3-T_4 in Fig. 2. These transistors are controlled by an integrated circuit Type LM3524. Two of its features make this device particularly suitable for the present application: the push-pull output stage, which can drive the switching transistors, and the error amplifier.

The error amplifier controls the width of the pulses at the input of the push-pull driver stage on the basis of the error signal at the output of the charger. The larger the deviation of the output current from the wanted value, the shorter the switch-on time of the power transistors carrying the output current.

The voltage doubling circuit consists

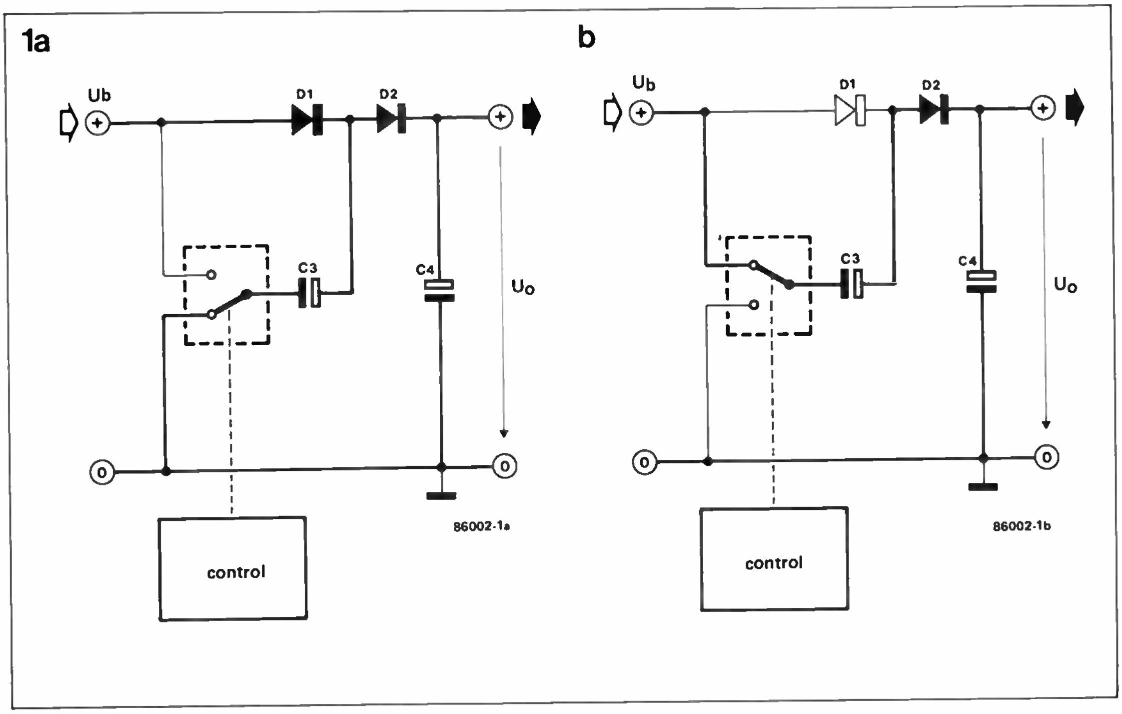


Fig. 1. In a, both C_3 and C_4 are charged to U_b minus the small drop across the relevant diode; in b, the output voltage is the sum of the voltages across C_3 and C_4 minus the drop across D_2. The switch is controlled by an oscillator, modulator, and regulator.

of capacitors C_3 and C_4 and diodes D_1 and D_2. These diodes are fast recovery power types in a TO-220 case, which is readily mounted onto a heat sink.

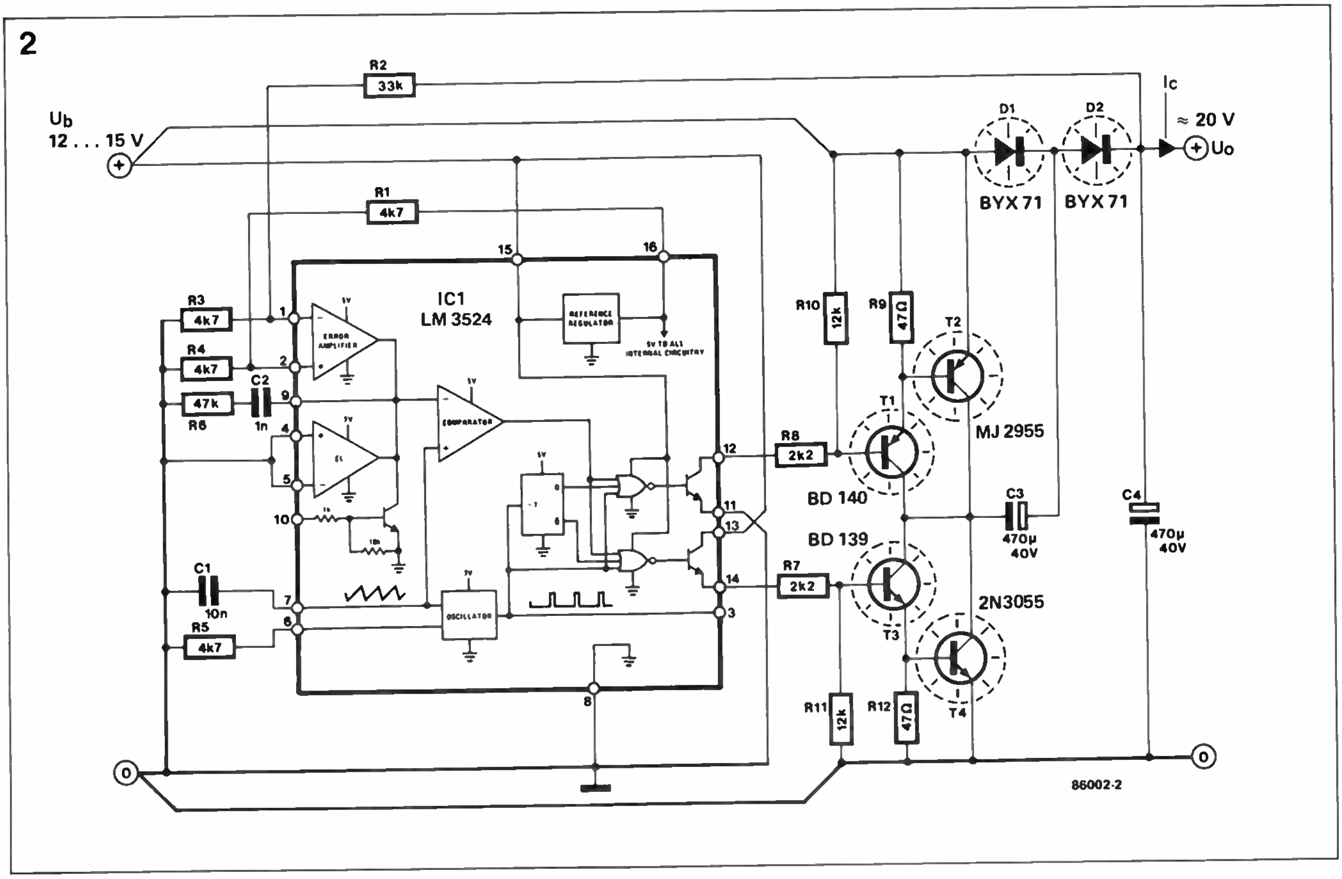
An oscillator in the LM3524 generates a rectangular signal for the T-type bistable and the two NOR gates, and a sawtooth signal that is applied to the non-inverting input of a comparator. The frequency, f_o, of the oscillator is

$$f_o = 1/2\pi R_5 C_1 = 1/295 \times 10^{-6} = 3400 \text{ Hz.}$$

A reference voltage of 2.5 V is provided by divider R_1-R_4 and applied to the non-inverting input of the error amplifier. The inverting input of this stage is provided with information as to the level of the output voltage via divider R_2-R_3.

The comparator here functions as a pulse-width modulator. Depending on the level of the error signal at its inverting input, and the level of the triangular signal at its non-inverting input, the comparator produces a rectangular signal with varying pulse-width at its output. This output constitutes the real control signal for the power transistors. To ensure synchronicity and a 180° phase shift, the comparator output is applied to the bases of the drive transistors via two NOR gates. Pulse-width control has the advantage that the average ▶

Fig. 2. The circuit of the battery charger consists essentially of the control, which is contained in one Type LM3524 integrated circuit, power switching transistors T_1 to T_4, and the voltage doubler comprising D_1, D_2, C_3, and C_4.



Parts list

Resistors:

R_1;R_3;R_4;R_5 = 4k7
R_2 = 33k
R_6 = 47k
R_7;R_8 = 2k2
R_9;R_{12} = 47 Ω
R_{10};R_{11} = 12k

Capacitors:

C_1 = 10n
C_2 = 1n
C_3;C_4 = 470µ;40V (axial types)

Semiconductors:

D_1;D_2 = BYX71
T_1 = BD140
T_2 = MJ2955
T_3 = BD139
T_4 = 2N3055
IC_1 = LM3524

Miscellaneous:

2 twisted vane TO220 heat sinks
2 twisted vane TO126 heat sinks
2 TO3 style heat sinks
PCB 86002

3

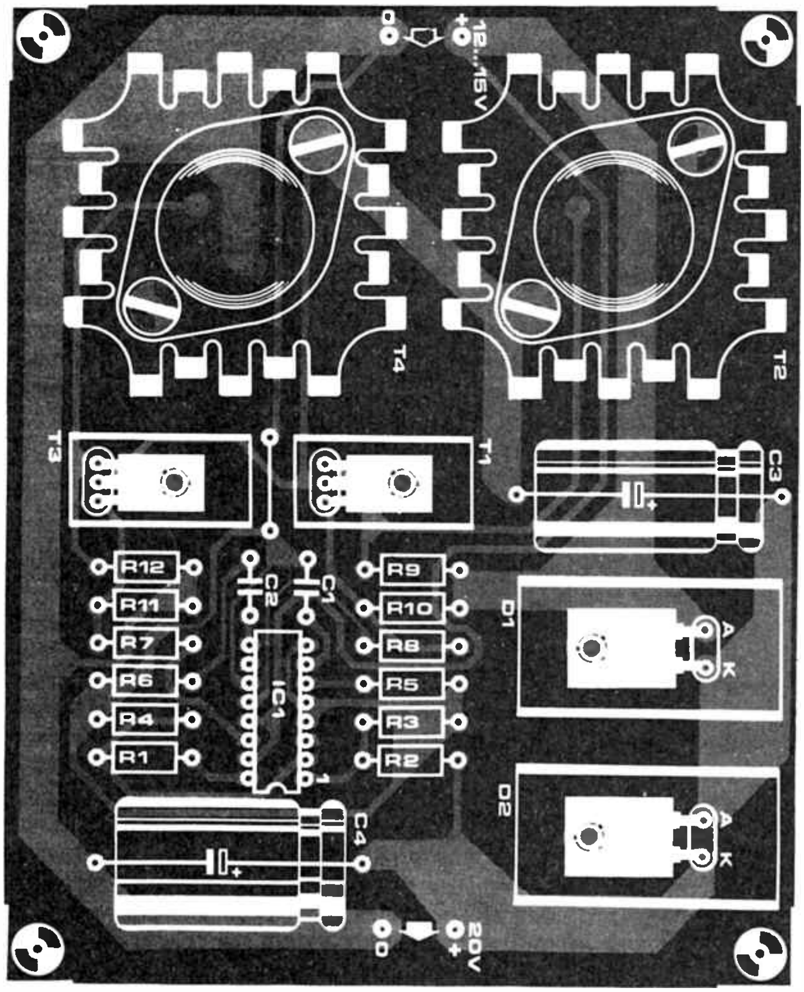


Fig. 3. The whole of the battery charger, down to the heat sinks, is contained on this printed circuit board.

Fig. 4. The output current vs output voltage shows that the output voltage remains substantially constant for load currents up to 3 A.

load current remains substantially constant.

The current limiter — CL — in the LM3524 is not used in this application.

Construction and test

All components, as well as the heat sinks of the switching transistors, T_1 to T_4, and the power diodes, D_1 and D_2, are fitted on the printed circuit board shown in Fig. 3. If the board is fitted in a case, there should be sufficient space above electrolytic capacitors C_3 and C_4 to ensure good ventilation.

Once the board has been completed, the open-circuit output voltage should be measured. This should be somewhat higher than 20 V. Note that a perfect voltage doubling, i.e. from 12 V to 24 V, is not possible because of the saturation voltage of power switching transistors T_2 and T_4 and the forward drop across the power diodes.

Next, the behaviour of the circuit under load should be checked with reference to Fig. 4. Our laboratory prototype has an open-circuit output voltage of 20.2 V. Under normal load conditions, the output voltage remains substantially constant (±0.5 V) until the load current exceeds 3 A.

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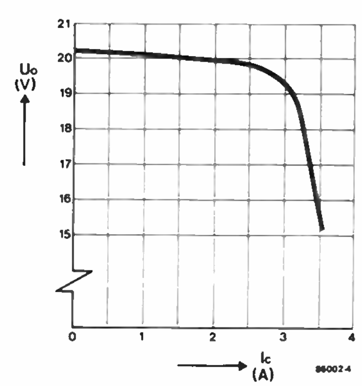

Fast charging

During fast charging, the charging current must, of course, be limited in accordance with the requirements of the cells or battery under charge. For example, NiCd cells are normally charged with a current, I_c, of 120 mA to 400 mA. If ten of these cells are charged in series, there will be a drop, U_d, of 15 V across them. A current limiting resistor, R_a, should then be used, whose value is calculated from

$$R_a = (U_o - U_d)/I_c = (20-15)/0.4 = 12.5 \ [\Omega]$$

The power, P_a, dissipated in R_a is calculated from

$$P_a = I_c^2 R_a = 0.4^2 \times 12.5 = 2 \ [W]$$

Sintered-plate cells are normally rated at 1.2 Ah, and may be fast-charged with a current of 2.5 A for thirty minutes. HS:GS

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R-1264	390 Ohm .5W carbon film resistor	.07
R-1272	820 Ohm .5W carbon film resistor	.07
R-1280	1.8k Ohm .5W carbon film resistor	.07
R-1282	2.2k Ohm .5W carbon film resistor	.07
R-1288	3.9k Ohm .5W carbon film resistor	.07
R-1296	8.2k Ohm .5W carbon film resistor	.07
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R-1052	120 Ohm .25W carbon film resistor	.06
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R-1014	3.3 Ohm .25W metal film resistor	.06

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		WAS
R-1428	12 Ohm 1W carbon film resistor	.12
R-1452	120 Ohm 1W carbon film resistor	.12
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R-1462	330 Ohm 1W carbon film resistor	.12
R-1470	680 Ohm 1W carbon film resistor	.12
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		WAS
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		WAS
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UNDER $2

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rms-to-DC converter

For some obscure reason, establishing the root-mean-square (rms) value of an alternating voltage seems to be among the least familiar procedures for many an electronics hobbyist; measuring the alternating voltage may be easy, but deciding on the relevant unit expressing quantity — rms, mean, or peak-to-peak value — is quite another matter.

Since the rms value of an alternating voltage is the most frequently used of the above mentioned three, some convenient means of obtaining that value without calculations may be of interest in practical measuring techniques.

The rms value of an alternating voltage U across a resistor R equals the direct voltage causing the same dissipation level in R.

Example: a 50% duty factor, 1 V_{pp} rectangular voltage across a resistor R. Find the rms level of this voltage. The mean dissipation in R, caused by this periodic signal equals

$\frac{1}{2} (U_{PP})^2/R = 1/(2R)$ [W]

The direct voltage causing the same dissipation has a level of

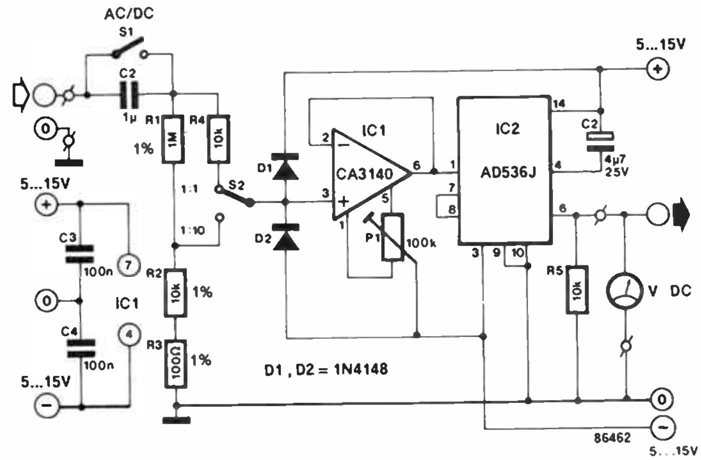
$\frac{1}{2}\sqrt{2} \approx 0.71$ V, since $P = (\frac{1}{2} \sqrt{2})^2/R = 1/(2R)$ [W].

This is also the conversion factor for obtaining the rms value from the peak-to-peak value, since

$U_{rms} = \sqrt{\frac{1}{2} U_{PP}^2} = \frac{1}{2} \sqrt{2}\, U_{PP} \approx 0.71 U_{PP}$ [V]

therefore $U_{PP} \approx 1.41 U_{rms}$ in this example.

1



Although moving coil meters measure the mean value of the rectified (pulsating) input voltage, they are calibrated in terms of rms voltages. Therefore, the calibration is only valid for sinusoidal voltages.

The proposed rms-to-DC converter is a relatively simple circuit as it incorporates a dedicated chip, the Type AD536 by Analog Devices. Alternating voltages applied to input terminal 1 are proportionally converted into a direct output current, which causes a direct output voltage across an internal 25 kohms precision resistor; a buffer opamp outputs the direct voltage equivalent (i.e. rms value) of the input alternating voltage. IC_1 functions as an input buffer in view of the relatively low input impedance of the rms converter chip. The maximum permissible peak-to-peak value of the input voltage to the Type AD536 equals the symmetrical supply voltage level; D_1 and D_2 have been added to protect IC_1 against accepting input voltage levels in excess of the ± supply voltage. S_2 functions as a ×1/×10 input attenuation selector to enable high voltage measurements; the function of S_1 is to block any DC components in the

Parts list

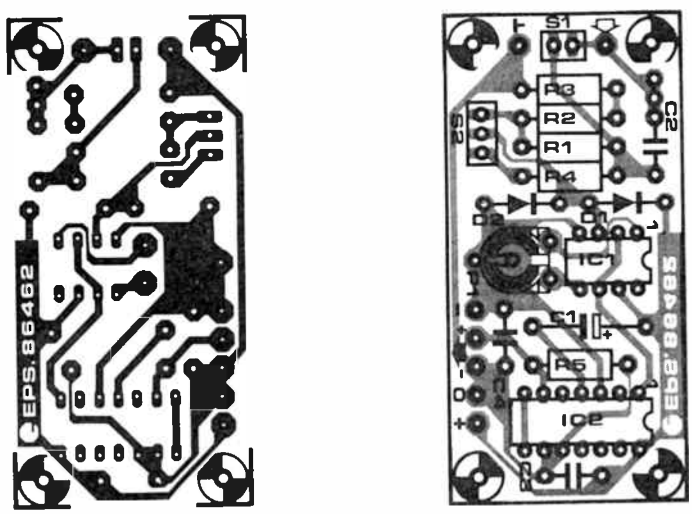
Resistors:
R_1 = 1M;1%
R_2 = 10k;1%
R_3 = 100Ω;1%
R_4;R_5 = 10k
P_1 = 100k preset

Capacitors:
C_1 = 4.7µ;25 V electrolytic
C_2 = 1µ;MKT
C_3;C_4 = 100n

Semiconductors:
D_1;D_2 = 1N4148
IC_1 = CA3140
IC_2 = AD536J

Miscellaneous:
S_1 = miniature switch
S_2 = toggle switch
PCB Type 86462 (see Readers Services)

2



input signal to the converter. It is useful to realize that the rms value of a composite (AC+DC) signal is calculated from

$U_{rms} = \sqrt{U_{DC}^2 + U_{AC}^2}$.

Preset P_1 should be turned to obtain 0 V with respect to ground at terminal 6 of IC_2 with no input signal applied and S_2 set to the ×1 position. The converter achieves an accuracy of 1% for input voltage levels lower than 100 mV and input frequencies up to about 6 kHz. For signals up to 1 V, the bandwidth is expected to be of the order of 40 kHz, while 100 kHz may be attained with input voltages above the 1 V level. Current consumption of the circuit is about 5 mA.

(TW)

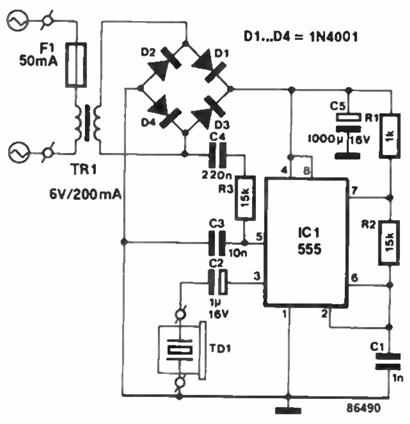
rodents deterrent

There are a number of well-founded arguments against the use of poison to get rid of mice, rats and other rodents in and around the home. From an ecological point of view, the undesirable side effects are mainly the disturbance of the natural food chain of animals we do not wish any harm whatsoever; most poisonous substances devised to exterminate mice are, unfortunately, quite difficult to break down compounds, which may, in the end, become manifest as dangerous to our own health.

The ecologically accepted method of getting rid of a population of mice is, therefore, based on the controlled introduction of such predators as cats and owls, causing a high degree of stress on part of the mice, which are then quite quick to leave the relevant premises or area.

Another method of bringing about a high degree of stress is to produce a high-pitch, frequency-swept signal just above the audible range for human beings. The signal is swept rather than of constant frequency in order to prevent mice from becoming immune to the sound.

1



The proposed rodents deterrent is based upon the Type 555 timer chip, which is configured to produce a 20 to 40 kHz output signal, swept at a 50 Hz rate. The latter frequency is obtained from the mains by means of C_4 and R_3, which pass the modulating signal to input pin 5. The output of the swept oscillator is connected direct to a high-efficiency piezo-ceramic horn tweeter, which ensures a sufficiently high sound pressure level to keep rodents out of reasonably sized areas, such as attics and garages.

The completed rodents deterrent circuit, along with the tweeter, may be mounted in a simple ABS enclosure, but care should be taken to observe the directivity of the loudspeaker when fitting the unit in its final position.

(W)

Parts list

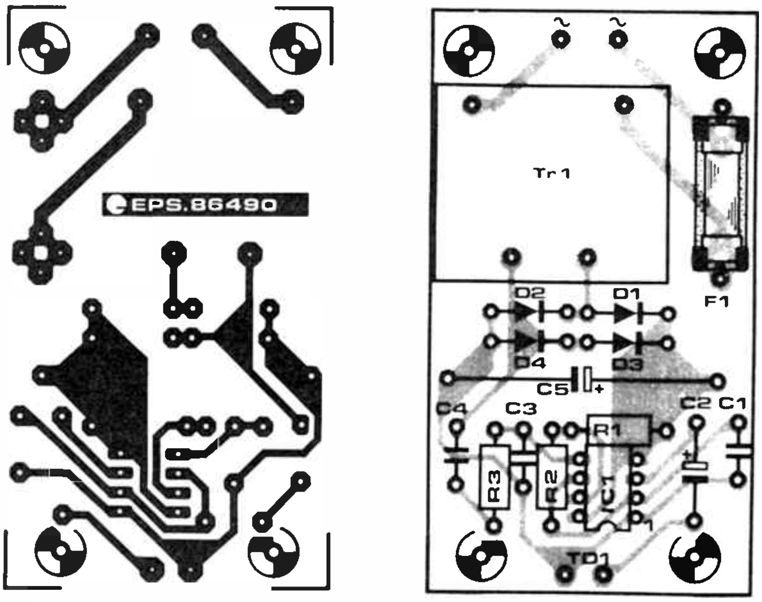
Resistors:
R_1 = 1 k
R_2;R_3 = 15 k

Capacitors:
C_1 = 1 n
C_2 = 1µ;16 V electrolytic
C_3 = 10 n
C_4 = 220 n
C_5 = 1000µ;16 V electrolytic

Semiconductors:
D_1 . . . D_4 = 1N4001
IC_1 = 555

Miscellaneous:
Tr_1 = 6 V;200 mA.
TD_1 = piezo horn tweeter.
F_1 = 50 mA, fuse, slow.
Fuseholder, PCB type, for F_1.
PCB Type 86490 (see Readers Services).
ABS enclosure for wall mounting.

2



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1000μF/25V	$5.00/10 PCS
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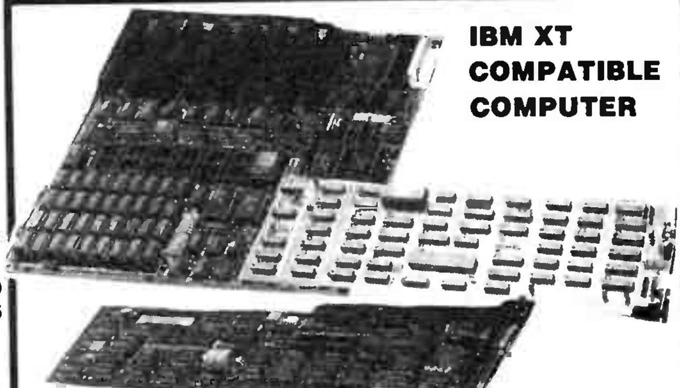

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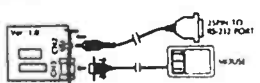

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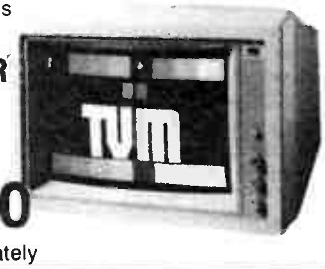

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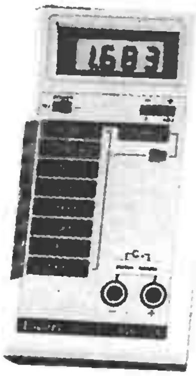

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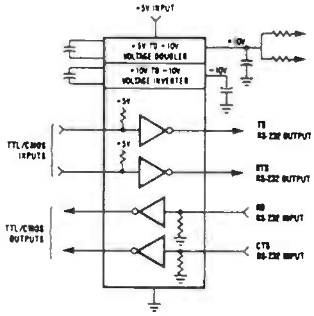

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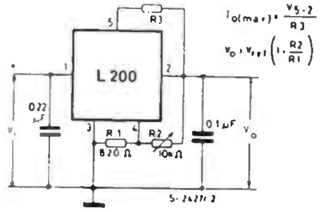

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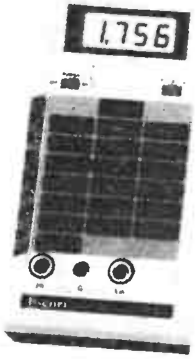

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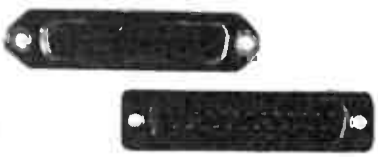

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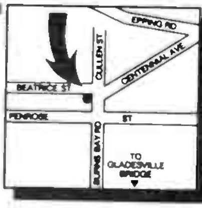

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INDUCTORS IN PRACTICE

In spite of their apparent simplicity, inductors none the less often pose problems, because invariably they cannot be obtained ready-made, i.e. they have to be designed and wound by the constructor. This article aims at removing some of the obscurities surrounding this subject and showing that making an inductor is not such a daunting task as some think.

An inductor is an electronic component that possesses appreciable inductance. Self-inductance is the property of a circuit to oppose any changes in current flowing through the circuit: this manifests itself by the production of a voltage that tends to oppose the change of current. This voltage is called the back-e.m.f. Mutual inductance is the phenomenon whereby voltage is induced in one circuit by changing the current in another. The unit of both self- and mutual inductance is the same: the henry, but their respective symbols are L and M (or L_{12}). An inductor has an inductance of 1 henry if the back-e.m.f. in it is 1 volt, when the current through it is changing at the rate of 1 ampere per second.

Inductors invariably consist of many turns of wire wound adjacent to one another on the same support, called the former, but in high-frequency applications they are often self-supporting (i.e., air-cored). The former may also be of ferromagnetic material to increase the inductance many hundreds of times. Unfortunately, so-called eddy currents are induced in the ferromagnetic material, and these increase the DC resistance in a practical inductor. Powdered-iron cores are, therefore, used at high frequencies because their high resistivity makes eddy-current losses negligible. Such ferrite materials are not as useful as iron at low frequencies, however, because magnetic saturation restrict the maximum power level of the inductor.

Inductors have a frequency -dependent resistance (called reactance) to AC currents, and an ohmic resistance, which is primarily due to the wire from which the inductors has been wound. The reactance, X_L, is equal to ωL, where $\omega=2\pi f$, in which f is the frequency of operation, and L is the inductance in heries. The ratio of the reactance to the ohmic resistance, i.e. $\omega L/R$ is called the *Q*(uality) factor of the inductor. The combination of reactance and resistance is called the impedance, Z.

An inductor is generally called a choke if its main purpose is to present a high reactance to AC currents. At high frequencies it is often sufficient to run the supply or bias lines in a circuit through small ferrite beads to effectively prevent these lines picking up (and radiating) RF signals.

Where spurious coupling with other circuit elements is to be avoided, the diameter of the choke should be kept small as a practical way of narrowing the magnetic field around it. Pot cores are another means of obviating radiation and spurious coupling.

Nowadays, designers have a wide choice of cores and formers for all types of application.

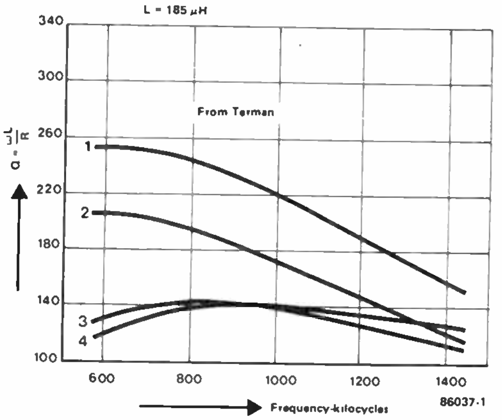
It should be noted that a wide range of standard RF chokes is available from most good electronics suppliers. These components are usually wound on a ferrite core and are encapsulated to prevent stray fields around them. The Q-factor of these chokes is often good enough to allow their use in tuned circuits. However, if they are to be used in filters, they should have a resistance of not more than 0.8 ohm per millihenry, and they must be ferrite-encapsulated. Non-encapsulated types must be separated by at least one diameter, or an earthed screen placed between them.

Inductors in tuned circuits

Inductors for use in tuned circuits, such as oscillators and filters, should normally be specially wound for the purpose to ensure correct inductance, resistance, *Q*-factor, and dimensions.

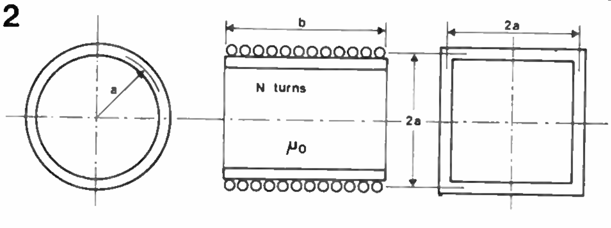
Losses in inductors are mainly due to the resistance of the wire used for winding the inductor, and the so-called *skin-effect*. Since RF currents travel mainly along the surface of a wire, this is often silvered to keep I^2R losses low. Where large wire diameters are necessary to achieve a certain inductance, it is possible to ▶

1

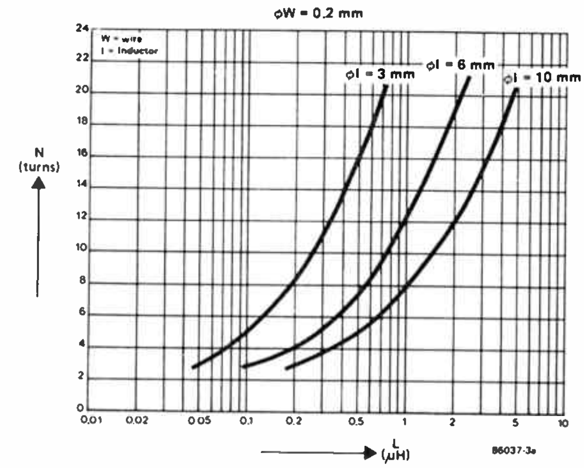


Coil No.	Length / Diam.	Diam.	SWG	No of turns
1	0.96	4.25"	No. 20	51
2	0.417	4.50"	No. 24	38
3	0.96	1.875"	No. 28	75
4	2.58	1.5"	No. 28	123

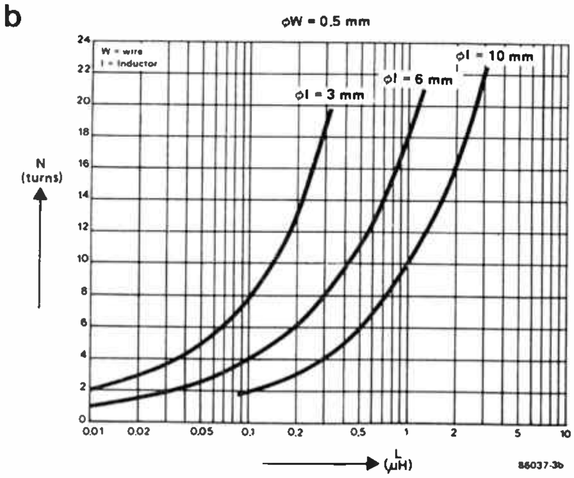
2



3a



b



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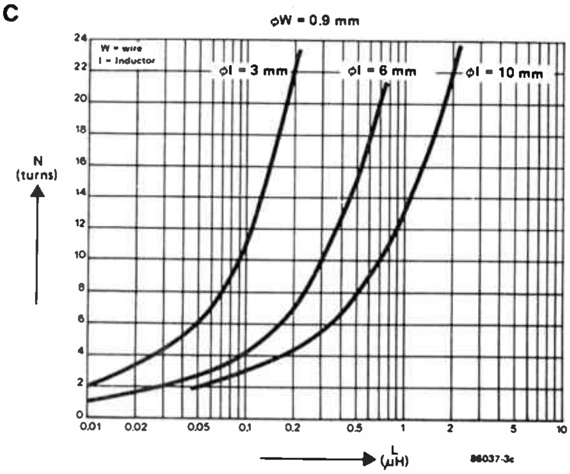


use hollowcopper tube to wind the inductor, since this may considerably lower its total costs and weight; from an RF point of view, it makes no difference whether the wire if hollow or solid, because of the skin-effect. However, it should also be noted that a solid wire has considerably lower resistance than a hollow wire of identical diameter. Since an increase in resistance inevitably causes a lower Q factor (see formula (10), the hollow tube is generally only used for relatively low frequency applications, where considerable currents flow, e.g. in the case of short-wave power amplifier tank coils, or antenna tuning units.
As already discussed, designing for a known Q factor is accomplished by careful consideration of a number of factors that relate to practical inductor winding data. To illustrate the relative importance of these factors, Fig. 1 shows a number of Q factor curves obtained with different winding data to obtain a given inductance. From these and

Fig. 1. These curves show that the Q factor of an inductor strongly depends on its winding data.

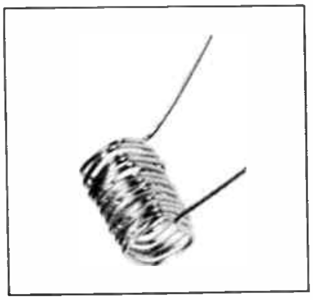
Fig. 2. These coil data provide the necessary information for the inductance calculations.

Fig. 3. Correlation between number of turns and inductance for a number of wire and former diameters.

Listing 1. This program, written in MBASIC, will come up with the number of turns for a circular or square inductor, given the target inductance, wire and coil diameter.

Listing 1

```
10 PRINT CHR$(26):REM clear screen kaypro
20 A$="JAN"
30 PRINT"                              Inductance Calculations"
40 PRINT"                              ------------------------"
50 FOR X=0 TO 5:PRINT:NEXT
60 PRINT CHR$(11);:PRINT CHR$(7);
70 INPUT "circular or square coil former (c/s)";O$
80 IF O$="c" OR O$="C" OR O$="s" OR O$="S"THEN 100
90 IF A$="JAN"THEN 10 ELSE 60
100 IF O$="S"OR O$="s"THEN 190
110 INPUT "coil diameter (mm) =";A
120 A=A/2
130 GOSUB 260
140 N=SQR(L/(.0000004*PI*A*(LOG(1+PI*V)+1/(2.3+1.6/V+.44/(V*V)))))
150 IF S<>1 THEN 330
160 GOSUB 450
170 IF Z<>0 THEN 140
180 GOTO 330
190 INPUT "side of the square (mm) =";A
200 GOSUB 260
210 N=SQR(L*PI/(.0000004*PI*A*(LOG(1+PI*V)+1/(3.64+2/V+.51/(V*V)))))
220 IF S<>1 THEN 330
230 GOSUB 450
240 IF Z<>0 THEN 210
250 GOTO 330
260 INPUT"Space between turns (Y/N)";S$
270 S=0
280 IF S$="N" OR S$="n" THEN B=A:S=1:INPUT"wire diameter (mm) =";D:D=D/1000:GOTO 300
290 INPUT "coil length (mm) =";B
300 INPUT"L (uH) =";L
310 B=B/1000:A=A/1000:L=L/1E+06:V=A/B:PI=3.14159
320 RETURN
330 R=N-INT(N)
340 IF R<.5 THEN N=INT(N) ELSE N=INT(N)+1
350 PRINT "number of turns =";N
360 IF S=1 THEN 380
370 PRINT "maximum wire diameter =";1000*(B/N);"mm"
380 FOR X=0 TO 79:PRINT "-";:NEXT
390 INPUT"More (Y/N)";A$
400 PRINT CHR$(11);
410 FOR X=0 TO 79:PRINT " ";:NEXT
420 FOR X=0 TO 2:PRINT CHR$(11);:NEXT:REM KAYPRO CURSOR UP
430 IF A$="Y" OR A$="y"THEN 70
440 END
450 Z=1:K=N*D:IF ABS((K-B)/B)<.00003 THEN Z=0:RETURN
460 B=(K+B)/2:V=A/B:RETURN
```



other experimental data, the following rules of thumb have emerged to obtain a high Q factor:

1. The ratio of the inductor length to diameter should be between 0.5 and 2.
2. The ratio of inductor to wire diameter must be greater than about 5.
3. For long coils, the spacing between turns should be 0.7 times the wire diameter. Short coils are best close-wound, or, where this is less desirable, with a turn-spacing not wider than 0.3 times the wire diamter may be used. (Literature reference 1).
4. Silvered wire is preferable for winding inductors for operation at frequencies above 300 MHz. (strip lines, lecher lines, UHF filters).

Inductance calculation

There are a number of formulas for the calculation of inductance, and these usually start from the the physical characteristics shown in Fig. 2. Note, however, that any inductance calculation is only a mathematical approximation, which gets closer to the actual inductance when it becomes more complex. To obtain very close approximations, the following formulas may be used (refer to Fig. 2):

$$L=\mu_0 n^2 a(\log_e(1+\pi a/b)) + 1/(2.3+1.6b/a+0.44(b/a)^2) <H> \quad (2)$$

for circular coils, and

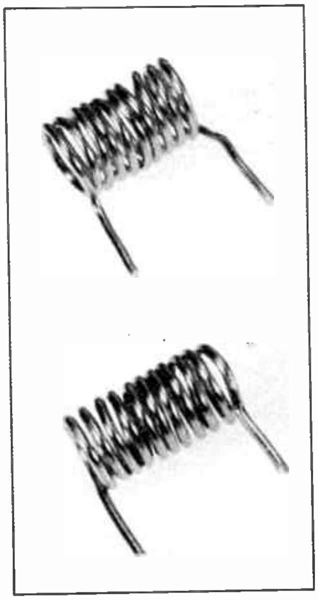
$$L=\mu_0 n^2 a(4/\pi \log_e(1+\pi\, a/b)) + 1/(3.64+2b/a+0.51(b/a)^2) <H> \quad (3)$$

for square coils, where *a* and *b* are the inductor sizes in metres as indicated in Fig. 2, *L* is in henries, and μ_0 is the absolute permeability standard, defined as $4\pi 10^{-7}$ <H/m>.

The three charts shown in Fig. 3 give inductor winding data for a number of popular wire and former diameters, but the computer program of listing 1 allows a great many more possibilities for fast calculation of inductor winding data, both for circular and square inductors. The latter are perhaps less known among designers, but square inductors may be used as window mounted, multi-turn rhombic aerials for directive reception of medium- and long-wave signals.

The computer program listed has been written in MBASIC, and may require a patch here and there to suit the specific screen and cursor commands of some computers. For spaced inductors, the program uses an iterative approximation routine, which supplies a start value (guess) to the main calculations and adapts the variables to step towards maximum accuracy. Obviously, the better the guess, the faster the program will come up with the result, since in that case less calculation time is required. It stands to reason that n-step iteration is practically not feasible with only a pencil and a cheap calculator, since far too much time would be wasted before a useful result is obtained. Therefore, the number crunching facilities offered by the computer are welcomed by many designers of air-cored inductors.

JB;BL



Literature references:

1) Proceedings of the IEEE, Vol. 70 no 12; December 1982: Wheeler, H A: 'Inductance formulas for circular and square coils.'

2) Radio Engineers Handbook, by F E Terman; McGraw-Hill.

RF CIRCUIT DESIGN

This month we commence a short series of articles on the design of RF circuits. Each of the articles will merely provide a framework and not necessarily a complete design of the relevant circuit.

Test oscillator

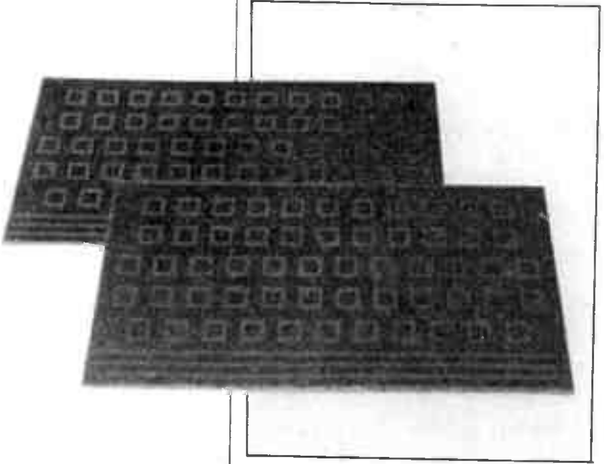


Fig. 1. The copper-clad universal RF board Type 85000 has fifty-seven islands and three isolated tracks for supply voltage or control voltage — such as AGC — lines.

This first article deals with a virtually indispensable unit in RF design: a simple signal generator. This unit provides a signal at a certain frequency and amplitude, and may be frequency- or amplitude-modulated. It is intended to cover a frequency range of 2 — 150 MHz in a number of bands.

Universal RF board

The Type 85000 (available through our Readers Services — see page 80) is an unpierced copper-clad board with fifty-seven isolated islands and three isolated tracks. It is particularly suited to RF circuits because of the large earth plane, and enables the connections of all components to be kept really short — a prerequisite in RF design. Examples of the board proper and of a voltage-controlled oscillator constructed on a copper-clad board are shown in the photographs in Figures 1 and 2 respectively.

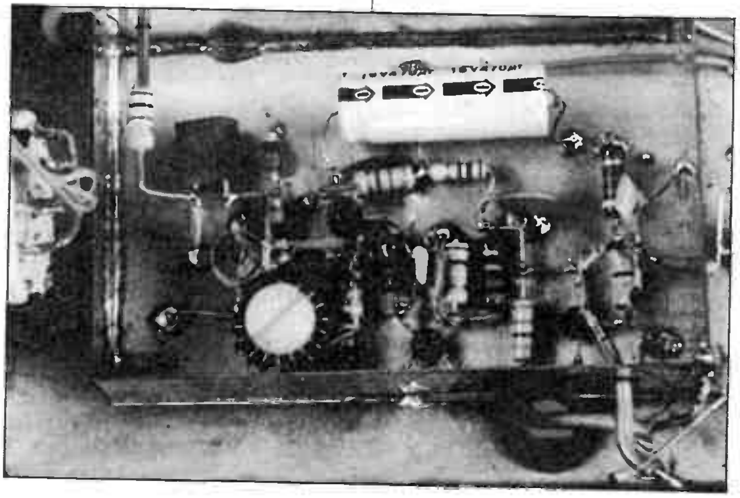


Fig. 2. Example of a voltage-controlled oscillator constructed on a copper-clad board.

Block diagram

The block diagram in Fig. 3 shows that the test oscillator consists of three separate sections: the oscillator; amplitude control; and output buffer. The oscillator is based on a MOSFET, whose mutual conductance, g_m, and consequently the amplitude of its output signal, is controlled by a direct voltage on gate 2.

The amplitude control section monitors the oscillator output and controls gate 2 of the MOSFET accordingly, so that a reasonably constant-level oscillator signal is obtained. This arrangement has the advantage that it enables the oscillator to work over a fairly wide frequency range.

The buffer section provides an output impedance of 50 ohms.

Circuit description

The oscillator — see Fig. 2 — is designed around T_1: its frequency-determining components are L_1 and varactors D_1 and D_2. These variable-capacitance diodes are controlled by P_1: a high voltage across them causes a small capacitance, and vice versa. The frequency of an *LC* oscillator is given by

$$f = 1/2\pi\sqrt{LC}\ \text{[Hz]} \qquad (1)$$

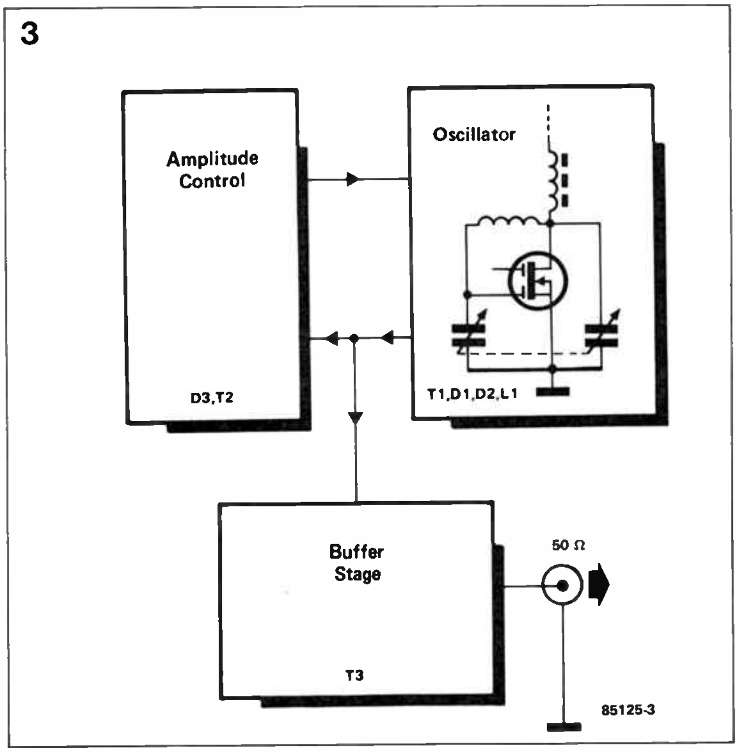
where *f* is the frequency of the oscillator, *L* is the inductance in henries (H), and *C* is the total capacitance of the two varactors in series in farads (F).

The ratio between the lowest and the highest oscillator frequency, f_1 and f_2 respectively, depends on the square root of the ratio between the maximum and minimum capacitance, C_2 and C_1 respectively, of the varactors:

$$f_1{:}f_2 = \sqrt{C_2{:}C_1} \qquad (2)$$

The maximum capacitance of the Type BB106 varactor is about five times the minimum capacitance for a reverse bias voltage of 3 of 25 V, so that the frequency ratio is roughly 2.236, or rather more than an octave. The highest attainable frequency is around 300 MHz, but this depends, of course, also on the value of L_1.

The series combination L_2-L_3-L_4 is intended as a sort of wide-band choke. The inductance of L_4 (100 mH) is rather too large for high frequencies, because the reactance at those frequencies amounts to a few kiloohms owing to parasitic capacitances. Lower inductances are, therefore, used for the higher frequencies: L_3 and L_2. Inductor L_2 is only of use at frequencies above 50 MHz: if the oscillator is not required to work on these frequencies, this coil may be omitted and replaced by a wire link.



The signal at gate 1 of the oscillator is rectified by D_1 and smoothed by R_2-C_3. As soon as the resulting direct voltage rises above 600 mV, the transistor tends to conduct harder, which causes the potential at gate 2, and therefore the oscillator output, to drop. This regulation is necessary if the oscillator is to work over a relatively wide frequency range. Also, without regulation, the output level would vary greatly with tuning: in the present circuit, the output level variation is held within 10 dB, i.e., a ratio of about 1:3.

The oscillator signal is applied via capacitive divider C_7-C_8 to transistor T_3, which is connected as a source follower. The mutual conductance, g_m, of this FET is about 20 mS, so that, since

$$Z_o = 1/g_m \quad [\Omega] \qquad (3)$$

the output impedance, Z_o, is 50 ohms.

Fig. 3. Block diagram of the RF test oscillator.

Mutual conductance is the ratio of the change in output current to the change in input voltage when the output voltage is held constant. It is measured in siemens (S), which replaced the mho (reciprocal of ohm) some time ago.

Fig. 4. Circuit diagram of the RF test oscillator. ▶

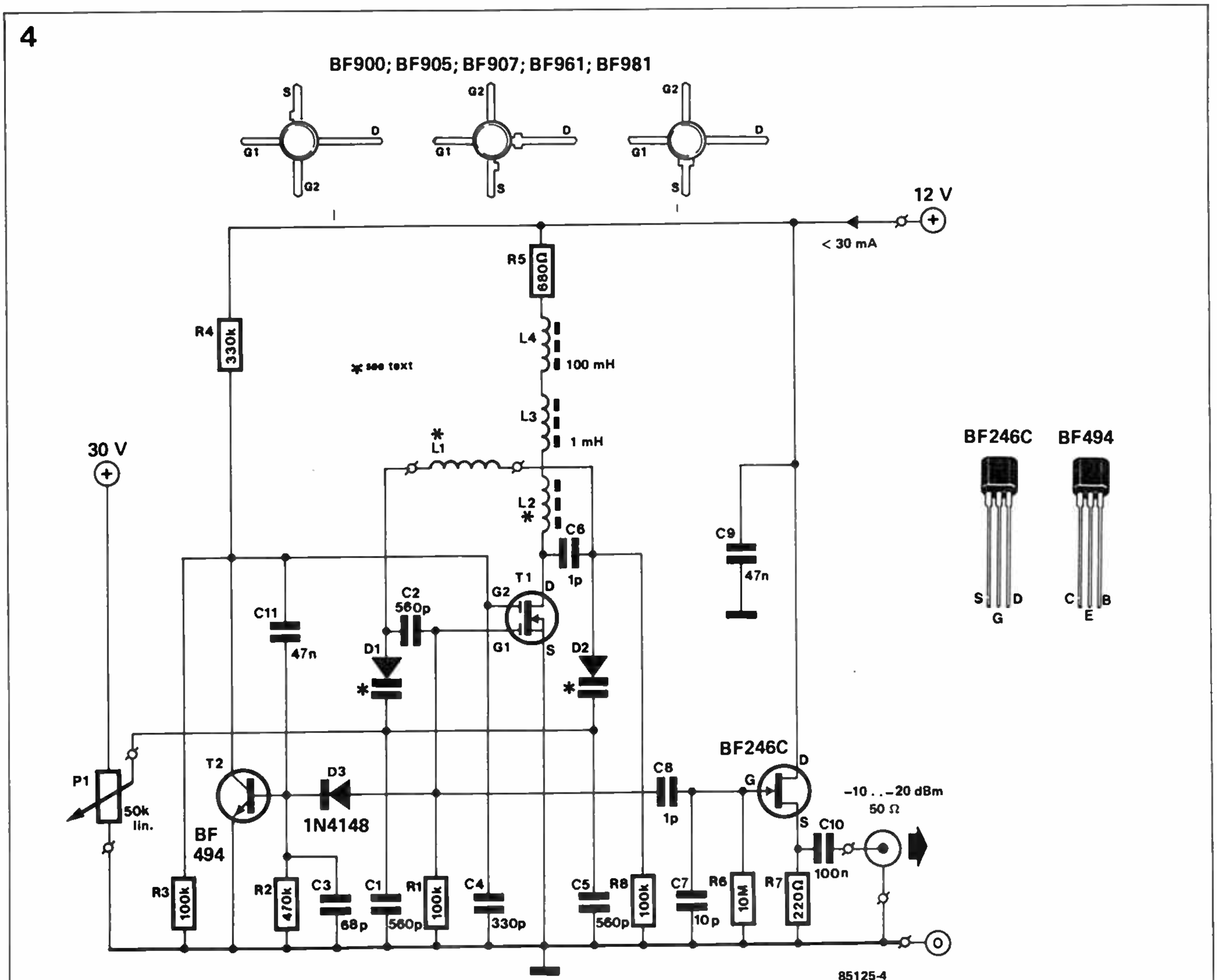


Fig. 5 Suggested component layout of the RF test oscillator

Parts list

Resistors:
R_1;R_3;R_8 = 100k
R_2 = 470k
R_4 = 330k
R_5 = 680Ω
R_6 = 10M
R_7 = 220Ω
P_1 = 50k linear preset

Capacitors:
C_1;C_2;C_5 = 560p
C_3 = 68p
C_4 = 330p
C_6;C_8 = 1p
C_7 = 10p
C_9;C_{11} = 47n
C_{10} = 100n

Inductors:
L_1 = 0.1 . . . 10mH (see text)
L_2 = 5 turns 0.3 mm dia. (30 SWG) enamelled copper wire on ferrite bead 3 × 3 mm.
L_3 = 1mH choke
L_4 = 100mH choke

Semiconductors:
T_1 = BF900 or BF905 or BF907 or BF961 or BF981
T_2 = BF494
T_3 = BF246C
D_1;D_2 = BB106 (see text)
D_3 = 1N4148

Universal RF board Type 85000 (available through Readers Services)

Fig 6. Circuit of a possible 50-ohm one-step attenuator. The resistor values in the accompanying table are calculated: in a practical circuit, the nearest standard values should be used.

Frequency range

If varactors Type BB106 are used, the oscillator can be tuned over a frequency range of one octave, i.e., the maximum frequency is about twice the minimum frequency. To cover a frequency range of, say, 2 MHz to 32 MHz (four octaves) four different coils are required for the L_1 position. Since it is not really possible to use a large tapped coil and a range switch — because the resulting stray capacitances would cause unreliable and unstable operation — separate plug-in coils must be used for L_1. At the highest frequencies — above about 150 MHz — the coil should be air-cored; below 150 MHz, it needs to be wound on a dust-iron toroid. Some examples of suitable coils for frequency ranges as stated are:

- 150-300 MHz: 50 mm enamelled copper wire, SWG20 (1 mm dia.), one turn;
- 75-150 MHz: 9 turns 24 SWG (0.6 mm dia.) enamelled copper wire on a Type T50/12 toroid;
- 7.5-15.0 MHz: 70 turns SWG 30 (0.3 mm dia.) on a Type T50/2 toroid.

Although the Type BB106 varactor can be used right across the frequency range, a Type BB105 is better if most of the work is carried out above 100 MHz, while a Type KV1226 is preferable below 20 MHz.

Modulation

Frequency-modulating the oscillator signal is achieved by applying the modulating voltage to the wiper of tuning potentiometer P_1 via a series resistor and coupling capacitor. It is possible to add a potentiometer for adjusting the level of the modulating voltage, i.e. the frequency deviation. Amplitude modulation could be arranged by injecting the modulating signal into gate 2 of the oscillator. This is, however, not a satisfactory method because the internal capacitances of the MOSFET vary with the modulating voltage, resulting in not only amplitude modulation, but also frequency modulation, of the oscillator signal. It is, therefore, better to modulate with the aid of an additional MOSFET connected between the oscillator and the buffer.

Output attenuator

It is very useful in many applications if the output signal can be attenuated in suitable steps. A suitable circuit for a one-step attenuator is shown in Fig. 6. Several of these circuits may be connected in series to obtain switch-selected stepped attenuations of, say, 2 dB, 4 dB, 8 dB, and so on. Note, however, that the greater the attenuation, the more attention should be paid to screening and decoupling. Any signal "leaks" at the output at low levels spoil the accuracy of the attenuator. The table accompanying Fig. 6 gives calculated values for the attenuator resistors; in practice, the nearest standard values in the E12 or E24 series should be used. Note that wirewound resistors should never be used in RF circuits owing to their high self-inductance. JB:BL

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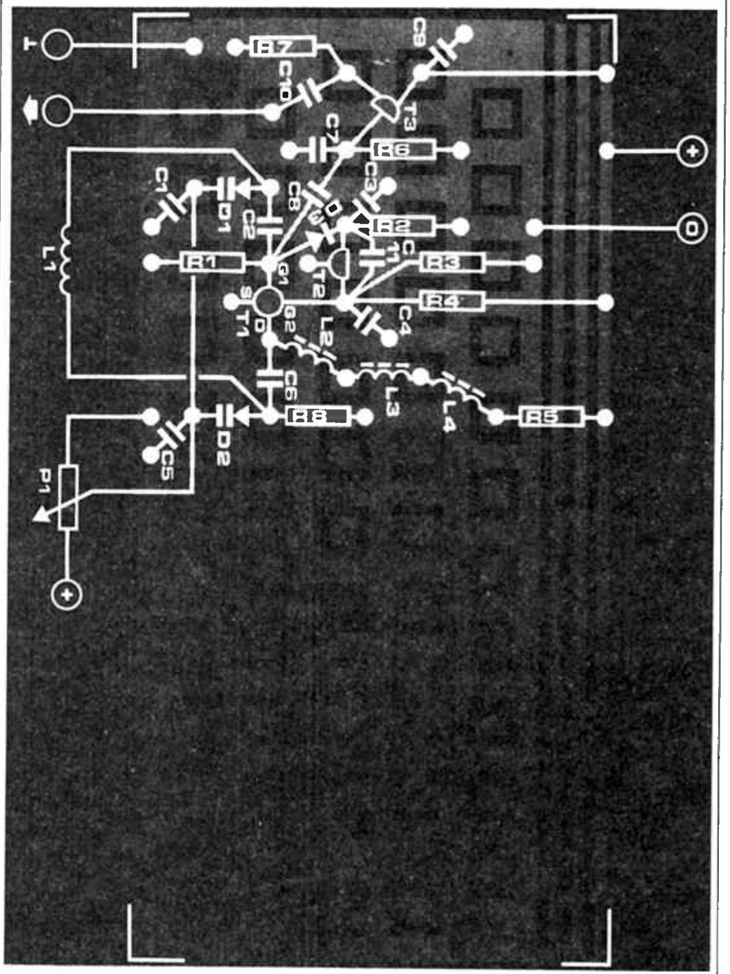

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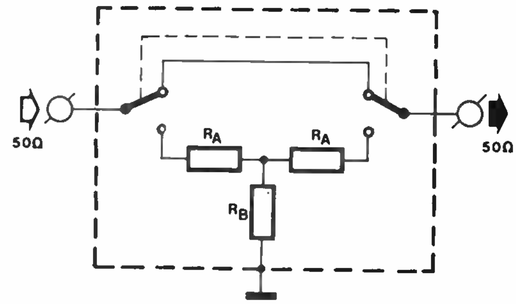


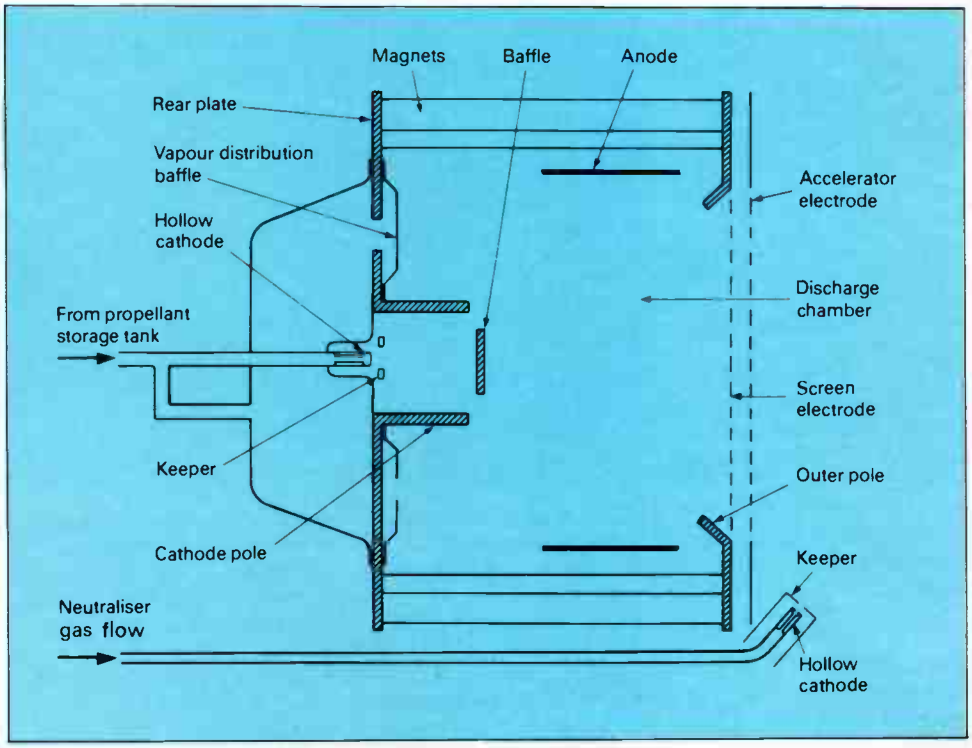
Attenuation	RA	RB
2 dB	5,7 Ω	215,2 Ω
4 dB	11,3 Ω	104,8 Ω
8 dB	21,5 Ω	47,3 Ω
10 dB	26 Ω	35 Ω
20 dB	41 Ω	10 Ω

85125-6

ELECTRIC PROPULSION FOR SATELLITES

by Dr Anthony Martin, Culham Laboratory, Abingdon, Oxfordshire.

Fuel is a significant fraction of a communications satellite's mass. A large part of it is needed for the rockets which keep the spacecraft stationary in orbit relative to tracking stations on the ground. Electric propulsion systems to replace chemical rockets promise large savings in fuel mass, with correspondingly greater communications payloads.



Schematic layout of an electron bombardment ion engine.

Most commercial satellites are destined for geostationary Earth orbit. That is, an orbit with a period of 24 hours, which means the satellite rotates about Earth at the same rate as Earth revolves about its axis. The satellite will then appear to be fixed in the sky, so the antennas receiving its signals do not have to be steered or moved to track it.

The greater part of Earth's long-range communications are now routed this way, including intercontinental telephone calls, and television from the other side of the world is familiar on our screens. Plans are already well advanced for direct broadcasting satellites which will relay signals with such a high power that they can be picked up by a relatively small dish antenna in the home, bypassing the need for large receiving stations.

But an uncontrolled satellite would not remain fixed in its 24-hour orbit for very long. Because the gravitational pull of the Sun and the Moon on a satellite distorts its orbit, it would wander about the sky and make tracking difficult. This effect has to be corrected by using an on-board propulsion system to correct the velocity by about 50 metres per second in one year.

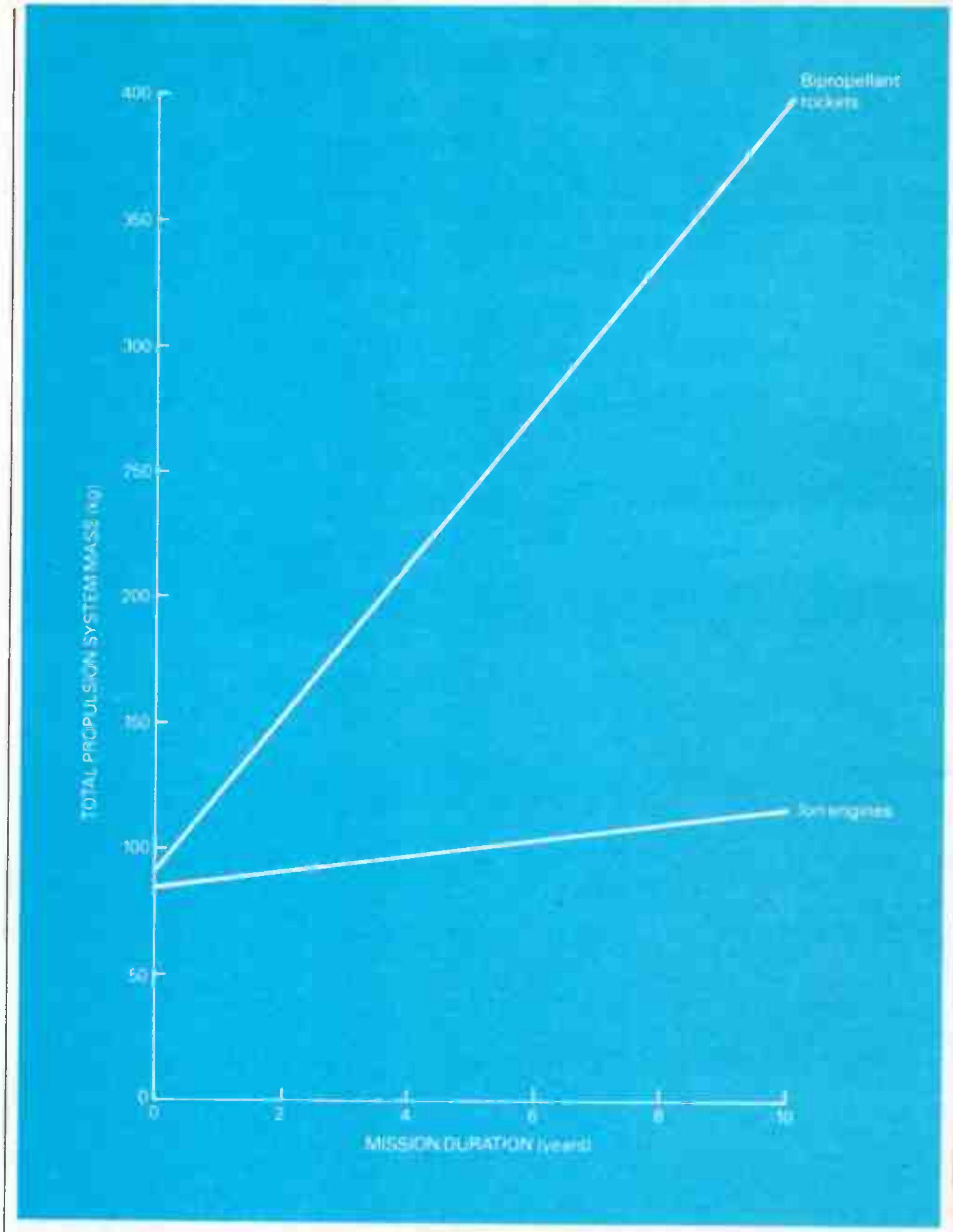
So, orbit control to keep a satellite 'fixed' in the sky or 'on station' is essential and the satellite must be able to provide this. Indeed, ability to correct the orbit may often decide the useful lifetime of the satellite: once it is unable to keep station, the communications payload is switched off and the satellite is abandoned.

Propulsion systems

Any orbit control system must be reliable and have a long life, which means about 10 years for modern spacecraft. It should also weigh very little, for every kilogram that is not used for payload reduces the revenue that the satellite earns.

Satellites now in service use chemical rockets for orbital control. The propellants used are allowed to react in a rocket chamber and the products from the reaction are expanded through a nozzle to produce a jet of fast-moving gas. The velocity of the jet, or exhaust, which the propulsion system can achieve is important. The amount of propellant that has to be used to provide the 50 metres per second change in velocity is related exponentially to the ratio that the velocity change bears to the exhaust velocity. The higher the exhaust velocity, the lower the mass of propellant that must be carried to keep the satellite on station.

Monopropellant rockets have exhaust velocities of about 2.2 kilometres per second and, for a 10-year mission, must carry 200 grams of propellant for every kilogram of satellite mass at the start of operations. Bipropellant systems have an exhaust velocity of about three kilometres per second, which means they must carry about 150 grams of propellant for every kilogram of satellite, but at the expense of a heavier, more complex rocket system.



Comparison of electric propulsion with chemical rockets, for a 10-year North-South station-keeping duty. Data are for a two-tonne geostationary satellite, with initial station acquisition and 50 metres per second velocity change per year.

Electric propulsion

However, the energy available from a chemical reaction is limited. To reach higher exhaust velocities, the source of energy must be decoupled from the propellant. It is here that electric propulsion systems offer an alternative to chemical rockets. Electric power is used to accelerate propellant to much higher velocities, in the range of 30 to 40 kilometres per second. That means only 12 to 17 grams of propellant are needed per kilogram of satellite mass. Of course, the mass of the electric rocket and its power supplies must be reckoned as part of the propulsion system, but even so it can be seen that the mass gains possible with this type of system are very large.

The case of a 2-tonne satellite, typical of those that will be used for the most important communications links until the end of the century, can be used to illustrate the point. The main propulsion requirement that has to be satisfied is the ability to provide a velocity change of 50 metres per second every year for station keeping and a further 60 metres per second at the beginning of the mission to place the satellite in the correct initial orbit.

If an electric propulsion system were used to carry out these manoeuvres, gains in the payload fraction of about 25 per cent could be realised, compared with the mass that would be needed by a chemical propulsion system with its much greater need for fuel. To emphasise this figure, the saving in mass of a 2-tonne satellite could be as much as 280 to 300 kilograms if electric propulsion were used instead of chemical rockets. This contrasts with the total payload mass of a modern telecommunications spacecraft: The *Olympus-1* satellite being built for the European Space Agency by British Aerospace, and scheduled for its first launch in 1987, has a communications payload of 307 kilograms.

Electric thruster

In an ion thruster, propellant is accelerated by electric forces to high velocities to produce thrust. For this to happen, the propellant must have an electron removed from the atom, leaving a positive ion. By far the most flexible means of carrying out this ionisation process is for electrons to bombard the propellant atoms and knock off an electron. So in an electron bombardment ion thruster electrons are emitted from a cathode and accelerated to a cylindrical anode, colliding on the way with propellant fed into the discharge chamber where the process happens. At the front of the chamber is an ion extraction system, usually consisting of two grids with a large number of small holes drilled in them. An electric potential, usually in the range of 1000 to 1500 volts, is applied across the grids, thereby causing the ions to be pulled from the discharge and accelerated through the second grid to form the beam.

If only the ions were extracted from the discharge, the satellite would build up a large negative charge very quickly. So a neutraliser is included, to eject electrons and balance the charge on the spacecraft.

All the foregoing has to do with the thruster part of the system. But a complete system needs an electrical power source. That might be the main solar-cell array powering the satellite. The array is usually oversized relative to the needs of the payload, to allow for solar-cell degradation over the lifetime of the satellite. Alternatively, the source might be the batteries carried by the satellite to support it through periods when the solar cell array is in eclipse from the Sun. Typical stationkeeping thrusters need a few hundred watts of power to operate them, which is a small fraction of the several kilowatts which are available on board large communications satellites. The need to draw power from the spacecraft, rather than from the chemical reaction of conventional rockets, governs the design of the propulsion system as a whole. High exhaust velocities, achieved by high accelerating voltages, reduce the amount of propellant needed. But they also mean that the power unit, which converts the output from the solar array or battery to the voltages required by the electric propulsion system, becomes heavier and heavier with a corresponding need for higher power. So there is an optimum point between a reduction in propellant mass and an increase in powersupply mass.

The UK 10-centimetre diameter ion thruster, designed for stationkeeping of multi-tonne communications satellites, now being tested with xenon propellant.

Future propulsion

Even with the prospects of all the benefits to be gained, communications satellites still do not use electric propulsion, but rely on chemical rockets. Why?

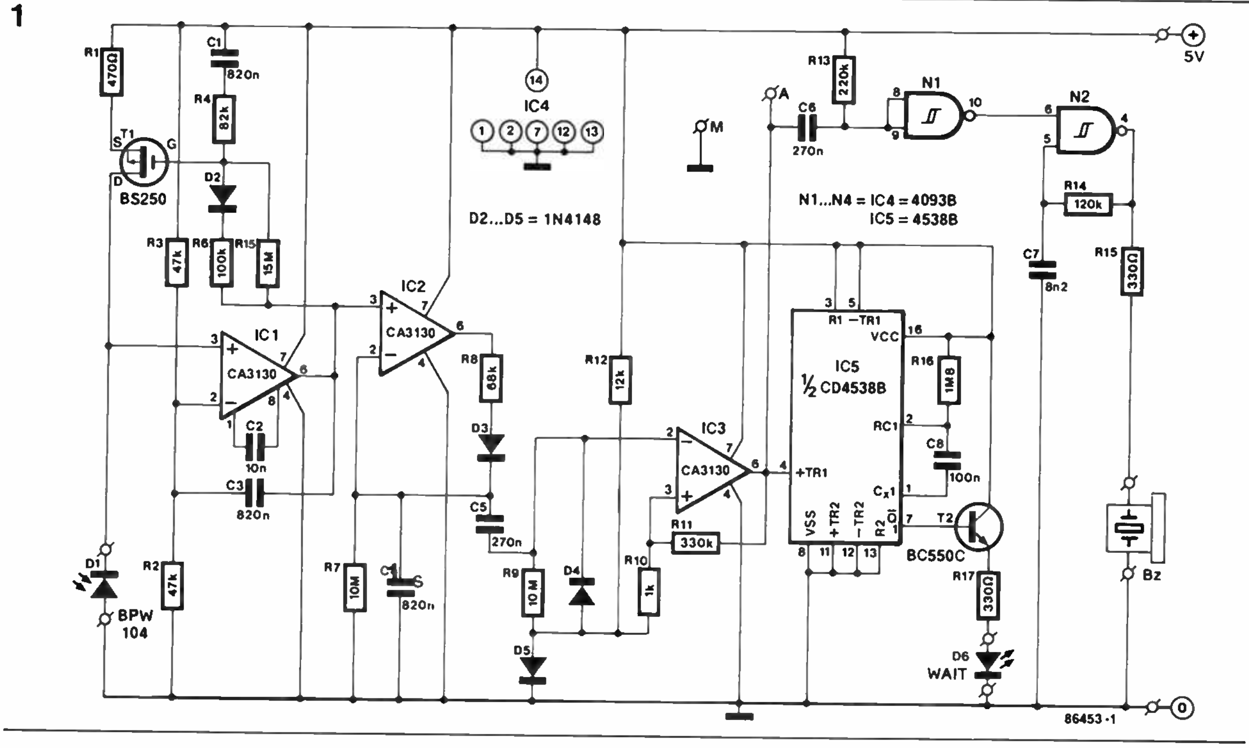
There are several reasons. Although electric propulsion systems are capable of increasing the payload by 20 to 25 per cent on a wide variety of satellites, it is only recently that communications spacecraft with masses of more than one tonne have become relatively commonplace. Previous generations of vehicles had masses of about 750 kilograms and the extra payload that might have been added was not considered enough to warrant the cost of developing the propulsion system.

It is only quite recently that communications satellites with powers of several kilowatts have become operational. Electric propulsion systems would absorb a small fraction of the total power available, in contrast to earlier available powers of 500 to 1000 watts; the propulsion appeared to require too large a fraction of that lower power to gain easy acceptance. Also influencing acceptance are natural resistance to change and reluctance to adopt what is often seen as a complex system of strange thrusters, power supplies and controls, compared with the chemical rockets which might be thought relatively simple because they are so familiar. It is only recently that the benefits from such a change have become so potentially great as to compel this attitude to be rethought.

One major objection to the use of electric propulsion has been the choice of propellant for most of the work carried out on thrusters, namely mercury. It is almost ideal as a propellant because it is heavy, dense and easily ▶

heart beat monitor

1



The proposed circuit is based on the fact that the degree of translucence of parts of a mammal's body depends, among others, on the flow of blood. Because the blood supply pulsates at the frequency of the heartbeat, this may be monitored in a simple way without the need for an electrical connection between the mammal and the measuring equipment.

In the proposed circuit, the flow of blood through a finger is monitored. To obviate errors caused by the position of the finger, the receiver diode is included in a loop.

The positive input (terminal 3) of IC1 is held at about 2.5 V. The gain of the device is determined by the ratio R_5:R_4. Network R_6-D_2 ensures that the circuit stabilizes rapidly. The amplified signal is rectified by IC_2. Time constants R_8-C_4 and R_7-C_4 are chosen such that the potential at pin 2 of IC_2 has a sawtooth shape. The CA3130 in the IC_3 position functions as a trigger. The output signal may, for instance, be applied to the input port of a computer.

If a computer is not available or deemed necessary, the beat is made audible by a piezo-electric buzzer operated by gates N_1 and N_2.

Circuit IC_5 provides a WAIT indication that shows when the circuit

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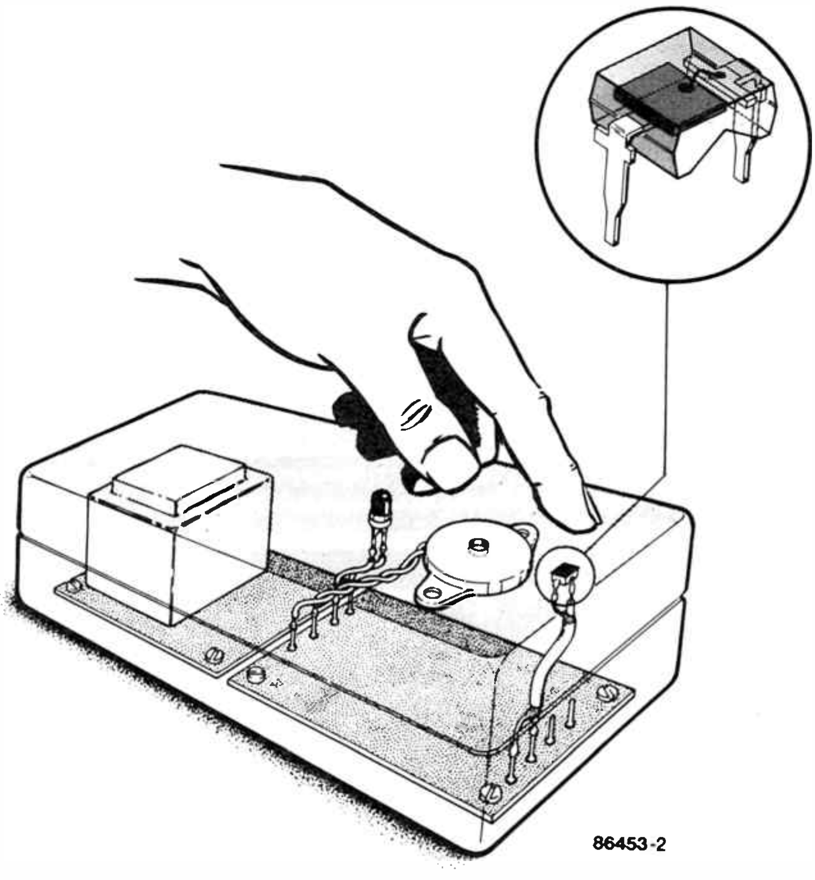
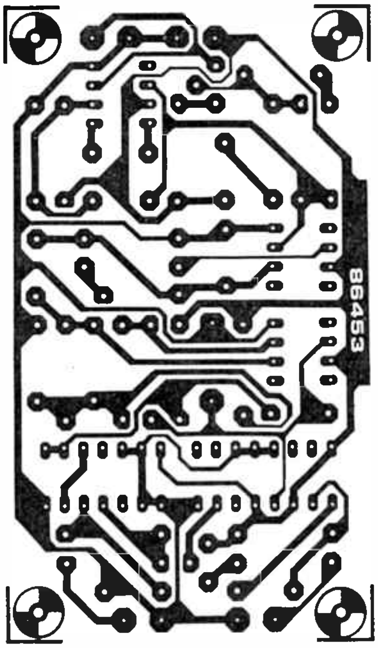
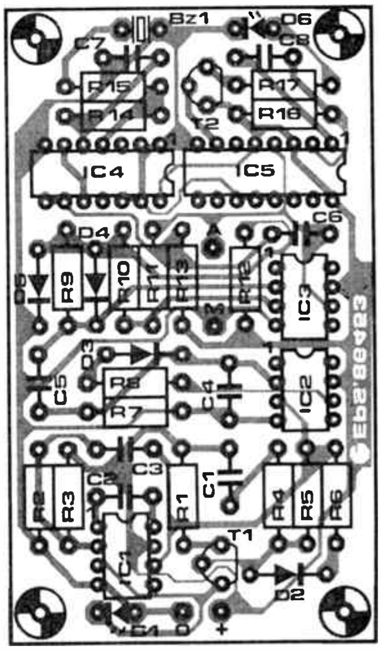


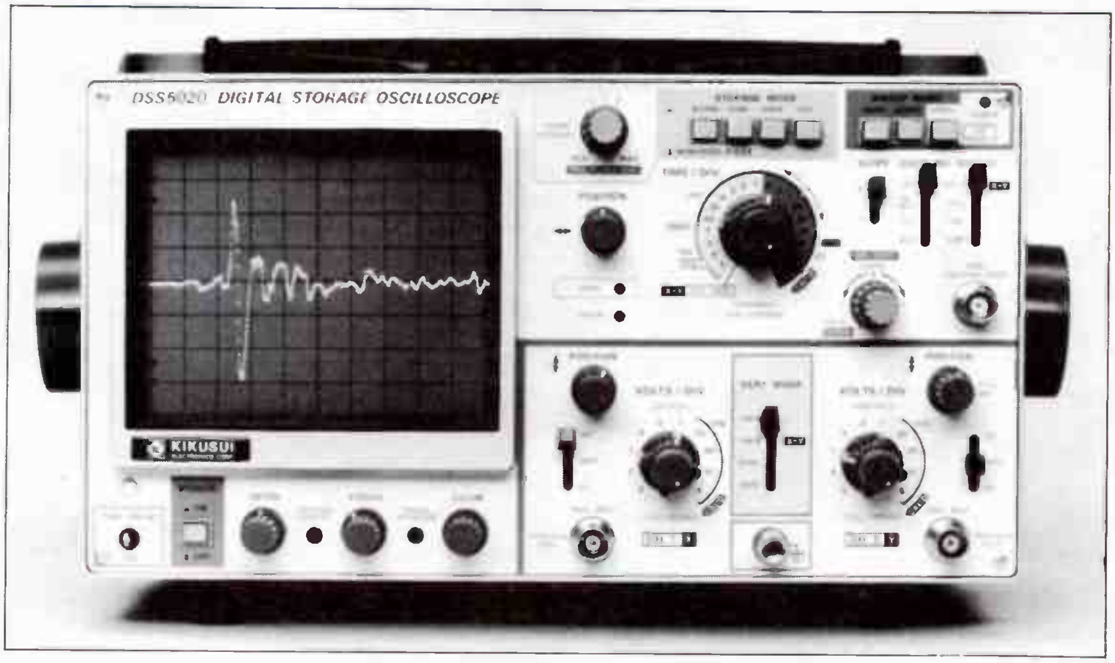
has stabilized and is ready for use.
The programme is compiled as follows: wait for a trailing edge, then count until the next trailing edge appears. The count is converted into a number per minute, and this is displayed on the monitor screen. However, the heart beat is not constant, which is quite clear from listening to the buzzer or observing the monitor screen. It is, therefore, advisable to calculate an average over, say, sixty seconds. It is then possible to display the instantaneous value, the average value over 60 seconds, and the trend (rise or fall).
Once the programme is known to work satisfactorily, it becomes interesting to display the actual signal on the screen. If the computer used has an analogue-to-digital converter, the output signal of IC_1 may be used for the display.
Fig. 2 shows a possible construction of the heart beat monitor in an ABS enclosure; the measurement may simply be taken by gently pressing one's finger onto the photodiode. *(B)*





stored. But it is not an ideal material as far as spacecraft designers are concerned, for it amalgamates rapidly with many metals such as copper, gold and aluminium, which means that the spacecraft structure, electrical wiring, power-producing solar cells and so forth could all be vulnerable to attack.
Another problem with mercury is to do with the fact that it is liquid at normal temperatures. Care must be taken to heat the propellant to a vapour before introducing it into a thruster, and to keep it as a vapour. If it condenses, it could lead to breakdown of high voltage insulation, shorting out of power supplies, damage to solar cell arrays and other serious problems.
All these disadvantages and problems with propellant are eliminated, or at least greatly reduced, if a gas is used instead of a liquid metal. The favoured candidate is the rare gas xenon, which is inert. It does not contaminate or react with the elements of space systems so it removes most worries about the structural integrity of long-life spacecraft. It does not condense upon components, so it does not cause electrical trouble.
The power supply systems are simpler, too, for no supplies are needed to heat and vaporise the propellant. That means better system reliability.
The problems of economic justification and power requirements hitherto associated with electric propulsion have diminished in importance, while those to do with choice of propellant and complexity of power supply have been reduced by thruster developments, so the time is ripe for this novel propulsion technique.
A very successful programme of work on the development of electric propulsion systems, led by the UK Royal Aircraft Establishment at Farnborough in collaboration with Culham Laboratory and several industrial firms, ended in 1978. The reasons for not continuing further had nothing to do with any failing in the systems that had been developed, which were at least as advanced and efficient as any others, but with the economics and other arguments to do with small, low powered spacecraft which I have already outlined. The programme has now been reactivated with a view to providing ion thrusters for station-keeping of multi-tonne satellites. The work is based around thrusters of 10 centimetres diameter operating with xenon propellant instead of mercury.
How far development reached in the previous programme is shown by the fact that the same thrusters are being used; the only modification needed was to remove components that were used to vaporise the mercury and keep it in vapour form. Present plans call for a test flight on board a satellite in 1989, and commercial implementation soon after.
Britain is not alone in such work, of course: all the leading space nations are planning to test electric propulsion systems in the next few years. The USA is due to fly a satellite with two mercury devices.
Japan has already flown a small mercury system and operated it for 200 hours in space, and is developing a 12-centimetre xenon system.
Germany has plans to fly a 10-centimetre xenon system for a six-month test on the European Retrievable Carrier (EURECA).
With so many contenders it is obvious that electric propulsion is about to come of age and find more and more application in the 1990s. The focus of work will then shift away from the proof-of-principle of a new propulsion system and concentrate more upon providing the most efficient, flexible and commercially attractive product for commercial users. Though electric propulsion will have been a long time coming, it will soon be here to stay.

STORAGE OSCILLOSCOPES



Photograph courtesy of Telonic Instruments Limited.

Conventional (real-time) oscilloscopes cannot capture very slow signals, such as, for instance, the charging curve of a battery or the sawtooth waveform of an AF wobbulator. Nor can they cope with infrequent events, such as noise pulses. They also do not allow a comparison to be made of events that happen at different times. All these drawbacks are absent from storage oscilloscopes.

In this article it will be assumed that the reader is reasonably familiar with conventional oscilloscopes. These instruments are sometimes called real-time oscilloscopes, because the input signal(s) are projected onto the screen immediately.

Two technologies

In principle, there are two distinct storage technologies: (1) analogue, in which the fluorescent screen serves as the memory, and (2) digital, which uses semiconductor memories.

Analogue storage oscilloscopes are quite well-known instruments. They are fitted with special cathode-ray tubes (CRTs) that are provided with a storage mesh—see Fig. 1. Before the electron beam reaches the screen, it hits the mesh and dislodges a number of electrons. These so-called secondary electrons are gathered by a special collector. The parts of the mesh from which electrons have been dislodged are positive, and form a true copy of the signal. Afterwards, the flood guns in the CRT illuminate the positive parts of the mesh to display the signal when required. The storage controls vary the charge on the mesh to permit a variation in the contrast between the trace and the background, and to fine tune how long the trace is stored. The trace is erased by applying a positive pulse to the storage mesh: this prevents the electrons emanating from the flood guns from reaching the viewing screen.

Analogue storage oscilloscopes such as, for instance, the Philips Type PM3266, permit very high writing speeds and a trace definition that is independent of the writing speed. They also provide variable afterglow duration.

None the less, most commercially available storage scopes are nowadays based on digital techniques. These types do not need a special CRT, and enable use to be made of modern semiconductor technology.

Figure 2 shows the functional diagram of a digital storage oscilloscope. The principal difference between this and a real-time oscilloscope is that its input signal to the vertical deflecting (Y) plates is first converted into a digital signal. This signal is stored, and then reconverted into a control signal for the electron beam.

Analogue vs digital

Analogue storage scopes are normally used when fast events must be captured and relatively short storage times (<1 hour) suffice. Their high writing speed and good definition are then decided advantages.

Digital storage oscilloscopes should be used when long storage times are needed.

To make the differences between the two types clear, their following characteristics will be compared:

- writing speed;
- storage time;
- signal tracing;
- triggering.

Writing speed

Periodic events can be stored without any problems in either an analogue or a digital scope. For one-off events, the writing speed is important, because this determines to what extent the signal can be stored on the storage mesh. This may be deduced from Fig. 3, which shows at which writing speed vs frequency and amplitude a previously sampled sine wave can be displayed. At the same time the ratio of two pulses (amplitude vs rise time) that could have been displayed at the same writing speeds is shown.

Two examples may make this clearer.

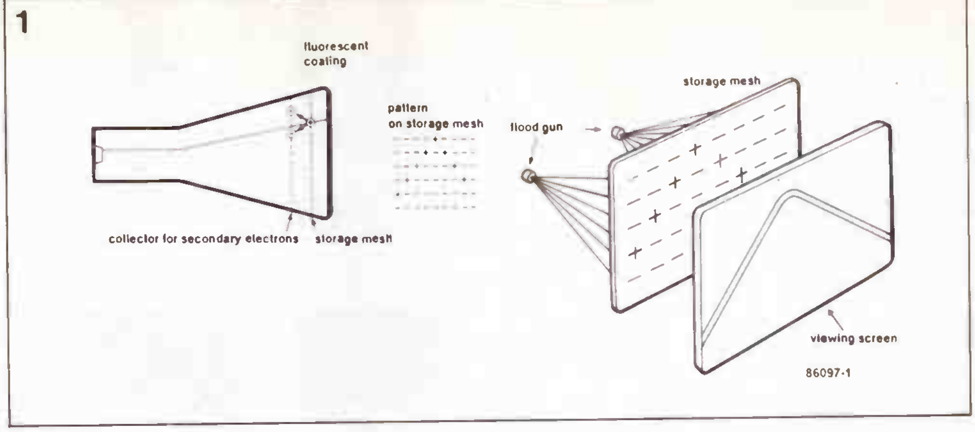
The maximum writing speed for a sine wave is approximated by

$v_m = 1/2\pi fA$ [div/μs]

where f is the frequency of the sine wave in Hz, and A is its amplitude in div.

From this, it is seen that an 8.2 kHz sine wave signal can be displayed with a peak-to-peak amplitude of not more than 10 div. at a writing speed of 0.2 div/μs.

1



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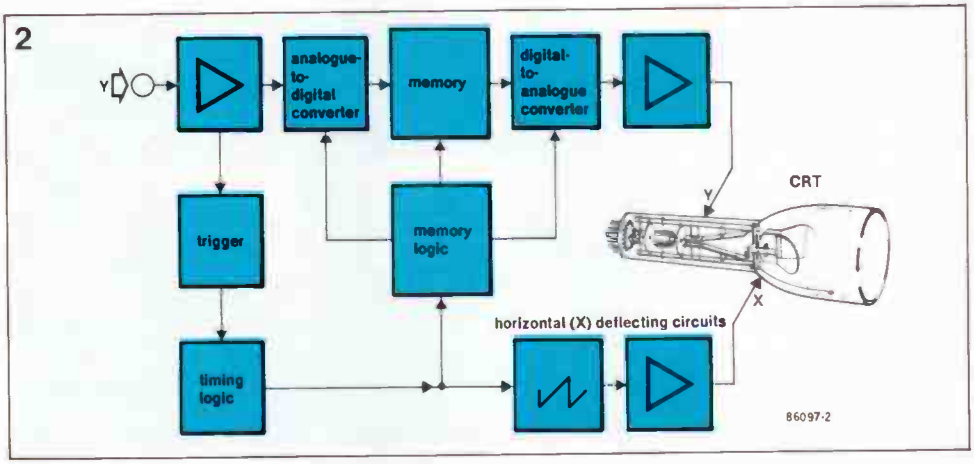

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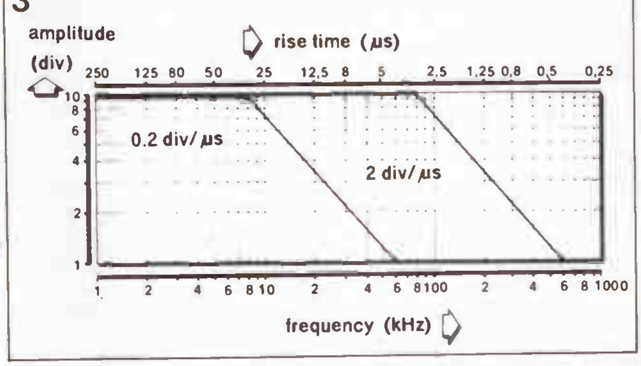


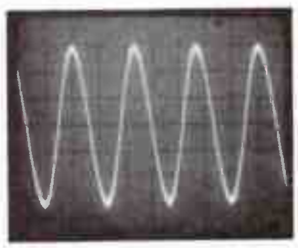


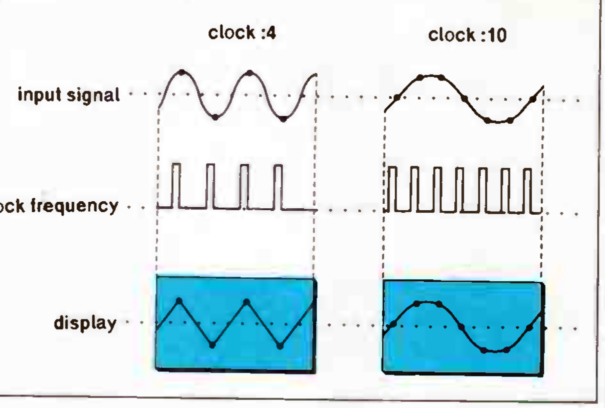
Fig. 1. Storage with special cathode-ray tube.

Fig. 2. Block schematic of a digital storage oscilloscope.

Fig. 3. Illustrating writing speed.

At higher frequencies, the maximum amplitude becomes smaller, until at 60 kHz it is only 1 div.
The maximum writing speed for a rectangular pulse is approximated by $v_m = 0.8A/T_r$ [div/μs] where A is the peak value of the pulse in div., and T_r is the rise time in microseconds.
From this, it follows that a writing speed of 2 div/μs, a pulse with a rise time of 4 μs can be displayed with a peak amplitude of not more than 10 div.
In a digital storage scope, the analogue signal is sampled during the analogue-to-digital conversion, in which the writing speed is of no consequence. The clock frequency, however, must be as high as possible to ensure good definition. In practice, the frequency of the input signal must not be higher than a fourth, and preferably not more than a tenth, of the clock frequency. How the original signal and the "copy" appear on the screen at these ratios can be seen in Fig. 4.
Frequently, greater writing speeds are required. Analogue storage scopes are fitted with a CRT that has a second, "fast", storage mesh, allowing speeds of up to 5500 div/μs. In this method, the "fast" mesh samples the signal well before the normal mesh. The signal is then transferred to the normal mesh and stored by it.
In digital storage scopes it is not so simple to achieve such high writing speeds, and comes down to a compromise between good vertical and good horizontal definition.
The background to analogue-to-digital conversion was described in *A/D and D/A Conversion* in the May 1985 issue of *Elektor Electronics*, and it is well worth rereading that article, if possible. The successive approximation method described in that article provides very good definition, but not very high writing speeds. The flash encoding process offers high sampling rates, but relatively poor vertical definition. None the less, low-cost storage oscilloscopes invariably use flash encoding.
Philips have recently introduced a technique whereby the analogue input signal is delayed before conversion takes place—see Fig. 5. The block designated P²CCD is nothing more than a fast sample-and-hold circuit which is fitted on a chip together with an analogue shift register. The input circuit samples, and stores the instantaneous value of, the input signal at a frequency of 125 MHz. After the delay, the signal is converted into binary form by the step approximation technique.
Although digital storage oscilloscopes appear to have a number of advantages over analogue models, they also have some drawbacks. To start with, they are generally very expensive, and almost certainly overpriced. Moreover, there are a number of operational difficulties.
In the measuring of signals that contain glitches, the high writing speed of an analogue storage scope is a decided advantage, because this enables the storing and displaying of pulses with a duration of 3.5 ns. In digital types, the sweep separation determines whether a given pulse can be captured and stored. For instance, a sweep separation of 8 ns allows pulses with a duration of not less than 10 ns to be sampled and stored: that is a factor 3 worse than is possible with an analogue scope. It is true, however, that special techniques, such as Hewlett-Packard's *periodic random sampling* afford a better perfomance in digital scopes.

4



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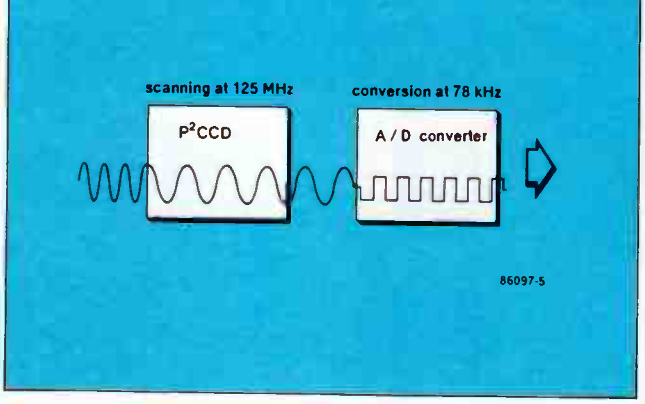


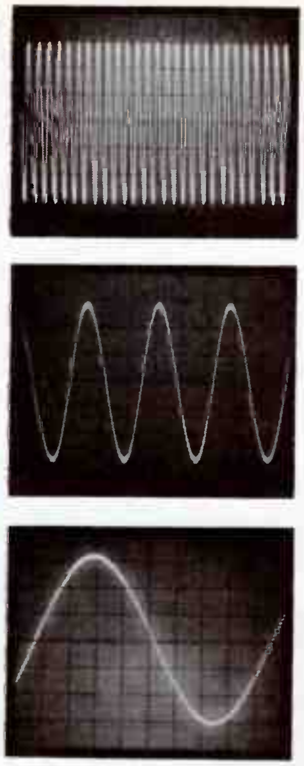
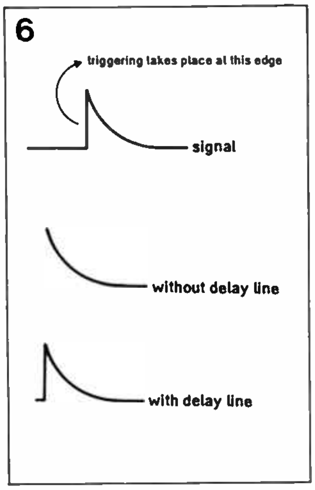


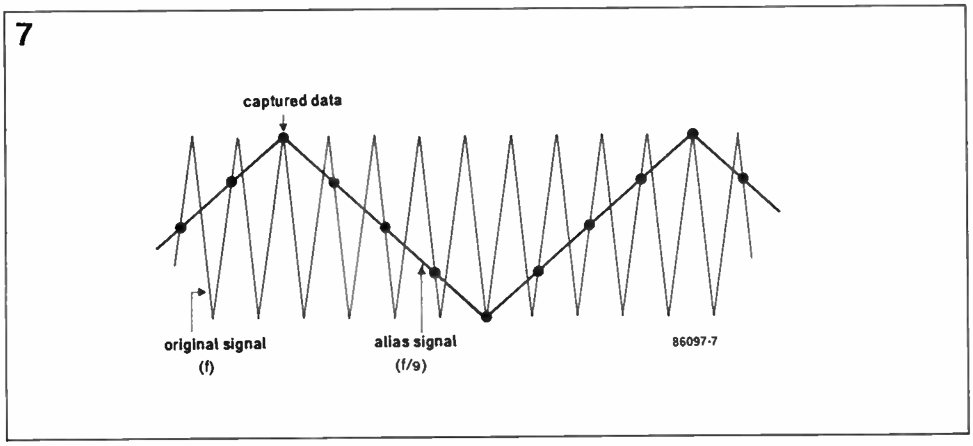
Fig. 4. Incorrect display at too low clock frequencies.

Fig. 5. Delay of the analogue input signal before digitizing takes place.

Storage time

The storage time of an analogue scope is limited, since the sample is formed on the storage





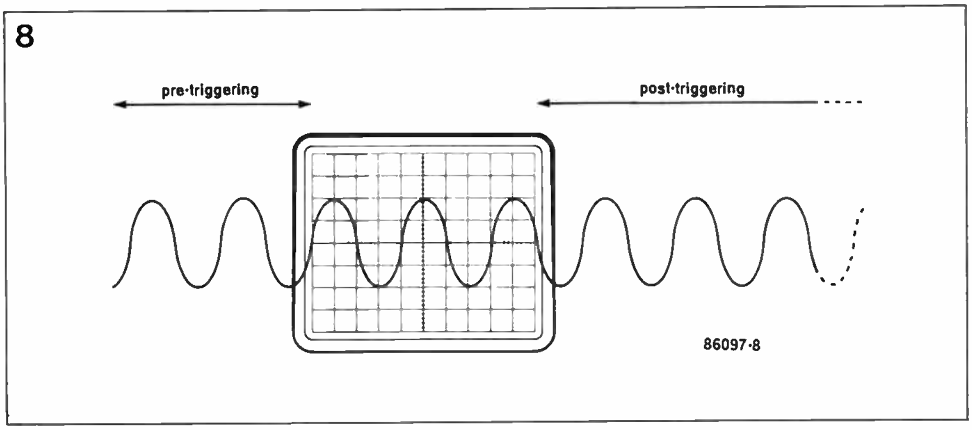


Fig. 6. Signal delay in analogue storage oscilloscopes ensures that the trigger point is also displayed.

Fig. 7. Illustrating the aliasing effect.

Fig. 8. Both pre- and post-triggering are possible in digital storage oscilloscopes.

mesh relatively slowly. None the less, depending on the type of CRT, storage times of up to 24 hours may be achieved. The view time is controlled by pulse modulation of the emission from the flood guns. This results in maximum brightness and minimum view time at maximum pulse width. Conversely, minimum brightness and maximum view time are obtained with minimum pulse duration.

The storage time of a digital oscilloscope is virtually unlimited, provided that the semiconductor memories are buffered. Most oscilloscopes of this nature are fully protected against mains faillures.

To enable the measuring process to be carried out as efficiently as possible, analogue oscilloscopes are available with a variety of tracing methods. Variable afterglow is used to effect the disappearance of a trace exactly at the moment a new trace is written. Automatic erasure ensures that the old trace is quenched completely before a new measuring cycle starts: this prevents possible errors in the new cycle. Automatic storage (AUTO STORE MODE) ensures that each and every change in the input signal is sampled and stored until display on the screen is required. Double-beam oscilloscopes may provide double-beam storage.

Signal tracing

There are basically two display modes in use for digital oscilloscopes. In the *dot join* mode, the digital signal is displayed as a continuous trace (with other methods it would be a dotted line). The *roll* mode is for use when very long duration events are to be displayed. In this mode, the trace moves very slowly across the screen right to left (it may take up to 40 hours to travel across the screen once).

There are also techniques which enable as many as eight traces to be displayed simultaneously: any of these may be real-time or stored.

Triggering

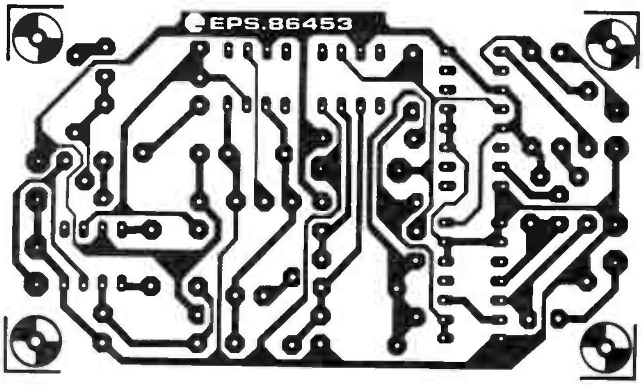
An important feature of any respectable oscilloscope is the triggering, which enables the trace(s) on the screen to be held still for precise observation or measured.

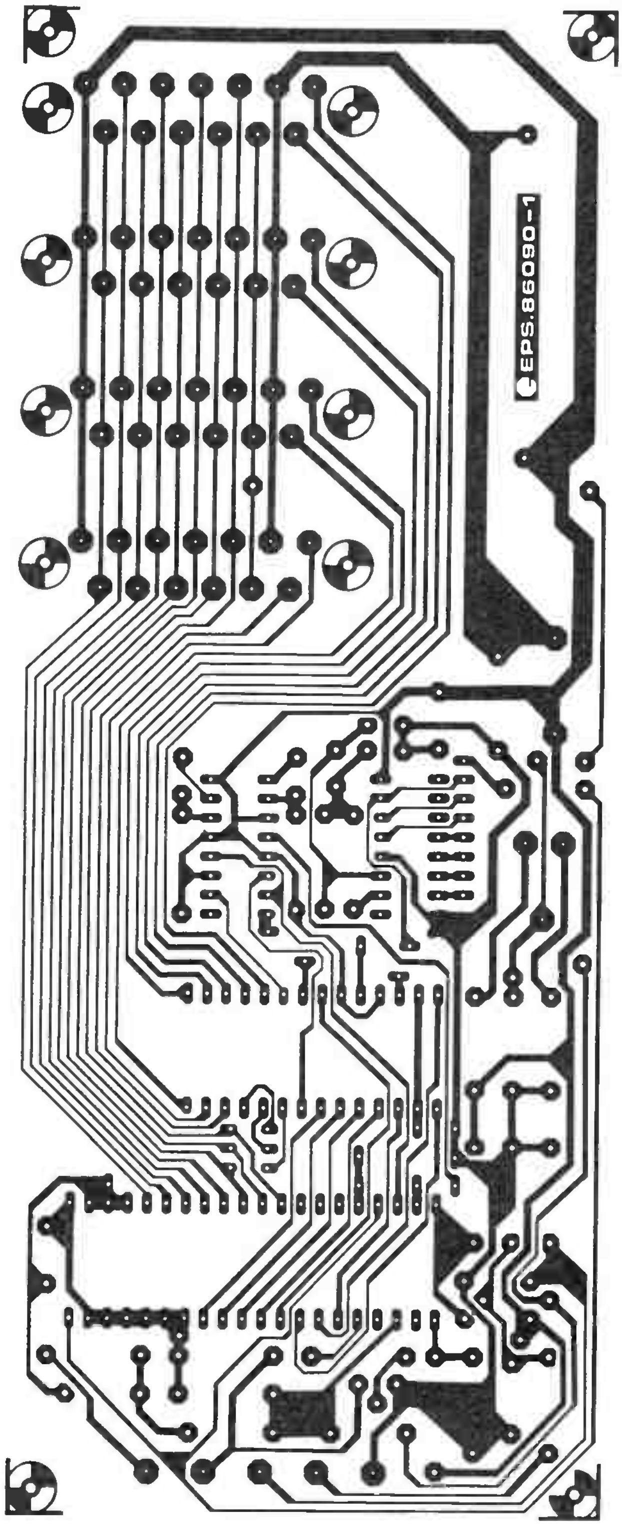
In analogue oscilloscopes, signal details that occur before the trigger can only be displayed if the scope is fitted with a delayed vertical sweep-see Fig. 6.

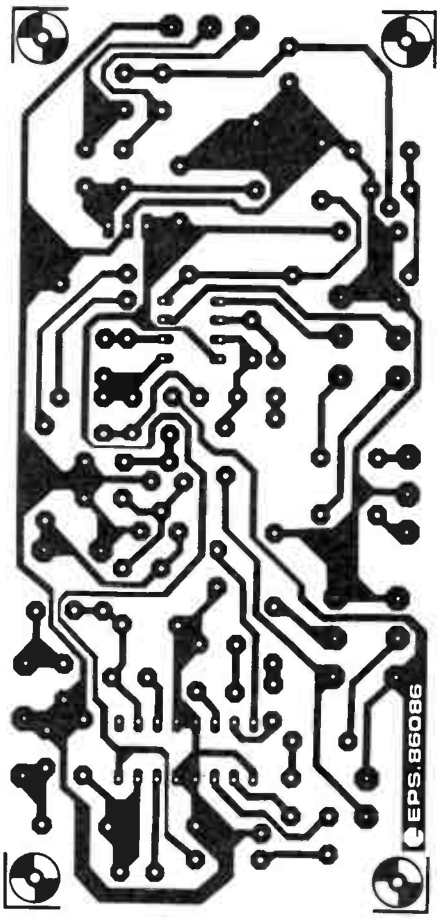
In digital storage oscilloscopes, pre-trigger parts of the signal are displayed as a matter of course. The pre-trigger time is equal to the screen width, i.e., it depends on the selected time base. This has, of course, the disadvantage that the input signal is swept at the selected time base. If the sweep rate is smaller than the frequency of the input signal, it is possible that the scanning samples at different periods of the input signals are taken at the wrong positions. As can be seen in Fig. 7, although the signal shape remains true, the frequency of the displayed signal is only a ninth of that of the input signal. This effect is called *aliasing*. If aliasing is suspected, operation should be switched to real-time to ascertain the true situation.

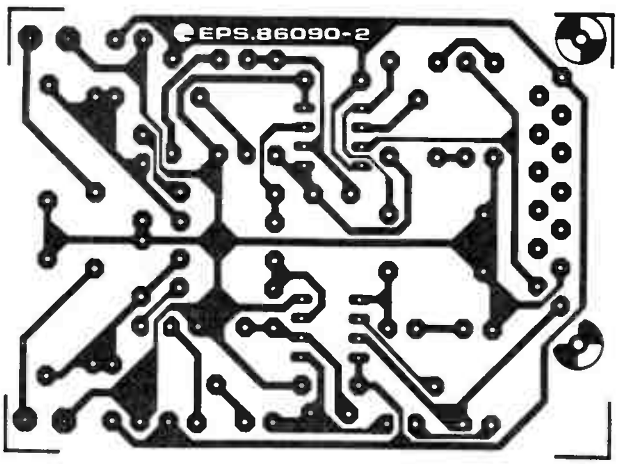
As in analogue storage scopes, post-triggering is possible in digital models. The delay in these can be up to 1000 times the screen width—see Fig. 8.

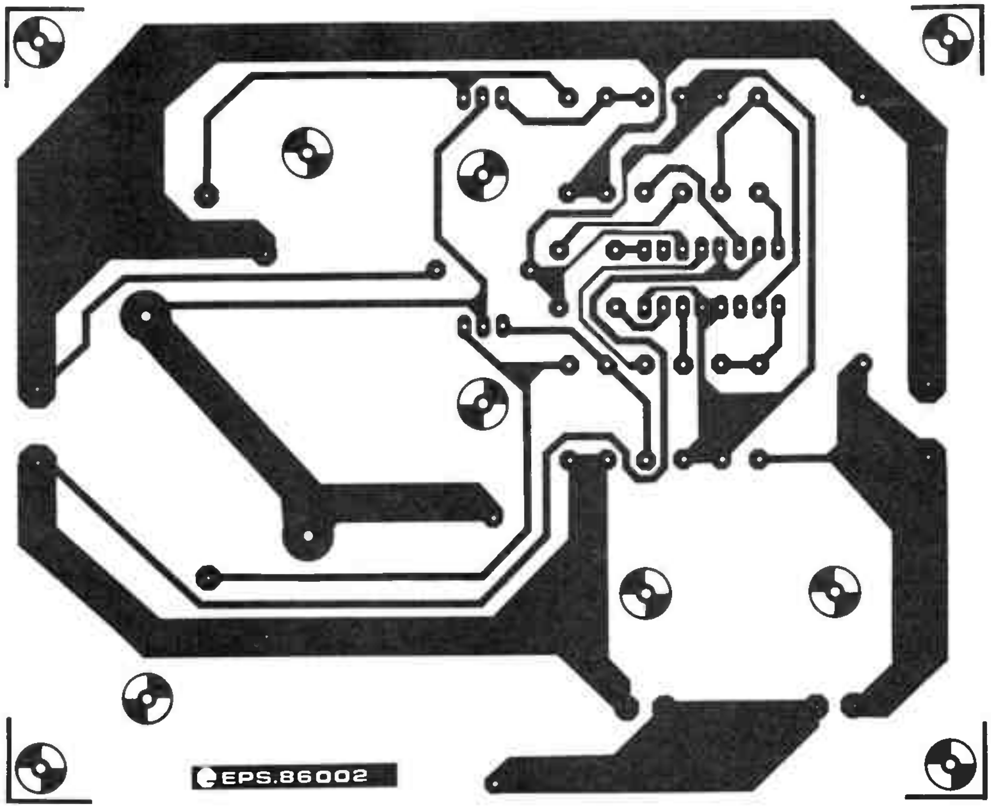
Elektor Electronics PCBs







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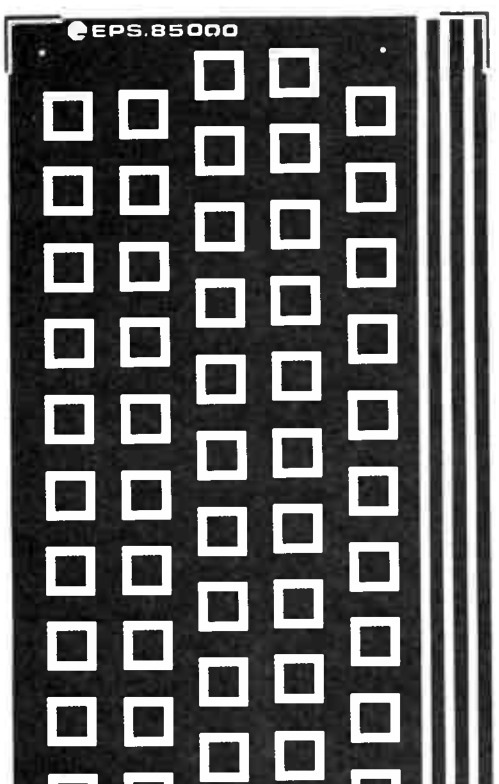
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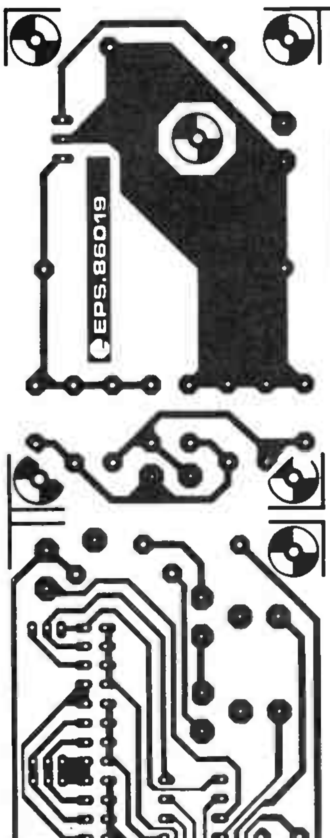
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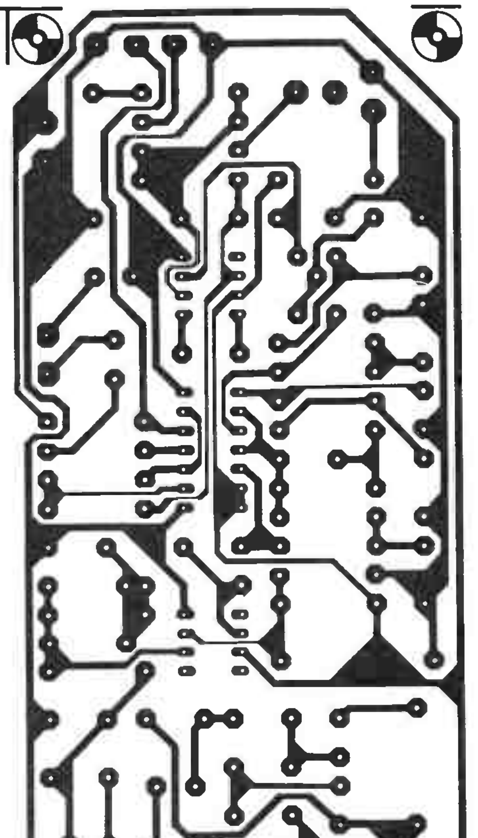
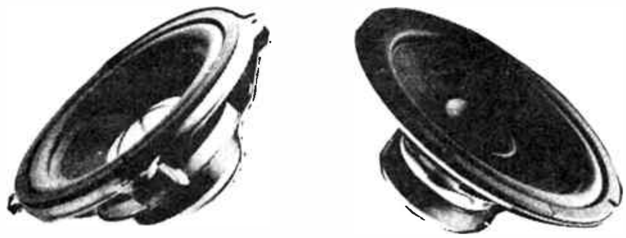




Jaycar stocking Magnavox

Magnavox speakers are back on the market, thanks to local manufacturer, Eltec, and you'll find them stocked at Jaycar outlets across the nation.

Jaycar are stocking a range of five drivers: the 12MV-012 8MV-003, 8W-020, 8WR-020 and the 8JX. The 12MV-012 is rated at 100 W RMS, has a claimed free-air resonance of 23 Hz, a sensitivity of 96 dB and features a 38 mm diameter long-throw voice coil. Jaycar's price is $69.50.

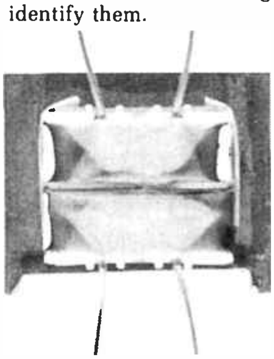
The 8MV-003 is billed as a replacement for that legend of the '70s, the Magnavox 8/30. It's rated at 100 W, the free-air resonance is quoted as 32 Hz and sensitivity as 95 dB. List price is $89.50.

The 8W-020 is a 60 W woofer for $32.50, while the 8WR-020 and 8JX are both wide-range twin-cone units for $34.50 and $26.50 each, respectively.

Jaycar has five stores in Sydney and one in Brisbane. Head office 'phone is **(02) 747 2022.**

Tiny tranny

Seeking a tiny pc-mount mains transformer for a low voltage on-board supply? Melbourne-based retailer, All Electronic Components has available a 240 V to 6 V tranny measuring 35 mm wide by 29 mm deep and standing just 25 mm high featuring tinned wire leads for pc board mounting. The label says "Dyne Type No. 1244", which should be enough to identify them.



The primary and secondary are wound on separate sections of the plastic bobbin, so primary-secondary isolation should be quite good for a wide variety of applications. The secondary is rated to deliver 100 mA.

For only $3.95, they're worth checking out at **All Electronic Components, 118-122 Lonsdale St, Melbourne 3000 Vic. (03) 662 3606.**

Project support from Hi-Com Unitronics

Looking for individual parts for projects, rather than whole kits only? Then consider Hi-Com Unitronics, located in Caringbah on Sydney's south side, for sourcing those individual components.

Proprietor, Anthony Hui, advises he stocks all individual parts for the AEM6000 MOSFET Power Amp, the AEM4505 Code to Speech Synthesiser and the AEM4600 Dual-Speed Modem. Naturally, you can also get all the bits for our Super Simple Modem from Hi-Com, too.

And for our Elektor projects, try Hi-Com for those European components. You'll find them at **7 President Lane, Caringbah 2229 NSW. (02) 524 7878.**

PROJECT BUYERS' GUIDE

This month's Star Project, the **RF Field Strength Meter**, is a very handy instrument for the amateur, CBer or communications serviceman. It is available as a kit from **Dick Smith Electronics** stores throughout Australia and New Zealand.

Constructors of the **AEM5506 Lamp Saver** should have little difficulty in obtaining components for this project as all parts employed are readily available from almost any electronics retailer. The same goes for the **AEM8501 Car Alarm**.

From our Elektor section, the **Serial Digitizer** has a few components you might have to hunt round for. The ADC0809 is a National Semiconductors device available from **Geoff Wood Electronics** in Lane Cove, Sydney. The CDP1854 UART is distributed by AWA Micro-electronics and is a rare retail item, but the General Instruments AY-3-1015, distributed by Daneva, is available at **Jaycar** stores in Sydney and Brisbane, **Rod Irving** in Melbourne and you might also try **Hi-Com Unitronics** in Sydney. For the TLC272, try **Geoff Wood** and **Hi-Com Unitronics**. The 2.4576 MHz crystal is a common item as it's used in many modem designs. The rest should be readily available.

The only 'special' component in the **Headphone Amplifier** is the TEA2025 stereo amp chip. This is distributed by **Promark Electronics** (Sydney and Melbourne). Try **Hi-Com Unitronics** in Sydney.

For the Dynaudio drivers used in the **Satellite Loudspeakers**, contact **Scan Audio, 52 Crown St, Richmond 3121 Vic. (03) 429 2199**. The crossover components should be readily sourced. The inductor (L1) is the same as L4 in our popular 6102 2-ways using the Vifa drivers. **Jaycar** stocks 100µ and 22µ bipolar capacitors suitable for the project.

The **Loudspeaker Impedance Meter** employs components which are, in the main, readily available. Prime sources we can suggest are **Hi-Com Unitronics** in Caringbah and **Geoff Wood Electronics** in Lane Cove, Sydney. You might also try **All Electronic Components** in Melbourne.

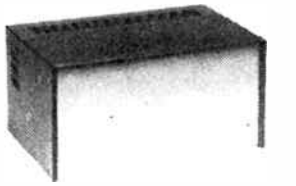
Constructors of the **DC Operated Battery Charger** should be able to source components through **All Electronic Components** in Melbourne, **Hi-Com Unitronics** and **Geoff Wood Electronics** in Sydney.

If you're interested in building the **RMS-DC Converter**, the Analog Devices AD536J is distributed here by Parameters. Try ordering through **Hi-Com Unitronics** or **Geoff Wood Electronics**, both in Sydney. We also note that **RS Components** list it in their current catalogue.

The **Rodents Deterrent** employs components that are generally available, except for the transformer. One of the tiny bolt-on types, such as the 2824, may possibly be used. **All Electronic Components** have a pc-mount type with 6 V output that may well suit. Most electronic stores carry piezo transducers suitable for this project's application, but choose something having the best sensitivity of those on offer.

The semiconductors for the **Test Oscillator** are not altogether common items. However, try **Geoff Wood Electronics** and **Hi-Com Unitronics** in Sydney, **Radio Parts** in Melbourne and **Protronics** in Adelaide. Reasonable substitutions may be tried with expectations of success, although performance may differ. A variety of dual-gate FETs may be used for T1, such as the MFE131 (widely stocked) or 3N201 (stocked by **RS Components**), while a BF245 (widely stocked) might replace the BF246, but the J112 (stocked by **RS Components**) is a direct substitute. The ferrite components specified may be obtained through **Truscott's Electronic World** at Croydon in Melbourne, **Electronic Components** at Fyshwick in the ACT, **Geoff Wood Electronics** at Lane Cove in Sydney and **Willis Trading** in Perth.

The BP104 photodiode used in the **Heart Beat Monitor** is a Siemens device with a peak sensitivity at 950 nanometres and a reverse voltage rating of 20 V. The Siemens SFH205 and SFH206 photodiodes may be acceptable substitutes. Check Siemens distributor **Protronics** in Adelaide for supplies. The FET, T1, provides a constant current bias source for the BP104 so that pin 3 of IC1 is held at 2.5 V. Substitutions may be made here, but R1 may need to be varied to obtain the correct bias. In lieu of the BS250, you might try a common dual-gate FET with both gates tied together.



Big box for big projects

When you need a truly substantial box for that truly substantial project, check out the new Australian-made K&W case stocked by Jaycar.

Measuring 305 mm wide by 150 mm deep and 200 mm high, it features the simple twin-U construction of the rest of the K&W range, together with plenty of slots in the top cover for ventilation. Jaycar list it as cat. no. HB-5468 at $22.95. Check it out at your nearest Jaycar store, or 'phone head office on **(02) 747 2022.**

Amidon ring cores

Those ferromagnetic RF cores by Amidon, so often specified in circuits and projects published US and European publications, are imported here by a small local firm known as RJ & US Imports.

They stock a variety of the more 'popular' cores and can obtain others on order. Data and a price list is available by sending them a stamped, self-addressed envelope of size 150 × 220 mm.

If you're looking for them over the counter, you'll find a range of the Amidon cores stocked by Geoff Wood Electronics at Lane Cove in Sydney, Electronic Components at Fyshwick Plaza in ACT, Truscott Electronics at Croydon in Melbourne and Willis Trading in Perth.

You can contact **RJ & US Imports at PO Box 157, Mortdale 2223 NSW.**

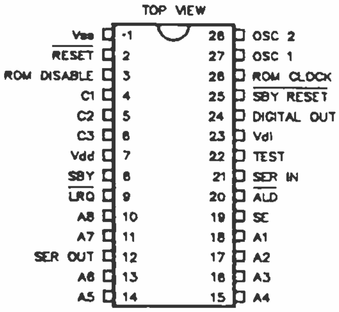
Beating the heat

Ridding your favourite project of internal heat relieves stress on components, reduces failures and prolongs their life.

"You've gotta fan it to keep cool", says the old blues song, so install a fan in your project cabinet and move that hot air out.

Fans can be picked up for bargain prices at Pre-Pak in Sydney. They have both three inch (80 mm) and five inch (120 mm) Muffin-style fans with 240 Vac motors, made by CIC of Taiwan, for just $20. They also have ex-computer 5" fans with 200 Vac motors for just $10!

For these fan-tastic bargains, perambulate to **Pre-Pak, 1a West St, Lewisham NSW. (02) 569 9767.**



Speech chips, again

Looking for sources for the General Instruments speech synthesiser chips featured in our two speech synthesiser projects, the AEM4504 and 4505?

The SPO256A-AL2 was used in the 4504 Low-cost Speech Synth., while that was teamed with the CTS256A-AL2 in the 4505 Code-to-Speech Synthesiser. Daneva distributes them.

Ian J. Truscott's Electronic World, of Croydon in Melbourne (03) 723 3860, has joined stockists Geoff Wood in Sydney (02) 427 1676 and Eagle Electronics in Adelaide (08) 271 2885.

Silver mica caps

Silver mica capacitors are renowned for their low loss and low drift characteristics. They are ideal for many RF applications from the low frequencies through VHF.

Sheridan Electronics have silver mica caps in assorted values from 1 pF to 17n8 (!) and tolerances from 0.5% to 5%. They come in bags of 200 for a measly $10, and it's worth buying two at that price.

For savings on silver micas, slip on over to **Sheridans at 164-166 Redfern St, Redfern 2016 NSW. (02) 699 5922.**

— from page 32

Generally, the industry acknowledges that it's a tough market out there, but innovation and value for money will win the day, not price points alone.

Bits and pieces

The distinctionbetween musical instruments and computers is becoming distinctly blurred. Commodore, the computer company, was showing off MIDI (musical instrument digital interface) system keyboard interfaces for their Amiga and C128, teamed with some snazz music composition software. Yamaha, the musical instrument company, virtually did the opposite. Meanwhile, Technics showed a range of home keyboard instruemtns incorporating sophisticated digital processing and 'computer' features, including floppy disk recorder add-on units.

MIDI is definitely here to stay in both home and pro musical instrument applications, particularly with keyboards. The marriage of computers and musical instruments will likely influence music composition in the same way as computers influenced word processing — by removing the mechanical drudgery to free our creative spirit.

Commodore, Microbee and Mobex (with the Atari range) were the only prominent computer exhibitors this year. Commodore and Mobex made musical applications the focus, while Microbee stuck to appealing and useful applications while showing off their new product lines.

The Atari 520ST and 1040ST computers attracted a lot of interest for Mobex, and they have the singular feature of CD-ROM interface ready for when that product hits the market (next year we hear).

Microbee's new product line-up featured the Teleterm and Chalkboard. The Teleterm is a dedicated communications package, specially designed for business users who want to access on-line databases like Telememo and Viatel. Of interest among its many features are its graphics-based windowing facility with pull-down menus and dialogue boxes all in full colour. The Chalkboard is a touch-sensitive 'graphics tablet' surface that bypasses your keyboard for drawing applications. Microbee's Electric Paintbrush software is bundled with it — you've got to see it to realise its features.

Car sound gets more extravagant by the year it seems. Eurovox, Alpine, Nakamichi and Kenwood vied for top dog in the extravaganza stakes this year — and you can pay more the the gear than the cost of the car!

West Australia's local industry put their best foot forward this year, not just to show visitors they weren't in hicksville, but to demonstrate they're up there in the technology stakes, too. The Show's 'token dignitary', Federal Minister for Science, Barry Jones, spent some time toying with the Parry Corporation's underwater surveillance robot on opening day, to the delight of the TV crews and show organisers. The entrepreneurial spirit is certainly alive and energetic in the west.

Overall, the eighth Perth Electronics Show was up to past performance, but I got the feeling it lacked a little of the "lustre" of past years. Maybe I'm jaded, though I found the show enjoyable. Where was the behind the scenes camaraderie and banter of years past?

Next year, the ninth show, the organisers plan to move to the Burswood Island Casino and hold it in October, a quantum leap up-market in venue and throwing it smack into the hustle-bustle of the Cup challenge. Good luck, fellas. See you there!

aem project 8501

A current-sensing car alarm with ignition killer

Anthony Tilbrook
David Tilbrook

This alarm is straightforward to build, yet provides features not available on many higher cost off-the-shelf car alarms.

IN RECENT YEARS the crime rate in all sectors of the community has increased to an all-time high. The most dramatic increase seems to have been in car theft. We are all aware of this disturbing fact. However, the rate and ease with which our vehicles can be stolen is staggering to say the very least. It has been estimated that a professional car thief can enter and start a vehicle in less than thirty seconds, which would look to the unsuspecting bystander like a completely normal and innocent entry to a vehicle.

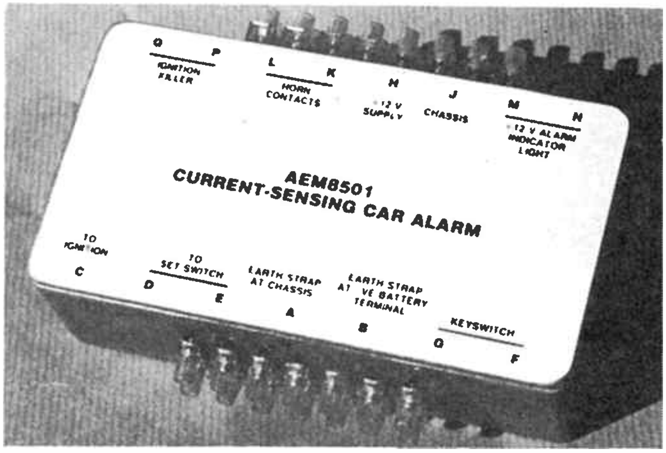
Although most people have insurance, there is no real replacement for prevention and the peace of mind that it brings. How often have you parked your vehicle somewhere secluded and had a fleeting doubt as to whether it would be there when you returned? No car alarm is infallible, and therefore no car will be completely safe from the most determined of thieves, especially professionals. However, most alarms will deter that most common of car thieves, the joy rider.

The first job of any alarm is to act as a deterrent. It must convince a would-be thief that stealing that particular vehicle is going to be impractical. However, if this fails then it is the alarm's job to attract the attention of people in the general vicinity to the illegal entry as the last thing a thief wants is undue attention. The sound of a blaring horn is usually enough to deter thieves from their task. But if the thief is determined enough to steal the car even with the sound of the horn ringing in their ears, it should then be the job of the alarm to render the vehicle useless.

While this sounds ideal, the problem that most of us encounter is that the effective commercial units available today are quite costly. This is not to say that it wouldn't be money well spent. However, we feel we have something to offer enthusiasts who wish to secure their vehicles. It was with this criteria in mind that we designed the AEM8501 Current Sensing Car Alarm (with ignition killer). This is a serious attempt at an inexpensive, yet extremely effective, safeguard for your vehicle.

Design features

As the name implies, the project operates by measuring the voltage drop across the small but finite resistance of the battery earth strap. This voltage drop will be caused by any accessory, for example the courtesy light, switching on at the moment of opening a vehicle's door, bonnet or boot. Details of how the circuit operates are described in the section headed "Circuit Operation". As discussed earlier, the features which are foremost to the protection of a motor vehicle must be incorporated into any serious alarm project.

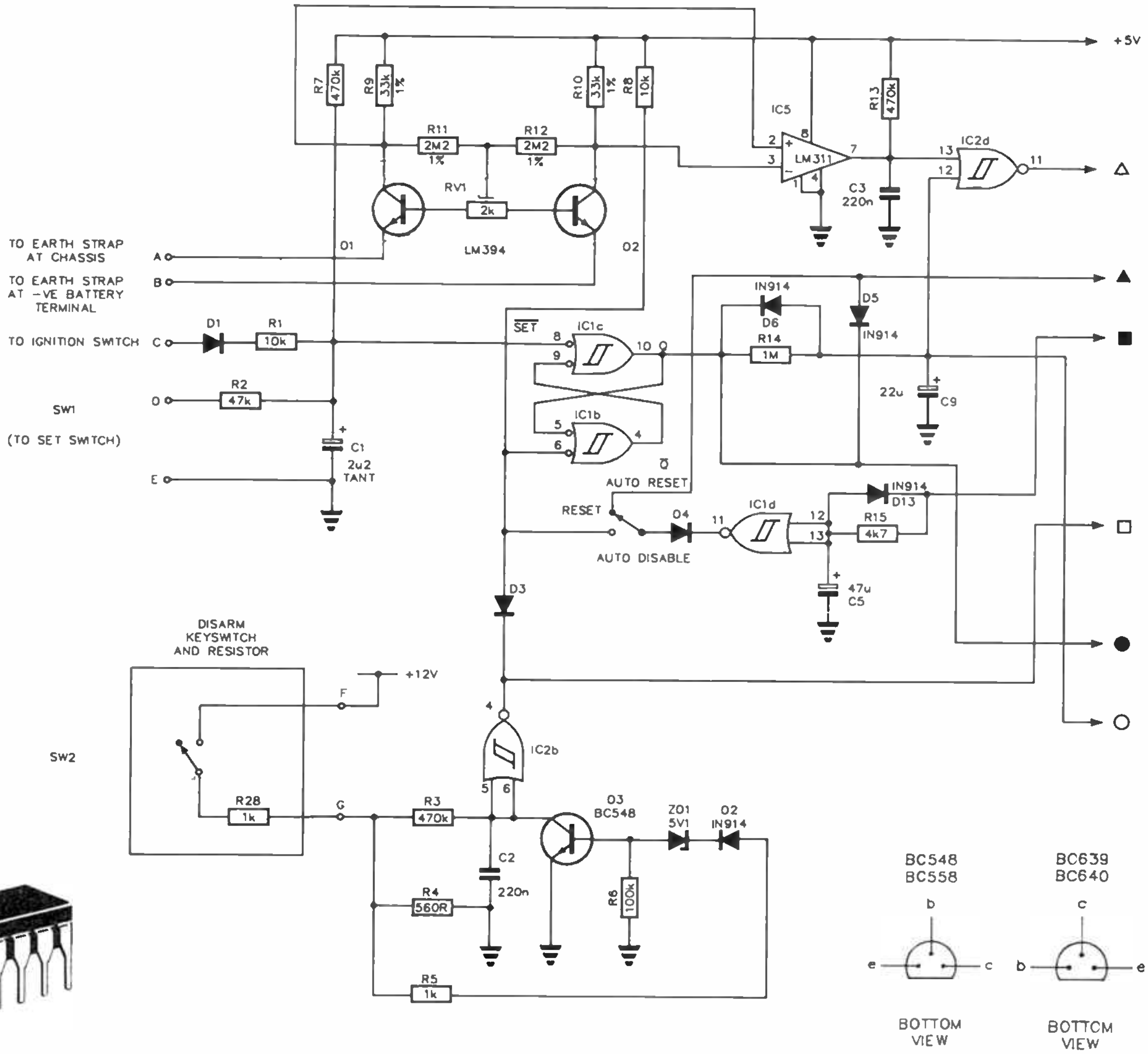


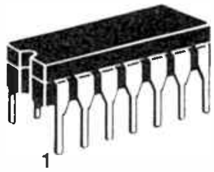
The completed project is housed in a diecast aluminium box. Connection to the vehicle's electrics is made via screw terminal blocks mounted on the box lid.

With the AEM8501, the first line of defence for your car is a flashing light which tells the potential thief that an alarm is installed and that disturbing the vehicle will attract attention. This light is incorporated in the circuit so that, after arming the alarm there is a 30 second delay before it begins to flash. Once the alarm is set the light will turn on constantly for 30 seconds, after which time it will begin to flash, indicating the alarm is armed. This represents the amount of time allowed for you to exit the vehicle (the 'exit delay'). Once the light begins to flash, any current drawn from the battery will trigger the alarm.

Once the alarm has been triggered, the light will cease to flash, which indicates there is 30 seconds before the horn will begin to sound. This doubles as the 'entry delay'. i.e: you have 30 seconds in which to enter your vehicle and switch off the alarm.

How to disarm the alarm quickly became a major problem as we realised conventional methods of disconnection were all too easily discovered and beaten by a determined thief. The hidden switch method became impractical as we realised the entry delay required was long enough for most thieves to find the switch and thus disarm the alarm, giving ▶





CIRCUIT OPERATION

The alarm is powered by the 12 V battery in your, car but is regulated down to 5 V by the 7805 voltage regulator, IC4. Capacitor C7 is present to provide high frequency stability. All external wiring is protected from RF interference by RC filtering.

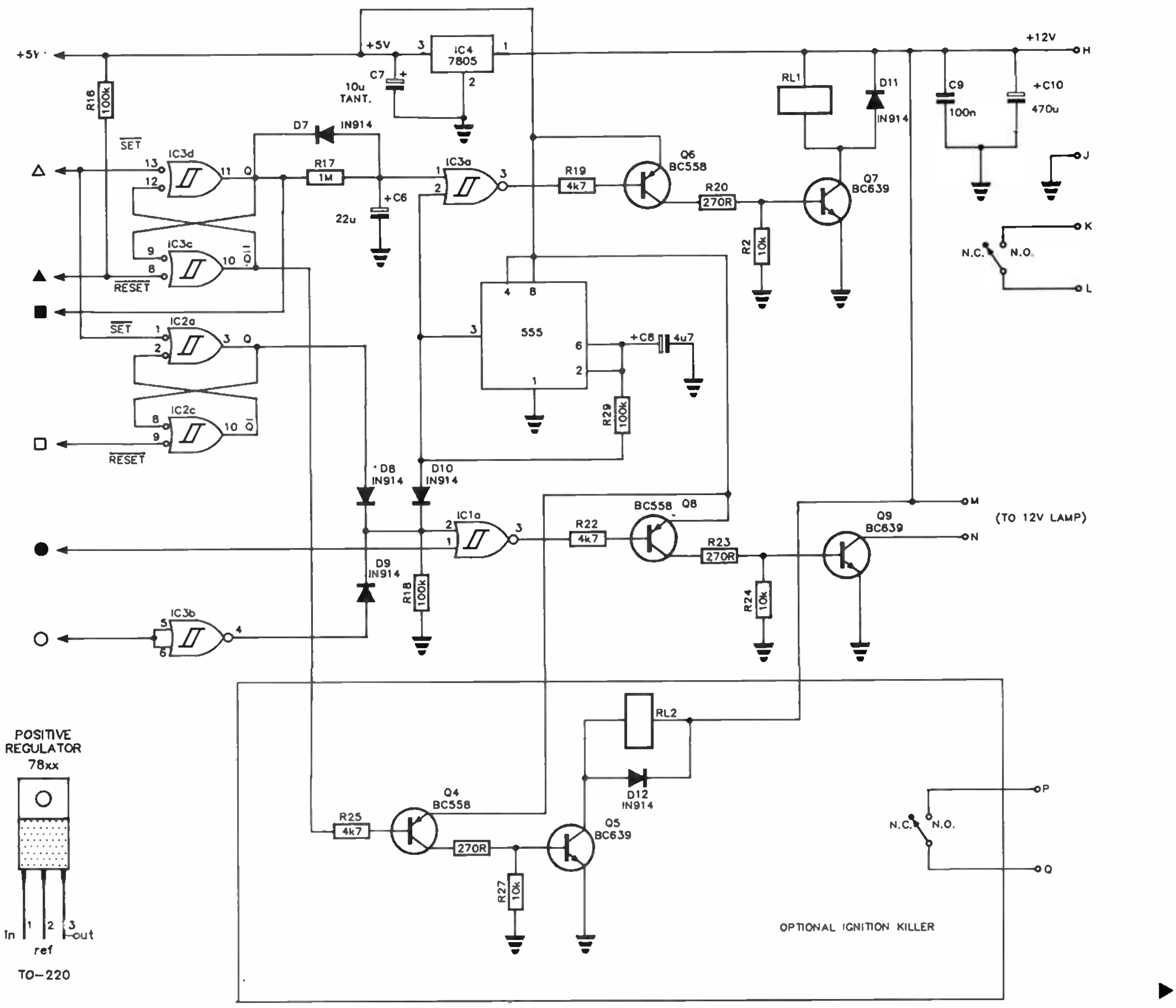
As mentioned in the main text, the circuit operates by sensing the voltage drop across the small but finite resistance of the battery's earth strap. The LM394 is a 'super-matched pair' of transistors which perform the function of detecting and amplifying the minute voltage drop induced across battery earth strap. The inclusion of the transistors in the same package helps to ensure that the two devices track each other very closely. This matching all but eliminates the chance of false triggering due to temperature variations.

While no current is drawn from the battery (save for that drawn by the alarm), the voltage difference between the collectors of Q1 and Q2 is small. Once a voltage drop appears across the earth strap however, a voltage difference appears between the bases of Q1 and Q2. The emitter of Q1 is pulled to a higher potential than the emitter of Q2.

This voltage difference is then amplified by the input stage and monitored by IC5, an LM311 comparator. The LM311's output will switch high if the voltage on its non-inverting input (+ve input) reaches a greater potential than its inverting input (-ve input). The bases of Q1 and Q2 are joined by a 2k preset which performs the function of a sensitivity adjustment. This operates by introducing a slight mismatch between Q1 and Q2 by unbalancing the drive to their bases. A voltage difference can be introduced in the opposite direction to that introduced by the triggering condition. Since this voltage offset must be overcome by the triggering input, it helps to ensure freedom from false triggering.

When the SET switch is pressed, C1 discharges via R2 which pulls pin 8 of IC1c low, thus setting the latch formed by IC1c and IC1b. Pin 10 of IC1c now goes high, which begins to charge C4 via R14. The time delay introduced by this RC network provides the exit delay. This time constant is calculated by the formula t = RC, which in this case allows approximately 30 seconds for you to exit the vehicle. During this time, the low present on pin 12 of IC2d will prevent the output of IC2d from going low.

After the exit time has elapsed, the voltage across C4 will have reached the Schmitt input level of IC2d and IC3b. Once this has occurred, the high on pin 12 of IC2d will enable the output of the voltage comparator to control the state of pin 11 of IC2d. A high on pin 7 of the voltage comparator will result in a low at pin 11 of IC2d, setting the 'alarm triggered' latch formed from IC3d and IC3c. A high on pins 5 and 6 of IC3b causes pin 4 to be taken low, which allows pin 2 of IC1a to be toggled high and low by the 555 timer (IC6). Prior to this (i.e: before the exit delay period has elapsed) a high will be present on the output of IC3b, which is coupled via diode D9 to pin 2 of IC1a. This prohibits this pin from being taken low by the output of the NE555 timer and hence prohibits flashing



of the alarm warning lamp. Once the exit delay period has elapsed, the alarm is armed.

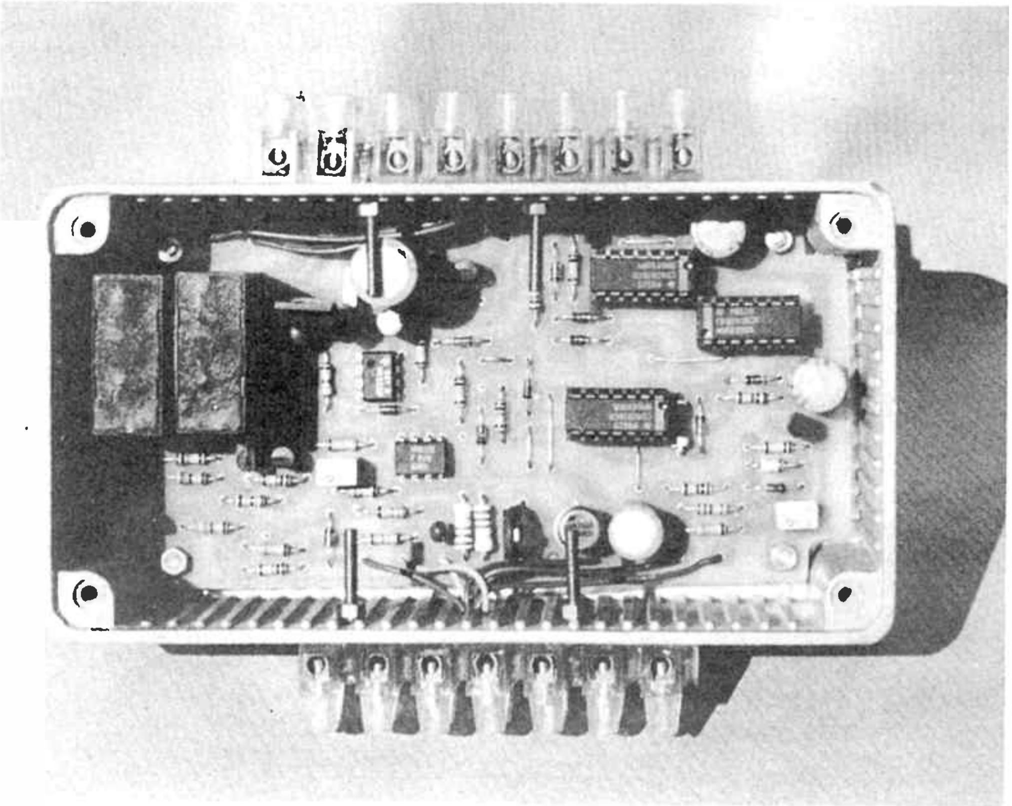
If the vehicle is tampered with and the alarm is triggered, the output of the LM311 will go high forcing pin 13 of IC2d high. This will switch pin 11 of IC3d high, charging C6 via R17 forming the time constant to give an entry delay, at the same time charging C5 via R15. This time constant provides the time for which the alarm will sound after triggering. Once C6 has charged, pin 1 of IC3a switches high enabling the output of the NE555 to determine the output state of IC3a, which in turn causes the horn relay to be activated. The relay is toggled on and off at the rate set by the frequency of oscillation of the NE555. The alarm will sound until the capacitor C5 is charged to a sufficient voltage to exceed the Schmitt input level of IC1d. When this occurs the output of IC1d is taken low which will have one of two possible effects depending upon the option selected. If the auto-reset option has been selected , as shown in the circuit diagram, the low at the output of IC1d resets the alarm-triggered latch formed by IC3d and IC3c. This in turn discharges capacitor C5 rapidly via diode D13, automatically re-arming the alarm. Note that if the triggering condition continues to exist after this occurs the alarm will be retriggered.

If the auto-disable option has been selected, on the other hand, the low at the output of IC1d resets the alarm-armed latch formed by IC1c and IC1d which disables the alarm completely.

The keyswitch anti-disarming circuitry has been designed to decrease the possibility of a potential thief disarming the alarm simply by shorting across the rear of the key-switch. This was achieved by developing circuitry which would sense the presence of the correct resistance before disarming. As the keyswitch is turned 12 Vdc is applied to the potential divider formed by resistors R28 and R4, which in turn applies approximately 4.3 V to point G. This charges C2 via R3, which was previously held discharged by R4. Once the capacitor charges, pins 5 and 6 of IC2b will exceed the Schmitt threshold of IC2b, the output of which is then taken low, disabling the alarm. If an attempt is made to short the contacts on the rear of the keyswitch together, a full 12 V will be applied to point G instead of 4.3 V. This voltage is then enough to switch on ZD1 and D2. This switches the transistor, Q3, on which prevents capacitor C2 from charging, hence preventing the alarm from being disabled.

The automatic ignition killer is operated at the instant the alarm is triggered. Once pin 11 of IC3d goes high, pin 10 of IC3c goes low turning Q4 and Q5 on, activating relay RL2. This relay can be used to disable the ignition, preventing the car from being started.

Gates IC2a and IC2c are used to form a latch, which becomes triggered, once the alarm is triggered but which remains triggered even after the alarm has been disabled. This latch is used to stop flashing of the alarm-armed warning lamp to provide an indication that the alarm has been triggered.



them all the time needed to steal the car. Finally, after much deliberation, we decided on the use of a keyswitch. Unfortunately, key switches have their own set of problems to overcome.

For a keyswitch to be practical it needs to be fairly accessible to the user. This means the potential thief only needs to pull the leads off the back of the switch and short them together to fool the system. This of course is completely unsatisfactory for an effective alarm. That is why the AEM8501 has been designed to disarm only when it sees the correct impedance. If the circuitry sees anything else it will not disarm but instead will trigger as though an 'incorrect' condition exists. A description of how to create such a keyswitch is set out in the construction section later in this article.

If the alarm is not disarmed in time the horn will begin to sound at the same rate the light is flashed. Another feature of the alarm is that, after a predetermined time dictated by the design, it will reset itself in one of two ways decided by the user.

The first option is one which resets the alarm to its original condition. In this case, the alarm will sound as long as the break-in condition prevails. The other option is to have the alarm switch itself off. How to implement the option you have chosen is described in the construction. Once triggered, the light will remain constantly on. For example, if a thief has opened the car door and has been deterred by the alarm, slammed the door and fled, the horn will sound for about six minutes, when the alarm will reset itself according to the option you have chosen. The light will remain on constantly to inform you of the vain attempt when you return to the vehicle.

The features already stated are enough for a perfectly good alarm. However, there still remains the stubborn thief who might attempt to drive the vehicle with the horn blaring. To prevent this, we decided to include as an option an automatic ignition killer. When the alarm is triggered by the intruder the ignition is instantly shorted out, not allowing the engine to start until the triggering condition is removed. If this option is not required, then some of the components will not be necessary. These are pointed out in the construction section.

Construction

Circuit-wise, the AEM8501 is relatively simple, but constructionally, the project isn't trivial. A highly dense printed circuit board, along with mounting the device in any vehicle, makes this project a challenge. Nevertheless, if you've had a moderate amount of construction experience, you'll find the results rewarding.

The process of construction should begin with a thorough check of the pc board. The board was designed with the aid of a computer program called Smartwork. When using this program the board is laid-out at twice its final size, which helps to increase the density of the components and tracks. This is then plotted onto Herculine film which is photographed to half original size (50%) using a bromide camera. A 50% reduction from the original has the effect of reducing the pads and the size and distance between the tracks. All of this, added to the fact that the project had to be made as compact as realistically possible so as to be mounted under the dashboard of the 'average' car, resulted in a board that is fairly dense and in some places becomes a little difficult to solder. It is because of this that we strongly recommend a thorough checking of the pc board before and after soldering to ensure that there are neither copper nor solder bridges present. As some of the tracks tend to be rather close, it is a good idea to use a magnifying glass of some description to ensure a thorough inspection. If available, we would recommend the use of a fine tip on your soldering iron to facilitate ease of soldering. — to page 123

▶

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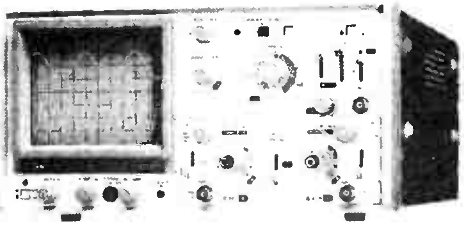

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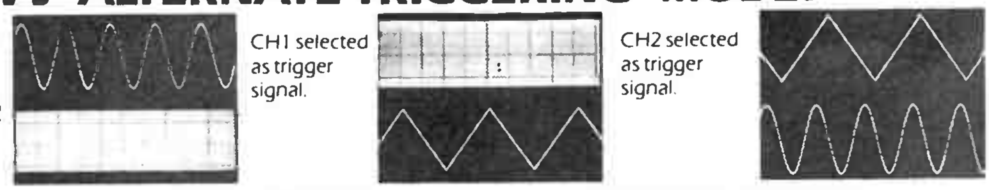

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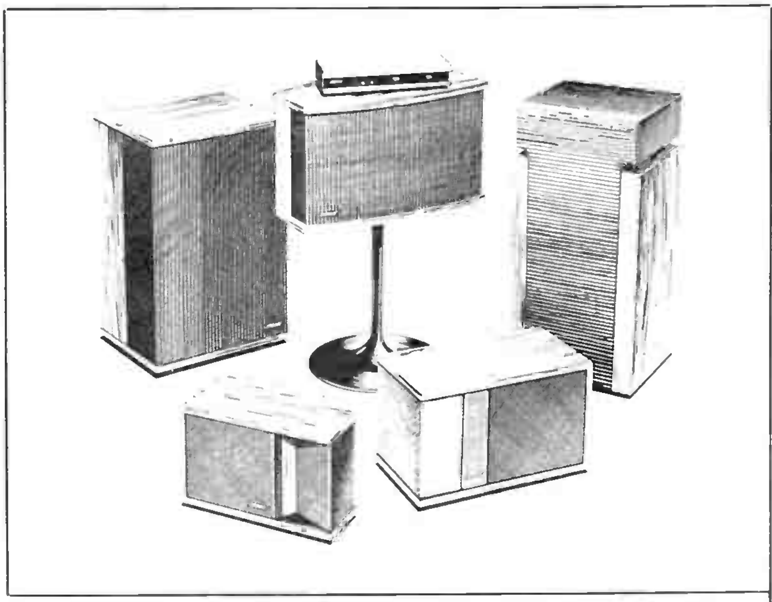

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An electric fence controller with variable output

Part 1

Graeme Teesdale

Most electric fence 'controllers' generate a high voltage pulse output of fixed amplitude of around 3-5 kV, although the actual amplitude depends on the fence 'load'. While the higher outputs are effective with larger animals, such as horses and cattle, lower outputs are better used for controlling access of smaller beasts to defined areas - like keeping dogs off your garden (or even snails, it has been suggested!).

SO-CALLED 'ELECTRIC' FENCES are widely employed for animal management in the agricultural industry. They are designed to keep animals either IN or OUT of a defined area. The fence itself is comprised of one or more wires supported by insulators attached to posts or stakes. (See Figure 1). The fence may be a permanent or temporary fixture. A 'controller' is attached between the wires and a 'ground' stake. The controller sends out short duration, high voltage pulses at intervals of a second or so. An animal making contact with the fence while standing on the ground will receive a short duration 'kick' from the fence, brought about by muscular contraction due to the electric pulse from the fence. This does not physically injure the animal, as do barbed-wire fences for example, but they learn not to contact the fence.

Australian Standard AS3129 covers the specifications required for electric fence controllers sold in Australia. When boiled down, AS3129 permits a peak output not exceeding 5000 volts when the controller is driving into a load impedance of one megohm and a suitable amount of capacitance to cause peak output. In addition, the output current into a 500 ohm load shall not exceed 300 milliamps for a duration of more than 300 microseconds (0.3 ms). The time period between the peak 300 mA and when it drops to 5 mA should not exceed 100 ms (0.1 s), while the minimum time interval between pulses should not be less than three-quarters of a second (0.75 s or 750 ms).

Design considerations

The principle of operation of electronic electric fence controllers is similar in many ways to a capacitive discharge ignition system. Both charge up a capacitor with a dc voltage in the region of 200 to 500 volts, then use an SCR as a switch to discharge the capacitor into the primary of a suitable output transformer. The general arrangement is shown in Figure 2.

In the past, I have seen electric fence designs that use a car ignition coil as an output transformer. However, whilst on the face of it this seems a good idea, a car ignition coil is unsatisfactory because the output impedance for the required mass power transfer is too high, resulting in poor pulse energy and an ineffective fence. In addition, the isolation specifications necessary do not meet AS3129 standards. The output transformer is probably the most critical component in the design.

For the sake of versatility, I decided to make this project battery-operated. However, it is easily converted to mains operation by using a suitable dc supply.

Most capacitive discharge ignition circuits employ a self-oscillating inverter. In this design it was abandoned in favour of an externally-driven ('oscillator-driver') type for the following advantages it offers:

(i) it reduces the complexity of the driver transformer.
(ii) the circuit's frequency determining components are external.
(iii) current drawn by power driver circuitry can be controlled by changing the mark-to-space ratio.

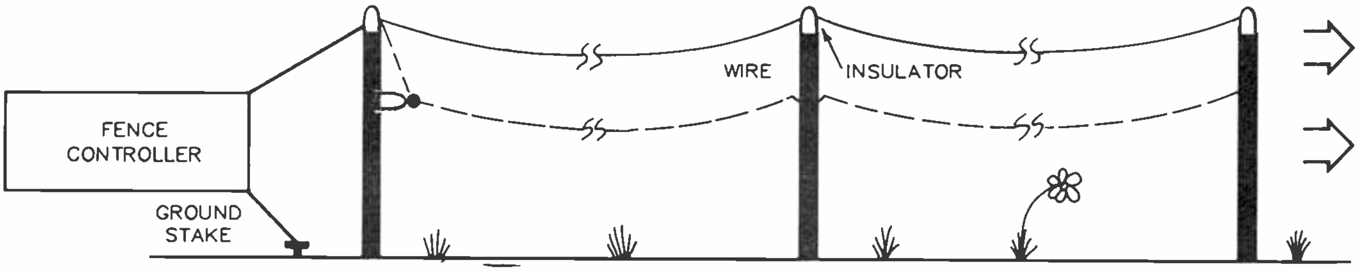


Figure 1. General arrangement of an electric fence. Several wires may be strung parallel to one another and connected together. Often, unenergised wires will be interspersed between the 'live' wires.

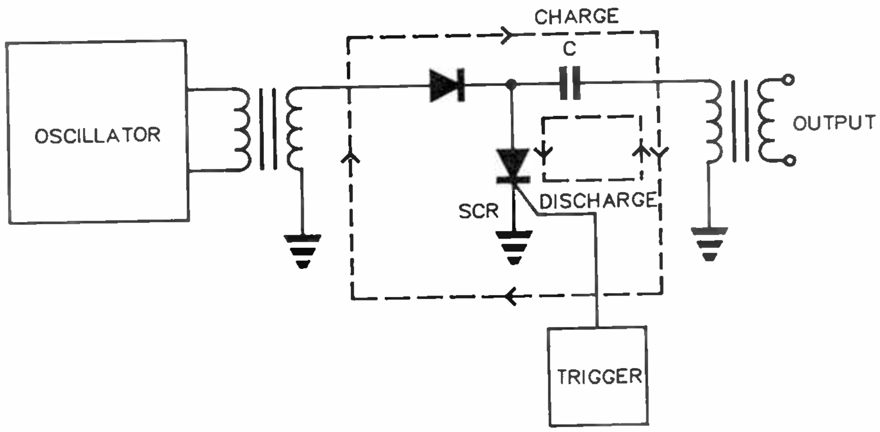


Figure 2. Electric fence controllers have much in common with capacitive discharge ignition systems. An oscillator is transformer coupled to a rectifier which charges capacitor C via the path indicated. The SCR acts as a switch when triggered, discharging C through the primary of the output transformer, supplying a high energy, high voltage pulse at the secondary.

The capacitor in a capacitive discharge ignition system is generally no greater than 1 μF, and is typically 0.5 μF. For electric fence controllers, where the pulse energy needs to be greater, the discharge capacitor can be as large as 100 μF!

With such a large capacitance on the output side of an inverter, it is doubtful whether a self-oscillating inverter would start oscillating! The design presented here has been tried with a total discharge capacitance (made up from several parallelled capacitors) of 25 μF without any evident problems.

Designing a controller to drive a pulse of energy into a long fence line is not quite as simple as it appears. The fence 'looks' very much like a transmission line, having distributed inductance and capacitance, plus series and parallel loss resistance. Figure 3 illustrates.

The loss resistance can be quite substantial as joints are normally made by twisting the galvanised steel fence wire ends together. In my experience, the more powerful electric fence controllers will weld together such joints with their high current pulses.

If a short occurs on the fence fairly close to the controller, the pulse energy sent out will be 'reflected' as the fence behaves as a transmission line, and large amplitude reflection pulses can occur at the controller terminals, sometimes inverted (i.e: with the opposite polarity to the pulses sent out). These pulses produce a damped oscillation output. To provide a good energy transfer, the output impedance of the controller must be low, hence the secondary of the controller's output transformer is generally wound of heavier wire and using fewer turns than would be found on an ignition transformer. The disadvantage here is that the transformer requires a high volts/turn ratio and this necessitates splitting the secondary winding into several sections and encapsulating it in a potting compound, or vacuum-impregnation, to eliminate the possibility of arcing between the windings, especially on open-circuit load (the worst-case condition).

The peak pulse output performance of the controller depends on the nature of the load placed on the output terminals. Like any transformer, the secondary load (in this case, the fence) is reflected into the primary, and this affects the peak discharge current and pulse period delivered by the discharge capacitor (C in Figure 2).

In theory, the mass energy, in joules, that the controller is capable of supplying, assuming no losses, is given by:

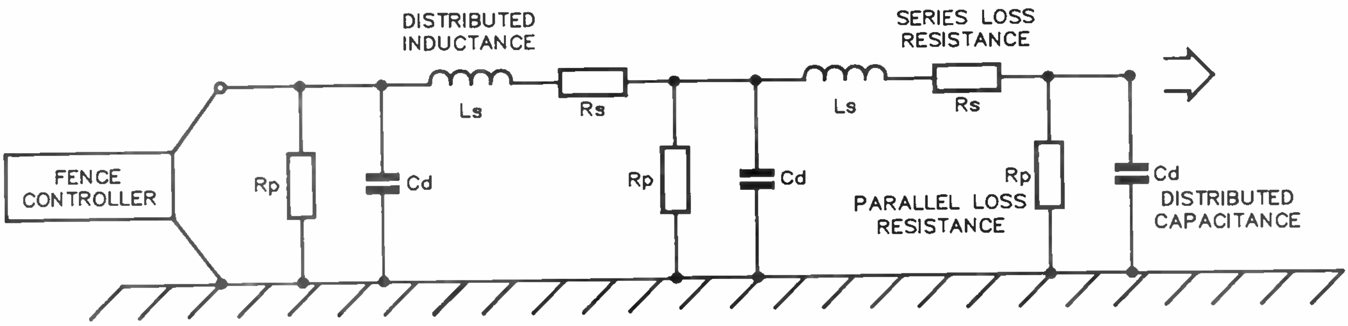
$$\text{Energy} = 0.5\ CV^2 \text{ joules}$$

A commonly available discharge capacitor suitable for this application is 6.5 μF/250 Vac. Its peak dc voltage capability is $250 \times \sqrt{2} = 350$ V (near enough). Thus, the energy a controller can deliver using this discharge capacitor is:

$$= 0.5 \times 6.5 \times 10^{-6} \times (350)^2$$
$$= 0.398, \text{ or about } 0.4 \text{ joules}$$

The peak discharge current delivered by the capacitor is fairly high, around 25 to 30 amps, and will be a maximum when the fence terminals are short circuited. The SCR used would need to have an I_{TSM} (maximum peak single cycle, non-repetitive surge current) greater than that and a di/dt (rate of change of current) of 30-40 amps/microsecond. I have specified a C122D for this project, which features an I_{TSM} of 80 amps and a di/dt of 40 A/μs. Other types may be employed, but they must have similar or better specifications. The circuitry has actually been arranged so that a wide variety of SCRs with widely differing gate sensitivities may be used. ▶

Figure 3. The fence 'looks' rather like a transmission line, with distributed inductance and capacitance plus series and parallel loss resistance. The loss resistance can be quite substantial — arising from joints in the fence wire, wet grass etc touching the wire.



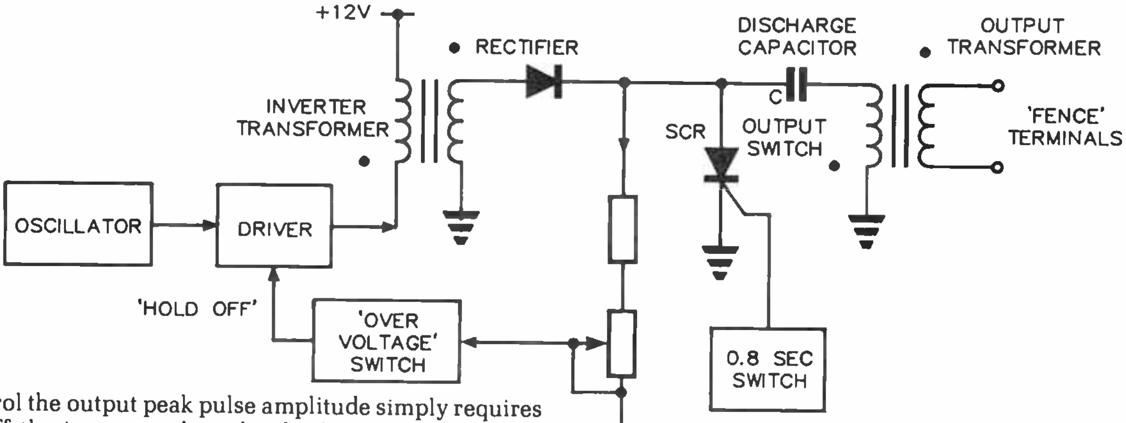


Figure 4. Block diagram of the fence AEM9502 controller project. The oscillator-driver inverter permits the use of a discharge capacitor of substantial value (up to 20 uF) to achieve high energy output. The 'overvoltage' switch arrangement provides for output voltage control. The secret of success lies in the output transformer which must have an output impedance of around 500 ohms.

To control the output peak pulse amplitude simply requires turning off the inverter when the discharge capacitor has been charged to a predetermined level.

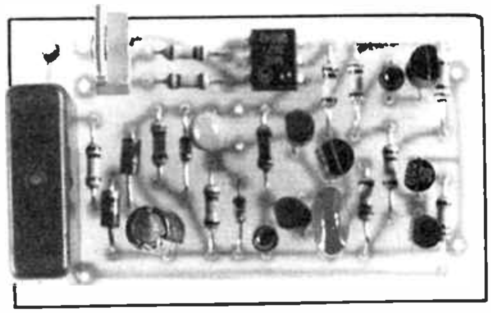
The final design

A block diagram of the final controller design is shown in Figure 4. As you can readily see, I have employed an oscillator-driver configuration for the reasons discussed earlier. A 0.8 second-period switch drives the SCR gate, pulsing it at the required intervals.

The rectifier output voltage is tapped off by a resistive divider and goes to the input of an 'overvoltage switch' circuit. This turns off the driver circuit when the rectifier output exceeds the predetermined input threshold of the overvoltage switch. A potentiometer in the divider allows setting the overvoltage switch's input level, and thus the point at which the driver is turned off.

Thus, the discharge capacitor can be charged to as high or as low a level as desired, within the control's range, permitting some amplitude variation of the output pulse. The actual amplitude will be determined largely by the fence 'load', but this scheme permits good control nonetheless, and you can set it to suit individual circumstances.

The "Lamp Saver"



Jonathan Scott

Incandescent lamps exhibit a characteristic that shortens their working life – a very low 'cold' resistance of the filament that permits very high in-rush current at turn-on, especially at or near the mains peak voltage. This 'slow-start' circuit "smooths the way", greatly lengthening the life of those expensive chandelier or spotlight lamps.

A NUMBER of Nobel prizes have come to wise men not because they saw new physical effects, but because they questioned them. Isaac Newtown was probably not the first to see an apple fall, but he pondered on the observation (so the story goes), and formulated the theory of gravity. This theory is involved in events as grand as the revolution of the planets, and as minor as your garbage bag ripping and spilling rubbish on the carpet. Similarly, this project was born out of a number of observations which together promoted some thought, and some research.

Firstly, I was annoyed at the rate that one of the chandeliers in my house was blowing (expensive) globes. This provided the stimulus, rather than the direction, for designing a circuit to counter the effect.

Secondly, the magazine *Choice* published a report on light globes, purporting to show that all globes lasted as long as manufacturers claim, and saying that all globes purchased functioned perfectly. It was clear that the study had not allowed for certain effects, such as cold starting and cycling of the globes, or mains voltage variations. Its results just did not tally with what I had been told by numerous friends concerning their experiences with light globes. Neither did it agree with my own experiences.

Thirdly, I had noticed speculation in various places as to the efficacy of turning globes on at the supply "zero-crossing" as a method of protecting light globes from failure. The idea is that most globes blow at the moment of switching on; when the power is first applied, the filament is cold and has a low resistance, and a lot of current flows. The sudden heating may be uneven in the filament. If one part gets hotter than the rest, the resistance in this part will increase, in turn increasing the dissipation there even further. This positive feedback effect can escalate, with the result that the filament vapourises in one part before another is even warm, rapidly destroying the globe. (This is the familiar "plink" sound which hails the demise of a globe at the instant of switching on). Some people would have us believe that if the mains is only applied as it crosses zero volts, the relatively gentle sinewave rise in voltage allows the filament to heat evenly, preserving the globe. There is no doubt that turning on the supply at a peak will aggravate the problem, but I am skeptical as to whether preventing it helps a lot.

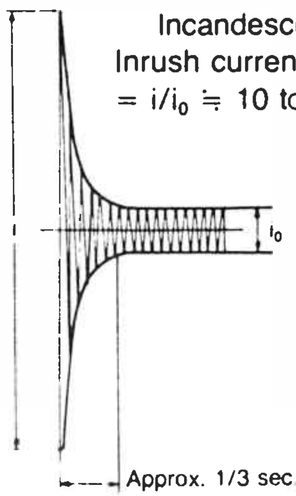
Lastly, I had noticed that an increasing number of traffic lights in Sydney appeared to be "moving slower". By this I mean that they changed from red to green, say, by dimming out the red lamp over a period of half a second or so, and simultaneously bringing up the green lamp over a similar period. I reasoned that this had to be deliberate.

The makers of traffic lights have a strong incentive to preserve their globes: the cost of sending an indian to change a globe in a traffic light is many times the cost of a slow acting dimmer switch (or "lamp saver", a name we coined for the gadget), quite apart from the danger involved in dead traffic lights. Thus, whatever they are doing is likely to have been checked out carefully. As more traffic lights slow-up, the more convince I became of the efficacy of the mechanism.

The above considerations taken together, it appeared time ▶

INCANDESCENT LAMP CHARACTERISTICS

The 'cold' resistance of an incandescent lamp's filament is around one-tenth to one-fifteenth that of its 'hot' resistance. When power is first applied, the current that flows is entirely determined by the lamp's cold resistance and the applied voltage. If you happen to turn the lamp on at or near the peak of the mains cycle, a 100 watt globe, for example, may draw as much as four amps or more! Typically, it takes around a third of a second for the current to fall to the globe's steady state running current.



Clearly, those first few mains cycles immediately after turn-on are important to the lamp filament's life expectancy. Even if you only turn on the current when the mains is crossing zero, the peak in-rush current will still reach high enough values to stress the filament, limiting its life.

that a decent lamp saver was designed and tested. The requirements as I saw them were:

1) The circuit must gradually increase power to the globe over a period of time, in the order of hundreds of milliseconds;

2) The circuit must be sufficiently low in cost that it can be installed for much less money than a light fitting, although it can cost several light globes. (The idea is that it saves the effort of buying globes and replacing them, as well as the inconvenience of sudden darkness, together with the cost of a few globes over its lifespan. It can thus cost more than a few years' supply of globes for one luminaire.)

3) The circuit must fit inside a light fitting or the plate carrying the lightswitch, so that it can be installed without demanding additional space or fittings.

4) The circuit should be designed to withstand globe failure and electrical faults, etc. In other words, the household or globe fuse* should be more likely to blow than the triac employed.

5) The circuit should contain no peculiar or rare components. *The AEM5508 fullfils all these goals.*

The Circuit Description covers the design and operation of the unit.

Construction

Before addressing the problem of assembly, three of the components deserve some comment to assist in selection of the component if you have not obtained it as part of a kit.

The first and foremost is the triac. It is of course possible to use a triac of low rating — a 2 A/400 V device should be able to handle a 500 W load. Whatever the ratings of voltage or current, the power dissipated will be minimal in all conceivable domestic situations. Such a device will probably not be able to survive a fault condition, however.

In a domestic installation with a "semi-enclosed rewirable fuse" (the porcelain 8 and 15 amp fuse holders common in Australia) a full fault current surge of up to 300 A or so will result when there is a bad short. This will typically blow the fuse in less than one cycle. A circuit breaker of the industrial sort may allow the fault to continue for several cycles. It is hard to estimate the currents that flow with a bad lamp failure (the plink noise indicates such a fault). A guess would give a typical peak current of up to 150 A, resulting in the fuse incorporated in the base of most globes vapourising in under one cycle, and possibly in under two milliseconds.

In order to survive such a fault, the triac must withstand about 150 A peak. Most triacs will handle a peak of about 10 times their maximum average rating. Thus you should select a device rated at something like 16 A. This is what I have recommended. If you are driving lamps of more than 100 W apiece, such as garden floods or the more exotic Italian lamps with quartz globes, use a device of at least 25 A continuous rating.

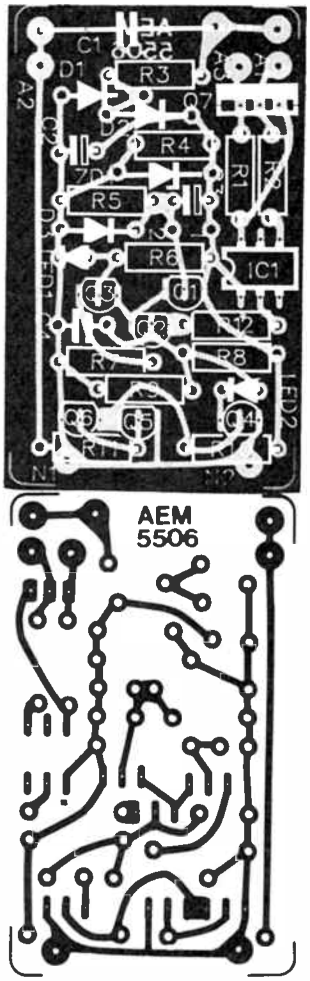
The second component is R5, which sets the speed of turn-on. For simple 25-100 W globes, the speed set by our value of 220k seems satisfactory. Pessimists and people with exotic globes are advised to use 470k, or even 1M, to slow the process right down, giving the lamp an extra chance to warm up at each use! As a rule of thumb, increase R5 with increasing triac rating.

Lastly, C1 should be mentioned. This is the single largest component in the whole circuit. It has been placed near the edge of the pc board so that it can be large, and overhang the edge if necessary. The value of 220n is the minimum value which can reliably used. If you have a suitable capacitor on hand, or wish to substitute another, these are the requirements: It must have a value of between 220n and 1 μF, and a voltage rating of at least 400 Vdc or 250 Vac.

Having collected all the components together, the assembly consists of simply following the overlay supplied. None of the components are particularly fragile. Only resistors and the two polyester capacitors can go in either way around. All the others have right and wrong orientations. While soldering the board, check for small bridges, hairline cracks or bad joints. Remember that there will be a lot of hassle getting at the board later.

There are three options for making the external connections. You can either leave the external connection pads blank and solder the wires to them as you install the circuit, or install small soldering posts onto which you can solder the wires later, removing the need to thread connections through the board, or attach wires now and merely connect these to terminal blocks at installation time. If you have terminal blocks where the board is going, we recommend the latter. The former methods save the cost and volume of screw termination blocks. ▶

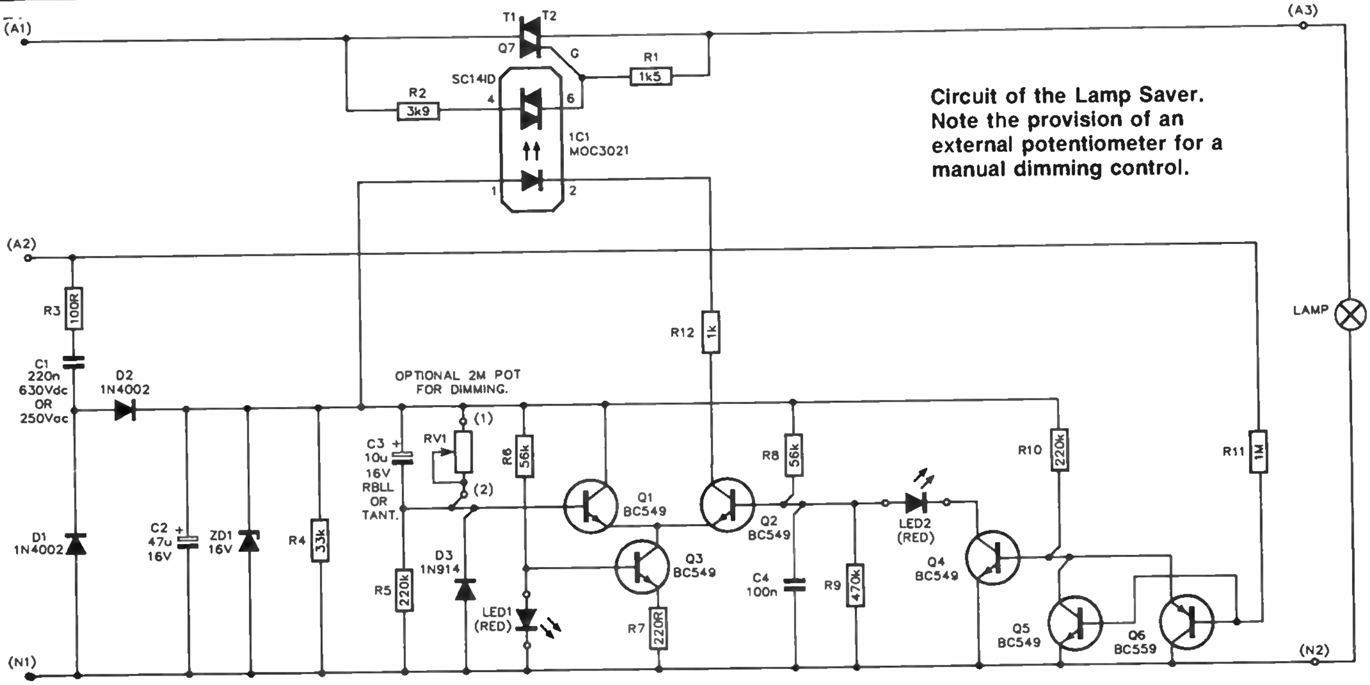
Common light globes have built in fuses. The thin wires connecting the filament supports to the metallic fitting or base are fuses. The idea is that if the filament shorts the support wires after a failure or the cold surge is extreme, large currents can flow. Since the globe will have to be replaced after this anyway, it is sensible to put the fuse that is to blow in the globe. There is no additional cost, since the wires must be there, and may as well be set to fuse at the correct level. All it costs is some care in design, and using heavier wires would only consume unnecessary metal!



AEM5506 PARTS LIST

Semiconductors	
D1, D2	1N4002
D3	1N914
LED1-2	3 mm red LED
IC1	MOC3021
Q1-Q5	BC549
Q6	BC559
Q7	SC141D, SC146D
Resistors	all 1/4W, 5%
R1	1k5
R2	3k9
R3	100R
R4	33k
R5	220k
R6	56k
R7	220R
R8	56k
R9	470k
R10	220k
R11	1M
R12	1k
RV1	2M pot. (optional)
Capacitors	
C1	220n/250 Vac
C2	47µ/16 V RB electro.
C3	10µ/16 V RBLL or tant.
C4	100n greencap
Miscellaneous	
AEM5506 pc board; mains rated hookup wire.	

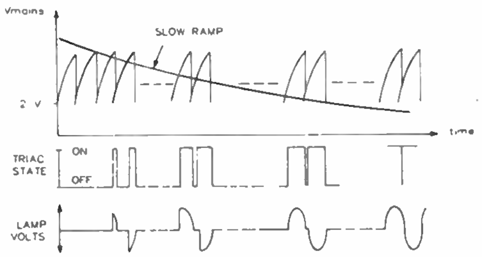
Estimated cost: $15-$20



Circuit of the Lamp Saver. Note the provision of an external potentiometer for a manual dimming control.

CIRCUIT DESCRIPTION

The circuit is rather intricate for something occupying a few square centimetres. It is more easily understood in electronic terms once its action is described in logical terms. The circuit basically develops two voltages. One is reset every time the mains crosses zero volts, and it rises in a (non-linear) ramp upward for the 10 milliseconds following each zero crossing. It starts from a couple of volts each time, and reaches about two thirds of the supply. The second voltage starts at the supply voltage (12 volts) and slowly drops toward zero. Each time the second, slower, falling ramp voltage is overtaken by the first, faster rising ramp, the triac is triggered.



Initially, the second ramp is above even the highest point of the fast ramp, so nothing happens. This time gives the electronics an opportunity to stabilise after the switch is turned on. After a while (tens to hundreds of milliseconds with the components we have used) the faster ramp will just reach the slower at the end of a half cycle of mains. Thus the triac will trigger for a short interval. This is the case depicted in the second quarter of the figure below. Gradually, the period of trigger in each cycle increases, as the overlap between ramps grows, and the globe(s) come slowly up to full brightness. When the slow ramp falls belows the lowest level of the fast one, the lamps reach the full-on condition.

Electronically, the circuit may be broken down as follows: R1, R2, IC1 and the triac form an eletrically isolated electronic switch, by which the other circuits may control the power. R3, C1, C2, D1, D2, ZD1 and R4 form a novel power supply which provides the 12 volts without the need for a transformer or large resistors. R6, LED1, R7 and Q1-3 form a small comparator which compares the ramps, and drives the switch IC. C3 and R5 develop the slow ramp. C4, R8 and R9 develop the fast ramp. LED2, Q4-6, and R10-11 form the zero crossing reset circuit which restarts the fast ramp with each half cycle. The resistor, R12, in the collector of Q2 is used to prevent oscillation, while D3 is used to quickly reset the circuit once the switch is opened, so that if it is reclosed after a moment, the circuit is ready to act correctly again.

The power supply is a charge-pump type. During the negative half cycles of the mains, C1 is charged up to almost –350 volts via D1. The charge on C1, Q, equals CV in this case, or about 75 μC (microcoloumbs). R3 is present to limit surges that might damage the diodes if the switch were to be closed mid-cycle. When the supply goes positive, C1 is charged the other way, to almost +350 volts, but this time via D2 and C2. This time, 75 μC of charge is placed on C1 the other way around. The total charge transferred is about 150 μC. The same charge is fed into C2, of course. Again noting that $Q = CV$, we see that about 3 V is accumulated on C2. Should this cause its voltage to exceed 12 volts, ZD1 clips off the extra, bypassing some of the charge fed to C2. Thus a low voltage supply is derived from the mains with very little loss of energy, since capacitors do not waste any energy at all. R4 serves only to discharge the capacitors after the supply is turned off, resetting the circuit.

The slow ramp is developed as C3 charges via R5 and the base of Q1. Thus C3 and R5 set the speed with which the circuit acts. Increasing R5 up to 1M will cause a more 'slothful' action.

Transistors Q1-3 are a small comparator amplifier. R6-7, Q3 and the LED form a current source, while Q1 and Q2 switch the current alternately via IC1 to trip the triac, or directly to the supply. The two ramp voltages appear on the bases of Q1 and Q2.

When IC1 is fed current by Q2 (that is, when $V_{Q2b} > V_{Q1b}$) it fires the triac. IC1 is an optically isolated triac driver designed for this special purpose.

The fast tramp is developed on C4. When the mains voltage is near zero, neither Q5 nor Q6 is turned on, and thus R10 biases Q4 on. Q4 discharges C4 via LED2. The LED ensures that the capacitor is only discharged to about 1.8 volts, so that when the slow ramp falls below this level, the triac is continually driven. When the mains is positive, Q5 is turned on, and Q4 off. When the mains is negative, Q6 is turned on and Q4 off. Thus the fast ramp is reset to just below 2 V at each zero crossing, synchronising the circuit.

As the triac spends most of its working life solidly conducting, no "snubbing" or RF suppression components have been fitted. These would greatly increase cost and size of the unit. Provision is made for the circuit to have an external pot for dimming the lights manually, but the action is not smooth and low dimming levels not stable in a lot of cases. Because the function of the circut is not primarily that of a dimmer, the cost of "cleaning" up the action in terms of additional components is not seen as worthwhile.

Installation

The AEM5506 board is designed to be installed behind the plate carrying the lightswitch itself. The circuit is designed to have a connection to the unswitched active of the house wiring, as well as the active interrupted by the switch. It requires a connection to neutral, and to the luminaire. (A luminaire is any light fitting with one or more lamps mounted in it!) It is not necessary for it to be connected to the neutral wire leading to the luminaire, though provision is made for both house neutral and luminaire neutral to be terminated at the board.

It can operate with only the switched active connection; that is, it is not vitally necessary to have a connection to the unswitched active for operation. Thus, there are four ways that it can be wired up. These are depicted in Figures 1 to 4, which are discussed later on. The method you use will probably be determined by just what cables are accessible behind the switch plate. In other words, the method of wiring will be determined by how your house is wired up.

There is a problem with any triac-based circuit, however, which makes the unswitched active connection desirable. Triacs and SCRs suffer from the problem that a rapidly applied voltage will cause triggering without any external gate signal having been applied. (This is caused by exceeding the "dV/dt" rating of the device. The limitation arises from unavoidable junction capacitances within the silicon of the device.)

If the active connection is suddenly applied to the circuit, and the mains is part way through a cycle at that instant, the triac will trigger and conduct for the remainder of that half cycle. This may cause a brief glow in the lamps at the instant of turning on, if the whole circuit is wired to the switched active, instead of having a permanent active connection. No globes that we have investigated fail with the energy delivered in one half cycle, so we believe that the effect is purely of nuisance value, and will not compromise the preservative effects of the circuit.

It is interesting to contemplate the effects of this dV/dt limitation on any circuit which uses the simple zero-crossing powerup idea mentioned previously. If there are no snubber components (an RLC arrangement around the triac) the triac will almost certainly trigger at the instant that the voltage is applied to it. If there was no continuous active connection separate from the switched one, this would *completely cancel* the good effects (if any) which might otherwise have been produced! Since snubber components consist of a relatively sizeable capacitance, resistance and inductance, the cost and size considerations often mean that they are left out. Beware any such circuit!

So, to installation. You may elect to have it installed by a professional, or do it yourself. (Some states forbid the latter). Decide where you are going to place the board. It it is within any metal structure, such as a light fitting, the board will need to be insulated from the metalwork. (The metal will, or normally should be, grounded.) The best method is perhaps to use paper. Paper is a good insulator, and contrary to instinct, is difficult to ignite by simple heat; it will resist burning to over 230 degrees Celsius, before which most light fittings will burn or melt themselves. Most capacitors were once made with paper as the insulator. If you wish to use paper, fold it until it is thick enough to prevent the sharp wire ends punching through, and, after connecting the board, wrap it neatly.

Once the position is decided, identify the wires present in the enclosure. Determine if unswitched active is available, as well as the switched active, and also determine whether

WIRING POSSIBILITIES

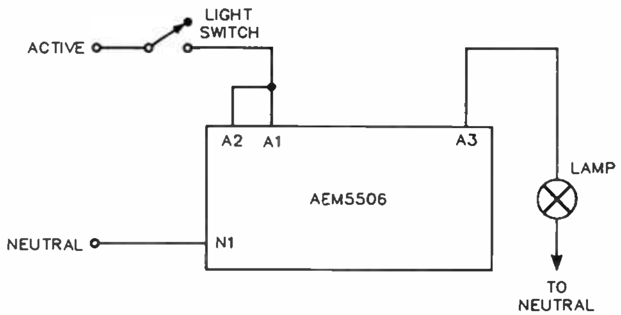


Figure 1. Switched active only, neutral termination available.

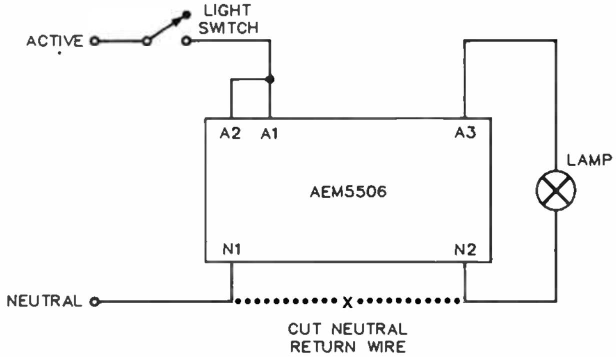


Figure 2. Only switched active, only neutral return wire.

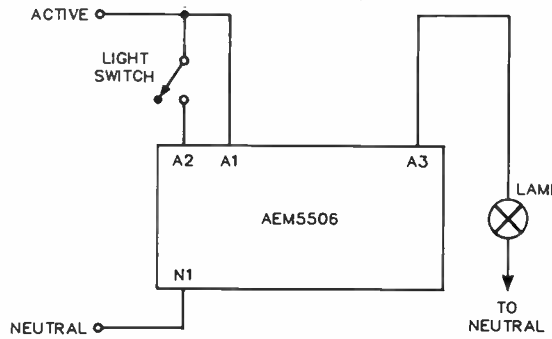


Figure 3. Unswitched active, neutral termination.

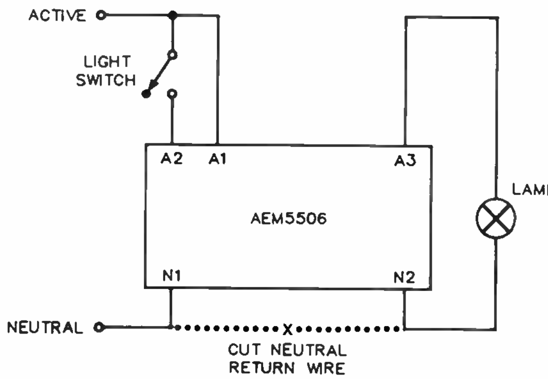


Figure 4. Unswitched active, only neutral return.

it will be necessary to cut a neutral wire to make connection to it, or if there is any neutral connection nearby. With these two pieces of information, select the appropriate wiring connection from the choices in Figures 1-4.

Before touching any wires, turn on the light. Now remove the house fuse. Check that the light has gone out. Turn off ▶

— to page 126

Assembling the AEM6103 3-way Vifa Loudspeakers

Having eagerly unpacked everything — where to start?

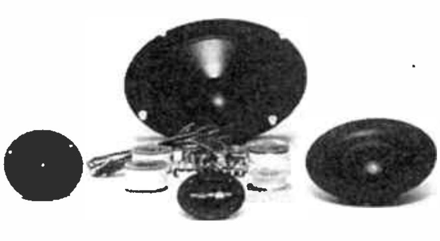
Such has been the popularity of the AEM6103 loudspeakers since the design and construction was first published in January '86, that we've received continuous requests for a blow-by-blow 'handyman' style description for assembling the kit produced by Scan Audio. Here it is, presented with the kind photographic and manual assistance of Gunther Boeckenhauer – now there's no reason not to treat yourself to a pair of these fine speakers!

ASSEMBLING a pair of these loudspeakers is a pleasure as the kit is very well made and fairly easy to assemble. The only tools needed to assemble the kit were a Phillips-head screwdriver, a small hammer, a trimming knife (or a good pair of scissors), a half-round file and a hand or power drill. You will need a few pieces of scrap wood or masonite to aid assembly. In addition, you'll need to have on hand, or purchase, the following:

a tube of Liquid Nails or Silastic
a can of adhesive spray glue
a can of black spray paint
one roll of 50 mm wide PVC sticky tape
one 250 ml bottle of PVA wood glue
one roll of 137 cm wide by 180 cm long, 25 mm thick high density foam (from Clark Rubber)

To buy all of this may cost in the vicinity of $45.

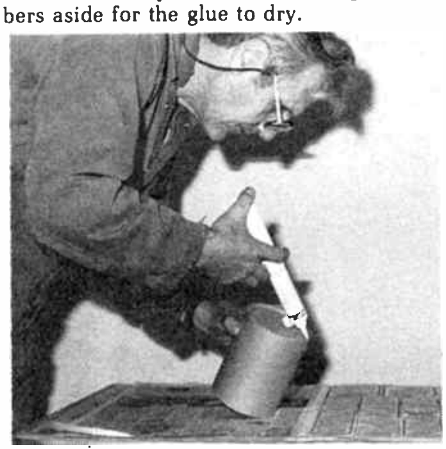
The first thing to do is unpack your hardware kit, drivers and crossovers. Take care here, because it's possible to damage the veneer on the hardware kit. Also take care with the drive units, particularly the midrange and tweeter units, the domes of which are susceptible to damage. Sort out and identify the various components.



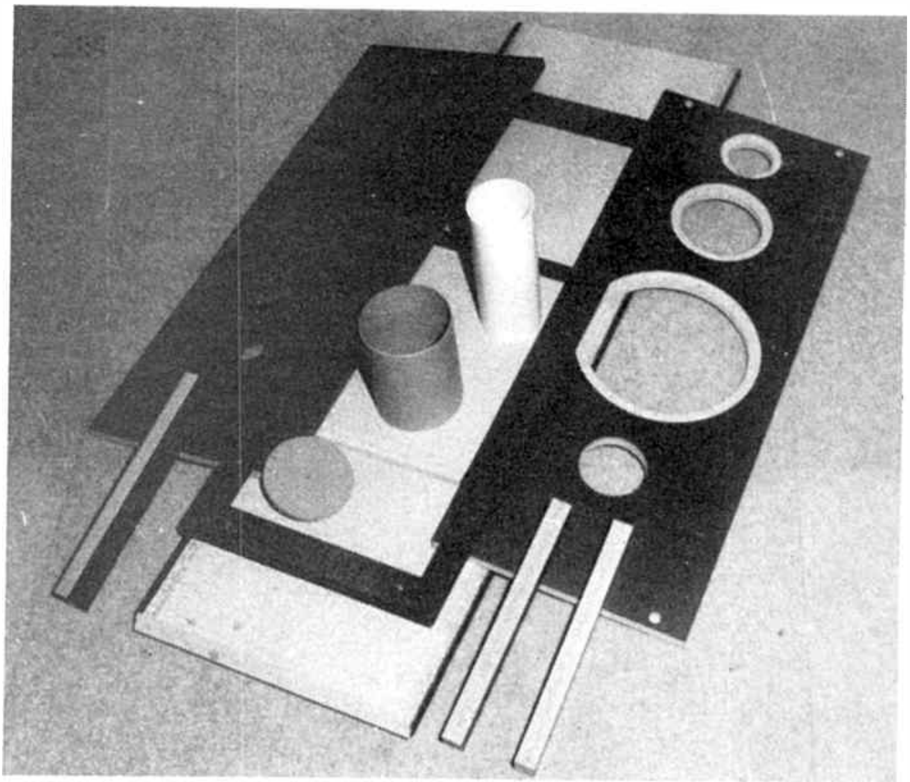
The drivers and crossover, with the spring connector terminals in front.

You will need somewhere clear to work, a table or workbench, where you can spread things out. Cover it in newspaper or painting drop cloth to protect both your work area and the cabinet components.

Start with the two cardboard mid-range chamber tubes and their end caps. Insert the end caps edge-on, then turn them over and push them to within 40 mm of one end. Take your liquid nails and put a sealing bead of it around the inside of the tube about 30 mm in from the end (about 10 mm from the end cap). When this has been placed evenly around the tube, place a small piece of scrap masonite, slightly smaller than the inside diameter of the tube, on your workbench. Upend the tube (glue end down) and press the end cap down until it seats abainst the masonite. This should provide a perfect end seal. Turn it over and inspect it. Use a spatula to spread the glue, if necessary. It is extremely important that the seal be tight so that there are no leaks in the mid-range chamber. When finished, put the two mid-range chambers aside for the glue to dry.

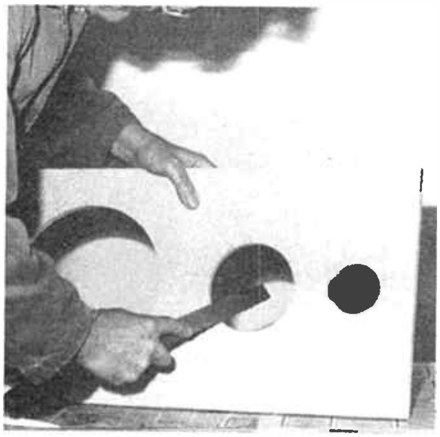


Apply liquid nails to the end of the mid-range chamber.



The cabinet components.

Spray the bass reflex port tubes black inside.



Chamfer the mid-range hole on the inside to make fitting the mid-range chamber easier.

Now take the two bass reflex port tubes. These are cut from plastic 'plumbing'. Spray them black inside and put them aside to dry.

Take the front baffle from the cabinet kit, turn upside down (that is, inside facing up) and chamfer the mid-range hole (the middle one of the drivers) where the mid-range chamber is to be fitted. This makes it easier to insert the mid-range chamber from the rear later on, and helps provide a proper seal when glue is applied.

Now take the two long pieces of veneered chipboard. These make the cabinet sides, top and bottom. Place newspaper or a drop cloth on the floor and unfold the veneered chipboard, placing the veneer down. Take your rear panels and have them ready for gluing. Keep handy the roll of 50 mm wide PVC sticky tape.

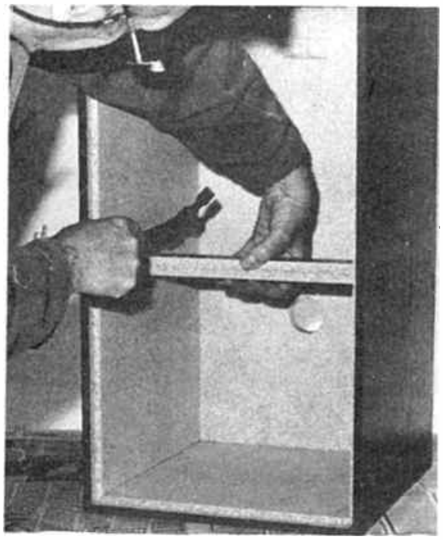
Run a bead of white PVA glue in the rear panel groove, the whole length of the veneered pieces. Position the rear panel with the long side down in the groove where you've just run the glue. Make sure the black side is facing outwards and that the hole for the spring connector terminal is toward the short end of the veneered panel pieces (this short end makes the cabinet bottom). Run a small bead of glue in each corner groove, save for the last one at the short end. Don't put too much glue in here as it may cause the veneer to break when you fold the cabinet together.

Now fold the cabinet around the rear panel. When bringing the last piece over (that's the short end, which becomes the bottom), hold it up at 45 degrees and run glue in the last V groove. Run a smear of PVA glue along the edges that meet up forming the last corner. You may use strips of the 50 mm PVC tape to hold the last corner or, better still, a few 25 × 1.25 mm bullethead panel pins. Having secured the last corner, turn the cabinet on its back and leave it to dry for a while. Check for excess PVA glue along all joints and remove it with a damp sponge.

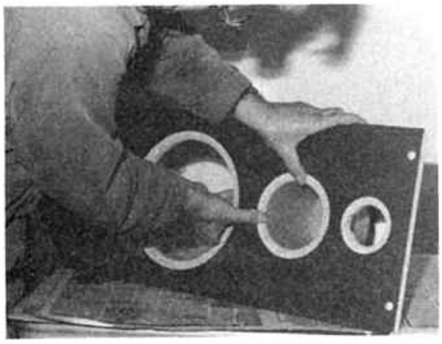
Hammer panel pins in the last corner to hold the cabinet together until dry.

The bracing between the side panels of the cabinet is tackled next. They are best 'skew-nailed' and glued. First drill pilot holes at an angle in the side and through the end, on each end. Smear glue on the ends, then nail the bracing in place, taking care that the nails do not penetrate the outside face of the cabinet. Position the bracing as shown in the drawings with the original article (copies are enclosed in the kit). Note that the upper bracing has to be positioned closer to the rear panel so that the mid-range chamber tube does not interfere with the bracing.

Drill holes in the bracing for skew-nailing.

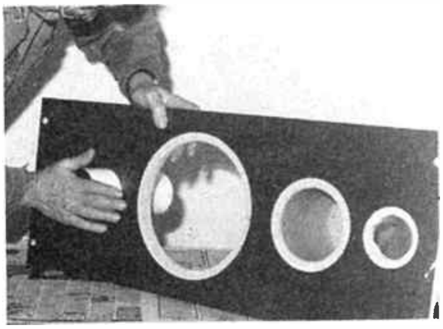


Skew-nail and glue the bracing in position.



Ensure that the mid-range chamber does not protrude too far through the front panel.

Apply PVA glue around the outside of the mid-range chamber, right on the inside surface of the front panel, to effectively seal the joint.



Push the bass reflex port, chamfered end first (!), into the front panel hole.

Apply a seal of Liquid Nails to the bass reflex port tube, around the outside of the tube and flush with the inside surface of the front panel.

At this stage, the cabinet assembly and mid-range chambers should be left to dry thoroughly overnight.

Now you can glue the mid-range chambers into each front panel. First push the tube into place from the rear side, then turn the panel up to see that it is not pressed too far through and adjust it if necessary. Turn the front panel face down again and run a bead of PVA glue around the outside of the chamber where it meets the panel. This should form a tight seal.

Take the bass reflex port tube and chamfer the outside of one end at an angle of about 45 degrees. This makes it easier to press it into the hole in the front panel. Now press the port into the front panel (chamfered end first!) from the front. Take care not to damage the front surface of the front panel. Carefully hammer the port into place with a piece of scrap wood as a 'buffer'. See that it finally sits flush with the surface of the front panel.

If your port tubes are an easy push-fit, push them through a little further, then put a bead of Liquid Nails around the outside of the tube flush with the inside of the panel, then push the tube back until it's flush at the front. This should effectively seal it. It's a good idea to seal the port tube anyway.

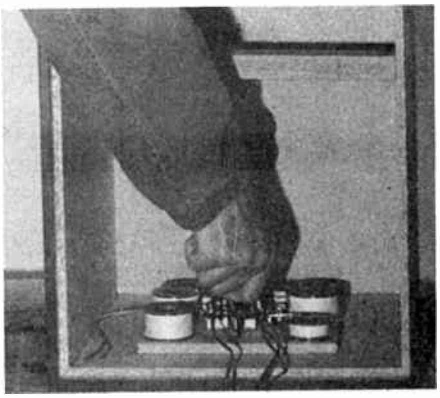
Take the front panel and one of the longer braces and position the front panel in the cabinet. Now determine where to glue. Position the bracing so that it fits just between the bass driver and the mid-range chamber. Mark up on the bottom of the cabinet where the bracing is going and remove the front panel and bracing again.

Turn the speaker around and mount the spring terminal connector on the rear panel. Then mount the crossover network on the bottom panel of the cabinet. Connect the two blue leads from the crossover to the terminals, making sure that the blue lead with the white stripe is connected to the positive (red) spring terminal.

Lining the box comes next. You will need six pieces of 25 mm foam, 325 × 885 mm for back and sides of the boxes, four pieces 325 × 280 mm for top and bottom, plus a few scraps for the mid-range chamber. don't forget to cut holes in the back pieces for the bracing and leads to the spring terminal connector. Place the foam on the inside faces of the cabinet. If necessary, glue it in with adhesive spray or some strips of Liquid Nails.

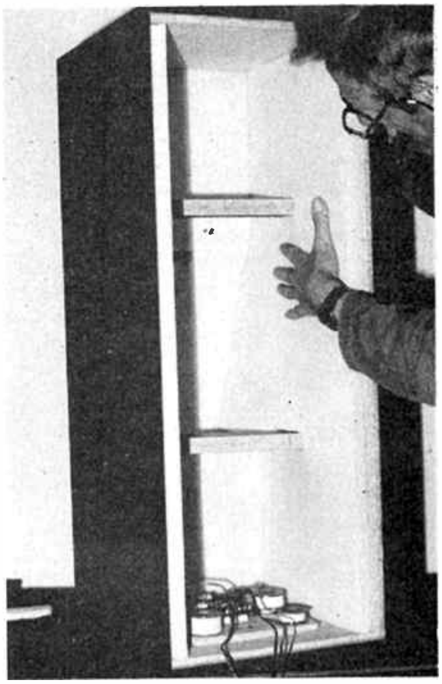
It is now time to place the front panel in the cabinet. Before doing so, glue in the bracing from the rear to the front panel. Place PVA glue on the recess around the front edge of the cabinet and place the front panel in it. Make sure that the bass reflex port is facing the spring terminals. You should now check and see if the side panels have firm, tight seals from the middle of the speaker towards the front panel. If the sides can be pressed in further, place some 50 mm wide sticky tape across the front panel to press the side of the speaker cabinet closer towards each other and leave it until dry. This would normally take four to six hours.

The speaker is now ready to be fitted with the drivers. First, carefully place each driver in position and mark the position of the screw holes. Then take them out and drill pilot holes to the root diameter of the screws supplied.

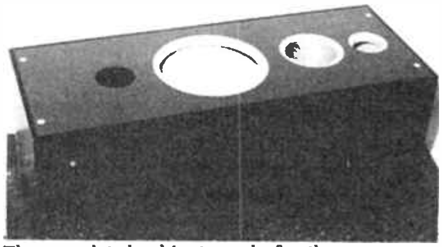


Mount the crossover network on the bottom of the cabinet. Simply glue it in place with PVA glue. Hold it down with panel pins or short screws if you like.

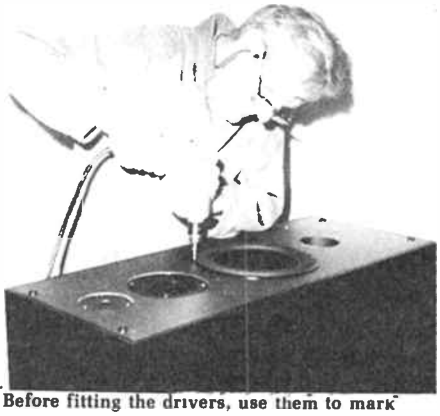
Cut the high density foam to size before lining the cabinet with it. Don't forget the strategic holes in the rear pieces to allow for bracing and wires to the rear spring terminal connector.



The foam is fitted in the cabinet, held in place with glue.



The completed cabinet, ready for the drivers to be fitted.



Before fitting the drivers, use them to mark the screw hole positions then drill pilot holes the root diameter of the screws to be used.

The drive units are sealed and set flush with the front panel by making gaskets from 12 mm wide Body Moulding Tape. Take care when mounting the tweeter and mid-range.

The woofer is fitted last of all.

Connect the drivers with the leads from the crossovers. The black leads go to the bass driver. Make sure you connect the lead with the red stripe to positive or red terminal on the bass driver.

When you connect the mid-range take the brown leads and place them through the hole in the mid-range chamber. After doing so, seal the hole carefully with silastic or Liquid Nails. Line the mid-range chamber inside with the foam scraps and connect the leads to the drives. Observe that the brown lead with the white stripe is connected to the positive terminal. You'll find + and – is marked on the white connecting strip on the mid-range driver.

When connecting the black and red lead to the tweeter, put the red lead to the positive terminal marked on the white strip on the tweeter.

If any of the holes for the drivers are rebated too deep, simply place a rubber strip or similar material such as a gasket underneath each driver before screwing them into the cabinet so that the front of the driver is flush with the front.

For gaskets, we used 12 mm wide Body Moulding Tape which is readily available from hardware stores.

The speaker is now almost complete with the exception of placing the grille cloth onto the frame. do this by placing the grille cloth on newspapers. Place the grille frame on top of the grille cloth, then take a can of adhesive spray glue and spray the frame and that part of the grille cloth that sticks out of the frame. After drying for 30 seconds you can now stretch the grille cloth over the frame. Start with one corner and go to the opposite corner for best stretch and do likewise to the other two corners. Thereafter, work right through on the sides and the ends of the panels. When the grille cloth is stretched right over, cut the excess grille cloth on the inside of the frame with a sharp knife.

Now take the grille fasteners and hammer the male fasteners into the grille frame. this is easily done by placing a female grille clip over the male and hammering the male clips into the frame. When this is done, remove the female clip and go to the next hole in the grille frame. When all the male grille clips are mounted you can hammer the female clips into the holes on the front panel of the cabinet.

Finish off by placing the Vifa badges onto the top corners of the grille frames. Your AEM6013 speakers are now ready to be used.

Before connecting the speaker to the amplifier it would be wise to test the polarity of the speaker. Take a 1.5 volt battery and momentarily connect the positive end of the battery to the red terminal on the rear speaker and the negative to the black terminal. You will hear a loud thump in the speaker. Check that the diaphragm on the woofer moves out. If it does the speaker is phased correctly.

When both speakers are checked you can now connect it to your amplifier and you will be able to enjoy a most outstanding sound quality from your new Vifa AEM6103 loudspeakers. We wish you many hours of enjoyable listening.

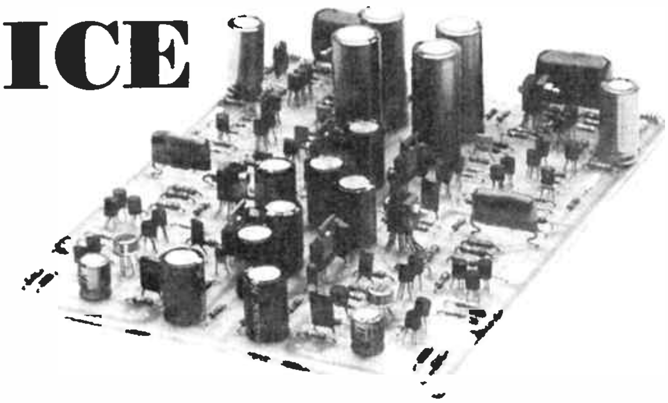
Place the frame on top of the grille cloth and spray part of the frame and the part of the grille cloth that sticks out past the frame with spray adhesive.

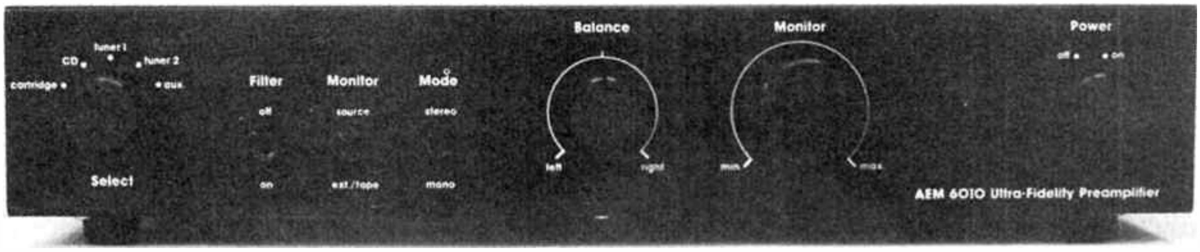
Stretch the grille cloth over the frame after the spray adhesive has dried for 30 seconds.

Hammer the male fasteners into the grille frame, then hammer the female fasteners into the front panel of the cabinet.

The finished product, a pair of Vifa AEM6103s. Your pride and joy!

AEM KIT CONSTRUCTION SERVICE





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IBM to bring on their 'clone-crusher'

International Business Machines Corporation (IBM) is widely expected to take the offensive against low-cost imitations of its own personal computer by introducing a "clone crusher" which will be cheaper and harder to copy than existing models.

"If they want to have it out by the Christmas season, and I'm sure they do, then they have to bring it out very soon and certainly no later than October," said Norman DeWitt, president of the market research firm Dataquest Inc.

IBM will not comment on unannounced products. However, that has not stopped many of the consultants and analysts who make their living by scrutinising every move of the world's largest computer company from making some detailed predictions about any new computer that may emerge.

They have even given it the traditional preannouncement codename — PC/ET, for extended technology.

Clones, or IBM-compatibles, are personal computers which are built around the same standards as IBM's machine and use the same software. In the five years since IBM announced its first personal computer, clones have managed to capture some 60 per cent of the IBM-compatible market (IBM has the other 40 per cent) by offering sharp discounts for IBM's list price.

IBM's reaction to the clone invasion has been to cut its own prices — the most recent roound, in mid-August, was a 16 to 22 per cent reduction on its low end models, so that a computer with 256K of memory now costs US$1595.

But clone prices are still lower. The popular Leading Edge Model D, made by south Korea's Daewoo, costs US$1400, including 512K of ram, a modem and some software programs.

And the lowest price yet has been announced by the Hyundai Group, also Korean, which will start mass marketing a 512K clone, the Blue Chip, for only US$699 this month.

Because IBM is not one to take a threat to its market share lying down, and because the company has already taken some large price cuts, industry observers said its most likely next move will be to announce a new computer, and possibly some new standards.

Most analysts said they expect the ET to be based on the Intel 8086 microprocessor and be targetted at the home and educational market. Price estimates range from a low of US$600 to a high of US$1400 dollars.

Andrew Seybold, publisher of the Seybold Report on Professionnal Computing, said IBM will use the ET to break the 1000 dollar barrier, a price level is has not been at since it discontinued the PCjr home model.

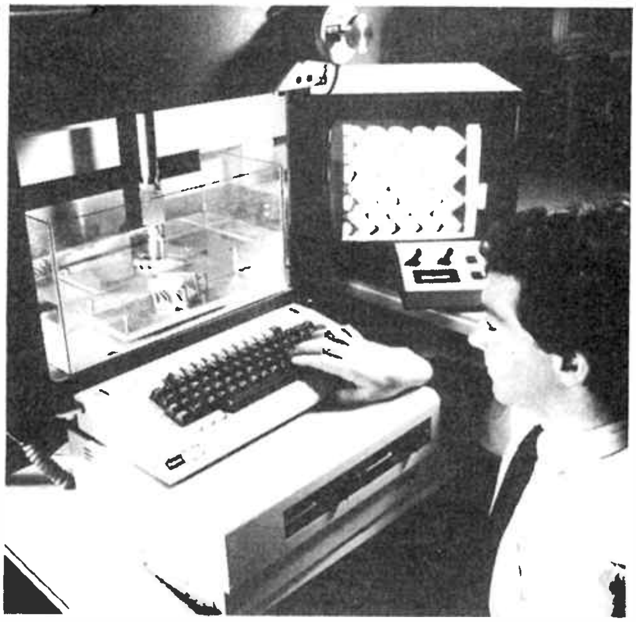
"I think that within IBM 995 dollars has been identified as the target price," Seybold said.

Not all analysts envision a "clone-crusher" from IBM, however. Some think instead that IBM will come out with a new version of its high-end PC-AT, based on the Intel 80286 chip, priced below 3,000 dollars. This would be the long awaited PC-2 computer, which IBM aaid last summer did not exist.

Some analysts still expect further price cuts from IBM as well, probably around the christmas season. But further price cuts could also bring IBM into an area it says it wants to avoid — commodity pricing, like flour or sugar, where brand name carries little weight.

"I do not think IBM wants to get out of the PC market," said Dataquest's DeWitt but added "I think they will do everything they can to keep it from becoming a commodity, by differentiating their product."

Most consultants agreed that IBM can afford to keep its prices 300 dollars to 400 dollars above the clones, because there are still a lot of users who would be willing to pay extra for the well-respected IBM label on the box.



SOUNDING OUT DEFECTS

This scanning acoustic microscope system inspects compressor blades in gas-turbine engines for flaws, ceramics for defects and even lesions in the skin to detect cancerous growths.

Designed and developed primarily for the inspection of engineering ceramics in which the presence of flaws a fraction of a millimetre across can be catastrophic, the microscope has been further developed to carry out many other tasks. These include the bonding between silicon chips and their heat-sinks — obviating relatively expensive and time consuming 'burn-in' processes — and surface profile measurements where the device has been used by the Rutherford and Appleton Laboratories for checking the uranium targets used in high-energy physics experiments.

Based on an 8-bit microcomputer and display with disk storage, colour monitor and printer, the microscope has magnification to ×100 with resolution in colour as fine as 7.5 microns and it will accept specimens up to 300 millimetres square.

The Fulmer Research Institute, designed and developed the microscope. It is an independent contract research, design and development organisation mainly concerned with the science and technology of engineering materials, processes for their manufacture and products and components making the optimum use of material properties. The Institute is based in Slough, UK.

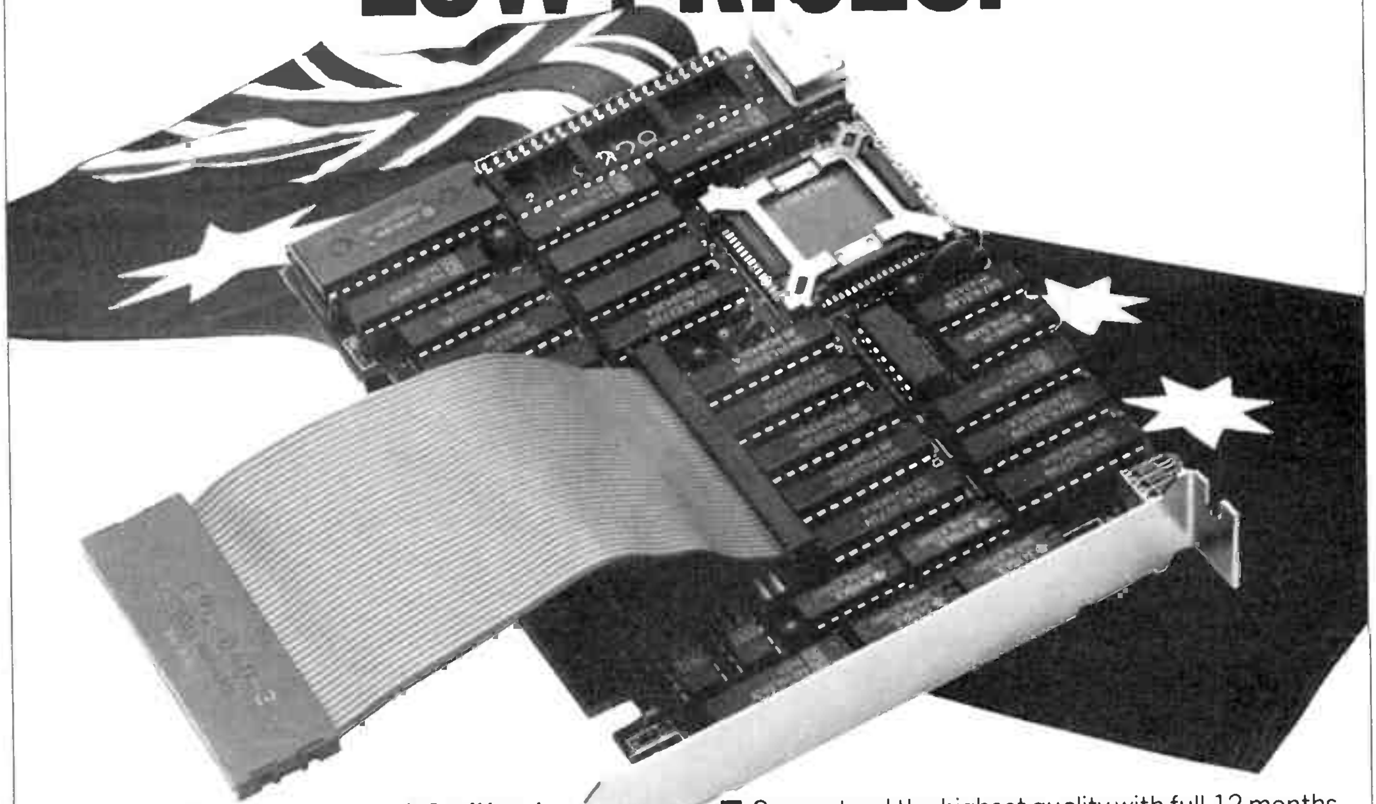
New SBC features HD64180

Microtrix of Melbourne has released a new high performance single board computer with features that make it suitable for many applications, ranging from stand-alone data processing to data acquisition and process control.

Based on the HD64180 the new high integration processor from Hitachi, the MicroMaster will run all current CP/M and Z80 software but with greater speed and efficiency.

The MicroMaster is an STD bus compatible card with up to 512K of RAM on-board, two RS232 serial ports, a centronics printer port, a floppy disk controller, and a full STD bus implementation. The floppy disk interface is totally adjustment-free for maximum reliability, ▶

HIGH SPEEDS LOW PRICES!



Significantly speed up your PC without spending thousands of dollars to upgrade.

You can do it brilliantly with Hypertec's Australian designed and manufactured accelerator boards – Hyperace-286 and Hyperace-286 Plus.

Specifically designed for the IBM PC/XT (and compatibles).

Both boards run on an Intel 80286 processor chip. The Hyperace-286 runs at 6MHZ – equivalent to IBM PC/AT performance and up to three times faster than a standard PC.

The Hyperace-286 Plus runs at 10MHZ, producing an amazing five times increase in your PC's performance. You can even switch back to your PC's original speed through a pop-up menu (software controlled).

Add to this both boards' support for the 80287 maths co-processor chip, and you have two short boards long on user benefits.

Our reputation is your guarantee of quality.

These boards are:–

- Designed to increase the power, flexibility and range of uses of IBM PCs and true compatibles.
- Australian designed, manufactured and locally supported – all by us.
- Guaranteed the highest quality with full 12 months warranty.
- Available at highly competitive prices.

Both boards come with full manual plus simple step-by-step procedures in plain English to make installation a breeze.

Dealer enquiries welcome.

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Please send me more information on the boards indicated and details of my closest dealer.

☐ HYPERACE-286 ☐ HYPERACE-286 PLUS

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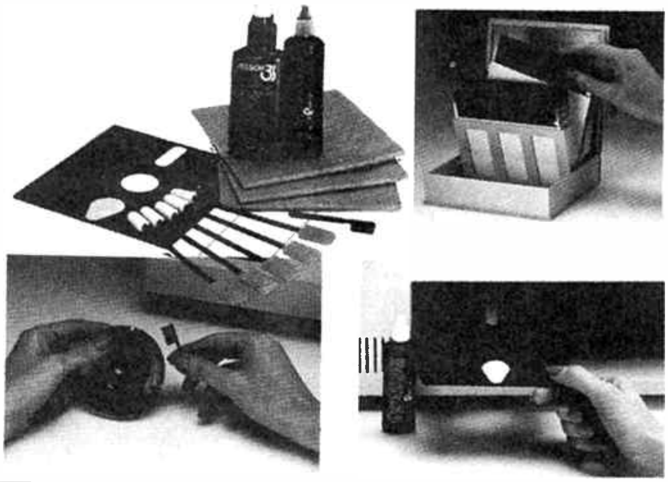
2469/FP/Little

Computer cleanup

Allsop's recently released computer cleaning kit comes with a bonus — it's packed in a disk case (or 'organiser,' as they say) that you can use long after the cleaning kit goodies are used up.

The new cleaning kit includes everything you need for maintenance of disk drives, monitors, keyboards and printers.

You get a non-abrasive cleaning diskette featuring a porous lint-free 'disk' inside that is used in conjunction with a specially



formulated cleaning fluid containing isopropyl alcohol and freon.

Five swabs, three lint-free wipes and a small brush are provided for general care. A pump-spray bottle of cleaning fluid for monitors and keyboards is also included.

Dubbed the "Small Wonder" Computer Cleaning Kit, it is available for both 5.25" and 3.5" systems. Further details from **Allsop Computer Products Division of Communications Power Inc. (Aust.) Pty Ltd, PO Box 246, Double Bay 2082 NSW. (02) 357 2022.**

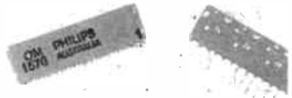
▷ providing support for all standard floppy disk sizes and formats. Any memory not used for the operating system is implemented as a RAM disk.

Other features include two DMA channels, a memory management unit, 12 source interrupt controller, and two 16-bit counter/timers. Whille software compatible with the Z80, the HD64180 executes most instructions in less time and provides several additional instructions, such as hardware multiply.

For single user processing applications, an enhanced CP/M-like operating system is available. Called Z-System, it will run all CP/M application programs, but provides many additional facilities and utilities with features similar to MSDOS and UNIX. TurboDOS will be available for multi-user situations.

Locally designed and manufactured, it is fully supported with development software such as assemblers and debuggers and operating systems. A full 12 months warranty is offered. Several supporting cards are already in development.

For more information, contact **Microtrix Pty Ltd, 24 Bridge Street, Eltham, Vic. 3095. (03) 439 5155.**



All out, bus terminates!

Philips has added a bus termination network to their wide range of custom hybrid circuits. The OM1576 Future Bus Terminator is a thick film hybrid with eight identical termination points. It is suitable for use as a termination network for the IEEE P896 Futurbus.

Features include: 39 Ohms ± 2%, low inductance terminating resistance from each bus line to Vterm; Schottky clamp diodes from each bus line to Vclamp with Vf of 320 m V at 1 mA; low stray capacitance; distributed decoupling capacitors, 5 nF to ground from both Vterm and Vclamp for each bus line; operating frequency dc — 100 MHz.

The bus termination hybrid is 39.2 mm long by 13.2 mm high by 3.5 mm thick and has a 15 single-in-line pins at 0.1" spacing. It is encapsulated in a plastic conformal coating.

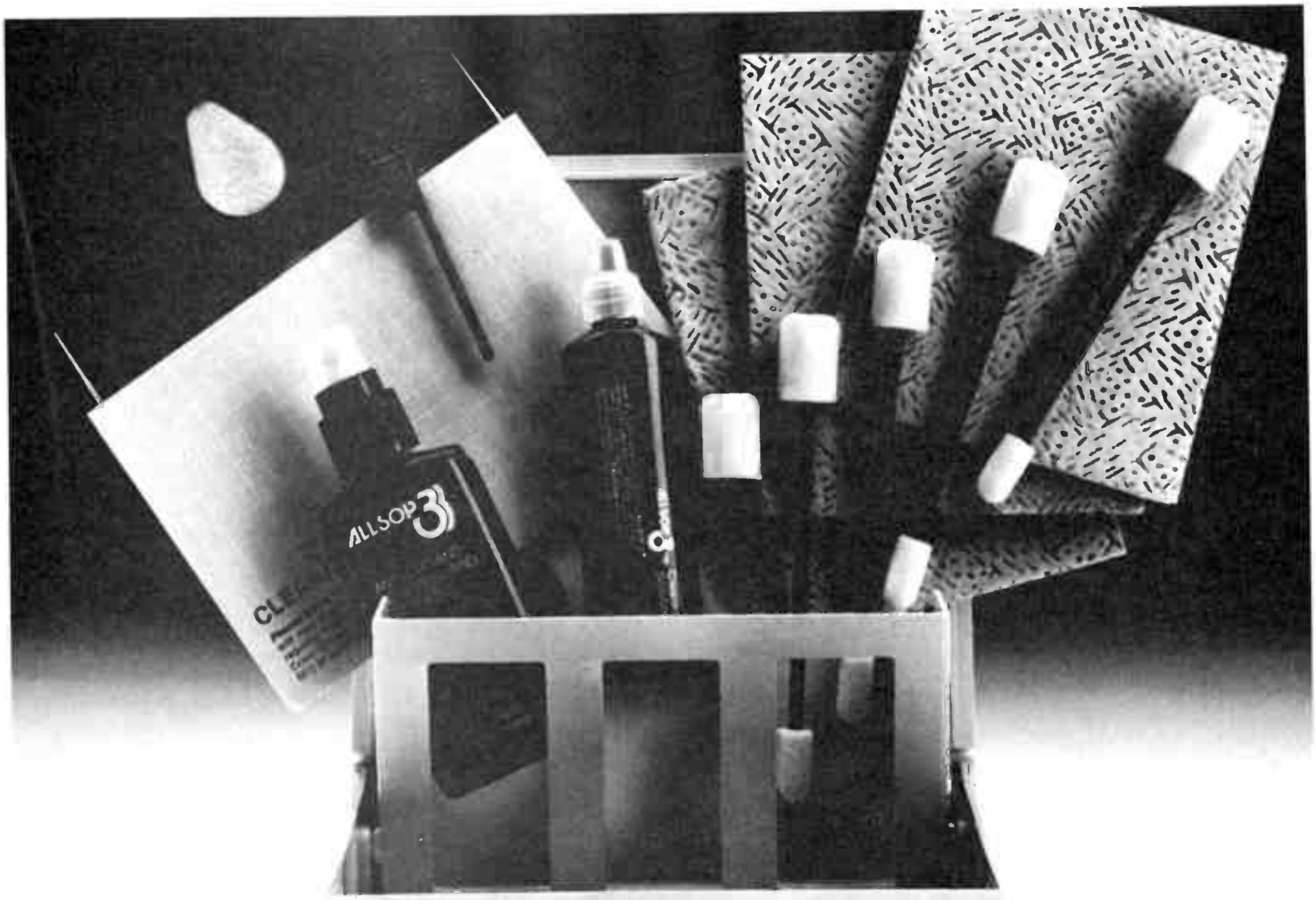
For further information, contact **David Segal, Philips Elcoma, 11 Waltham Street, Artarmon 2064 NSW. (02) 439 3322.**

Low-cost disk transfer service

What do you do when you need to transfer data or software from one brand of computer to another?

The problem has been solved, according to Tuldin Marketing Services at North Sydney, who provide a fast, economical disk-to-disk transfer service. Approximately 300 formats (all 5¼ inch minifloppy at the moment) are available, in a huge range of 40 and 80 track formats. This includes some very popular "older" formats such as Apple II and Osborne.

For furtheer information, contact **Tuldin Marketing Services, 107-109 Union Street, North Sydney NSW. (02) 959 3650.**



Small Wonder.

Allsop Introduces the Computer Cleaning Kit That Turns Into a Free Disk Organizer.

When it comes to versatile computer accessories, Allsop has a better idea. Like packaging a computer cleaning kit with a free disk organizer.

You get all the benefits of our new computer maintenance kit. Plus you get our disk organizer absolutely free.

Allsop engineering makes the difference.

We engineered our cleaning kit to provide you with everything you need to increase the performance and extend the life of your disk drives, monitors, keyboards and printers.

Then we packaged it in our compact storage and filing system, designed to protect and organise your valuable floppy disks.

That's Allsop engineering.

Available in both 5¼" and 3½".

Buy one and you will wonder how you ever got along without it.

For more information on our complete family of computer accessories, call us today on (02) 357 2022. Or write: Allsop Computer Products Division of Communications Power Inc. (Aust.) Pty Ltd, PO Box 246, Double Bay NSW 2082. Telex: 23381 "COMPOW". Trade inquiries welcome.

Find out how this little wonder can work wonders for you.

ALLSOP®

PROTEL, a home-grown CAD package

Tom Moffat

Protel is a recent addition to the family of IBM-PC programs written to use a computer to aid in the production of various drawings ... in other words, computer aided design. Protel's product is artwork for printed circuit boards, and it certainly is an improvement on the old way of doing things.

WHEN I FIRST STARTED designing magazine projects back in 1979, I used to produce the circuit board designs by first working out the design on translucent graph paper, and then transferring the tracks to the copper board using a special etch-resistant pen. It usually took several starts from scratch with the graph paper to get it right. That method was a real drag.

Later I discovered Bishop Graphics. In this method you still use graph paper to design your layout, but you don't draw the result directly onto the copper board. Instead, you use special black tapes and transfers to produce a version of your artwork in double size on a white translucent base. This is then photographically reduced back to normal size, and then transferred to the printed circuit board using photo etching. The Bishop Graphics method produced excellent results, but it's terribly hard work. And staring at that high-contrast artwork all day produced some terrible eyestrain and headaches.

Getting the smarts

The computer first came into the picture with the arrival of a program called Smartwork. This program takes all the drudge out of doing the graph paper designs and then sticking down all the transfers and bits of tape. Instead, you work out your design on the screen using a graphics editor, and then make a plot of it using a precision plotter. The plot consists of thick black ink drawn on translucent film. Once plotted, the artwork is processed into a circuit board exactly as it would be with Bishop Graphics.

I have been using a fairly early version of Smartwork. It allows you to produce double-sided boards with both layers shown at once on the screen, if desired. If you have a colour monitor, one layer can be in red, the other in green, and the holes and pads (which occupy both sides) in yellow. You can insert or delete pads and tracks from either side, chopping and changing your mind as often as you wish. Using Bishop Graphics, this would mean ripping up bits of tape and relaying other bits elsewhere. I have done many hours work with Smartwork and it has served me well.

Enter PROTEL

Now enter PROTEL. It picks up the basic idea of Smartwork and expands on it in some very useful ways. I will not attempt to explain every feature; Protel's instruction manual is tightly written, but it still runs to 160 pages, so we'll have to be content with its more unusual facets.

Protel is a Tasmanian product (yippee!). It was written in Turbo Pascal by Nick Martin, a name you might remember from the Mytek software days. Nick was responsible for some of those flashy Microbee graphics games. Now he's living in Tasmania, doing his thing with IBMs. PROTEL shows the attention to good graphics that would have come from games writing experience.

PROTEL can design boards with up to six (!) copper layers, plus a component overlay on the top. Most users however, would be content with a normal double-sided board. But it's nice to have that component overlay, especially when first laying out the design, even if the overlay is never eventually silk-screened onto the top of the printed circuit board. The components for the overlay can be brought out from a library of component shapes supplied as part of the software, and you can add some of your own to the library. We'll see the advantages of this shortly. Protel can work on a board with a maximum size of 32 × 19 inches; you could almost use it to do a motherboard for a pinball machine! (During this discussion we will stick with inches, since pc boards are still laid out in grids of inches, not millimetres.)

You can select one of nine different grid sizes, ranging from 1 to 200 mils (thousanths of an inch). IC pins are spaced 100 mils apart, so most people would use the 50 mil grid since it allows you to put one track between each pin, although it's possible to do more. You can select pad sizes from 50 to 250 mils, either round or square, and there are special pads for DIP packages and connectors. You can also select four different track sizes, from 15 to 100 mils.

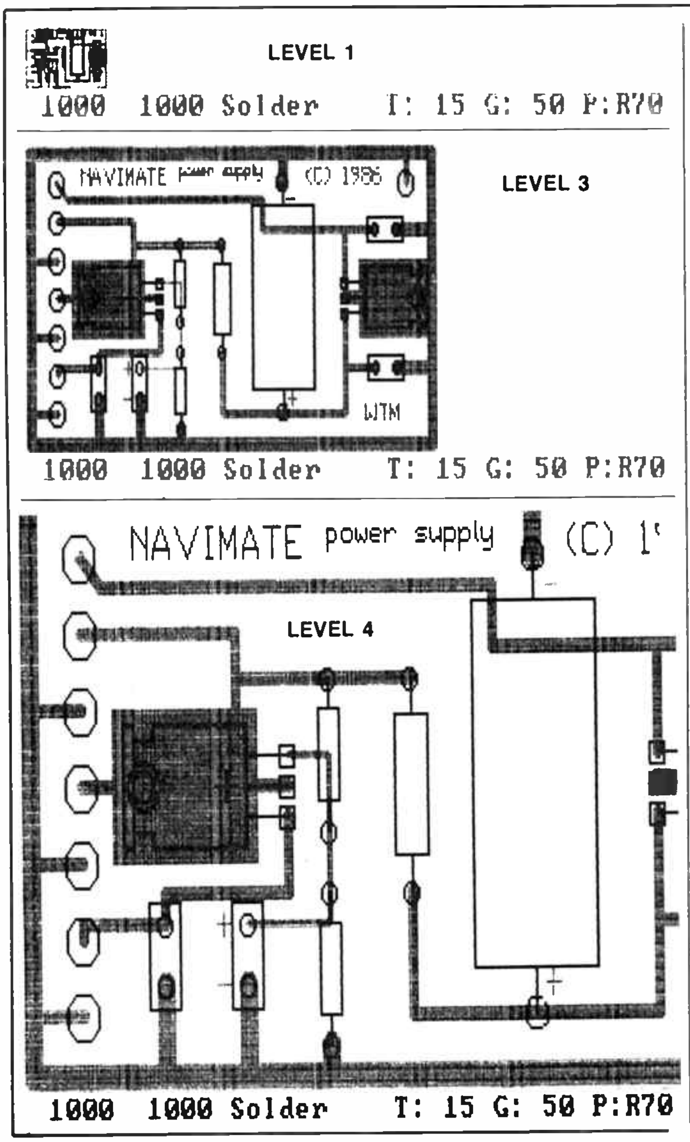
PROTEL at work

Perhaps the best way to see PROTEL at work is to actually design a pc board with it, and that is exactly what I have done for this article. The PCB shown in the illustrations is a power supply board for Flexible Systems' NAVIMATE facsimile receiver. It uses one IC regulator, one transistor regulator, and a few other discrete components.

PROTEL can show all of the board, or zoom up to show you part of it in fine detail. There are five levels of zoom, as shown in the illustrations. The illustrations are screen dumps of the IBM screen, much as you would see them, although they are squashed a bit in the horizontal direction due to the characteristics of the printer used to reproduce the screen dumps. At the bottom of the screen is a status line. This tells us that the working cursor is at grid co-ordinates 1000 × 1000 (mils), we are working on the solder side of the board, any tracks drawn will be 15 mils, the grid size is 50 mils, and any pads placed will be round ones of 70 mils diameter.

Above the status line is the board layout being worked on. At the first zoom level we are looking at the whole 19 × 32 inch work area, and our small board is just a little bitty im-

Tom Moffat, apart from being a prolific author and project producer for AEM, works as a design engineer for Tasmanian innovator and manufacturer, Flexible Systems, famous for Tasman Turtle Robots.



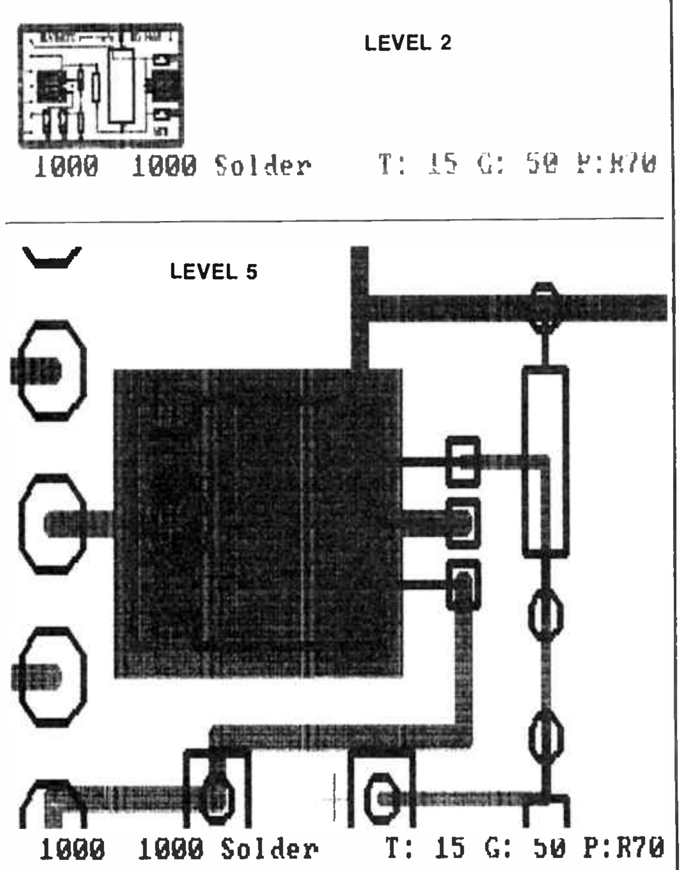


Figure 1. Screen dumps, showing the five "zoom" levels.

age in the corner. Level 2 is 16 × 9.5 inches, our board looks bigger now. Level 3 is 6.4 × 3.8 inches, the last level at which we can see the whole layout at once. Level 4 is 3.2 × 1.9 inches, and since our layout is two inches high, the top of it is out of view. The fifth level is a real blow-up . . . 1.6 × 0.95 inches. You can see one transistor and little else, but the level would be great for really fine work.

All the screen displays are available in colour. You can select various combinations of red, green, yellow, cyan, magenta, and white for the PCB layers and the overlay. (See the display options menu, Figure 2.) You can also select one of sixteen background colours, ranging through black, grey, olive, red wine, bright purple, and grapefruit. (Well, that's how they looked to me!) I thought the nicest combination for a single-sided board was red tracks, yellow pads, and green overlay, all superimposed on a dark grey background. This looks super!

But for a long designing session, I still prefer a soft amber monochrome display; I find it much easier on the eyes than all that bright colour. The effect with PROTEL is much like the screen dumps, with the overlay and pads at maximum intensity and the tracks grey, against a natural background. Or you can have them the other way round, if you like.

To produce the Navimate power supply layout, I began by bringing in the required component shapes from the component library: axial packages with 0.5 inch spacing for resistors, radial shapes with 0.2 spacing for capacitors, etc. One shape not in the library was a 1.5 inch axial package for the big electrolytic capacitor in the middle of the board. So I used the graphics editor to make one, and then stored it in the library along with the others! As you bring each component out of the library, you are asked to assign it a label (R1, C2, etc.) and you can also assign a comment (220k, 47pf, or whatever). Later on, if you get confused, you can place the editing cursor on a component and then hit "ALT-F6". PROTEL will tell you you're looking at R1 and it's a 220k resistor or whatever. Clever! If the program itself gets you bamboozled from time to time, you can press the "?" key for a full set of on-screen instructions. Of course, you should have read the manual before you started, shouldn't you . . .?

With all the components on the screen in more or less the correct locations, I used some more commands to move them exactly to their final locations. this is similar to placing the actual components on graph paper and then shoving them around until they fit. With PROTEL you can move a component at a time, rotate its position, or you can shift whole blocks of the picture at once (these use the Wordstar block move commands; how convenient!). Once all the parts are in place on the overlay you can then go to the "solder side" and connect them together with tracks.

Here's an interesting feature: if you've already started wiring-up the components and then decide to move one, you can still do it. And you can tell PROTEL to "drag" the tracks, so that they still remain connected. It's as if they're made of rubber! Once the component is in position you can use other commands to further drag and stretch the tracks to fix up any that have crossed or shorted. The whole effect is quite wierd; see Figure 3. Like I said, it's as if you were using the old tape method, but the tape was made of rubber. All this activity, by the way, is normally carried on with the IBM's function keys, but you can also use a Microsoft Mouse if you're into mice. It seems you could almost use it to pull ▶

```
PROTEL PCB    DISPLAY OPTIONS MENU

Component Side : OFF              Solder Side    : 1
Mid Layer 1    : OFF              Mid Layer 3    : OFF
Mid Layer 2    : OFF              Mid Layer 4    : OFF
Overlay        : 3

Pads : ?

Thick Tracks   : ON               Thin Tracks    : ON

Text           : ON
Text Size      : 0.12

Background Colour : 0
Palette Number    : 3

BACKGROUND     COLOUR 1     COLOUR 2     COLOUR 3

PgDn to Exit Menu
```

```
PROTEL PCB    PAD SELECTION MENU

A : Round  dia = 0.05 in            L : Square Width = 0.25 in
B : Round  dia = 0.07 in            M : DIP Pad   0.05 inch
C : Round  dia = 0.10 in            N : DIP Pad   0.08 inch
D : Round  dia = 0.15 in            O : DIP Pin 1 0.05 inch
E : Round  dia = 0.20 in            P : DIP Pin 1 0.08 inch
F : Round  dia = 0.25 in            Q : Edge 0.05 in x 0.25 in
G : Square Width = 0.05 in          R : Edge 0.05 in x 0.50 in
H : Square Width = 0.07 in          S : Edge 0.08 in x 0.50 in
I : Square Width = 0.10 in          T : Edge 0.12 in x 1.00 in
J : Square Width = 0.15 in          U : Solid Square   0.05 in
K : Square Width = 0.20 in

Vertical/Horizontal Pad / Edge Connector Orientation : Vertical

Press Key To Select Function Assigned To F1    PgDn To Exit Menu
>
```

Figure 2. The 'Display Options' and 'Pad Selection' menus.

a track away and then let it snap back, sending components flying in every direction!

With the layout finished, you can use PROTEL to put some text into one of the layers, or onto the overlay. I used it to put + and – onto the polarized capacitors so that some idiot (me) didn't put them in the wrong way around. Other text was used to put a title on the board. Since this was to be a single-sided board with no component overlay, the text went onto the copper side. It could just as easily have gone onto the overlay, in which case I would have used another command to "flip" the text to a mirror image so it read the right way around from the top.

That pretty well finished the PCB design, and it ws stored away on three different disks (just in case!), ready for plotting. Just going back to Smartwork for a moment, this program lets you plot your work on a proper plotter, or onto a graphics printer. The printer product is a bit rough, but for many prototyping operations it's good enough. It also gives you a hard copy of each layer of your design, so you can give it to someone else and have them check it against the circuit diagram.

Plotting

PROTEL has no graphics printer option, which is sad. I hope the next version includes this; after all, most small organizations have printers with their IBMs, but how many have access to a proper plotter? You can of course hire a plotter, for about the same price as you could hire a plumber! If you have to re-make a prototype a few times, it's going to cost you. PROTEL can do check plots, but this time it wants a colour graphics plotter. Come on PROTEL, let us use our existing printers, at least to confirm that the board design is correct!

I raised this matter with a spokesman for PROTEL's distributors, HST Industries. He said the graphics printer option was specifically excluded because they wanted PROTEL to be seen as a quality product, and they didn't want to give it the capability of producing scungy plots. I responded that I thought scungy plots were better than no plots at all for people who don't own plotters. He wouldn't budge, and I wouldn't budge, so I think we're at a stalemate on the subject of graphics printers.

As well as plotting the artwork, PROTEL's PLOT program can go back to those comments and labels you assigned when you first started laying down components onto the overlay. It shuffles them around into alphabetical order, and then prints out a Bill of Materials for your circuit board (onto a printer, not a plotter!) This could save a lot of work and double checking on a really big PCB layout.

Conclusions

Should you buy Protel? That's a good question. If you're a hobbyist, you'd find it a bit expensive at $900 for just casual use. If you're at the other end of the spectrum, say in a university or government department, the price isn't such a barrier. You'd be silly to continue using the old methods of PCB de-

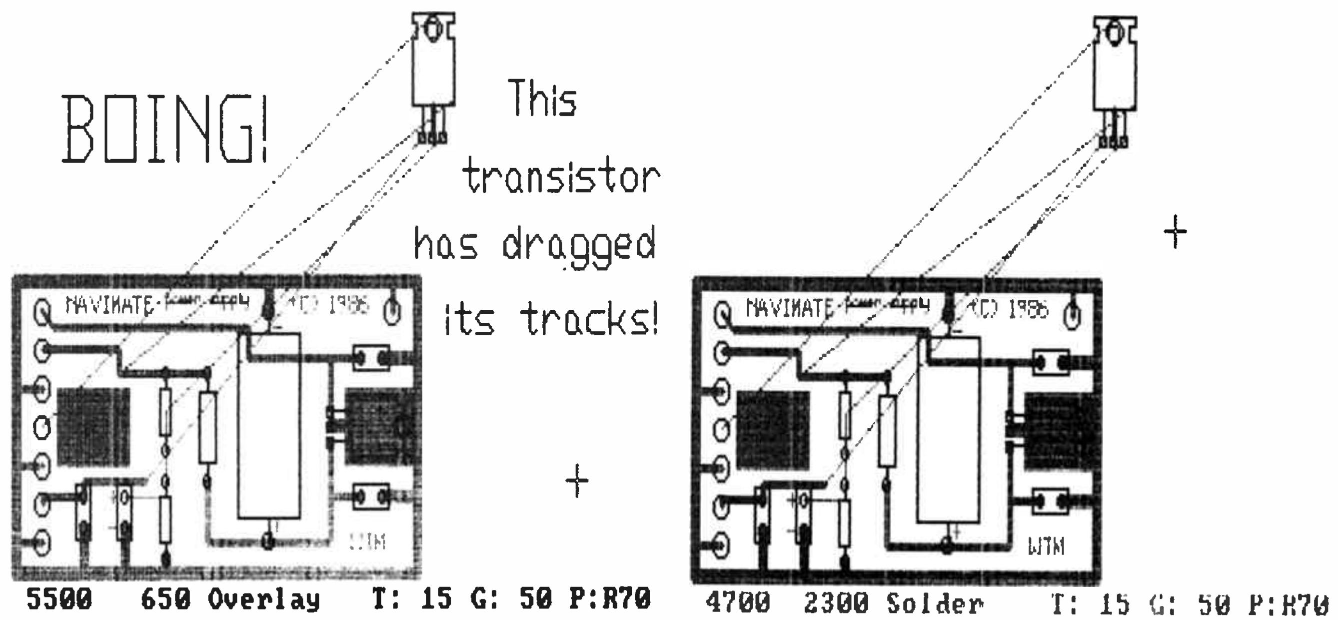
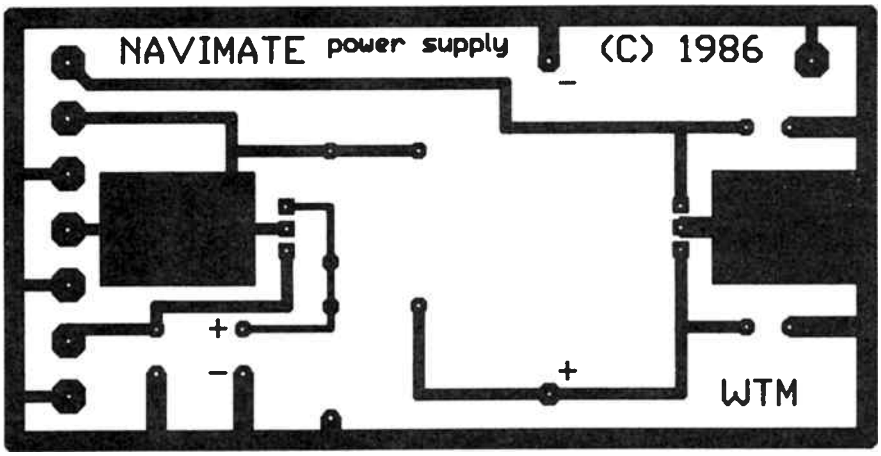


Figure 3. Here, a component has been moved but it's still attached to where it came from! This also shows off PROTEL's text capabilities.

sign, and PROTEL must be a strong contender among the microcomputer-based systems, especially if you have access to a plotter! It's extremely well packaged and presented; a thoroughly professional product. I don't think you could go wrong.

If however, you are a struggling design engineer in a small business, you may still be using graph paper and bits of tape. You are going to have to do some finagling to shake some money loose. Point out that time is money, and a computer system would speed things up. Occasionally go home sick with a raging headache. Point out that a computer screen is much easier on the eyes. Also point out that IBM "clone" computers are now down around the $1000 mark. You get the idea; lean on them a bit. Whether you wind up with PROTEL, Smartwork, or some other system, your circuit board designing sessions will certainly be more productive. If you like the looks of PROTEL, you might also point out that it appears to be the cheapest of the lot at the moment.

Protel is priced at $900, delivered anywhere in Australia, from: HST Industries P/L, GPO Box 536F, Hobart, Tasmania 7001.



BILL OF MATERIALS FOR : B:NAVISUPP.PCB

COMP No.	LABEL	PACKAGE	COMMENTS
1	C1	RADØ.2	4.7 uF Tantalum
2	C2	RADØ.2	Ø.1 Mono
3	C3	RADØ.2	Ø.1 Mono
4	C4	AXIAL1.5	25ØØ uF Electro
5	IC1	TO-22Ø	78Ø5
6	Q1	TO-22Ø	TIP-31
7	R1	AXIALØ.5	1ØØ Ohm
8	R2	AXIALØ.7	4.7 Ohm 1 Watt
9	ZD1	AXIALØ.5	7.5 V Zener

Figure 4. The completed pc board layout, shown with the bill of materials.

FUNCTION KEYS

Place Pad	F1	:	F2	Delete Pad,Arc,Copper
Begin/Continue Track (Left Mouse Button)	F3	:	F4	End Track Laying (Right Mouse Button)
Contract Display	F5	:	F6	Expand Display
Stretch Track(s)	F7	:	F8	Delete Track Section
Redraw Screen	F9	:	F1Ø	Re-Centre Screen

Press Return To Continue Any Other Key To End

BLOCK COMMANDS

^K^B	Mark Block	:	^K^V	Move Block
^K^H	Remove Block Markers	:	^K^Y	Delete Block
^K^R	Read in Block	:		

OTHER COMMANDS

^A	Place Arc On Overlay	:	^O	Toggle Ortho Mode
^B	Break Track Section	:	^P	Pad Selection Menu
^E	Erase Text	:	Q	Quit Editor
^F	Fill Area	:	^T	Select Track Size
^G	Select Grid Size	:	^W	Alter Track Width
^I	Toggle Cursor Information	:	^X	Place Text
^L	Select Layer	:	^Z	Zap Whole Track

ALT C Copy Track Stack : ALT E Empty Track Stack

PgUp Display Options Menu : PgDn Return To Editor

Press Return To Continue Any Other Key To End

LIBRARY ORIENTED COMMANDS

ALT F1	:	Load Component From Library
ALT F2	:	Delete Component From Board
ALT F3	:	Move/Rotate a Component
ALT F4	:	Move/Rotate Text
ALT F5	:	Find A Component By Specifying Its Name
ALT F6	:	Identify The Component Over The Current Cursor Position
ALT F7	:	Re-Comment The Component Over The Current Cursor Position
ALT F8	:	Re-Label The Component Over The Current Cursor Position
ALT F9	:	List Library Components
ALT F1Ø	:	List Components on Board

Press Return To Continue Any Other Key To End

CURSOR CONTROL

The Arrow Keys Move The Cursor In Units Of The Current Grid Size.

Shift Arrow Keys Move Cursor In Units Of 1Ø x The Current Grid Size.
Use Mouse If connected.

Use F5 and F6 To Expand And Contract The Display Window As Required.
When Expanding or Contracting The Window Position Will Be Adjusted
So That The Cursor Is In The Centre of The Screen if Possible.

Press Return To Continue Any Other Key To End

Hardware and software aspects of screen handling on the VZ-200/300

Concluding with coverage of the software interface in the VZ and the MC6847 VDG, looking at the standard screen modes.

Part 2
Bob Kitch

IT IS NOW OPPORTUNE to briefly discuss the software interface in the VZ and the VDG. I will only discuss the standard screen modes used on the VZ — not the additional modes mentioned in Part 1.

Lo-res/Text/Mode (0).

In the lo-res mode the screen is formatted into 16 lines down the usable window with each line containing 32 characters. Thereby providing 512 addressable characters on the screen. A quick calculation (or look at Table 1) will show that each character is composed of 8 by 12 pixels (or dots). Furthermore, each character is 'described' in a single byte in the video RAM section of memory. The upper left-hand character on the screen is memory mapped onto address 7000H (28672D), and the lower right-hand character is mapped onto 7000H + 1FFH (29183D). A memory map for the lo-res screen is given in Figure 5.

A formula is often used to calculate the address of a particular character on the screen. Let AA be the position of the character ACROSS the line (which ranges from 0 to 31) and let AD be the line number DOWN the screen (ranges from 0 to 15). i.e: working in the SE quadrant of an X-Y axis system. The relationship between (AA,AD) and the address in RAM is —

MAPPED ADDRESS = START ADDRESS + (32 · AD + AA) or
Addr = 28672 + (32 · AD + AA)

This calculation is often used in games to POKE values into selected memory locations or when screen formatting via the use of the PRINT@ statement where it is performed 'transparently'.

When the VZ is 'soft switched' to MODE (0) three of the modes in the VDG become available. There are internal ROM Alphanumerics (Normal and Inverse) and Semigraphics 4. There is no user-definable external character generator available in a standard VZ and also the Semigraphic 6 mode is not implemented due to hardware limitations. (Although I understand that the LASER 200 had SG6 rather than SG4 implemented as standard — but see previous section).

Let's digress for a while to describe how the on-chip customised character generator located in ROM on the VDG actually formats the 8 by 12 pixels to form each character. Firstly, in text mode. Table 2 shows the actual character set with corresponding codes resident in the VDG ROM. Figure 6 shows a typical character in Alphanumeric Mode (Internal). The spacing between characters across the line and between lines is set by the format held in the character generator. A Non-ASCII type character code is used on the VZ such that lower case (and control) ASCII characters are not represented. The 'lower case' ASCII values are used to signal 'inverse' characters by setting bit 6 high.

An Alphanumeric character in 'normal' mode is colour selectable as either green or orange with a black background. In 'inverse' mode, the character is black with the background

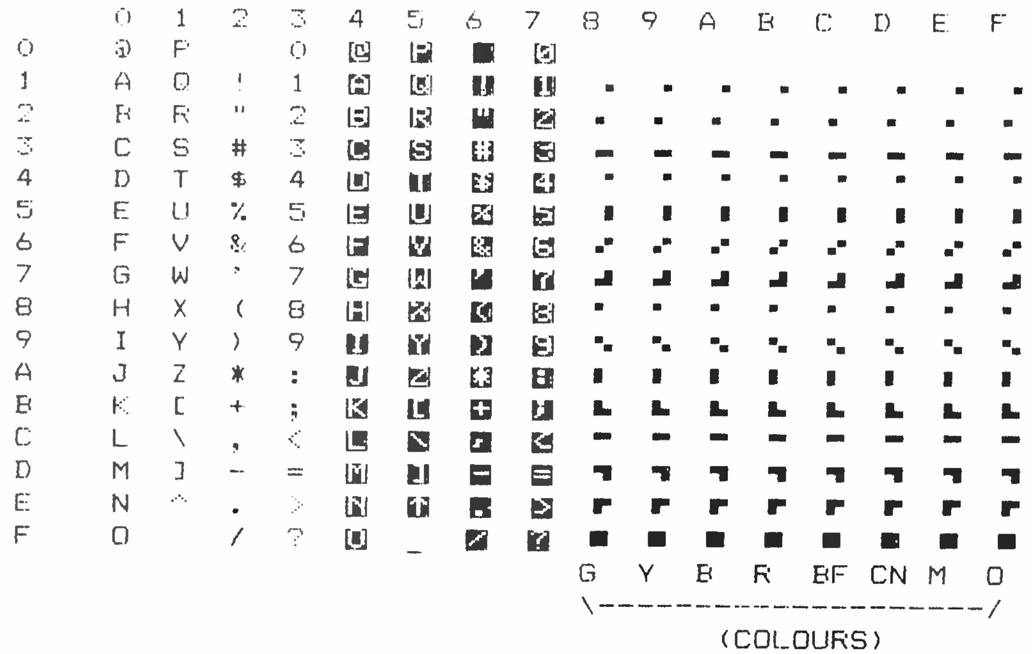


TABLE 2.
Alphanumeric and Semigraphic 4 character set for the VZ-200 and VZ-300 held in MC6847 on-chip ROM.
(Users — note errors in shape table held in VZ ROM for inverse J, X, 3 and 5).

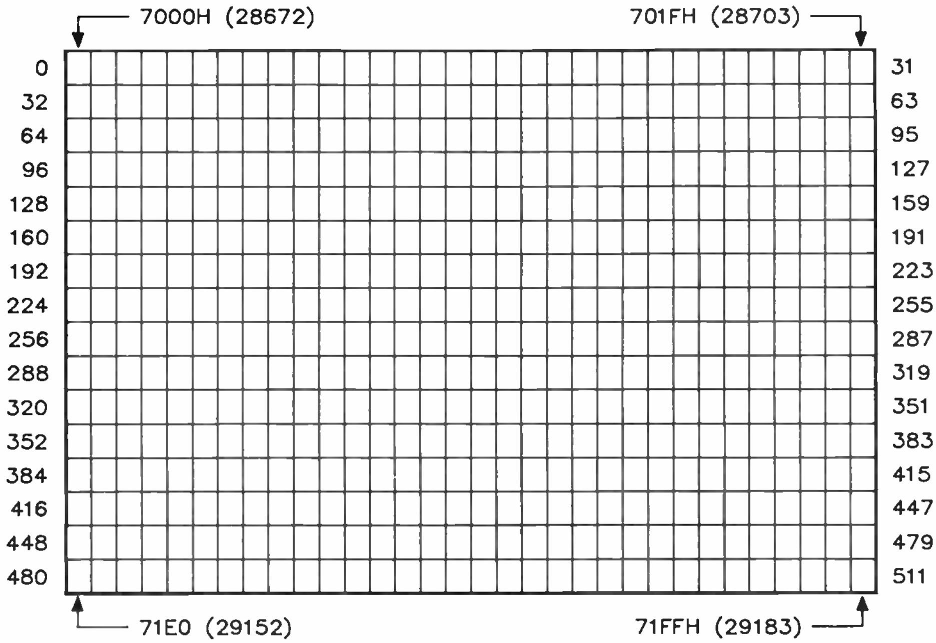


Figure 5. Screen addressing for MODE (0) or lo-res displays on VZ computers. This mode corresponds to Alphanumeric and Semigraphic 4 on VDG and is 32 by 16 characters in size. Each character is byte-mapped as indicated.

being selectable from green or orange. Remember that the Inverse mode of the MC6847 is set by bit 6 of the data value contained in video RAM. (see also Figures 1 and 6).

An understanding of this involves looking at individual bits within the bytes and also looking at how these bits can control and reset certain control lines on the VDG (as outlined in Part 1).

In text mode there are 64 characters in each of the Normal (0-63) and Inverse (64-127) sets. This implies that a 6-bit code is used to encode the character shape and that bit 6 determines whether Normal or Inverse.

For example:—

b7	b6	b5	b4	b3	b2	b1	b0	
0	0	1	0	0	1	0	1	Binary = 37D or '%' normal.
0	1	1	0	0	1	0	1	Binary = 101D or '%' inverse.

Note the way that bit 6 determines normal/inverse. Also note that bit 7 does not change. The most significant bit (MSB) is used to indicate text character to the on-chip ROM.

In summary, for the character source, a 6-bit ASCII code is used to call the elemnent from the on-chip ROM, the seventh bit indicates normal or inverse illumination, and the eighth bit is held low to indicate Alphanumeric mode.

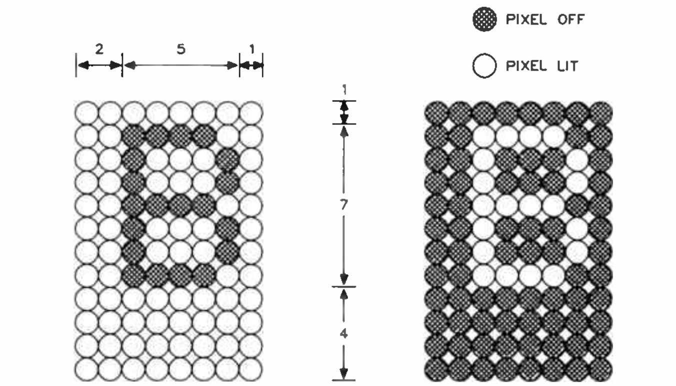
b7	b6	b5	b4	b3	b2	b1	b0
alpa *A/S	inv INV		6-bit		ASCII		

In graphics mode the Semigraphics 4 mode of the VDG is used. The 8 by 12 pixel character is divided into four 'rectangular' quadrants of size 4 by 6. The quadrants are 'psuedo-addressable' by selecting the correct area as shown on Figure 7.

In Semigraphics mode, a more comprehensive form of encoding is used. The character codes extend from 128 to 255, implying that the MSB (or bit 7) is set to 1 (or high) to indicate that a graphics character is encoded in the byte. The graphic block character contains 16 discrete patterns involving 'switching' on or off the four quadrants. The four low-order bits handle a quadrant a piece (refer Figure 7). Additionally one-of-eight illumination colours is encoded in the next three bits (bits 6 to 4).

For example:—

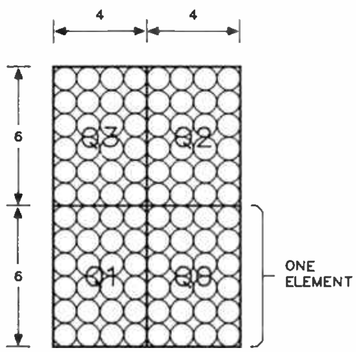
b7	b6	b5	b4	b3	b2	b1	b0		
0	0	1	0	0	1	0	1	Binary = 217D or	cyan
0	1	1	0	0	1	0	1	Binary = 145D or	yellow



INVERSE
Black character
Green or orange background (selectable)

NORMAL
Black background
Green or orange character (selectable)

Figure 6. Format of Alphanumeric Mode — internal on MC6847. Each character is 12 by 8 pixels and each screen is 32 by 16 characters. A 6-bit ASCII code specifies the character from an on-chip ROM.



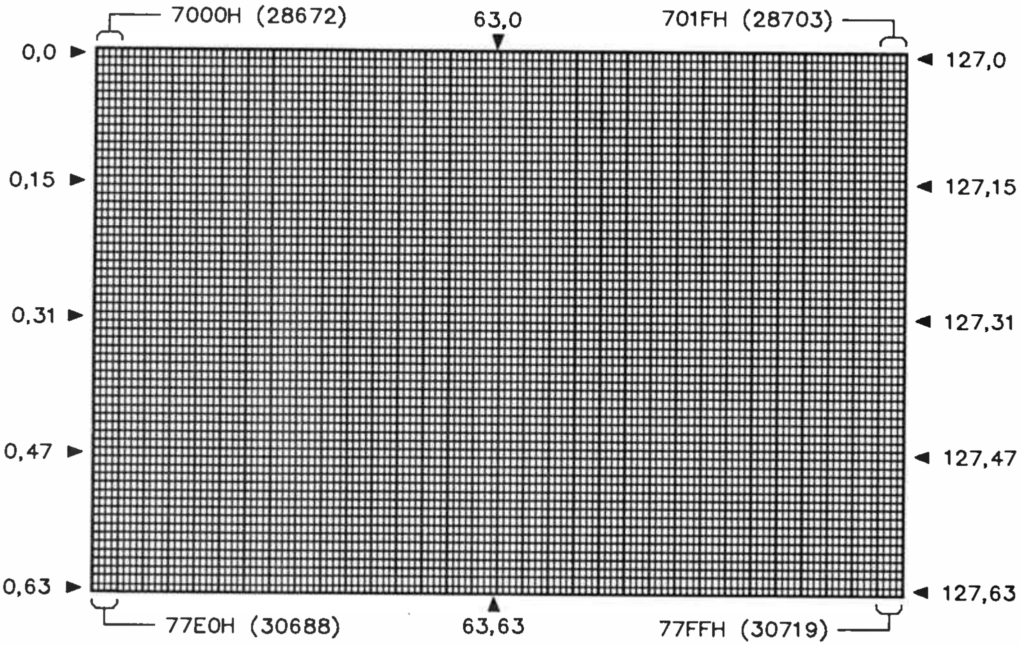
Qx	C2	C1	C0	COLOUR
0	X	X	X	BLACK
1	0	0	0	GREEN
1	0	0	1	YELLOW
1	0	1	0	BLUE
1	0	1	1	RED
1	1	0	0	BUFF
1	1	0	1	CYAN
1	1	1	0	MAGENTA
1	1	1	1	ORANGE

1	C2	C1	C0	Q3	Q2	Q1	Q0

BYTE ORGANISATION

Figure 7. Format of Semigraphic 4 Mode on MC6847. Each character is 12 by 8 pixels but elements or quadrants can be individually illuminated giving a screen resolution of 64 by 32 elements in up to eight colours.

Figure 8. Screen Addressing for MODE (1) or hi-res displays on the VZ computers. This mode corresponds to Colour Graphics 2 on the VDG and is 128 by 64 elements in size. Each element is mapped with two bits.



In summary, for Semigraphics mode it can be seen that each of the four least significant bits controls one of the quadrants, whilst the next three bits determine the colour of the illumination. The most significant bit is set high to indicate a graphics block is encoded.

b7	b6	b5	b4	b3	b2	b1	b0
graphic *A/S	colour			G3	G2	G1	G0

In this mode, although the screen is formatted into 32 by 16 graphics blocks, in fact the quadrant resolution is actually 64 by 32 and with all of the eight colours available. This may be thought of as an intermediate resolution display mode.

Thus it can be seen that Alphanumerics in either Normal or Inverse style and Semigraphics blocks of up to eight colours can be individually set on the lo-res screen by byte mapping. Different forms of encoding the necessary information are used in each case. These features combine to make MODE(0) quite a powerful display despite its lack of resolution.

Hi-res/Graphics/Mode(1)

In hi-res or MODE(1), the screen has 128 by 64 elements individually addressable. This corresponds to 8192 elements and with only 2K of video RAM available, then some sort of trade-off in features over lo-res must ensue. In hi-res, each element is 2 by 3 pixels in size and is (noticeably) rectangular in shape. Video RAM addressing extends from 7000H (28672D) to 71FFH (30719D) — 2048 bytes as shown in Figure 8.

This mode corresponds to Colour Graphics Two (CG2) on the VDG chip. Each byte addresses four consecutive elements across the screen. Each element may be one-of-four colours (selected from either of the two colour sets). Note the trade-off in colours and the different way in which elements are addressed on the screen — such that MODE(0) and MODE(1) screens cannot be mixed.

There are a couple of ways in which each element may be illuminated.

The simplest (and slowest) way is by using the BASIC commands of SET and RESET. These commands alter two bits of the appropriate byte in the video RAM area. The processing is very slow because of this limitation and the fact that it is done through the BASIC interpreter. Listing 1 provides a simple illustration of this method. The program fills the entire screen with hi-res elements according to the COLOR command. The use of integer index variables speeds up the program a little.

LISTING 1

```
10 '***SNAIL GRAPHICS DEMO***
20 '***       HI-RES       ***
30 '***     VERSION 1.2    ***
40 '***  R.B.K.   22/5/86  ***
50 '*** EXECUTION TIME 43.7 SECS.
100 'SET TO HI-RES
120 MODE(1)
130 COLOR 3,0
140 SOUND 10,1
200 FOR V%=0 TO 63
210 FOR H%=0 TO 127
220 SET(H%,V%)
230 NEXT H%
240 NEXT V%
250 SOUND 10,1
260 STOP
270 END
```

LISTING 2

```
10 '***SNAIL GRAPHICS DEMO***
20 '***       HI-RES       ***
30 '***     VERSION 2.3    ***
40 '***  R.B.K.   22/5/86  ***
50 '*** EXECUTION TIME 8.3 SECS.
100 'SET TO HI-RES
120 MODE(1)
130 COLOR ,0
140 V%=170:SOUND 10,1
200 FOR I%=28672 TO 30719
210 POKE I%,V%
220 NEXT I%
250 SOUND 10,1
260 STOP
270 END
```

LISTING 3

```
10 '***NEAR-LIGHT-SPEED GRAPHICS DEMO***
20 '***             HI-RES             ***
30 '***           VERSION 1.2          ***
40 '***         R.B.K.  22/5/86        ***
50 '*** EXECUTION TIME 0.5 SECS.
100 '***LOAD BLOCK MOVE MACHINE CODE.***
110 FOR I%=-28687 TO -28674
120 READ A%: POKE I%,A%
130 NEXT
140 DATA 33,0,112,17,1,112,1,255,7,54,170,237,176,201
200 '***INITIALIZE USR() TO ADDRESS 8FF1H OR -28687D.***
210 POKE 30862,241: POKE 30863,143
300 '***SET TO HI-RES.***
310 MODE(1)
320 COLOR ,0
330 SOUND 10,1
340 X=USR(0)
350 SOUND 10,1: SOUND 0,9
360 COLOR ,1
370 SOUND 10,1: SOUND 0,9
380 STOP
390 END
```

LISTING 4

```
10 '**************************
20 '***  2000 VZ SCREENS  ***
30 '***     VERSION 1.2    ***
40 '***   R.B.K. 18/5/86   ***
50 '**************************
60 '
100 '***FIND TOP OF MEMORY.
110 M1=PEEK(30898):L1=PEEK(30897):'***PRESERVE TOM POINTERS.
120 TM=M1*256+L1-20                :'***RESERVE TOP 20 BYTES.
130 MS=INT(TM/256):LS=TM-MS*256
140 POKE 30898,MS:POKE 30897,LS
150 '
200 '***SET UP LOADING OF USR() ROUTINE.
210 TM=TM+1                        :'***NEXT ADDR IN RESERVED MEM.
220 MS=INT(TM/256):LS=TM-MS*256
230 POKE 30863,MS:POKE 30862,LS
240 AD=TM+10                       :'***ADDR. FOR CHARACTER BYTE.
250 IF TM>32767 THEN TM=TM-65536 :'***CONVERT TO SIGNED INTEGER.
260 IF AD>32767 THEN AD=AD-65536
270 '
300 '***LOAD MACHINE CODE.
310 FOR ID=TM TO TM+13
320   READ VL:POKE ID.VL
330 NEXT
340 '
400 '***Z-80 BLOCK MOVE SUBROUTINE.
410 DATA 33,0,112        :'LD HL,7000H  (*28672D START VIDEO RAM)
420 DATA 17,1,112        :'LD DE,7001H  (*28673D NEXT OR DEST.)
430 DATA 1,255,7         :'LD BC,07FFH  (*2047D SIZE OF VIDEO RAM)
440 DATA 54,85           :'LD (HL),55H  (*85D YELLOW OR CHAR."U")
450 DATA 237,176         :'LDIR         (BLOCK MOVE INSTRUCTION)
460 DATA 201             :'RET
470 '
500 '***INITIALIZE DELAYS - CONTROL SPEED OF EXECUTION BY D.
510 T=0         :'***TONE  0 IS REST.       RANGE IS 0 TO 31
520 D=4         :'***DURATION  9 IS LONG.   RANGE IS 1 TO 9
530 P=30744     :'***ADDR. FOR INVERSE CONTROL.
540 POKE P,0    :'***SET UP SCREEN.
550 '
600 '***SET UP DEMO LOOP.
610 FOR ID=0 TO 255
620   POKE AD,ID                     :'***SET CHARACTER BYTE.
630   '***SCREEN MESSAGE.
640   MODE(0)                        :'***SET *A/G LO.
650   POKE P,0                       :'***SET INV LO.
660   PRINT@234," CHAR = ";ID:SOUND T,D
670   '***LO-RES SCREENS.
680   '***LO-RES GREEN CHARACTER ON BLACK BACKGROUND.
690   X=USR(0):COLOR,0:SOUND T,D:'***SET CSS LO.
700   '***LO-RES ORANGE CHARACTER ON BLACK BACKGROUND.
710   COLOR,1:SOUND T,D              :'***SET CSS HI.
720   POKE P,1                       :'***SET INV HI.
730   '***LO-RES BLACK CHARACTER ON GREEN BACKGROUND.
740   X=USR(0):COLOR,0:SOUND T,D:'***SET CSS LO.
750   '***LO-RES BLACK CHARACTER ON ORANGE BACKGROUND.
760   COLOR,1:SOUND T,D              :'***SET CSS HI.
770   '***HI-RES SCREENS.
780   MODE(1)                        :'***SET *A/G HI.
790   POKE P,0                       :'***SET INV LO.
800   '***HI-RES COLOR SET 0 - GREEN SURROUND.
810   X=USR(0):COLOR,0:SOUND T,D:'***SET CSS LO.
820   '***HI-RES COLOR SET 1 - BUFF SURROUND.
830   COLOR,1:SOUND T,D              :'***SET CSS HI.
840   POKE P,1                       :'***SET INV HI.
850   '***HI-RES COLOR SET 0.
860   X=USR(0):COLOR,0:SOUND T,D:'***SET CSS LO.
870   '***HI-RES COLOR SET 1.
880   COLOR,1:SOUND T,D              :'***SET CSS HI.
890   '***RESET CONTROLS.
900   POKE P,0:COLOR,0:CLS
910 NEXT
920 '
930 '***RESET TOM POINTERS.
940 POKE 30898,M1:POKE 30897,L1
950 STOP:END
```

A quicker way is to POKE values into each byte, thereby setting four elements at a time. Listing 2 demonstrates this technique. This program also fills the entire hi-res screen with elements whose colours are determined by the variables V%.

The quickest way is to use a machine language program to load appropriate values into the video RAM. This technique is a very rapid way to fill the screen. Listing 3 is an example of this method. This program POKEs machine code into hi-memory. The subroutine uses the very efficient Z80 Block Move command to fill the screen according to the value stored at address -28677D. It is fast!

Both of the last two methods require that an understanding of the value to enter into RAM is known. This requires a knowledge of how each byte is organised in CG2 mode.

As mentioned previously, each byte controls four elements which can be selected from four colours. Bits are treated in pairs (dibits!) with each pair corresponding to an element. Each dibit can have a value of 00B to 11B to indicate colour. This is set out on Table 3.

Four example, suppose we want an entirely BLUE screen. Then POKE (128 + 32 + 8 + 2) or 170D into the appropriate area

TABLE 3:
CONFIGURATION OF BYTES IN MODE (1).

3	2	1	0	Element #
0 0 0	0 0 0	0 0 0	0 0 0	Bin. = four GREEN/BUFF elements. Dec = 0D
0 1 64	0 1 16	0 1 4	0 1 1	Bin. = four YELLOW/CYAN elements. Dec. = 85D
1 0 128	1 0 32	1 0 8	1 0 2	Bin. = four BLUE/MAGENTA elements. Dec. = 170D
1 1 192	1 1 48	1 1 12	1 1 3	Bin. = four RED/ORANGE elements. Dec. = 255D

The decimal numbers corresponding to each element position AND colour provide the value that needs to be POKE'd or loaded.

of the screen. If, however, a striped screen consisting of RED-GREEN-BLUE-YELLOW vertical bands is required, then POKE (192 + 0 + 8 + 1) or 201D.

Although only four colours are available, there are two colour sets available. These are called by the COLOR command.

COLOR, 0 sets the background colour to green and the 'strong' colours of yellow, blue and red are available.

COLOR, 1 sets the background to buff and the 'pastelle' colours of cyan, magenta and orange are available.

To think back to the RESET command mentioned before, it should be apparent that this command simply resets each dibit or element back to 00B, or the background colour.

Finale

Well there we have it! For those who have perservered thus far I have included Listing 4 which is entitled '2000 VZ Screens'. It is about as exciting as watching a Late Night Movie — and takes about as long to run! Actually it illustrates all of the features discussed in this article. For those who wish to sit-it-out — watch those control lines operate!

REFERENCE LISTING OF VZ-200/300 MAGAZINE ARTICLES

Since its introduction in early 1983, over one hundred articles on the VZ-200 and 300 have appeared in magazines. some articles review the hardware and others describe peripherals, some excellent games have been published and a very useful set of utility routines has emerged.

This bibliography for the VZ computer is a must for the serious VZ User.

UTILITIES

Oct.	83	APC	52, 4	BASIC program conversion. (Surya)	(2)
Nov.	83	APC	57, 9	Program conversion Pt. 2 (Surya)	(2)
Nov.	83	APC	89-95	BASIC converter chart. (Surya)	(7)
Feb.	84	APC	140-1	Program conversion Pt. 2 (Surya)	(2)
Mar.	84	APC	42-3	Program conversion — Apple II (Surya)	(2)
Apr.	84	APC	71-2	Program conversion — TRS 80/System 80 (Surya)	(1)
May	84	APC	75-6	Program conversion — Atari (Surya)	(2)
Jun.	84	APC	67	Program conversion — Sinclair (Surya)	(1)
Jul.	84	APC	129-30	Program conversion — BBC (Surya)	(2)
Mar.	84	ETI	63	More functions for the VZ-200. (Olney)	(1)
Apr.	85	ETI	117	Notes and errata for Olney.	(-)
Jul.	84	M80	3-4	VZED — three new functions.	(1)
Aug.	84	M80	2	VZ-200 output latch.	(1)
Aug.	84	M80	9, 15, 16	Memory peek VZED. (Carson)	(1)
Aug.	84	M80	3-4	Microsoft ROM BASIC Level I bug.	(1)
Apr.	85	APC	97	VZ-200 bug. (Tritscher)	(-)
Aug.	85	APC	31	VZ bug. (Tritscher)	(-)
Aug.	84	APC	94	VZ-200 moving message and trace. (Batterson)	(1)
Nov.	84	APC	125	Trace function. (Breffit)	(-)
Nov.	84	APC	125	VZ-200 correction. (Kelly)	(-)
Oct.	84	ETI	135-7	Extending VZ-200 BASIC. (Olney)	(3)
Nov.	84	APC	125-6	TRON/TROFF function for VZ-200. (Thompson)	(1)
Nov.	84	APC	208-12	MON-200 machine code monitor. (Stamboulidas)	(5)
Nov.	84	PCG	55-56	Lprinter. (Quinn)	(2)

Nov.	84	PCG	suppl.	VZ-200 reverse video.	(1)
Feb.	85	APC	171	BASIC understanding (Hobson)	(1)
Feb.	85	APC	20	VZ-200 into puberty — Olney's extended BASIC.	(1)
Apr.	85	PCG	62-64	Find. (Stamboulidas)	(3)
Apr.	85	APC	19	Use of RND in dice and card games. (Holland)	(1)
Apr.	85	APC	103	VZ variable definition. (Stamboulidas)	(1)
Apr.	85	APC	95	Variable GO TO on VZ. (Olsen)	(1)
Jul.	85	APC	176	Correction to VZ variable GO TO	(-)
May	85	APC	52-3	Lusco support for VZ-200. (Young)	(1)
May	85	ETI	99-101	VZ-200 hardware interrupt. (Olney)	(3)
May	85	APC	110	Background VZ. (Williams)	(1)
Aug.	85	APC	130	VZ-200 instant colour. (Willows)	(-)
Aug.	85	APC	130-3	Reversed REM. (Quinn)	(1)
Sep.	85	APC	145	Real-time clock. (Griffin)	(1)
Oct.	85	APC	218	APC benchmark BASIC programs.	(1)
Oct.	85	APC	147	VZ deletions. (Quinn)	(1)
Nov.	85	APC	189	VZ EDITOR/ASSEMBLER tips. (Lam)	(1)
Nov.	85	ETI	94-5	Olney's Level II BASIC for VZ-300/300. (Rowe)	(2)
Jan.	86	APC	83, 5	VZ user graphics.	(1)
Feb.	86	APC	127	Machine language calls.	(1)
Mar.	86	APC	chart	APC BASIC converter chart 1986.	(8)
Mar.	86	YC	103-5	VZ-200 cassette inlays. (Dutfield)	(3)
Jun.	86	APC	209	VZ pause.	(1)

GAMES

Dec.	83	APC	161-3	Missile Command. (Whitwell)	(2)
Jan.	84	YC	65	Graphic Sine Waves for VZ-200. (Nickasen)	(1)
Apr.	84	APC	178-80	Moon Lander. (Alley)	(2)
Jul.	84	APC	174-8	Blockout. (Pritchard)	(3)
Jul.	84	M80	7, 22	Battleships. (Carson)	(1)
Jul.	84	M80	7, 20, 21	Junior Maths. (Carson)	(2)
Aug.	84	M80	9, 16	Contest Log VZED. (Carson)	(1)
Aug.	84	M80	9, 16, 17	Dog Race VZED. (Carson)	(1)
Oct.	84	PCG	55-7	High Resolution Graphics Plotting. (Thomson)	(3)
Nov.	84	PCG	82	Tips for 'Ladder Challenge', 'Panik' and 'Asteroids'.	(1)
Jan.	85	PCG	54	POKEs to 'Ghost Hunter'.	(-)
—	85	BYC	146-7	Gold Simulation. (McCleary)	(2)
Mar.	86	CFG	4-5	Gold Simulation. (McCleary)	(-)
—	85	BYC	147	Knight's Cross. (Lucas)	(1)
Jan.	85	APC	129-31	Sketcher. (Leon)	(3)
Jan.	85	YC	88-89	Punch. (Rowe)	(2)
Jan.	85	PCG	44-48	Space Station Defender. (Shultz)	(5)
Mar.	85	YC	105-9	Decoy. (Rowe)	(2)
Apr.	85	YC	160	Painter. (Daniel)	(1)
Apr.	85	PCG	65-7	Roadrace. (Thompson)	(3)
May	85	YC	106	Number Sequence. (Thompson)	(1)
May/Jun	85	PCG	63-7	Sketchpad. (Thompson)	(5)
Jun.	85	YC	70	Morse Tutor program. (Heath)	(1)
Jan.	86	YC	150-1	Morse Tutor — again. (Heath)	(2)
Jul.	85	YC	81	Electric Tunnel. (Daniel)	(1)
Aug.	85	YC	114	Number Slide. (Daniel)	(1)
Oct.	85	PCG	47-52	Cube. (McMullan)	(6)
Oct.	85	YC	105-7	Yahtzee. (Thompson)	(3)
Mar.	86	APC	208-9	VZ Frog. (Alley)	(1)
May	86	ETI	93	Balloon Safari, The Drop and Flatten. (Sheppard)	(1)

BUSINESS

Aug.	84	APC	172-7	Database VZ-200. (Barker)	(6)
Oct.	84	APC	214	WP for VZ-200. (McQuillan)	(-)
Oct.	85	APC	82-3	Comment on Barker's and Quinn's DB. (Lukes)	(-)
Oct.	84	APC	126-30	Minicalc Spreadsheet. (Stamboulidas)	(5)
Dec.	84	APC	214	Correction to Minicalc.	(1)
May	85	APC	162-3	Micro Type (WP). (Browell)	(2)
Jul.	85	APC	164-6	Database. (Quinn)	(2)

PERIPHERALS

Feb.	84	EA	131-2	Real-world interface.	(1)
Aug.	84	EA	65	Improved graphics on VZ-200. (Dimond)	(1)
Aug.	84	PCG	83	I/O card for VZ-200. (ad)	(1)
Oct.	84	APC	214	Serial help request. (Pope)	(1)
Dec.	84	APC	36	Add-ons for VZ-200. (Bleckendorf)	(-)
Oct.	85	YC	140	VZ-200/300 Modem. (ad)	(-)
Nov.	84	ETI	106-12	A 'Glass-Teletype' using the VZ-200 Pt I	(7)
Dec.	84	ETI	93-7	A 'Glass-Teletype' using the VZ-200 Pt II	(5)
Aug.	85	ETI	72-8	VZ-200 terminal.	(7)
Jun.	86	EA	106	VZ serial terminal. (ad DSE kit K6317)	(-)
Feb.	86	ETI	72-4	Modifying VZ-200 16K memory expansion. (Olney)	(3)
Mar.	86	ETI	48	Talking VZ-200. (Bennets)	(1)
Sep.	86	AEM	89-92	VZ-200/300 Screen-handling. (Kitch)	(4)

COMMERCIAL SOFTWARE REVIEWS

Mar.	84	APC	190-1	Review of DSE 'Matchbox', 'Biorythms', 'Circuit', and 'Poker'. (Davies)	(2)
Aug.	84	pcg	46-47	Review of DSE 'Panik' and 'Ladder Challenge'.	(1)
Oct.	84	PCG	90-91	Review of DSE 'knights and Dragons', 'Ghost Hunter', 'Othello', and 'Invaders'.	(2)
Nov.	84	PCG	90-96	Review of LYSCO 'Cub Scout' and DSE 'Dracula's Castle'.	(1)
Jan.	85	PCG	65	Review of DSE 'Air Traffic Controller' and 'Tennis'.	(1)
Feb.	85	PCG	76	Review of DSE 'Defence Penetrator' and 'Star Blaster'.	(1)
Mar.	85	PCG	76-77	Review of DSE 'Planet Patrol' and 'Learjet'.	(1)
Apr.	85	PCG	94-99	Review of DSE 'Asteroids', 'Super Snake' and 'Lunar Lander'.	(1)
Apr.	85	ETI	103	Logbook and Morse on VZ-200.	(1)
Oct.	85	PCG	68-9	Review of DSE 'Duel'.	(1)
Nov.	85	PCG	70-1	Review of DSE 'Attack of the Killer Tomatoes'.	(1)

HARDWARE REVIEWS

Apr.	83	APC	58-66	VZ-200. (Hartnell)	(5)
Apr.	83	CC	38-43	Review of VZ-200	(3)
May	83	CC	26-30	Video Technology VZ-200 PC. (Ah1)	(3)
Jun.	83	EA	137	New low-cost computer — VZ-200.	(1)
Jun.	83	ETI	30	Dick Smith colour computer.	(1)
Jun.	83	YC	6	DSE VZ-200.	(-)
Aug.	84	PCG	12	VZ-200.	(-)
Jul.	83	ETI	32-7	DSE's personal colour computer. (Harrison)	(3)
Jul.	83	EA	130-3	The VZ-200: colour, graphics and sound. (Vernon)	(4)
Jul.	83	PCN	16	Timing the Laser's phazer. (Stokes)	(1)
Sep.	83	WM	40	Laser.	(-)
Aug.	83	YC	20-33	Cash and Carry Computers. (Bell)	(9)
Sep.	83	CC	202-4	Review of VZ-200 and PP40	(1)
Oct.	83	APC	77-8	VZ-200.	(1)
Oct.	83	WM	135	Texet TX8000.	(1)
Oct.	83	CT	12	The Laser 200.	(-)
Dec.	83	CT	11	Laser 200.	(-)
Nov.	83	CT	37-40	A look at the Laser. (Green)	(4)
Nov.	83	WM	42-108	The Laser — a shot in the dark.	(3)
Feb.	84	CC	218-21	Laser PP40 Printer/Plotter.	(2)
Spring	84	MC	52-4	Laser 200. (Green)	(3)
Jun.	84	EA	12-9	Buying your first computer. (Vernon)	(6)
Aug.	84	EA	30-3	An important role for small computers. (Williams)	(4)
Oct.	84	PCG	82-87	Home micro supertest. Pt. 3 (Bollington)	(5)
Nov.	84	PCG	14-19	Home micro supertest. Pt. 4 (Bollington)	(4)
Nov.	84	EA	78-80	VZ-200 as a WP (DSE E&F tape WP). (Williams)	(2)
Dec.	84	CHC	28-31	Review of video games consoles.	(4)
Jul.	85	ETI	102-6	Dick Smith's new VZ-300. (Rowe)	(5)
Aug.	85	EA	22-7	WP on the new VZ-300. (Williams)	(5)
Dec/Jan	86	PCG	11-15	How to buy a micro — VZ-300 compared.	(4)

GENERAL PROGRAMMING

Jan.	83	PE	3/1-3/5	PE Micro-file #3 — Z80. (Coles	(5)
Mar.	84	APC	73-85	Teach yourself assembler Pt. 1 (Overaa)	(6)
Apr.	84	APC	57-64	(8080, Z80, 6502) Pt. 2 (Overaa)	(5)
May	84	APC	89-98	(8080, Z80, 6502) Pt. 3 (Overaa)	(5)
Jun.	84	APC	53-60	(8080, Z80, 6502) Pt. 4 (Overaa)	(5)
Jul.	84	APC	61-64	(8080, Z80, 6502) Pt. 5 (Overaa)	(3)
Aug.	84	APC	110-116	(8080, Z80, 6502) Pt. 6 (Overaa)	(5)
Sep.	84	APC	145-151	(8080, Z80, 6502) Pt. 7 (Overaa)	(4)
Jan.	85	APC	122-124	Sort at input. (Ithell)	(1)
Feb.	85	APC	103-109	The basic art — algorithms, structures (Liardet)	(4)
Mar.	85	APC	98-109	Pick a number — arithmetic. (Liardet)	(5)
Apr.	85	APC	79-87	It takes all sorts — sorting. (Liardet)	(5)
Oct.	85	APC	82	The Art of Programming — Progress. (Hjaltson)	(-)
Jun.	85	APC	170-171	Comment on binary search. (Lamich)	(1)
Jun.	85	APC	171-173	Comment on disbribution sort. (Riordon)	(1)
Oct.	85	YC	107-8	Sorting out the sorts. (Jankowski)	(1)

— to page 121

ADMARKET

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with Roy Hill

WELCOME to the first of what we hope will be a monthly appearance of this column. I have been asked to write this as a regular news/update feature of the magazine on the topic of computer communications, with special emphasis on the Maestro Supermodem (AEM4610) and its associated expansion boards and peripherals. This has been prompted largely by requests from constructors and users for on-going support. The success of this column will therefore depend to a large extent on contributions from you. So here's the offer!! Let's here your comments, suggestions or any ideas you may feel will make a contribution to the success of the Supermodem. Every contribution will receive a full evaluation between myself and the designers of the project, Chris and Dan Darling. Please feel free to criticise the column and/or the modem, but please be constructive (i.e: suggest how improvements may be made) rather than destructive in your criticisms. We'll also entertain queries on the other AEM project modems, plus suggestion on modifications, additions, etc.

Firstly, a progress report on what has been happening to the Supermodem itself. Sales of both the kit and the completed article have been phenomenal. In fact, sales have been so good that I still don't have a modem myself full-time! Yes, I did build one (I had to build one to be able to write the series of articles from a constructor's point of view), but I only had it for a while — someone out there is using the modem I built. Chris (who designed the software) only got his own modem quite recently. Brother Dan kept filching each one he built and sending it elsewhere! I believe that Chris has pro-locked (i.e: professionally locked) this one to his workbench.

V.22 and other news

The V.22 expansion board is very close now — a prototype has been worked up and proven and the first circuit boards are due for delivery within weeks. A dedicated Videotext board is also near to production, so you can expect to hear more about that in the next few issues, followed by a speech synthesis expansion board. Your Supermodem will then be able to TALK to people (it may even be possible to make it sound like you — just think of the possibilities!).

A Version 5 update of the Maestro EPROM is available from Maestro Distributors (Calool St, South Kincumber 2256) for the cost of $15. Please send back the old one when you receive the latest — they can be re-cycled and this helps to keep costs down. V5 contains several additional commands that were not available on previous releases (see the Command Summary Table this column). However, for those with patience, V6 is not far away now, Chris assures me, and it will contain significant differences to even V5 (i.e: it will contain V.22 routines).

Bugs, fixes & other updates

1. Pin 14 of IC24 (the 1488 line driver) has had the power supply changed from +5 to +12 V. It was found that performance was more consistent at the higher voltage.

2. The output (pin 3) of IC16 (the 555 timer) is the opposite logic to the RESET line. That is, the output is high on power-up and then goes low. The output is then inverted through pin 1 of IC7 (a 74LS04 inverter).

3. The 74LS251 chip is completely interchangeable with the 74LS151 — your Supermodem may contain either.

4. It has been found that IC20 performs better if R9 is changed to a 470 ohm resistor, rather than a 100 ohm resistor. Check the value before you replace it — only early versions had the 100 ohm resistor.

5. The test procedure for IC9 (the 6821 PIA) is incorrect. However, the procedure for IC13 is correct. Because the two chips share the same address and data buses, there is no real problem with checking them out. If there appears to be a problem with one of the PIAs, try swapping them around (you can do the same thing with the two ACIAs if you suspect either of them).

One of the most frequent requests coming both to Maestro and AEM is for a detailed quick reference chart for the Hayes AT command set as it applies to the Supermodem. The original table (AEM June 86, pp 90-96 inc.) was incomplete and had a few minor bugs. The updated version is given here in a form suitable for cutting out and pasting on a piece of cardboard for keeping beside your computer. Commands that have not been included in the previous construction articles will be printed in *italics*. Commands whose functions have been modified or expanded will be printed in **bold type.**

Use of registers

This section provides details of the modem registers available for use with programmers or those wishing to take advantage of options within communications packages. Refer to Note 5, also.

Register	Range value	Default	Function
0	0->225	0	This register controls the number of rings before the auto-answer responds.
4	0->127 ASCII	10	Line Feed character.
10	1->255 (x 1/10s)	7	Delay time between loss of carrier and auto-disconnect of the modem.

REGISTER 0

This determines the *approximate* number of rings the modem will count before it will auto-answer the incoming call. If a value of 0 is selected (the default value), then the modem **will not answer any incoming call until this register is set to a non-zero value.** When this value is changed to a non-zero value, the modem enters the Auto Answer Mode (see below).

REGISTER 4

This register determines the character sent after the carriage return when receiving responses from the modem. If you do not need or want a linefeed character, then you can change this value to a null character (using command ATS4=0), but you cannot disable line feeds.

REGISTER 10

This register determines the delay time for which the carrier signal can disappear from the line, without your modem disconnecting. Assigning the maximum value of 255 tells your modem to ignore the Carrier Detect signal status and act as if a carrier is constantly present.

CHANGING A VALUE

To change a register's value, use the 'Sr=n' command where 'r' indicates the register number and 'n' indicates the new value. For example, if you wanted the modem to answer the phone on the sixth ring, you need to issue the command 'ATS0=6' and press return. You will then receive the standard 'OK' response if you have typed the command correctly.

AUTO ANSWER MODE

Auto Answer is the mode set to allow the modem to await incoming calls. This mode is activated when Register 0 is set to

AEM4610 SUPERMODEM COMMAND SET SUMMARY

COMMAND	PARAMETERS	FUNCTION	EXPLANATION
ATA	—	Manual Answer	This puts the modem *immediately "off-hook"* to wait for a carrier. (1)
ATC	0	Transmitter Off	Turn off the transmit Carrier Enable on the modem.
	1*	Transmitter On	Turn on the Transmit Carrier Enable on the modem.
ATD	P*	Use Pulse Dialling	
	T	Use Tone Dialling	(Not supported in current version).
ATE	0	No Echo	Don't display commands on the screen.
	1*	Echo	Display commands on the screen.
ATF	0	Half Duplex	The modem will echo characters as they are sent to the remote computer.
	1*	Full Duplex	The modem will echo charachters as they are re-transmitted from the remote computer. This only occurs in the On-line mode.
ATH	0*	On Hook	Telephone circuit is disabled — can't transfer data — can dial.
	1	Off Hook	Telephone circuit is enabled — this command is not often used.
ATI	—	—	**Display the Version Number** of the software.
ATL	—	—	Display Menu and current status setting — enable changes to the current setting.
ATM	0	Speaker Off	Can't monitor the dialling sequence.
	1*	Speaker On Temp	Speaker on until carrier is detected — then off. (2)
	2	Speaker On	Leave the speaker on all the time.
ATO	—	On-line	Change from COMMAND mode to ON-LINE mode (3)
ATQ	0*	Modem Response	Echo modem responses to host computer. (4)
	1	No Modem Response	Don't send modem responses to the host computer.
ATSr = n	—	**Registers**	**16 status registers** used by modem — several available to users. (5)
ATV	0	Digit Responses	Send message numbers only to host computer. (6)
	1*	Message Response	Send messages instead of numbers to host computer.
ATW	*0**	*Normal Operation*	*Normal operation — auto bps* turn-around disabled. (7)
	1	*Enable Auto-turn*	*Auto turn-around feature* enabled.
	2	*Toggle V.23*	*Toggle between 1200/75 and 75/1200.*
ATX	0*	Basic Responses	Use the standard (abbreviated) response set.
	1	Extended Responses	Use the extended response set.
ATZ	—	System Reset	Reset all options to their default values and re-initialise the modem. Use this feature as an "if all else fails — bail out" procedure.
AT,	—	Pause	Insert a Pause in a command. (8)
+ + +	—	COMMAND Mode	Return to COMMAND mode (or return control to the communications pacakge in use) from the ON-LINE mode.
A/	—	—	Repeat the last command line — may also be abbreviated to '/' by itself.

NOTES:

* All commands so marked are the default settings on power-up or on RESET (either hardware or software).

1. When this command is invoked, the action taken depends upon the current menu selection. If the current selection is an **ORIGINATE** selection, the modem will immediately go off-hook and await a carrier. If the current selection is an **ANSWER** selection, the modem will immediately pick-up the phone and send a carrier. Monitoring of the DTR line for default to Auto-answer mode has not yet been implemented, due to no requests from users. If anyone is interested in seeing this feature included, please let us know.
2. The default setting for this command is automatically selected on power-up. If the user wishes to have the speaker remain on-line after a carrier is detected, the command ATM2 should be entered prior to the dial (ATD) command, or on the completion of the telephone number, immediately prior to pressing <RETURN>.
3. The ON-LINE mode is used to permit the host and remote users to type information on their keyboards and have that information appear on their respective screens. This means that the users are conducting a two-way typographical conversation. It is not possible to issue commands in the ON-LINE mode. To return to the COMMAND line, it is necessary to wait one second after the last character has been typed, type three '+' signs, wait another second and then press <RETURN>. This will produce the standard response 'OK', indicating that the user has returned to the command mode.
4. The default setting for this mode allows for any messages from the modem to be displayed on the host computer. If this feature is turned off, no messages wil be sent. Several of these commands (ATQ, ATV and ATX) have an interactive effect. It should be fairly self-evident that if the zero parameters for either ATQ or ATV are selected, any parameter set for ATX will be irrelevant.
5. 'r' indicates the register number (0–>16) to be interrogated/modified and 's' indicates the value (0–>255) to be placed in the register. The three status registers which may be of use are 0, 4 and 10. Their use will be described at the end of the notes. These are the only registers that users should attempt to modify.
6. It is normal to select message responses from the modem. If you find that you don't get an 'AT ERROR' message or the 'OK' message, but receive a number instead, then you should reset the ATV Setting to 1.
7. This new feature has been added to allow the user to obtain maximum benefit from 1200 bps transmission. With a setting of 0, the V.23 mode is treated as per normal and any drop out or loss of the carrier will result in auto-disconnection, depending upon the value selected for Register 10. With the parameter set to 1, the modem will enable the auto turn-around feature. In mode, the loss of a normal V.23 carrier will cause the modem to wait up to 30 seconds for a reversed V.23 carrier. When the reversed carrier is detected, data connection will be re-established and the 'CONNECT' message will be sent to the host computer. Data transfer cannot recommence until the 'CONNECT' message is received. Under normal circumstances, the switching of the V.23 signal will occur within one and a half seconds. If a key is pressed within this waiting period, the modem will abort the auto turn-around and return to COMMAND mode. With the parameter set to 2, the V.23 line is toggled between 1200/75 and 75/1200. That is, if the modem is currently communicating at 1200/75, the modem will switch to 75/1200 and remain in the **data transfer** mode, or vice versa. This effectively enables users to communicate over telephone lines at 1200 bps in both directions.
8. A pause may be necessary in the dialling sequence to allow time for exchanges using crossbar switching mechanisms to activate, or to allow an outside line to be locked in from an internal PABX switchboard. As many commas as necessary to obtain the desired length of pause may be inserted into the dialling sequence. Each comma generates a pause of about one half second.

a non-zero value. When a non-zero value is set, the modem will wait for and then answer an incoming data call. This mode is activated **immediately** upon changing Register 0. In this mode, the modem will only respond to the 'AT' command or an incoming call. The 'AT ERROR' message is disabled. If you enable Auto Answer mode, the keyboard of your computer will appear to be inactive, except in response to an 'AT' command, or until an incoming call is detected by the modem. If the modem receives an incoming call, but does not detect a carrier, or, if data connection is established and the call is terminated,the modem will stay in Auto Answer mode until Register 0 is either reset to 0, or the modem is hardware reset.

When a call is received by the modem in Auto Answer mode, the modem will automatically adjust its receiving bps rate to match the transmission speed of the transmitting modem. This feature is known as Auto Ranging (or Auto Baud Rate Sense). Auto Ranging will not affect the communication rate between the Supermodem and the host terminal/computer/communications package — it only operates on the external Telecom line. Selection of this option requires great care and consideration on your part. If your terminal/computer is communicating with the Supermodem at 300 bps and the Supermodem is in the Auto Answer mode (as selected above), and an incoming call is received at 1200 bps, then your terminal/computer will only receive every third character.

That's all I can fit in for this issue, more next month. Please don't forget to send those requests to me at "Dial-up", AEM PO Box 289, Wahroonga 2076.

Improved radio link for NSW emergencies

A new radio communications network, established by the Bush Fire Council of NSW, could bring a significant improvement to the control of future emergencies.

Mr George Paciullo, Minister for Police and Emergency Services, in inaugurating the new network at Picton in August said, "It is one of the most important moves to facilitate greater co-operation and co-ordination between emergency services made in recent years.

"Operating on newly developed Philips equipment, the UHF radio network will enable greater efficiency when emergency services combine for operations, for example during bush fires which cost the community $46 million in a typical summer."

Installed at Mount Gibraltar, near Bowral, the Philips equipment consists of an FM815 talk-through repeater. Five bushfire control centres, with Philips FM92 desk-top trigger base radio systems, use the Mount Gibraltar repeater for talk-through operation between each other.

This link-up is the first of what is to be a series of systems throughout the state. Called 'strategic radio networks', they will form an information exchange between senior emergency service personnel.

While the network of repeaters will be used by the Bush Fire Brigade organisation, the Bush Fire Council said other emergency organisations would be welcome to join the network. These would include land management agencies such as the National Parks and Wildlife Service and Forestry Commission and the other emergency services — police and ambulance — and also the army.

"Strategic radio networks will solve the vexing problem of inter-service communication when emergency services combine during major bushfire fighting operations," said Mr Koperberg NSW Bush Fire Council Chairman. "With strategic radio networks operational throughout NSW, greater co-ordination of emergency services and their resources will be possible."

Gary Ghent, group general manager of Philips Communication Systems, stated "The FM900 series of Australian-developed radios, to which the FM92 base equipment belongs, is probably the most widely used by emergency services throughout Australia and is even used by the police force in London", he added. "It has also won the Australian Design Award for both it's electronic and functional design."

Philips Communication Systems radio communications manufacturing centre at Clayton Victoria is the major producer of radio communication equipment in Australia and maintains a valuable export market.

Mr Paciullo NSW Minister for Police and Emergency Services, inaugurated the new repeater facilities.

New 10-500 MHz digital attenuator

A 10-500 MHz, six-step digital attenuator has been announced by Alpha Industries' Microelectronics Division.

The unit features 1 μs switching speed, six-line control and TTL compatibility. It is supplied in a hermetic enclosure.

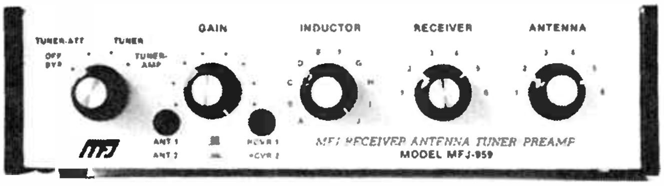
The Insertion Loss is 4.5 dB typical, operating at +5 Vdc, 175 mA max.

Alpha Industries is a major manufacturer of materials, devices, components and subsystems used in microwave applications for the defense electronics, commercial telecommunications and other commercial markets; represented in Australia by **Benmar International Pty Ltd, GPO Box 4048, Sydney 2001 NSW.**

Active antenna matcher for SWLs

Most short Wave Listeners are faced with the problem of not being able to physically accommodate an antenna for each band they are interested in listening to. Alternatively it is difficult to obtain a suitable broadband antenna which performs adequately.

MFJ has solved the problem by building the MFJ-959 Active Antenna Matcher. With it, they claim, an SWL can now use a single random length of wire, which may be of any length that best suits his real estate, and still obtain 'dipole-plus' performance over all shortwave bands.



The importers, GFS, say users have reported up to seven S-points improvement over using just wire on its own.

The MFJ-959 can provide this performance because it electrically matches the antenna to 50 ohms, at the frequency of operation, then introduces 20 dB of gain at 50 ohms to the receiver.

Other facilities on the MFJ-959 are twin coax switches designed to allow the users to select between two different antennas. It also incorporates an additional front panel coax switch which allows the 959 to be bypassed completely, the tuner or matcher section only to be used, the matcher used with the preamp and, if necessary, 20 dB of attenuation to be inserted.

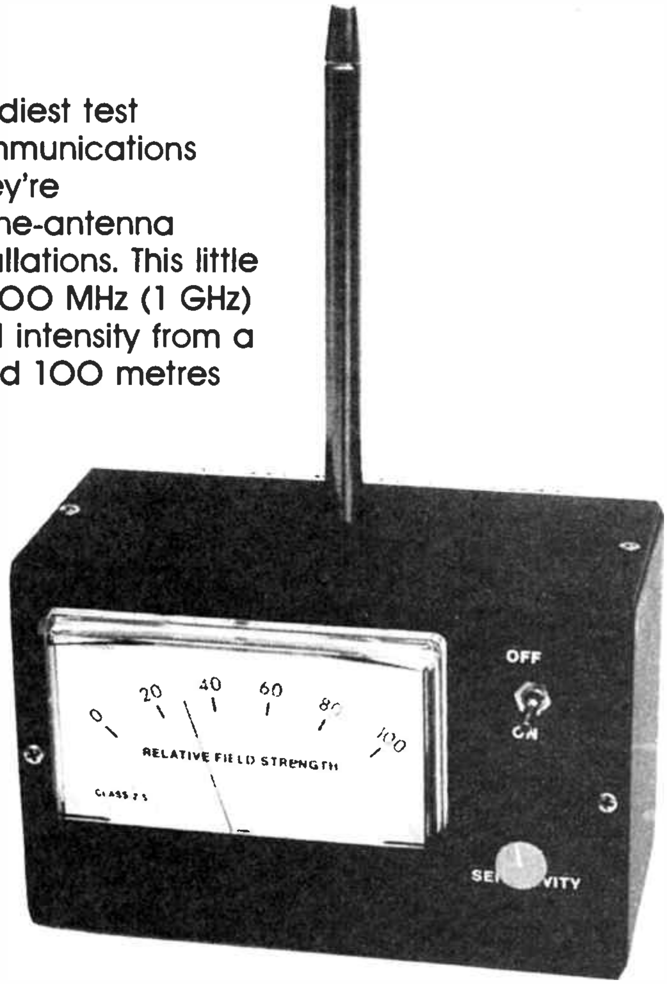
Power requirements of the MFJ-959 are 9-18 volts. All input and output connectors are rear panel mounted and duplicated in both SO-239s and RCA types.

If you would like more information, contact **GFS Electronics, 17 McKeon Road, Mitcham, 3132 Vic. (03) 873 3777.**

Amateurs, CBers — build this RF field strength meter

Dick Smith Electronics
Technical Products Division

An RF field strength meter is one of the handiest test instruments any radio amateur, CBer or communications service technician could have on-hand. They're indispensible for checking transmitter-feedline-antenna systems, especially mobile and marine installations. This little unit performs across the range 3 MHz to 1000 MHz (1 GHz) and is sensitive enough to indicate the field intensity from a 144 MHz 1 W handheld transceiver at around 100 metres distant.



A view of the completed prototype.

THE FINAL CHECK for any transmitter installation is RF field strength. A means of measuring field strength, or 'relative' field strength, is pretty well essential when making adjustments or alterations to a transmitter installation which involves varying any part of the transmitter-feedline-antenna system. After all, you want to know whether you're making an improvement or going backwards!

To provide the widest possible application, this project had to cover a very broad frequency range, virtually from the 2-3 MHz marine band, right through to the 477 MHz UHF CB band, or beyond. For simplicity, this meant an untuned or 'aperiodic' design. Now, RF field strength meters are generally little more than a crystal set under a different guise, having a sensitive dc current meter (usually a micro-ammeter) on the output rather than headphones. If it employs a tuned circuit, the Q of the LC circuit provides a measure of voltage amplification. But we don't have that benefit without tuned circuits, and the unit's sensitivity suffers accordingly. However, with the addition of a simple dc amplifier, one can gain all the sensitivity required.

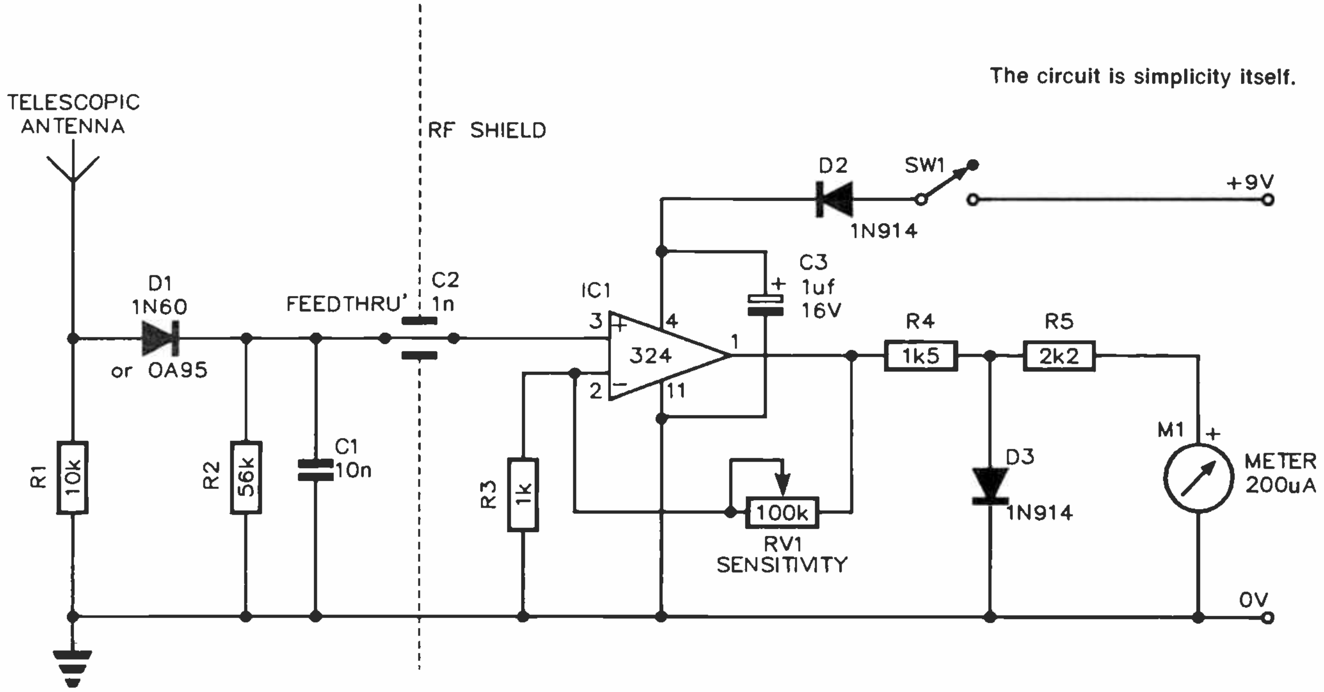
A telescopic whip antenna, of the type you commonly see on protable transistor radios and "ghetto blasters," provides the pickup antenna. The detector is quite straightforward, employing a sensitive germanium diode. The detector's dc output passes to the non-inverting input of an op-amp used here to provide the dc amplification. An RF shield separates the circuit sections, the detector output passing to the dc amplifier via a feedthrough capacitor which effectively prevents RF 'leaking' between the sections via this connection. RF leakage into the op-amp may upset the op-amp's performance, particularly at the lower frequencies.

Variable sensitivity is arranged by providing variable dc negative feedback around the op-amp. The gain can be varied from unity ('1') to 100. The op-amp's output drives a large face (65 mm) 200 μA meter which is easily seen from a distance of around five meters or more (depending on age and eyesight!). Some meter overscale protection is provided by resistors R4 and R5, and diode D3, which together limit the maximum current that can be supplied to the meter. The op-amp is powered from a 9 Vdc transistor radio battery.

Actual frequency response will depend very much on the telescoped length of the antenna, but the unit works well across the range 3 MHz to around 1000 MHz. At the upper end of the range, sensitivity will depend on whether the antenna is set close to a half wavelength or a quarter wavelength. The former will generally provide better sensitivity.

Apart from the applications already mentioned, the project has applications such as a 'bug' detector, an RF cable leakage detector and for checking antenna radiation patterns (particularly mobile and marine antenna installations). ▶

The circuit is simplicity itself.



CIRCUIT DESCRIPTION

Passing RF energy induces current in the antenna which is expressed as a voltage across R1. The RF is rectified by D1, the output being 'smoothed' by R2/C1, although the time constant here will not 'strip-off' amplitude modulation. The feedthrough bypass capacitor, C2, has a role to play, particularly at the higher frequencies. The detector section is shielded from the dc amplifier section to prevent RF energy, particularly at the lower frequencies, possibly getting into the op-amp input, upsetting its operation.

The dc amplifier is provided by one op-amp from an LM324 quad op-amp package. This op-amp requires only a single supply rail and the input can 'work around' ground, or 0 V. RV1 varies the gain of the op-amp, and thus the unit's sensitivity. Maximum gain is × 100.

The op-amp output drives a 200 µA meter via the resistor-diode network, R4, R5, D3. The diode effectively "clamps" the maximum voltage applied to the meter to about 0.7 V, while R4 limits the op-amp's output current and R5 limits the meter's maximum coil current. This prevents inadvertent "slamming" of the meter needle with an unexpectedly strong signal.

Diode D2 provides for reverse supply polarity protection. Capacitor C3 bypasses the op-amp's supply pins.

Construction

The project is very simple to construct. It is built on a small pc board that mounts directly on the meter terminals. Only the sensitivity pot and the power switch are off-board. The telescopic antenna mounts via a small right angle bracket which bolts to the board. The case for the unit provides some support for the antenna, which passes through a grommeted hole in the case top.

Before commencing, check the pc board to see that all holes are drilled and of the right diameter. The RF shield, a length of single-sided pc board about 12-13 mm wide, should be assembled to the board first. First solder the feedthrough capacitor in place. Then solder three 'pc pins' in place on the board as indicated on the component overlay. Lastly, solder the shield to the pc pins.

Now all the small components can be soldered in place on the board. Take note of the polarity of the three diodes, the tantalum capacitor and the IC. When soldering the resistors on board, note that R5 'stands up' on one end. Bolt the right angle bracket for the antenna foot in place. Solder suitable lengths of hookup wire to the appropriate places on the board for later wiring up of SW1, the battery and the sensitivity pot. Now check it all thoroughly. Correct any errors before proceeding.

A Scotchcal meter scale is supplied with the project, and this may now be fitted in place. Take care to position it accurately. A Scotchcal front panel label is also supplied. Attach this to the box. Scotchcal is most easily positioned when you first soak the Scotchcal itself and wet the panel before applying it. This allows the label to be readily slid around the surface for accurate placement.

Screw the completed pc board to the terminals on the rear of the meter. Note that the RF side of the board (where the antenna attaches) goes uppermost (faces the same way as the 'top' of the meter scale).

The Horwood box supplied has two 'ends'. Remove these. Mount the sensitivity pot and on/off switch, taking care not to damage the Scotchcal label. Bolt the battery holder in place. Put the rubber grommet in place in the hole in the 'top' of the box. Now mount the meter, followed by the telescopic whip antenna.

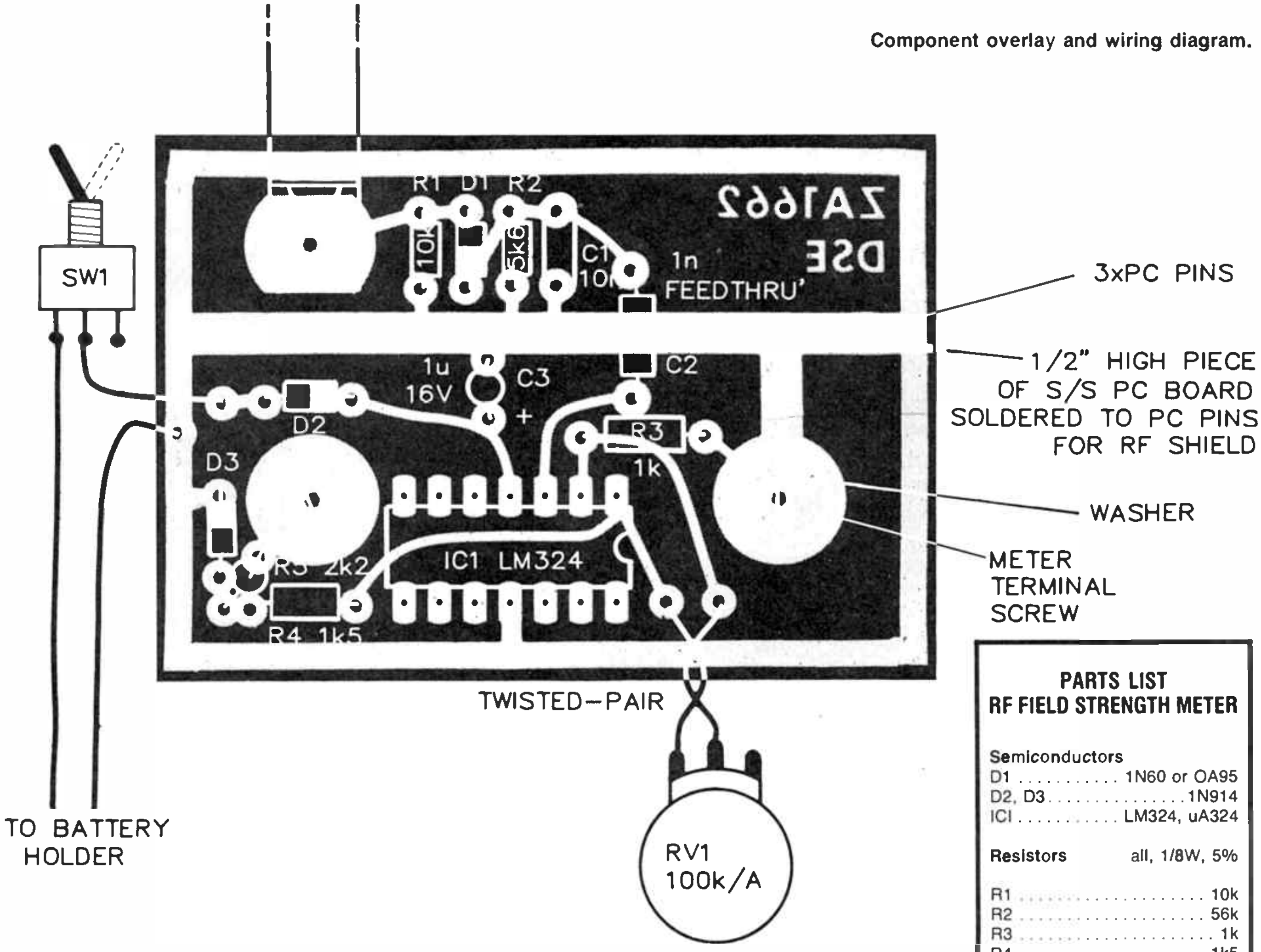
Finally, wire-up the flying leads to the pot, on/off switch and battery holder. You're ready to go!

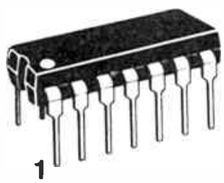
Firing up!

Try it out with a signal generator and a short length of wire. You'll likely need quite close coupling between the two. First set the unit's sensitivity pot to minimum and wind up the generator output. Adjust the sensitivity for a reading. If you get little or no sense out of it, go searching for an un-made connection, or wrongly oriented diode, before seeking other faults.

If or when the unit behaves sensibly, try using it with a 'real' transmitter installation. A little experimentation will soon familiarise you with using the project to best advantage.

Component overlay and wiring diagram.





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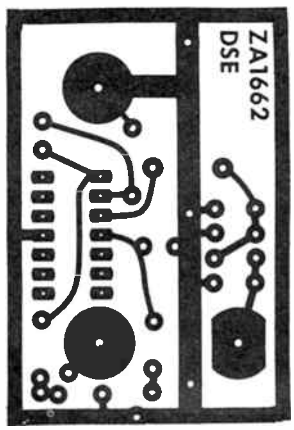

PARTS LIST
RF FIELD STRENGTH METER

Semiconductors
D1 .... 1N60 or OA95
D2, D3 .... 1N914
ICI LM324, uA324

Resistors all, 1/8W, 5%

R1 .... 10k
R2 .... 56k
R3 .... 1k
R4 .... 1k5
R5 .... 2k2

RV1 .... 100k/A pot.

Capacitors
C1 .... 10n disc ceramic
C2 .... 1n feedthru'
C3 .... 1u/16 V tant.

Miscellaneous
M1 .... 200 uA, 65 mm scale meter

Sw1 .... SPDT toggle switch (S-1173)

ZA1662 pc board; Horwood aluminium instrument case 100 × 152 × 77 mm; telescopic antenna, cat. no. L4902; right angle bracket, cat. no. H1895; rubber grommet, cat. no. H1719; battery holder for No. 216 battery; Scotchcal front panel; knob; meter face plate; two 3 × 6 mm CSK bolts with nuts and flat washers; one 4 × 12 mm roundhead bolt with two nuts and lock washers; one 3 × 6 mm bolt with flat washer to suit base of telescopic antenna; solder, hookup wire.

Kit Price: $49

— from page 114

AEM	Australian Electronics Monthly
APC	Australian Personal Computer
BYC	Bumper Book of Programs by YC
CC	Creative Computing (US)
CFG	Computer Fun and Games
CT	Computing Today (UK)
CHC	Choice
EA	Electronics Australia
ETI	Electronics Today International
MBO	Micro-80
MC	Micro Choice (UK)
PCG	Personal Computer Games
PCN	Personal Computer News (UK)
PE	Practical Electronics (UK)
WM	Which Micro (UK)
YC	Your Computer

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Personal opinion

Heads in a cloud over high-tech

Russell Kelly
Vicom, Communications engineers, Melbourne

GOVERNMENTS at both State and Federal levels have their heads in a cloud over hi-tech industries. The fact is that Barry Jones and his Department are preoccupied, even mesmerised, with the software industry. They seem to regard it as the panacea for all Australia's export ills.

What they don't seem to recognise is the important role that can be played by the electronics industry and other middle- to high-technology industries.

My own company is experiencing a growth rate of 50 per cent a year. I expect current annual sales of $6 million to reach $10 million by next year and more than $20 million by 1990. That's worth considering!

A gross mistake is being made that could have serious repercussions on Australia's capacity to compete effectively in export markets. Let's face it, an eight-year-old kid could develop a lot of the software that's being bandied about as hi-tech.

What Governments have to do is to look at what is really exportable and so-called hi-tech, with it fetish for second board listings and attendant high risk, is not really where the action is.

Vicom is a leading supplier of electronics for communications systems and is currently involved in intensive research and development work to cater for a worldwide market. We are already producing state-of-the-art electronics for communications systems and I predict that Vicom alone, within five years, will generate export earnings in excess of $20 million. These are figures that cannot and should not be ignored by governments.

The apathy of governments is further reflected in the lack of planning in the education of young engineers to work in the industry.

As an example, when we asked for an appraisal of the work of a young Vicom apprentice from his school we found that it was devoting a whole unit to valves. Valves haven't been around for twenty years!

There are important things that they should be teaching but aren't and it's left to us.

But one of the really big problems is that the schools will not go out and talk to the industry. The last time we tried to encourage dialogue we were told to mind our own business. Similarly, universities are only concerned with theory and research. In a practical sense, they are a dead loss. Only a few institutions — Colleges of Advanced Education, particularly Canberra, with its new communications Engineering course, and Swinburne and Footscray in Melbourne — are producing graduates in tune with the industry. But they cannot hope to provide nearly enough to meet the requirements.

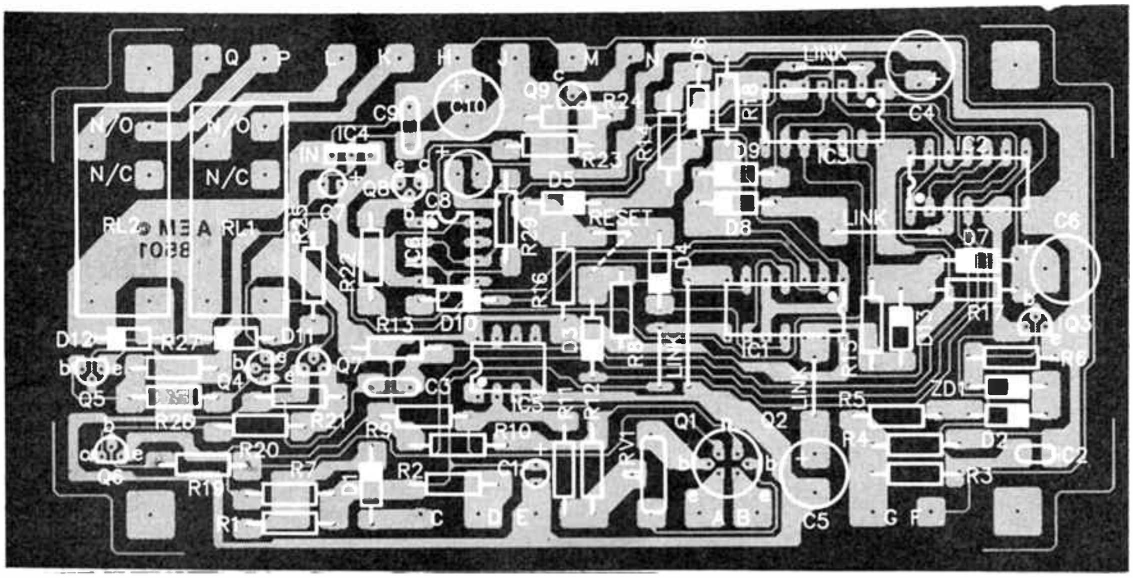
The industry has made semi-formal approaches to various educational institutions but the results were so disappointing that we've pretty well given up.

Put simply, the educational situation is so bad that we have had to import engineers to satisfy contracts.

The end result of this lack of proper education standards and manpower planning and government inaction is that we are looking very seriously at setting up our major manufacturing and research and development base in the United States. Not only have the US got the human resources but just as importantly they have the mental environment, the excitement and enthusiasm to get things done.

It's a shame, but it is clear that governments and the system in Australia are letting the communications engineering industry down. I regard it as the role and responsibility of government to provide not only properly educated people but also the necessary mental environment in which they know they are achieving. What we don't need is paying lip service to technology.

Hi-tech is the buzz word, but there's a lot more to the issue than that. And the sooner it's recognised the better.



Component overlay. The board is fairly dense and care needs to be exercised during assembly of the components.

— from page 88

Once the check has been completed, you can begin loading the pc board by positioning the resistors, small capacitors and links. Be aware that the tantalum capacitors are polarised components and as such need to be oriented appropriately so as to avoid damage. The best and simplest method to create links is by using the offcuts of the resistor leads. Remember, however, that the positioning of the link directly above components D8 and R8, shown on the accompanying component overlay, will determine an option provided in the design.

By positioning the link as shown in the overlay, the alarm will reset itself in the event of triggering after the preset time has elapsed. With the link in this position the alarm will automatically reset to its original condition. However, as discussed above, the light will remain constantly on so as to indicate the attempted theft. This means that if the situation which caused the triggering still exists, the alarm will detect this and trigger once again. The net result is that the alarm will be heard to sound continuously until such time that the triggering condition is removed.

The option chosen by positioning the link shown on the overlay by a dotted line is that of 'automatic disarm'. If the alarm has been triggered and the preset time has elapsed, the alarm will completely disarm itself but will leave the light constantly on again to indicate triggering. The obvious disadvantage to this option is that your vehicle is left vulnerable to any further attempts. The advantage, however, is that the horn will cease and therefore the battery (and those within earshot!) will not suffer unnecesarily.

The next group of components to be positioned should be the diodes and transistors. They need to be oriented according to their polarity. Be especially careful not to interchange the BC639 transistors with the BC558 or BC548 transistors. This is important because the BC558s are PNP types while the BC548s are NPN devices with the same pinout, and the BC639 has an altogether different pinout. The remaining components in this section are the zener diodes and the LM394 'super-matched pair'. This device is a highly matched pair of transistors in the same package, which ensures the best thermal tracking. By following the component overlay you will ensure the correct positioning of these components, thus avoiding unnecesary problems or possible damage.

Finally, the ICs, electrolytic capacitors and relays can be soldered into position. The electrolytic capacitors are polarised and therefore need to be positioned accordingly. The six ICs need to be positioned with their first pin aligned as shown in the overlay. The final components to be positioned are the relays. It is a good idea to leave these until last as their physical size would hamper the placement of smaller components which may place unnecessary stress on their leads. ▶

AEM8501 PARTS LIST

Semiconductors

IC1-IC3	4093
IC4	7805
IC5	uA311, LM311
IC6	555
Q1, Q2	LM394
Q3	BC548
Q4	BC558
Q5	BC639
Q6	BC558
Q7	BC639
Q8	BC558
Q9	BC639
D1-D12	1N914
ZD1	5V1/1 W zener

Resistors — All 1/4W, 5% unless noted

R1	10k
R2	47k
R3	470k
R4	560R
R5	1k
R6	100k
R7	470k
R8	10k
R9, R10	33k, 1%
R11, R12	2M2, 1%
R13	470k
R14	1M
R15	4M7
R16	100k
R17	1M
R18	100k
R19	4k7
R20	270R
R21	10k
R22	4k7
R23	270R
R24	10k
R25	4k7
R26	270R
R27	10k
R28	1k
R29	100k
RV1	2k preset

Capacitors

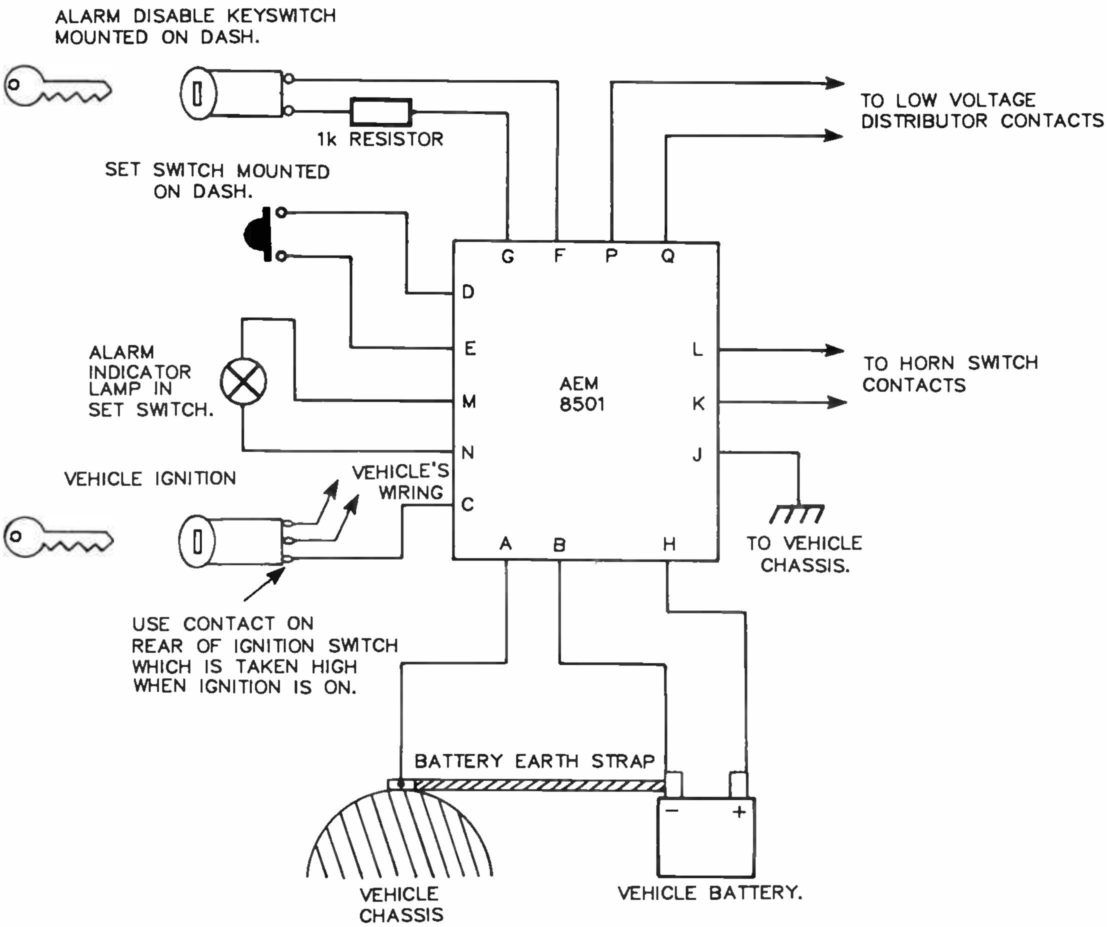
C1	2μ2/10 V tant.
C2, C3	220n poly. (MKT)
C4	22μ/16 V RB electro.
C5	47μ/16 V RB electro.
C6	22μ/16 V RB electro.
C7	10μ/10 V tant.
C8	4μ7/16 V RB electro.
C9	100n poly.(MKT)
C10	470μ/16 V RB electro.

Miscellaneous

RL1, RL2	12 V relay with 5 A contacts, e.g: DSE S-7125.
SW1	illuminated pushbutton, e.g: DSE S-1520.
SW2	keyswitch.

AEM8501 pc board; 15-way terminal strip; Aluminium diecast box 150 x 50 x 80 mm (e.g: DSE H-2206, or similar); nuts, bolts, solder, epoxy or sealing compound, hookup wire.

Expected cost: $75-$85



Wiring diagram.

At this point I would like to mention the automatic ignition killer option. If you decide you do not wish to use this option there is no need to include R25, R26, R27, Q4, Q5, D12, and RL2. The rest of the alarm's operaton will not be affected.

Finally, the pc board should be complete. with the exception of the wiring which can be simply achieved by soldering lengths of wire to the points indicated by the overlay. These wires need only be long enough to wire to screw terminal blocks mounted on the outside of the box.

You should now do a final check of the board to ensure that all of the components have been oriented correctly and inspect the solder side for any solder bridges.

When mounting this board into a box, we recommend the use of an aluminium type as detailed in the parts list elsewhere in this article. A metal box is preferable for this application since it will assist in shielding the CMOS ICs to decrease the possibilty of false triggering. Mount the eight-way terminal strip on the side of the box closest to that side of the pc board which has eight output pads. Mount the seven-way terminal strip on the other side.

The project should now be ready for mounting into the dash of your vehicle. Before doing this it is advisable to wire it up and test the alarm as a fully operational unit. Set the sensitivity preset on the pc board until the alarm triggers to your satisfaction, as described in the Set Up section later in the article.

If all is well, it can be mounted under the dash of the vehicle. This should be located in a position that is inconspicious and difficult to reach. The light and the keyswitch can be situated anywhere convenient within the car. The light should be easily visible from the outside of the vehicle to act as a deterrent. However, it is advisable to mount the keyswitch somewhere not so obvious from the outside so as to avoid an attempt at 'hot-wiring' the alarm. As discussed earlier, an attempt of this nature would be futile due to the safety feature designed into the project.

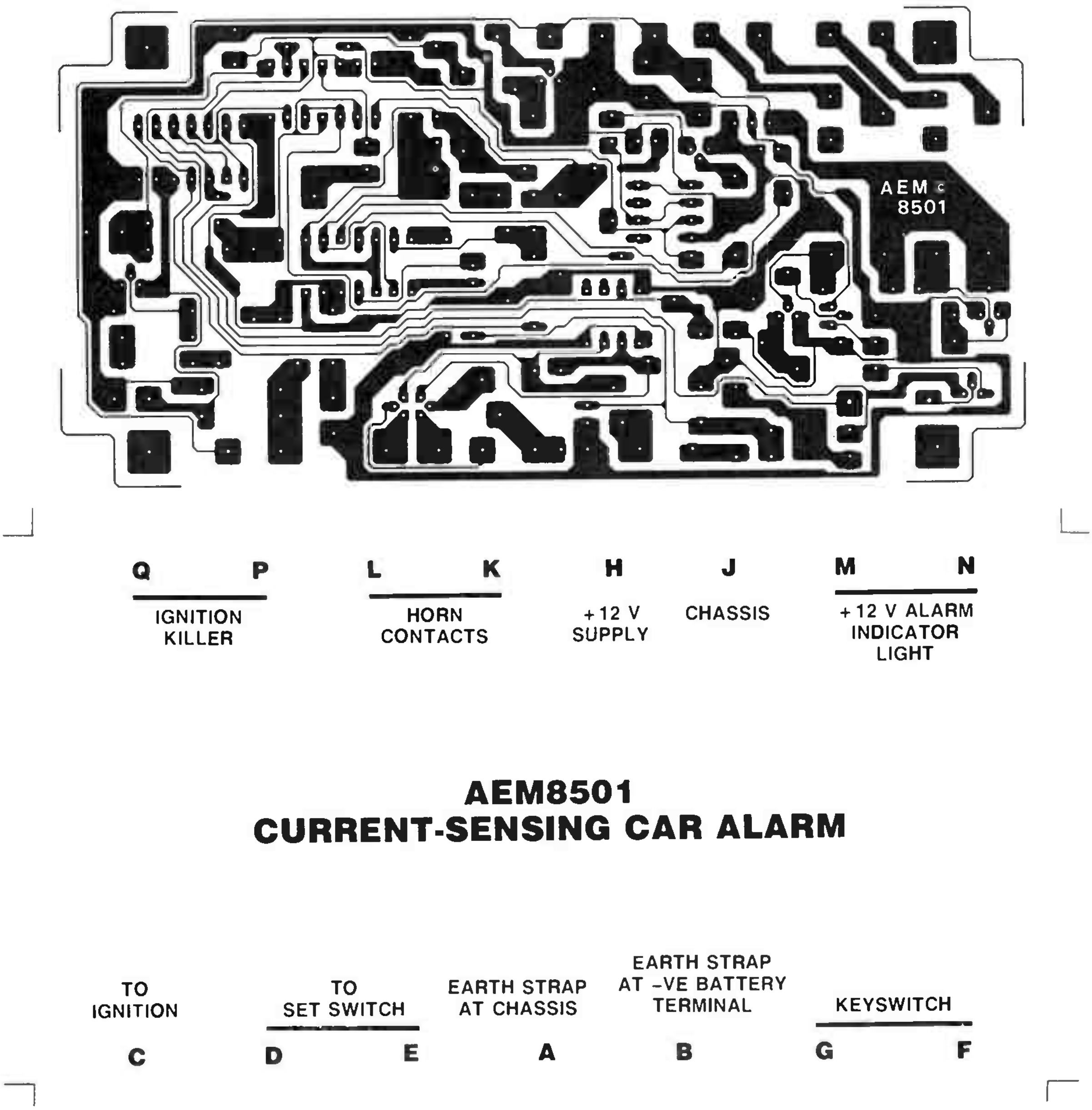
To accommodate this feature the switch must be modified slightly to include a resistor to provide the 'correct' impedance for the alarm circuitry. To do this, simply solder a 1k resistor to one terminal of the switch. The connections to the pc board are made by wiring to the free end of this resistor and to the other terminal of the switch. Once it has been wired, the back of the key-switch should be fully enclosed, incorporating the resistor, by some kind of epoxy or sealant to ensure inaccessability to the wiring of the switch. This leaves only the wiring after the resistor accessible which, when shorted, has no effect on the operation of the alarm. To hot-wire the alarm, the thief must first remove the protective epoxy or sealant, by which time the alarm will have sounded.

The wiring should be carried out as per the accompanying wiring diagram. Be careful to ensure that the box is mounted securely and that all of the wiring has good, strong electrical and physical connections. Take care to run the wires to the battery strap and ignition circuitry along with the vehicle wiring loom, to avoid possible damage or tampering.

Setting up and using the alarm

The only set up procedure necessary is to adjust the sensitivity preset, RV1. This is reasonably simple. Place your multimeter across the entry delay capacitor, C6. Without any current being drawn from the battery (other than by the 8501), adjust the preset until C6 won't charge and take note of the setting of the preset. Opening the door should now trigger the alarm. If not, check the preset adjustment and the wiring to the earth strap. Whilst the door is open, and hence the courtesy light on, turn the preset until the alarm just fails to trigger and take note of this position on the preset. The ideal setting will be with the preset wiper centred between these two positions. If, after setting the preset, you discover that the alarm is triggered by the car radio or other appliance, simply reduce the sensitivity by adjusting the preset towards the latter of the two positions.

Using the AEM8501 is simplicity itself. You've parked your motor vehicle for the evening, but are somewhat disturbed regarding its safety. To arm the alarm you simply push the arming button which also doubles as the indicator light. This light will now turn on constantly, indicating that you have approximately 30 seconds to exit the vehicle and ensure all doors are closed. At the end of the thirty seconds, the light will begin to flash indicating that the alarm is now armed, and any current being drawn from the battery will trigger it. To enter the vehicle after returning, you have another thirty secounds in which to disarm the alarm. As soon as the door has been opened and the courtesy light is switched on, the alarm will be triggered and the alarm light will remain on constantly, indicating that the horn is about to sound. At the instant of opening the door, the automatic ignition killer cuts in until the alarm is disarmed. Entry and exit delays are set by varying the values of certain components. These components and how to vary the times are explained in the Circuit Operation.



— from page 96

the house mains. This renders the wiring safe. DO NOT ATTEMPT TO MAKE ANY CONNECTIONS OR ADJUST OR TOUCH ANY PART OF THE CIRCUIT WITH POWER APPLIED.

Once the power is off, connect the board according to the appropriate circuit selected from the figures. Wrap or mount the board as appropriate to prevent short circuits between any metal of connection blocks, and refit the enclosure. Return power and verify that the circuit is working.

If for any reason operation is not satisfactory after installation, refer to the next section on troubleshooting and follow the directions there.

Troubleshooting

Because the circuit is directly connected to the mains, all forms of measurement and troubleshooting are difficult and potentially hazardous. This section describes the methods I used. I stress that if you are inexperienced, you should not undertake any measurements at all. Experienced people should read the procedures outlined here carefully, and be sure to understand the precautions before actually using them. A careless mistake can cause lethal shock or burn injury.

The logic for troubleshooting this circuit is presented at the end of this section. However, I shall first describe how to make ordinary (scalar) measurements with a multimeter, both ac and dc, and then how to attach a CRO to the circuit.

The circuit should be placed on a plastic or wooden bench. My favoured method for working on live circuits is to have a piece of wood about 40 cm square, and to tether the circuit to this, along with a mains cable and whatever other components that are required. Self-tapping screws which are shorter than the wood is thick can be placed wherever necessary to tie down PC boards, cables, etc. Once attached to the bench or baseplate, connect (physically and electrically) a mains cable and a sample globe. The globe can be a simple 75 W bayonet type. Wires can be soldered to the base of the globe to make contact, dispensing with the need for a bayonet or other fitting.

Select a battery-powered DVM or plain analogue multimeter. If you must use a mains-powered meter, ensure that it has the capability to work with common-mode voltages of at least 400 V with respect to earth. Turn off the circuit, and unplug it. Attach the meter leads to the points between which you wish to measure the circuit voltage. Then, without touching circuit or meter, turn on the power and read the voltage. If the meter needs to have any controls adjusted, it is wiser to turn off the power to do this. Do not trust mains power point switches. Some isolate only one connection, and if they have been accidentally mis-wired, the neutral rather than the active connection may have been broken, with the result that appliances turn off, but their circuitry remains connected to the active power line.

As most CROs have their chassis tied securely to earth, using them on the circuit can be a delicate operation. The following procedure should be undertaken only if absolutely necessary, though it is quite informative about both the circuit operation and the mains supply.

Firstly, set the CRO to a range of at least 50 V/division. With the same procedure as used above — complete shutdown effected before altering either CRO setting or probe connection — place the probe on both the active and neutral lines of the incoming mains in turn and note which is which, and what the signal levels are on each. You will probably find that the mains neutral is not exactly at earth potential, but has several volts peak-to-peak of a distorted sinewave on it. Since we wish to make measurements with respect to this neutral connection (which is local earth for the control circuit of the 5506) a method of cancelling it must be used.

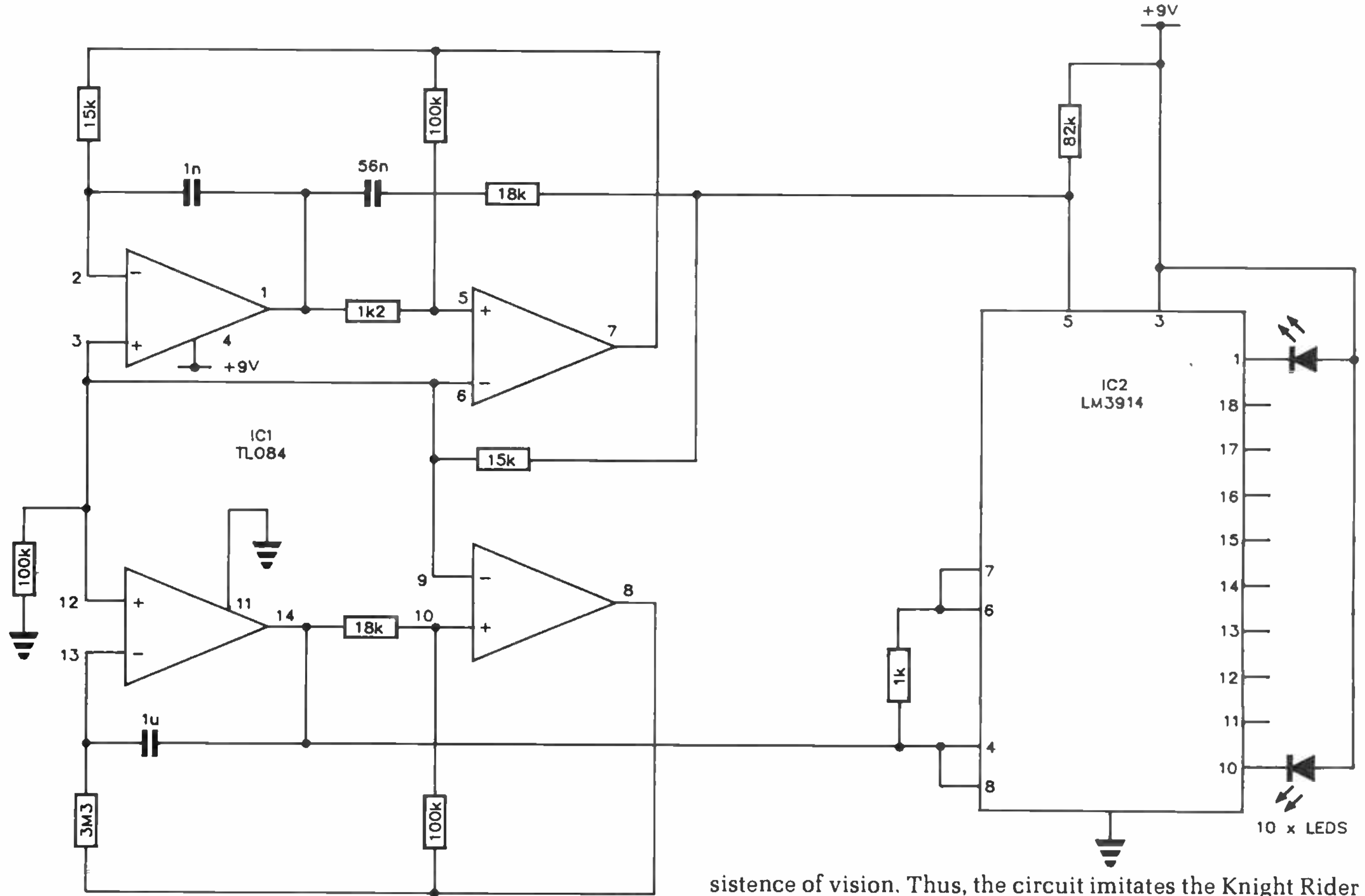
Either the CRO sum/invert facility can be used, or the CRO earth can be tied to the neutral. The latter makes measurements easier, and does not tie up the second channel, but may present problems. The neutral signal is the voltage dropped across the return wires in the building between wherever you are and the ground link in the distribution box or fuse box. Consequently, it will have small level, but a very low impedance. Connecting the CRO earth to the neutral lead of the 5506 supply eliminated most of the common-mode signal in my laboratory, but about two amps of current flowed in the CRO probe earth return lead, warming it up considerably! This was a satisfactory situation and the one we used. Once the neutral signal has been cancelled, the voltages in the circuit can be measured just as above with the multimeter.

In order to track down a fault, follow the logic set out below. The unit must exhibit one of three fault conditions: **1)** The lights come on at once to full power; **2)** The lights remain off; and, **3)** they come up partially and then flicker or otherwise fail to reach full illumination. Select either the first, second or third paragraph below depending upon which fault condition is exhibited. Most faults will be locatable using a multimeter and a shorting link, placed across various points in the circuit. Be sure to disconnect power between each test!

1) The first step is to determine if the fault is in the triac circuit or the control circuit. Solder a wire shorting out pins 1 and 2 of IC1, and re-try. If the lights still turn on, the fault is in the triac circuit. Check orientation of the triac, the values of R1 and R2, etc. Removing R2 will stop the lights if IC1 is at fault, otherwise the triac may have failed. If the lights no longer come on with the shorting link in place, the fault is most likely to be in the fast ramp reset circuit. If shorting out C4 instead of IC1 gives lights out, the fault will lie between LED2 and R11, probably in Q4-6. If the C4 link has no effect, look at the dc voltage on LED1. If this is below 1.4 volts or above 1.8 volts, the fault is in the vicinity of R6/R7/LED1, or in the supply. Check that 12 ±1 V is present on C2. If not, the fault is in the supply — C1 to ZD1. If the LED voltage is in the above limits, check C3-D3.

2) Lights-off condition. Short pins 4 & 6 of IC1. If this does not get light at the next powerup, the fault is in the triac circuit, R1, R2 and the triac. Otherwise check the supply is 12 ±1 V, and if not, suspect R3 through ZD1. When the supply is checked, short Q2c to neutral. If this does not get light, IC1/R12 are suspect. Otherwise check that the dc on C4 exceeds 6 V, and if not, the fault will be in either R8-9/C4/Q1 or R6/R7/LED1/Q3. Decide which group by checking that the voltage on LED1 is between 1.4 and 1.8 volts, and if not, then that area is guilty.

3) "Dithering" lights can be caused by many things, but two are more likely. Either the charge pump supply is not coping, or the mains contains a lot of noise and interference. Perhaps the best way to test the mains is simply to try the unit somewhere else. Long wires may aggravate the problem, in which case it will probably vanish when you move to the test bench. If the unit persists in the fault, check that the supply of the control circuitry is 12 ±1 V. Test or increase the value of C1 and C2 to see if the supply is being overloaded. The electronics are set to draw a known current, with which the supply should be able to cope provided that the mains supply is adequate.



Knight Rider light chaser

The popularity of the TV "cops-and-robbers" show 'Knight Rider' featuring the high-tech car, Kitt, has brought numerous ingenious schemes to light for imitating Kitt's front end light chaser — which 'sweeps' a group of lights back and forth across a display.

This circuit is built around the common and popular LM3914 linear LED bargraph display chip. It drives a series of 10 LEDs mounted in line. The 3914 has a low frequency triangle wave applied to its input, which causes one LED of the display to be lit at a time, 'sweeping' the light back and forth on the display. However, to effectively get LEDs either side of the 'main' one lit, the 3914's reference voltage is also driven with a low amplitude, high frequency triangle wave. This effectively 'lights' three LEDs at a time, due to the persistence of vision. Thus, the circuit imitates the Knight Rider light chaser.

The two triangle waves are generated by op-amp pairs from a TL084 quad op-amp package.

G. Foster,
Avondale, Vic.

Benchbook is a column for circuit designs and ideas, workshop hints and tips from technical sources of the staff or you — the reader. If you've found a certain circuit useful or devised an interesting circuit, most likely other readers would be interested in knowing about it. If you've got a new technique for cutting elliptical holes in zippy boxes or a different use for used solder, undoubtedly there's someone — or some hundreds — out there who could benefit from you knowledge.

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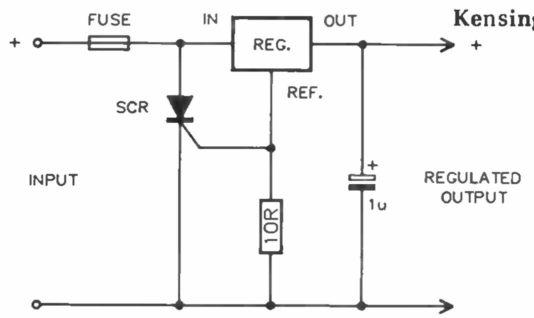
Over-volts protection for regulator ICs

This simple "crowbar" circuit will protect three-terminal regulator ICs from inadvertent application of too much input voltage. When the input voltage rises, the current through the "ref." terminal increases. This raises the voltage drop across the 10R resistor which will trigger the SCR when the input exceeds a threshold of, say, 5 V, below the IC's maximum input voltage (usually 40 V). When the SCR triggers it will short the supply, blowing the fuse and removing the excessive input from the regulator IC. Use a sensitive SCR and mount the components in close proximity. Some experimentation may be necessary with the value of the resistor in series with the regulator IC's ref. leg.

W. Watson,
Kensington, NSW.



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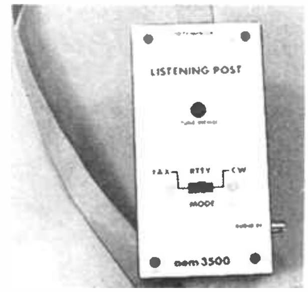

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Our most popular project, by far! It decodes the audio from a SW receiver and, with software, allows your computer (Apple II/BBC/C64/Microbee) to decode RTTY, FAX and Morse. (July '85)
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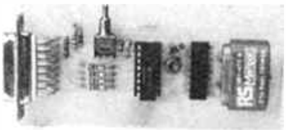
A versatile mixer/preamp for a guitar amp or stage amp. Select resistors to select the input impedance of the channels (Sept. '85)
$20.40

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

2500 AUDIO OSCILLATOR
A simple sine/square signal generator for the bench. It covers to 100 kHz and has output amplitude ranges from 30 mV to 3 V, fully variable. Separate sine and square outputs. (Dec. '85)
$9.65

8500 VEHICLE COURTESY LIGHT EXTENDER
Don't get caught in the dark! This project 'holds' your vehicle's courtesy light on for some 30 seconds after you leave or enter it. (Nov. '85)
$9.90

4600 DUAL-SPEED MODEM
A great little modem that provides 300/300 baud full duplex and 1200/75 half duplex operating modes at the flick of a switch. It features simple RS232 interfacing. (Dec. '85, 7910 data sheet, same issue)
$33.70, or $15.00 (faulty tracks, no overlay)



4502 REAL TIME CLOCK
This project plugs into the Microbee's parallel port and gives accurate date/time etc. Battery-backed. (Nov. '85)
$10.50

5502 MICROWAVE OVEN LEAKAGE DETECTOR
Anyone who owns a microwave oven needs one of these! Simple to build and low cost. (Dec. '85)
$9.15

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

4504 LOW-COST SPEECH SYNTHESISER
This simple to build project employs the GI speech chip SPO256-AL2 which allows you to put together 'word parts' to make electronic speech. It employs 8-bit parallel interfacing. ('Bee interface — Feb. '86, with data sheet; C64 interface — July '86)
$17.30

5503 BED-WET-ECTOR
This is a simple, safe battery-operated alarm that may be used to help overcome bed-wetting problems. (Mar. '86)
$9.20

5504 ELECTROMYOGRAM
This is a 'muscle activity' monitor, sensitive enough to detect muscle activity that cannot be detected by eye. Can be used for relaxation training, biofeedback, migraine relief etc. (Mar. '86)
$15.90

4610 SUPERMODEM
An intelligent modem with Hayes-compatible command set, for any computer with a serial port. It is capable of all V.21 and V.23 modes and features an expansion bus for later add-ons. Price includes necessary EPROM with resident software. (Apr-Aug. '86)
$139.00

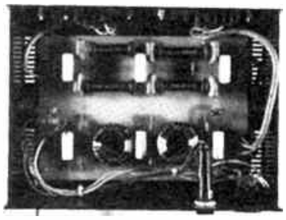
3502 SIGNAL-OPERATED CASSETTE CONTROLLER
Just the thing for taping signals picked up on your SW receiver or scanner while you can't attend. Simple to build, powers from 10-15 V. (Mar. '86)
$9.20

4501 8-CHANNEL RELAY INTERFACE FOR COMPUTERS
Get your comptuter to control something! Hooks up to 8-bit parallel port or data bus. ('Bee — Oct. '85, C64 — Sept. '86).
$13.00

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

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

6000 ULTRA-FIDELITY POWER AMP
A low-distortion amp module that delivers over 200 W into 8 ohms, featuring the high power 2SK176/2SJ56 Hitachi MOSFET output devices. (June-July '86, data sheet in June).
$31.20



5505 MAINS FILTER
This project, dubbed the "Hash Harrier", is a truly effective mains filter that copes with both common mode and differential mode noise, including spikes. It is rated for loads totalling up to 5 A. (April '86)
$26.00

4505 CODE-TO-SPEECH SYNTH.
Taking ASCII text input from a serial port, Centronics port or IBM slot, this versatile project will 'speak' text files. Double-sided, thru-hole plated board. (June-July '86)
$55.00

6102 2-WAY CROSSOVER
Crossover board for our popular 2-ways using the Vifa drivers. (Aug. '85)
$21.75

ELEKTOR BOARDS

86090 SERIAL DIGITISER
The project can attach to any computer sporting an RS232 port and features one to eight multiplexed analogue input channels, conversion time less than half ms, variable ref. voltage to 4 V and modular construction. The main board is 86090-1, input boards (up to four) are 86090-2. (Oct. '86)
$21.10 — 86090-1
$6.40 — 86090-2 each

86086 HEADPHONE AMP
Featuring the TEA2025 stereo amp chip, this project has ample output for headphones from 30 to 600 ohms. Uses a 12 V supply. (Oct. '86)
$15.50

86016 SATELLITE SPEAKERS
This is the crossover board for a set of two-ways featuring the Dynaudio 17W75 and D-28AF drivers. (Oct. '86)
$8.35

86041 SPEAKER Z-METER
This simple instrument measures the resistance and inductive reactance of woofers and 'wide-range' drivers with a range to 18 ohms resistive and 5 ohms reactive. (Oct. '86)
$17.60

86002 BATTERY CHARGER
This dc-operated battery charger is designed to charge 9, 12 or 15 volt NiCads from a 12 V car battery. (Oct. '86)
$15.75

86462 RMS-TO-DC CONVERTER
A great add-on for your multimeter. It features a response to 100 kHz above 1 V input, 6 kHz at levels below 100 mV. A x1 and x10 attenuator is included. Needs supply of 5-15 V. (Oct. '86)
$3.25

86490 RODENT DETERRENT
An ultrasonic 'screamer' to annoy rats, mice and maybe even cockroaches. Simple, cheap. (Oct. '86)
$4.65

85000 RF BOARD
A 'universal' RF board employed in the "RF Circuit Design" series. It has an array of pads, a set of three supply rails and a large groundplane. (Oct. '86)
$8.00

86453 HEART MONITOR
This low-cost project senses heart beat by placing your finger on an optosensor, providing an audible 'pip' output. (Oct. '86)
$5.40

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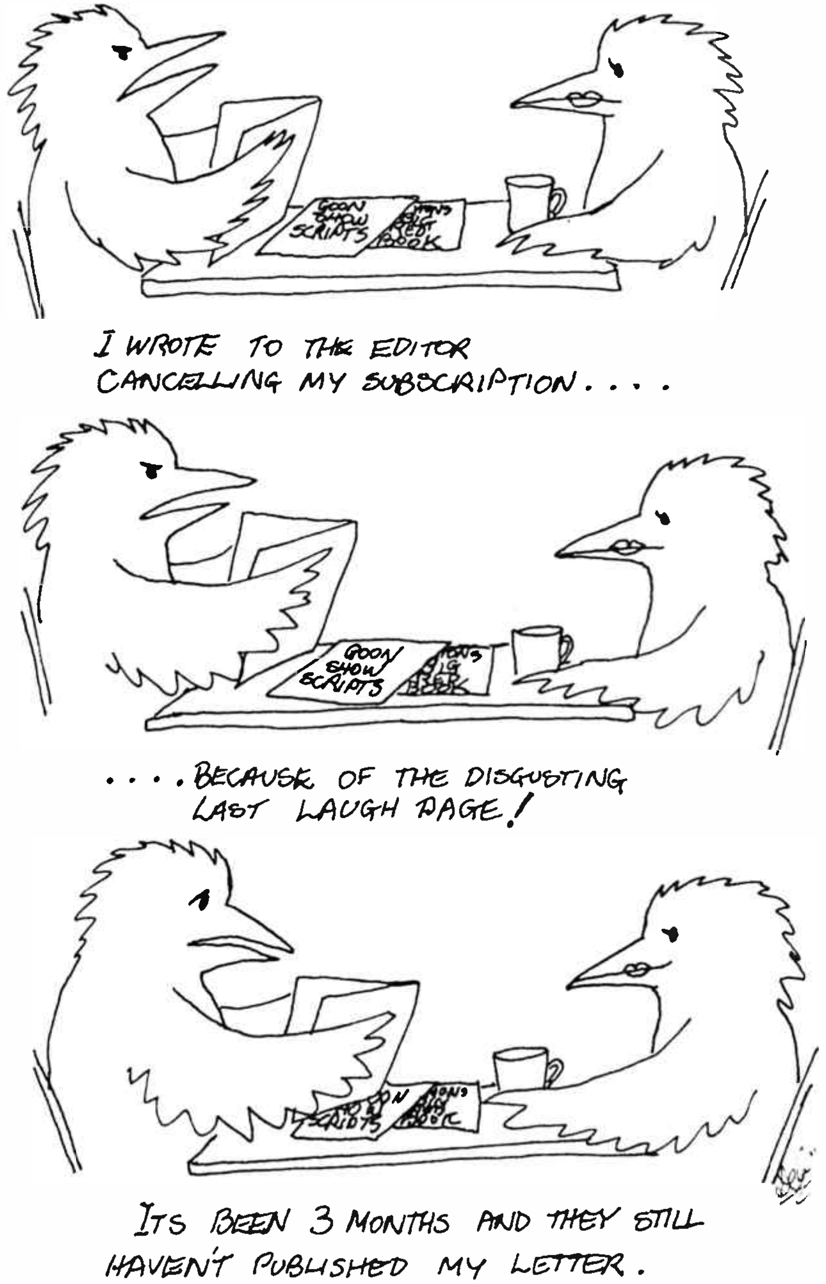

Cartoon by Deb Currie, with acknowledgement to Tanberg.

Digital time warps

Dear Sir,

I was going to write a longer technical essay in response to Mr Harwood's expose of "Digital Cancer" in the August '86 issue, but I know there will be such a large reader response that it would be selfish of me to indulge in boring facts and figures.

Instead, I would like to offer a practical solution to one of the problems of CD reproduction mentioned by Mr Harwood in his letter. He states quite correctly that: "Many CD players use only one D-to-A converter. They just delay one audio channel compared to the other for stereo channel decoding".

Well, this problem CAN be solved without expensive hardware modifications!

If you really MUST listen to compact discs, follow these instructions as I have, and avoid this most annoying effect.

STEP 1. Locate the speaker (left of right) from which the sound emerges first. Label this speaker with a small sticker on which is written "L.I.T." This stands for "Leading In Time".

STEP 2. Label the opposite speaker which is lagging in time, e.g: UN-L.I.T.

STEP 3. Move your listening chair laterally a few centimetres towards the speaker which is not leading, i.e: the UN-L.I.T. one.

Due to the different path lengths through the air, the sound from the LIT speaker will be delayed, whilst that from the UN-LIT speaker will be advanced (relatively speaking). Thus, normal time balance is restored!

However, if you are a beginner in audio, you may not yet possess the refinement to identify which speaker is leading in time in the first place, so try moving left then right until the "echo effect" disappears.

If you cannot get rid of any echo by means of this method, then it is likely your CD player is delaying and advancing BOTH channels very quickly due to a modulation-dependent switching fault.

This latter effect can be minimized by nodding your head back and forth in time to the music along a centreline between both speakers. This alternately lengthens and shortens the acoustic path delay to BOTH speakers at once.

I do this all the time, and find the results quite satisfactory.

Trusting this may be of help to those plagued by inferior CD players exhibiting time domain effects.

John Norris,
Everton Hills, Qld.

The Last Laugh

Opening for research development . . .

DURING the research that occupies most of my waking hours, and often a good deal of my sleeping hours, opportunities for the formation of 'Sunrise' projects often present themselves.

One such opening, and I use the word advisedly, recently came to light and, in an unaccustomed burst of patriotism, I present it to the many Electronic Researchers who are hungry for new projects.

I refer to the development of a device that will alert the wearer to the fact that the zipper on the front of his trousers *is not closed*. With the development of men's dress and the use of a zipper in place of multitudinous buttons, the final action, or closure, is often overlooked.

My research indicates that 47% of males suffer from Closure Aberration (or C.A. as it is known in research circles) at some time during their life. It is observed quite frequently amongst single men who do not have a sharp-eyed, and probably apprehensive, spouse to give them final clearance before going to work in the morning or out in the evening.

I am a fairly constant statistic and quite often think that the job is done when I have done up the top clip and tightened my belt. It is only when my friends stare pointedly at that region and make hissing noises between their teeth, that the realisation sweeps over me that all is not well. Or perhaps, in winter, a blast of icy air brings, you might say, the point home.

So what we are looking for is a small device that will give a restricted audible or visual warning if the 'closure' is not made within a certain period of the top clip being done up. (Those of us who omit to close the top clip are beyond the scope of this project and have not been covered in my research.)

Such a device would also give warning of failure to close following the opening of the zip for necessary functions. The time interval between opening and the warning signal should be variable to allow for person-to-person differences. Too short a time interval would mean that the buzzer goes off before the operation for which the zip was opened in the first place, has been completed. Too long an interval could mean that the buzzer goes off or lights begin flashing in the train on the way home from work, thereby becoming counter-productive. There should also be a manual over-ride to allow for unforeseen circumstances, as there is on the interior door-operated light of your automobile.

Research indicates that there is a wide market for this invention. Many famous and gifted persons suffer from C.A. (closure aberration, see above). The late Sir Winston Churchill was such a person and when his aberration and its possible consequence were pointed out to him, was heard to remark that dead birds don't fall out of the nest.

It is only a small step further to a more comprehensive sensing device, perhaps one that could scan for bad breath, dandruff, non-matching socks and so on. Combined with a breath-analyser, a truly formidable social scanner would be available, perhaps placed in the better type of public toilet and available for a small charge. It could take the form of one of those frameworks that you are required to walk through at airports in case you are carrying a bomb or something.

But there I go, dealing with design details, whereas my talents really lie in the field of sweeping, imaginative concepts.

The design of the C.A.D. (closure aberration detector) I could probably take on myself were it not for the fact that I am at present busy developing an instrument to gauge the gap, if any, between mental inclination and bodily ability in a number of important categories. I anticipate a steady demand for such an instrument amongst maturer male members of our society.

In the meantime, I pass these ideas to the waiting laboratories, anticipating an almost immediate improvement in Australia's balance of payment.

For the raw research data, send $500.00 (Hutt Province currency) and a S.S.A.E. to the Sackville Academy of Lateral Thinking (S.A.L.T. of the Hawkesbury), Ebenezer, N.S.W.

D. F. Richards, Founding Professor and sole Beneficiary.

Originally presented as a talk on Robyn Williams' Science Show on the ABC, 18 June 1983. Used with permission.

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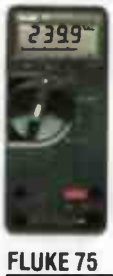

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