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The Australian Electronics Monthly

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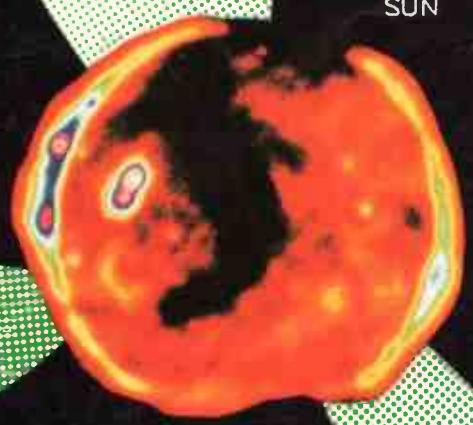

HIGH SPEED STREAMS

IONOSPHERIC DISTURBANCES explained

Power amp 'status monitor' project

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

How to beat the high cost of cheap meters.

You get what you pay for.
So get the Fluke 70 Series.

You'll get more meter for your money, whether you choose the affordable 73, the feature-packed 75 or the deluxe 77.

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diode test
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Autorange, range hold
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7000+ hour battery life
3-year warranty

FLUKE 77

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diode test
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THIS MONTH we introduce a new "feature" to the magazine, called "Profile". This will be an occasional column focussing on a facet of the broadly defined "electronics industry" and in particular in each column, an Australian company and the individuals behind it — after all, companies are not "natural-born" entities, they are composed of people who *are* the company.

Our aim is to highlight facets of this very diverse industry, and in so doing, build a "picture" of the industry and what it's all about; to give readers insights that are otherwise unobtainable, and to do something *positive* about communicating and promoting Australian endeavour and entrepreneurial effort in the electronics industry — because the Australia industry has within its ranks talent, dedication and enterprise that rarely receives the accolades so often deserved.

To kick it off, we thought it would be a good idea to start with the familiar and profile a firm so often identified with electronics, especially in the minds of "the general public", Dick Smith Electronics. But wait!, I hear the cries. Everybody *knows already* all about DSE. Read our first profile, and think again!

ALSO, this month we welcome on-board Rowan Wyeth of R.T. Wyeth & Associates, who will be representing us on the advertising side in Victoria. Rowan has had a long and distinguished background in specialist magazines and together we have great expectations for AEM.

Roger

Roger Harrison
Editor

CHANGE OF 'PHONE NUMBERS

As of 10 August, our telephone prefixes will change from **487** to **489**. Thus, our General Enquiries line will become 489 2700, while our Technical Enquiries line will become 489 1483.

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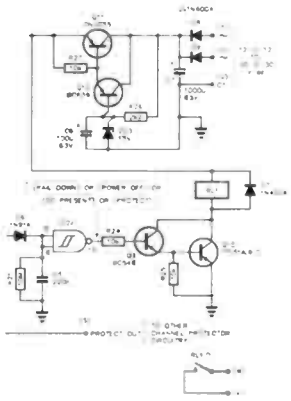
Eagle Electronics wishes to sincerely apologise for any inconvenience or embarrassment caused due to the unavailability of the Playmaster 60/60 amplifier at our advertised price– (Electronics Australia, July '86 p.75). The incorrect price was an honest error and in no way reflects any intention to mislead or default commitment to our valued customers or suppliers.

Malcolm Ling.

COVER

Illustrating Sun-Earth interactions; as discussed in this month's Radio Communicators Guide. Concept and design, Angelika Koop.

PROJECTS TO BUILD



AEM6504 Power Amp 'Status Monitor' 37

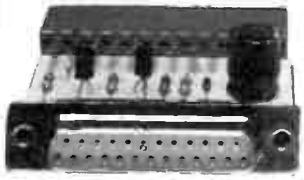
An unusual project that 'monitors' an audio amp and opens the output, protecting both amp and speakers should a dc fault arise or if it's driven into excessive clipping.

AEM9501 Dual Rail Power Supply Module 51

A single-board 'component' supply that provides +/– regulated rails from 2.4-26 volts — just choose a tranny to suit your requirements!

AEM6000 'Ultra-fidelity' MOSFET Power Amp, Part 3 44

Power supply and protection details.



STAR PROJECT

A 'Modem Coupler' for Commodore 64s and 128s 70

Use this simple, low-cost interface and a few lines of software to get your Commodore 'on-line' with a cheap modem — or any modem!

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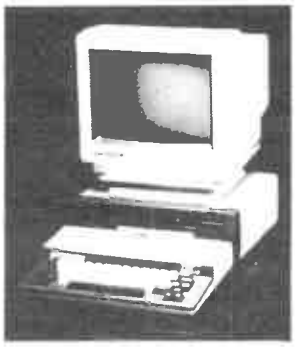

AEM Computer Review — Microbee's 'Premium' 66

Who better to judge Microbee's latest offering than 15-year-old Microbee Whizz, Hayden Brotchie? See what Hayden has to say about this versatile new 'Bee.

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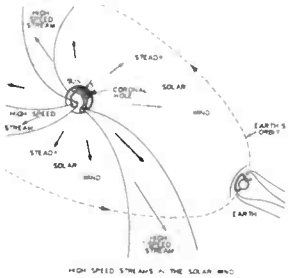

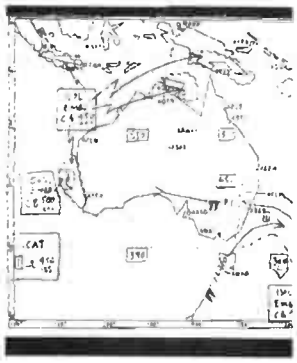

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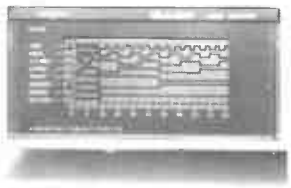
NEWS & GENERAL

NEXT MONTH!



LOGIC FAULT-FINDING AND CIRCUIT ANALYSIS

With digital and microprocessor technology spread through just about every 'bastion' of electronics, logic fault-finding and circuit analysis has grown in importance in recent years. This timely feature looks at the instruments as "technical tools" — from simple 'logic probes' to sophisticated analysers — explains them and their application.

6000 SERIES STEREO POWER AMP

At last, it all comes together. This article, the last in the series, describes how to assemble the stereo power amp. A special diecast heatsink has been designed for this project, the completed unit 'marrying' well with the 'Ultra-fidelity' preamp.

SUPER SIMPLE MODEM

After the Supermodem, comes the Super Simple Modem! This project strips down the cost and hassles of getting a computer on-line. It's super simple to build and operate. It provides V.21 (300/300 baud) and V.23 (1200/75 baud) operation (Viatel) and features the simplest possible RS232 interfacing to reduce the hassles of hooking it up to any computer.

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

FEATURE

Great prizes to win in our

1ST BIRTHDAY CONTESTS!

CLOSING DATE OF THE CONTESTS is the last mail of **30 September, 1986**. Entries received within seven days of that date will be accepted if postmarked prior to and including the closing date.

It's our birthday and *we're* giving away the presents!

Enter any or all of our five Birthday Contests offering these fabulous prizes:

Philips 54 cm Stereo Colour TV!
Philips new 50 MHz CRO, Model PM3050!
DSE Multitech PC System 1 plus Racal 1200/1200 Modem!
Regency HX1000 VHF/UHF Handheld Scanner, from Emtronics.
Ersa MS1500 Temperature-Controlled Soldering Station, from Meltec.

RULES

You may enter each of the five contests as many times as you wish, but you must use a separate entry form for each entry and include a month and page number cut from the bottom of the relevant contest page. You must put your name and address on each entry form and sign it where indicated. That is, photocopies are acceptable but an original month/page number from a copy of this month's magazine must accompany each entry form.

The contest is open to all persons normally resident in Australia or New Zealand, with the exception of members and families of the staff of Australian Electronics Monthly, the printers, Offset Alpine, and/or associated companies.

Contestants must enter their names and addresses where indicated on each form. Photostats or clearly written copies will be accepted, but if sending copies you must cut out and include with each entry an original page number and month cut from the bottom of the page of the contest. This contest series is invalid in states where local laws prohibit entries. Entrants must sign the declaration, accompanying each contest, that they have read the above rules and agree to abide by their conditions.

The winning entry will be drawn by the Editor, whose decision is final; no correspondence will be entered into regarding the decision.

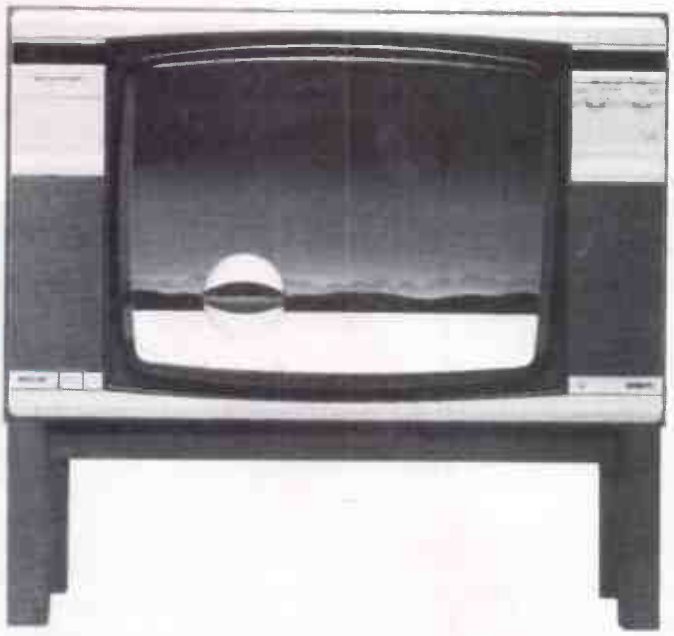
Winners will be notified by telegram the day the result is declared and the winner's name and contest results published in the next possible issue of the magazine.

Send your entries to: **AEM 1st Birthday Contests**
PO Box 289
Wahroonga 2076 NSW

Entry coupons with each contest

1ST BIRTHDAY CONTEST No. 1.

Win this fabulous Philips 54 cm colour stereo TV model CH285.



This TV receiver offers VHF and UHF reception incorporating a 'search' feature that finds the TV Signals for you, which can then be stored withthe press of a button. It comes with a full-function remote control and includes a 'Teletext Option' permitting the fitting of a Teletext decoder when required. The picture tube is a 90 degree deflection type with black matrix and pigmented phosphor, featuring quick-start in-line guns. Circuitry features automatic degaussing, automatic vertical and horizontal hold and automatic fine tuning plus interference suppression from cars and other electrical sources. Sound output is 2 x 10 watts RMS driving two 203 x 76 mm speakers. The set has been designed to complement the natural style decor of the Australian home, with attractive wood-grain vinyl and screw-in timber legs and rail. Philips offer a 12 mth free parts and labour warranty and 24 mths free picture tube warranty.

Prize kindly donated by Philips Consumer Products, a division of Philips Industries Ltd.

All you have to do is answer the following questions and then tell us in 30 words or less what you think are the most attractive features of the prize.

1ST BIRTHDAY CONTEST No. 1.

Q1: Three men were instrumental in the development of television with stereo sound. An Englishman devised the electronic line-scanned, 25 frames/second system of 'electric vision' using cathode ray tubes, which he published in 1908. A Russian-born US citizen patented the 'iconoscope' TV camera in 1923. Another Englishman, instrumental in putting to air the first public TV Broadcasts from London's Alexandra Palace, patented circuitry fundamental to the development of both television transmission and reception as well as stereo sound. What are their names?

.....

.....

.....

Q2: The first stereo/dual-sound channel TV set was designed and manufactured in Australia by Philips and launched on the market soon after the Minister for Communications announced the introduction of dual-sound channel television bradcasting. Name the month and year of that announcement.

.....

Q3: name the model number of that Philips TV.

.....

Q4: Philips' promotional theme for their stereo TVs revolves around one word. Use your head now! What is it?

.....

Now tell us, on a separate piece of paper, what you think are the most attractive features of the prize.

Name .....

Address .....

..... **Postcode** .....

I have read the rules of the contest and agree to abide by their conditions.

Signed .....

One standard.
Zero defects.
From IC people
committed to quality.

Some IC companies talk about defect standards of 500 ppm as if they were proud of them. At Philips, we have a different philosophy: one defect is one too many. So zero defects is the the standard we've set for our ICs. And the warranty for that standard goes like this: when you receive ICs from Philips, if you find a single defect in that batch, we'll take them all back for re-screening or replacement. The reason we can offer this warranty is that after 100% testing, we sample every batch. If we find a single defect, that batch isn't delivered.

The Philips IC activity is absolutely committed to a standard of zero defects. We have been for some time, in fact. In 1980, we instituted a rigorous 14-point program aimed at preventing mistakes – rather than correcting them. Since then, the program has evolved until it's now more than a program: it's a state of mind.

By working with you and examining rejects, we'll carry zero defects beyond a standard to a reality. You'll find that same commitment to quality throughout Philips, whether we're designing a VLSI chip containing more than 100,000 transistors, or a simple gate.

So while many IC companies are bragging about a standard of 500 defects per million, we at Philips are working our way towards zero. And when you put your trust in that kind of individual commitment, you can't lose.

When you're offered zero, why settle for less?

One standard. 0 defects.

Sydney (02) 439 3322 **Melbourne** (03) 542 3333 **Adelaide** (08) 243 0155 **Perth** (09) 277 4199 **Brisbane** (07) 44 0191

the UN 428

PHILIPS Electronic Components and Materials

PHILIPS

Lord Howe Is. 'links' into the satellite age

One of Australia's most isolated communities, Lord Howe Island, entered the satellite age on Anzac Day 1986 with the help of AWA 'Earth Link' direct broadcast satellite receiving equipment.

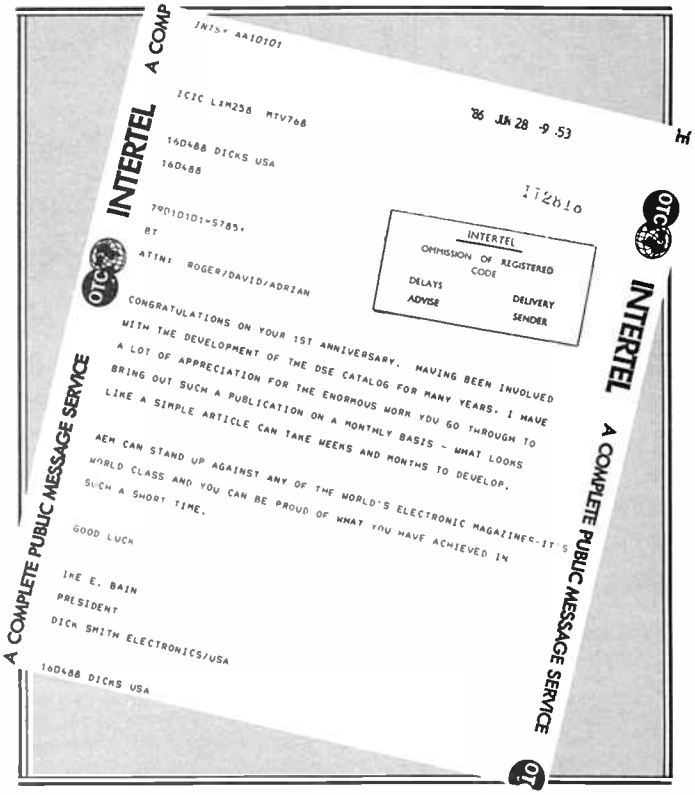
A live broadcast of the ABC's coverage of the Anzac Day March was beamed to the Island via AUSSAT and received by the equipment assembled and supplied by Mitsubishi Electric AWA.

Mr Yana Goosev, National Service Manager of Mitsubishi Electric AWA, and Mr Dennis Twohill of Retravision, Port Macquarie, organised the event. Mr Graeme Hyde from Retravision also assisted and was responsible for installing the first operational Earth Link system. Dennis Twohill, who has had a long association with the Island, described the broadcast as a great success.

"Once we solved the logistical problems of how to get the Earth Link equipment to Lord Howe, the rest was plain sailing," he explained. "Since the broadcast we have sold six Earth Link units and more are waiting to be installed."

Although Lord Howe Island was settled almost 150 years ago, communication with the rest of the world has never been easy. For the most part islanders have relied on HF radios and the postman.

Now, with the advent of Earth Link, islanders can use direct television broadcasts to keep up-to-date with world affairs. By the end of the year a commercial radio network will also be available allowing islanders to enjoy FM stereo radio.



International recognition for Philips researchers

The English Rank Award has been presented to three Philips researchers who, at the beginning of the seventies, laid the basis for the optical recording and reading of information on a disc.

Dr P. Kramer, senior managing director of Philips Research, Mr G. Bouwhuis, senior scientist at the Philips Research Laboratories, and Mr. K. Compaan, now retired, were presented with Rank Prize Fund awards at a ceremony at the Royal Institute, in London.

Sir John Davis, chairman of the trustees of the Rank Prize Funds, also presented awards to eight other scientists from the UK and the USA for their work on infra-red recording and large-screen television techniques.

The prestigious international distinction reflects the work the three Philips scientists carried out in laying the basis for the optical recording and reading of information on a disc.

This work led to the LaserVision optical disc, the Compact Disc, and the disc for storage of digital data, along with the corresponding electronic systems.

WHO'S A 'REAL GENIUS', THEN?

Dick Smith Electronics ran an in-store promotion to find Australia's 'Real Genius' during May. If you went into a DSE store in May no doubt you saw a crowd of youngsters around a Multitech PC. The contest was open to schoolchildren aged 18 years or under who entered by typing in their name and address and answering a series of randomly selected questions. The computer scored each contestant and results were compared to find a finalist in each state. Over 10 000 children entered!

The seven state finalists then competed in the National Grand Final on June 14 at DSE headquarters in Sydney. The prize was a trip for two to England with accommodation, donated by ANZ travel, plus $1000 in travellers' cheques from the ANZ bank.

The six interstate finalists were flown to Sydney by Ansett for the June 14 battle, compered by Andrew Harwood of TV's 'It's Academic' fame. The seven finalists were Phil Hallard of S.A., Quan Dinh of Victoria, Michelle Maystone of NSW, Mitchell Porter of Qld, William Higgins of the ACT, Roger Sweet of Tasmania and Robert Di Noto of W.A.

DSE's boardroom, where the finals were conducted, was full of nervous anticipation as the contestants filed in to tackle the final game — ten tricky questions to answer in the shortest possible time.

And the winner was — 16 year-old **William Higgins of Canberra!** William attends St Edmunds College in Canberra and enjoys chess, playing his music synthesiser, computing, debating and games.

Contestants ages ranged from 13 to 16. New South Wales' entrant, and the only girl to make the finals, was Michelle Maystone who attends Maitland Girls High School. She scored 8 out of 10 in 113 seconds to become the NSW 'Real Genius'. Youngest was Quan Dinh, who attends Burkehall Prep. of Xavier College in Melbourne, who scored 8 out of 10 in 149 seconds to reach the state final. His favourite hobby is reading.

FANTASTIC READER OFFER!

OFFER EXTENDED TO LAST POST 31 AUGUST — LAST CHANCE!

Works with any Computer (needs RS232 port & terminal software)

AEM4610 SUPERMODEM KIT

designed by Chris & Dan Darling, as described in Australian Electronics Monthly

By special arrangment with the designers, Australian Electronics Monthly is able to make this offer available, exclusive to our readers.

Don't miss this fantastic opportunity to own a truly smart modem and to enjoy the pride and satisfaction that comes from building it yourself!

Here it is at last! The modem kit that Australia has been waiting for. No need to buy expensive overseas modems when a kit is available to cover your current and future communications requirements. This kit has been fully designed, built and tested in Australia, so that local support is readily available. Furthermore, the kit is easily constructed by anyone with average soldering ability. To ensure a minimum of construction problems, all ICs are socketed and there are very few external passive components. All materials used in the kit are prime quality and there is even a "Sorry Dan, it doesn't work" offer available to all constructors. Even if you receive the kit and then decide that you aren't able to proceed, or if you can't get the completed kit to work, you can send $100 together with the kit to Maestro Distributors and it will be built (or fixed) and returned to you in fully working order.

The kit is supplied by Maestro and includes all components, pc board, EPROM (containing the required on-board software) and instructions.

SUPER FEATURES:

- All V.21 and V.23 modes, Bell and CCITT
- Fully software driven, no controls
- Hayes-compatible commands
- Auto-dial/auto-answer/auto-hangup capability
- Incoming baud rate sense
- Standard EPROM on-board for later upgrading
- Bit rate conversion on send and receive
- Line monitoring speaker
- Expansion bus for future add-ons
- 8K RAM buffer (with optional battery backup)
- Single board construction
- Meets Telecom approval requirements

Special Offer Price:

$295

(inc. tax)

Door-to-door delivery, anywhere in Australia: $6.60.

The expected retail price of the kit would normally be around $400.

★ An optional 16 Vac/1.5A plug pack power supply is available for an additional cost of $17.00.

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

DON'T DELAY, COMPLETE THE COUPON NOW AND SEND IT, TOGETHER WITH YOUR CHEQUE, MONEY ORDER OR CREDIT CARD DETAILS, TO:

AEM4610 SUPERMODEM OFFER
Australian Electronics Monthly
PO Box 289, WAHROONGA 2076 NSW

If you do not require a full kit, you can obtain the pc board and EPROM (containing the necessary operating software) through the AEM PC Board Service for $139.00, inc. postage.

(Please allow up to four weeks for deliver to cover normal mail and cheque clearance and any unforseen delays)

RUSH ME my AEM4610 Supermodem kit for $295 (inc. tax) plus $6.60 delivery.

Please include (tick box if required):

☐ IBM Viatel software @ $39.50
☐ Apple II Viatel software @ $39.50
☐ Plugpack power supply @ $17.00.

I enclose $..... total, payment by

Cheque/money order* ☐ Bankcard ☐ Visa ☐

Mastercard ☐ American Express ☐

Card No .....

Expiration date: ..../..../....

Signature .....

(note: unsigned credit card orders cannot be accepted)

Name .....

Address .....

..... Postcode .....

(*Make cheques or money orders payable to Australian Electronics Monthly)

Letters

Top of the heap!

Dear Sir,

I've been following your series of articles on the Supermodem with much interest and hope to get one before the offer expires. Detail, diagram clarity and article compactness put your effort at the top of the heap!

A pleasure to read.

Norm Wheeler,
Greenacre NSW

Digital cancer

Dear Sir,

I am a concerned hi-fi enthusiast. I feel that good quality audio has now become a thing of the past! I feel that we are all part of a massive marketing exercise to condition the listening public to the sound and so-called quality of the digital era. Of course, this is until HQD (High Quality Digital) or NIFSGD (Now It Finally Sounds Good Digital) hits the marketplace.

Don't get me wrong, I am not against digital mastering of records or CD players (I own one myself), but I am against the specifications that these devices have.

We seem to have lost some of the qualities that good analogue audio has attained over the years. If one ventures into a recording studio (one which uses an analogue console, multitrack and master recorder) one will see via a spectrum analyzer that most analogue musical instruments have harmonics that exceed the 30 kHz area. Any material recorded would be sent to the record company which would use an analogue cutting lathe to create the master record. To ensure better quality, techniques such as half speed mastering and direct-to-disc were used to maintain excellent standards in the pressings.

The audio enthusiast would then use a quality turntable with a cartridge and needle with specifications well above 40 kHz, and an amplifier and speakers to match to reproduce the recording.

Now, as anyone will tell you, the problem with records was the medium, i.e: the vinyl disc. Surface noise was high, crosstalk was high and every time you played it the recording deteriorated.

Eagerly, I awaited the digital era. It seemed fantastic. No noise. Great separation. Wide dynamic range. Last forever with no degradation. The packaging right. You beauty!!

Then I listened to it. Where have all of the highs gone? Why does it distort at low levels? On closer inspection of the specifications and principal of operation, one wonders who designed this new musical standard? It obviously wasn't an audio engineer.

Why isn't the sampling rate higher so better accuracy of the recorded signal can be achieved? It seems strange to use the same standard as telephone PCM systems i.e: The Nyquist minimum. And why isn't the bandwidth increased to allow those analogue harmonics to get through? Another classic is 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.

You will say that to achieve this we will need more storage capacity and I agree. I would have preferred a larger compact disc if the quality was there. I have been under the impression that the unwritten law of audio reproduction is to achieve the highest quality and faithful reproduction of an artist, i.e: the medium used to bring artist and listener together should be as transparent as possible.

Anyway, digital is here to stay. It's the in thing. Everything has got to be digital. This is the *Digital Cancer* that I speak of. We now have digital recording consoles, digital multitrack and mastering tape recorders. I believe that the cutting lathes are now controlled digitally. Then, of course, musical instruments these days are synthesised and digitally controlled and the reproducer in the home is a digital CD player or a turntable (which is probably digitally locked to speed anyway). And the radio stations are promoting it playing CDs and digitally mastered discs on air, and everybody thinks digital anything is just fine.

I just wish that I had digital ears and didn't know what the real instruments sounded like.

When will we see: We Finally Got it Right Digital!

Trevor Harwood
Coffs Harbour, NSW

Satellites and subwoofers

Dear David,

I read with interest B.W. Campbell's letter, and your reply, in the June issue concerning loudspeakers. My situation is somewhat similar to Mr Campbell's in that about 12 years ago I built a pair of massive (five cubic foot!) 4-way speakers using 15" woofers and had a lot of fun optimising the response and damping. I have now moved to a smaller house and have turned my thoughts to a very much smaller system. I am therefore interested in your development of bookshelf type speakers.

I recently came across articles in the March and April issues of *Elektor* for an active filter subwoofer system with satellite speakers. This type of arrangement appeals to me and would probably suit my situation.

Would you please advise me whether your proposed bookshelf type speakers would be suitable for the satellite system and when the design is likely to be published? In addition, are you likely to produce a subwoofer/active filter system, and when?

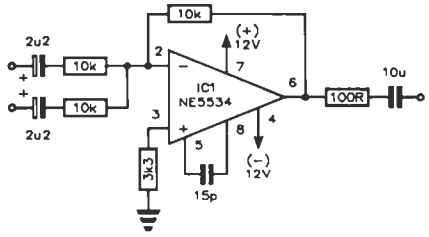
Congratulations on a quality magazine, and — Happy Birthday!

Geo Rostek
Beecroft, NSW

The Elektor system is a good one and well worth considering. We will be presenting a small two-way bookshelf system featuring the Vifa 6½" polycone woofer at some time in the future. We have also published the AEM6500 general purpose power amplifier module and are at present publishing the AEM6000 power amp. In February this year, we also published the universal four-way 24 dB per octave active crossover.

As soon as it is possible, we intend to describe a complete electronic loudspeaker system which employs these various components. The merits of electronic loudspeakers in comparison to their passive counterparts are substantial and these will be discussed of course in some detail in the article.

If you prefer the passive satellite loudspeaker/active sub-woofer approach, then the AEM active crossover is also suitable for this application. The only facility it does not provide is the ability to mono the outputs of the two low-pass sections so that they can be sent to a single mono power amplifier and loudspeaker system. Here is a circuit which shows a simple unity gain summing amplifier using a high quality op-amp for this purpose.



Good luck, whichever direction you take.

David Tilbrook

Setting-up the AEM6500

Dear Sir,

Regarding the setting-up procedure for the AEM6500 amplifier module, does the 100 mA quiescent current mentioned in your July 1985 article refer to the amplifier's general quiescent current, or to that through the actual output MOSFETs? ▶

Is there any sonic advantage to be gained by increasing the quiescent current, albeit with the need for larger heatsinks assumedly? Similarly, are there any sonic advantages in making the output coil more substantial; e.g: using 1.4-1.5 mm wire with, say, 13 turns at 16 mm diameter self-supporting, so that ringing can be reduced?

Mark A Butcher
Norwood, SA

The 100 mA quiescent current is the current which is required to flow through the output power MOSFET. This figure results from the fact that, at this current, the output MOSFET are thermally stable. Below this, the power MOSFET have a positive temperature co-efficient. If the gate-to-source voltage is held constant, the current flowing from the drain to the source will increase with increasing temperature.

Above the ideal operating point, the device exhibits a negative temperature co-efficient. With the gate-to-source voltage held constant, the drain-to-source current will decrease with increasing temperature. There is therefore, a tendency for the output power MOSFET to adjust its operating point until the zero temperature co-efficient operating point is obtained.

In reality, the actual operating point for an output stage employing power MOSFET is not so critical. A decrease in the quiescent current will tend to increase the amount of crossover distortion although distortion figures will certainly remain under .01%.

Many commercial power amplifiers employing power MOSFET in the outputs, particularly the more expensive and esoteric ones, tend to employ large amounts of quiescent current. Indeed, some operate completely in Class A while many are effectively Class A power amplifiers since the conversion point from Class A to Class B maybe set at 50% or higher or the maximum rated output power. In general, I think it is true to say that the subjective improvement as a result of increasing the bias current depends on many of the other aspects with the power amplifier's design.

In the case of the AEM6500 power amp module, a slight improvement in subjective performance seems able to be obtained by increasing the quiescent current to around 400 or 500 mA after, of course, increasing the heatsink capacity to reduce the MOSFET operating temperature. Above this operating point, the law of diminishing returns most certainly applies will disproportionately large dissipations required in comparison to the subjective improvement.

I'm doubtful if any subjective advantage would result from increasing the size of the wire used to form the output coil, although it is probably worth experimenting. If you try it and get significant improvements, please let me know.

David Tilbrook

Crossovers and phase shift

Dear Roger,

Thankyou for the Weller WTCPN Soldering Station which I won in Crossword No 7. I was very lucky.

A few words about your magazine: Overall, I think it's excellent — with a good balance between audio, computing, communications etc. Particular thanks to David Tilbrook, whose projects, especially the articles which accompany them, are very helpful. Since my formal electronics education ended very prematurely, his articles often point me in the right direction. It can be frustrating to have an article appear in AEM by David which would have saved me weeks of work (e.g: the Electronic Crossover).

Don't let the content of your magazine become too small; I just hate magazines which are all inserts and other advertising — a cheap trick.

One suggestion that I have is to include a bibliography at the end of all articles, or perhaps at the beginning of a series. Perhaps I'm a bit odd, but I often wish to read a lot further than it's practical to go in the articles. For example, considering the basic design philosophy behind the Electronic Crossover by David Tilbrook, I am not convinced that there is a subjective difference between no phase shift and a gradual phase shift over the audio bandwidth (see Ashley and Henne in *Journal of the Audio Engineering Society*, Vol. 19, No. 1, Jan. '71). I can't hear the difference, although I must admit that my hearing may not be as good as others. This zero phase shift ideal is possibly a pipedream considering the mangling that happens in the recording process. I'm looking forward to your bi-/tri-amping series, though.

Many thanks for a magazine which is, or should be, killing the other two in the marketplace. Keep up the good work.

David Tweedie
Evandale, SA

Thankyou for your comments regarding the magazine. Rest assured we have no intention of allowing the content of AEM to decrease. In fact, over the next few months we are planning some significant and exciting changes to the magazine which will involve a substantial increase in the editorial content. We are out to make AEM the best electronics magazine of its type in the world and with your help we are sure to succeed.

Your suggestion on including references and/or a bibliography is well taken. These have been included with articles from time-to-time, but we will attempt to include such things more often in future.

The subject of the audibility of phase distortion is an interesting and involved one. I am in no doubt that a large enough frequency dependent time delay does affect the subjective performance of a loud-speaker. The phase characteristic introduced by a fourth-order Butterworth filter is one which rolls through 360 degrees around the crossover point, being 180 degrees out of phase at the crossover point. Both the low- and the high-pass sections remain in phase with each other throughout the entire audio passband because the phase shifts introduced by the low- and high-pass sections track each other. This is an advantage because, although there is an overall phase shift introduced by the crossover the signals sent to, say, the mid-range and the high frequency drivers remain in phase for all frequencies, which reduces unwanted interference effects.

There are many other unwanted effects generated by crossovers, both passive and active, which degrade the sonic quality of a loudspeaker. Of these, the transient performance of the crossover is of vital importance. My own opinion as to the audibility of minor phase errors is that the effect is subtle and is easily masked if other more dominant errors exist simultaneously.

Roger Harrison,
David Tilbrook

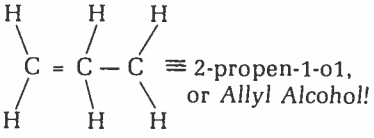
June's Last Laugh

Dear Sirs,

Struth! No wonder lecturers have so much trouble, especially if they're like Lance Wilson who 'lubricates' his throat with middies of C_3H_5OH — wow!!

I thought I was wild, but I only drink ethanol — C_2H_5OH!

Having studied chemistry at university, I recognised that Mr Wilson must be drinking the following:



≡ 2-propen-1-o1, or *Allyl Alcohol!*

This garlic-tasting gargle would definitely keep his throat lubricated. And his brain . . .??

There are other possibilities for C_3H_5OH which we won't go into here.

Happy Drinking!
Colin Stewart,
Broken Hill NSW

The Boss is away... so we've slashed our prices!

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$10 off!

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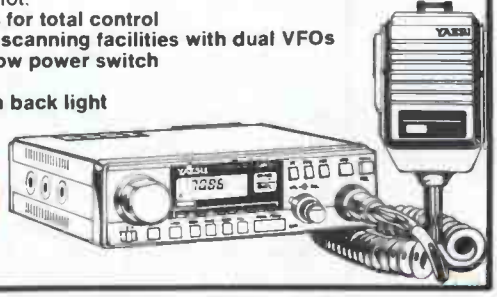
- **Die-cast, duct-flow heatsink**
- **Large, easy-to-read LCD with back light**

Cat D-3517



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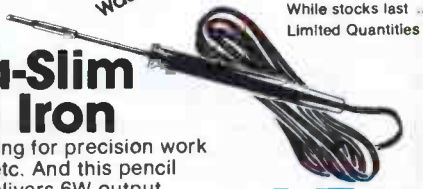

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5. 27MHz Whip 36"
Adjustable tip

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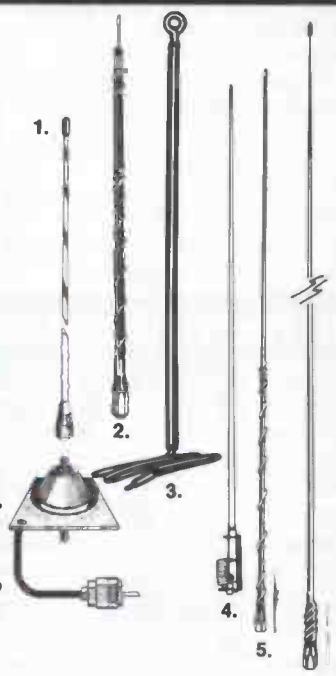

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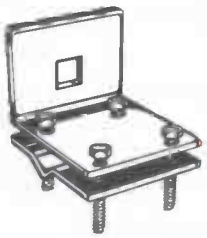

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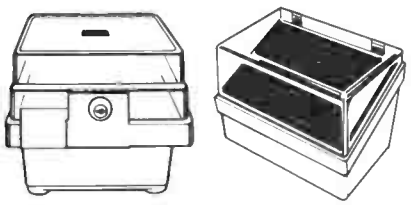

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If you're serious about good soldering, there's only one way to do it — with a temperature controlled soldering iron. Until now, temperature controlled irons have been expensive. But Dick Smith Electronics have solved the problem! The DSE Auto Temp offers you the best quality at an unbelievable low price. Features fully variable temperature control (from around 200° to over 500° Celcius) with a temperature meter to show you what's happening. And it's fully approved by the Energy Authority. The station comes complete with lightweight iron,holder and cleaning sponge, with a comprehensive instruction manual with full servicing information included — just in case you need it. Cat T-2000

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Tip Medium chisel T-2002 **$5.95** **Tip thick chisel** T-2004 **$5.95**
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Read all about Satellite TV

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The title says it all... everything you ever wanted to know: sitting and installing base stations, satellite orbit link-up and down link specs. 250 pages by Martin Clifford. Cat B-1841

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Satellite TV is here now! And it's growing. This amazing book tells you how to set up a station, the equipment needed, what programming is available and more. 326 pages by Cook and Vaughan. Cat B-1840

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More brilliant information about this growing international entertainment medium. Tells you how to select a system, install it and what you can see. 223 pages by Long and Keating. Cat B-1842

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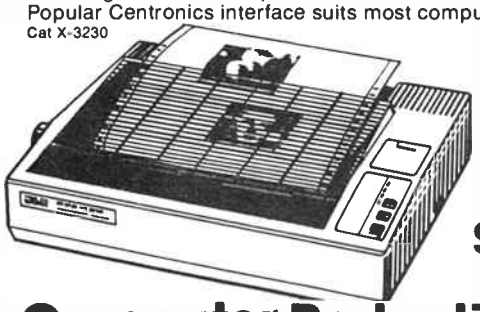
Real value-for-money! Versatile Data Mate DT-130 dot matrix printer combines speed with near letter-quality style for correspondence. Prints 130 cps: select normal, large, condensed or enlarged condensed print modes. Ideal for home and office. Popular Centronics interface suits most computers. Cat X-3230



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Own a computer? Our anti-static spray is invaluable! Simultaneously cleans, polishes and protects your micro. Leaves an anti-static film which minimises potential build-up — the common cause of data loss. 29.57ml spray.

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Considering an IBM PC? Think again and save hundreds of dollars! System One Multitech more than matches IBM's JX feature-for-feature, runs MS-DOS programs (including most IBM) but costs considerably less —even with IBM's current Cash Back offer. Impressive 128K memory and built-in disk drive satisfies a growing family's needs but easily expands if required. Cat X-8000

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FREE WIA CALLBOOK B-2323 WITH ANY PURCHASE OF AMATEUR RADIO EQUIPMENT (VALUE $8.50)

FT-270R Hi Performance 2 mtr Mobile

This feature packed compact is designed with two microprocessors for complete control. 10 memories give you the channels you want at the touch of a button. Advanced search scanning facilities let you tour through the band with ease. And dual VFO's let you handle odd repeater splits.

Features: • LCD display — with backlight • Unique die-cast, duct-low heatsink • Compact — just 140x162x40mm • High/low power output:

Cat D-3516

$659

WAS $859

Shinwa Low Pass Filter

Stubborn case of TVI and BCI? Try the 'Big Gun'. Shinwa filter has helped thousands of customers. Handles up to 500 watts. Cut off is around 30MHz, insertion loss is less than 1dB and maximum attenuation is around 50dB! Ideal for amateurs and CB'ers.

Cat D-7080 **$45.50**

Yaesu Scan Mic

Excellent value! And so convenient too. Hand held mic suits all Yaesu transceivers with scanning facilities. Just plug in (standard 8 pin plug) and you're on the way to easy scanning operation. Perfect for mobile use. 500 ohm impedance. Cat C-1116

$51.50

Mobile Bracket for FT290

Yaesu designed the sturdy MB-11 mobile mounting bracket specifically for their great FT-290 transceiver. Great security featre... take the rig with you. Complete with mounting hardware and cables.

Cat D-2911 **$69**

PA-3 Car Charger

Intended for operating 10.8 volt hand-held transceivers from a car cigarette lighter socket. Includes charging as well as power. Suits FNB-3 pack as well as other style transceivers.

Cat D-2899

ONLY $56.95

Fan Cooled Dummy Load

100W continuous or 500W short term: that's the WELZ CT 530 Dummy Load. DC to 450MHz with SO239 socket termination and fan-forced air cooling. A must for the serious amateur.

Cat D-7020

$149

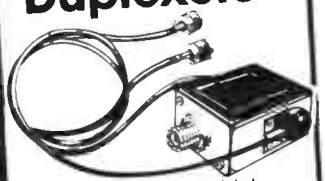
WAS $169

GREAT VALUE! Antenna Tuner

Match your transceiver and antenna perfectly! The FC-700 will give you the most from your 'rig'. Antenna matching can be as easy as turning a dial: so you'll have more time for better things. Gives maximum power and performance.
Includes large power/SWR meter, built-in dummy load AND covers all WARC HF bands. All this, and there's less than 0.5dB insertion loss. Cat D-2917

ONLY $335

Maldol Duplexers



What a bargain! Maldol duplexers add versatility to communications: single transmission lines are so much more convenient!

2-6m, Cat D-3555 **Was $62.95** **$52.95** SAVE $10!

2m - 70cm Cat D-3550 **Was $56.50** **$49.50** SAVE $7!

HF Mobile Antennas

Superb range of loaded whips from Mobile One — the Australian manufacturer that knows what you want! All feature adjustable tuning (no cutting required!) with heavy duty stainless steel stub, mobile mounting base, RG58C/U coax and PL259 connector.

80 Metre. Cat D-4307
40 Metre. Cat D-4308
20 Metre. Cat D-4309

ALL FOR JUST **$59.95** EACH

Mobile Hanger

Mounting Bracket

Mount your FT-757 transceiver securely... three angle positions available; place unit in suspended or slung position. Secure either under dash or on transmission tunnel. Cat D-3501

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Perfect match for our YH-1 headset (C-4195) for better communication — especially mobile! Two-way switch with locking tx one way, PTT other. With LED indicator, 7 pin mic socket. Cat D-3512

BARGAIN

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Enjoy 2m & 70cm in one Compact Unit

- 25W continuous on both bands
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- Scanning mic and mobile mounting bracket

NC15 Quick Charger

Cradle-type charger/supply powers up FNB-3 or FNB-4 NiCads in no time: just around 3-4 hours... that's all! Features auto charge sensing. Can double as a handy base supply, too. Cat D-3513 **$165**

Economy 2m Hand-held

Yaesu's compact and lightweight transceiver for the amateur who doesn't need all the frills: the brilliant new FT-203. Thumbwheel frequency switching makes for quick and easy channel selection — so no memories are required. But the FT-203 still packs a handy 2.5W output: more than enough for average simplex and repeater (inbuilt +/- 600kHz repeater split) usage. And for mobile use the FT-203 has a no-hands VOX system when used with the optional YH-2 headset.

- **450mAh battery included**
- **144-148MHz frequency range**
- **5W input for 2.5W output (F3)**
- **Tiny size — 65 x 34 x 153mm — and only 450g including battery!**
- **Double conversion superhet receiver, 0.25uV (12dB) sensitivity**

Cat D-3500

$429

Economy 70cm

Yaesu FT-703R — a superb little transceiver with all the most wanted features — without the expensive frills! Covers 430-440MHz with simple thumbwheel setting. There's squelch and volume controls, repeater offset switch and high/low power control. But if that weren't enough: • **VOX (with optional YH-2 headset) • Wide operating voltages: 5.5 to 13V • 2.5W power output (10.8V FNB-3 battery included).**

Cat D-3508

ONLY $489 INC BATTERY

Yaesu FT-2700RH

Amateur value that's hard to beat! Enjoy the best of both worlds (2m and 70cm) without the expense or space problems of two transceivers. Yaesu's FT-2700RH combines both bands in one unit with an impressive array of features. There's programmable scanning, 10 channel memory scan and priority too! Dual independent front ends, local synthesizers, full duplex crossbanding and much more!

JUST $1095

Push Button 70cm FT-709R

Yaesu's FT709R — packs a load of features and performance in a compact, hand-held unit! Full keyboard entry, scanning memories etc. etc.

• 10 Memories • 5 scanning modes: selective, priority, band, skip and busy or clear • Choice of Hi or Lo (optional) battery packs: FNB-3 (10.8V, 425mAh) or FNB-4 (12.5V, 500mAh)batteries. Cat D-3509

$549

AMATEUR KITS

VHF GaAsFET PREAMPS

Gives 2m VHF receiver/transceivers added performance with >15dB gain and device noise <2dB: covers 144-148MHz. Strip line techniques add real stability. Auto rx/tx switching suits masthead mounting (bracket included). Kit comes with high quality coax relays. Cat K-6311

$129

UHF GaAsFET preamp Cat K-6309 **$129**

Build a UHF Yagi and Save!

What a bargain for the 70cm amateur! Assembling this 13-element antenna yourself saves $$$ and time — all you need is a screw driver. Cat K-6305 **$39.95**

Ideal for satellite work: stack two units using our phasing harness. Cat K-6299 **$9.95**

VHF 2m with 10dBd gain!

This affordable 9-element Yagi kit will get your 2m gear working to the full! And there are no tuning hassles: pre-drilled for easy installation Cat K-6297 **$89.95**

70cm Vertical Base Antenna

Get the most from 70cm action with our latest base station antenna — from RF Aerospace, the leading manufacturer. Boasts impressive 3.2dB gain over 1/4 wave whip. Wide band: 430-440MHz at <1.5:1 SWR. Compact and easy to install, comes with a mounting clamp. Cat D-4704

JUST $59.95

MONEY BACK GUARANTEE

Check your nearest DSE store for super bargains!

Nut and bolt packs

Keep some on hand... just in case!

Nylon Nuts & Bolts

12mmx4BA cheese head. Pk.10. Cat H-1012

25mmx4BA cheese head. Pk.10. Cat H-1022

12mmx6BA cheese head. Pk.10. Cat H-1032

25mmx6BA cheese head. Pk.10. Cat H-1042

95¢ Pack

BA Type Nuts

4BAhex nut (brass). Pk. 20. CatH-1332

6BAhex nut (brass). Pk. 25 CatH-1342

$1.05 Pack

Metric Screw Packs

Asst. pan head. 160 pc. Cat H-1500

Self-tapping screws 1500pc. Cat H-1505

$3.50 Pack

Machine Screws

Asst. counter-sunk head 270 pc. Cat H-1515 **$5.95**

Asst. nuts 340 pc. Cat H-1520 **$7.50**

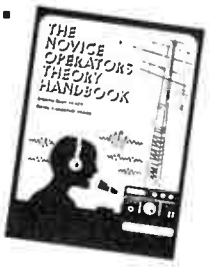
Asst. Counter-Sunk Head

Self-tapping screws 320 pc. Cat H-1510 **$5.95**

Morse Code... The key to CW!

Ideal for practice, just the shot for a youngster wanting to learn Morse. Cat D-7105

Learn Amateur Radio the easy way...



DSE's Novice Course pack is ideal for the person wishing to enter the hobby of amateur radio. Comes complete with Morse tape and novice theory book. Cat D-7110

$4.50 **$10.95**

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531 Pittwater Rd
Campbelltown Mall Queen St
Shop 235, Archer St Entrance
147 Hume Hwy
164 Pacific Hwy
315 Mann St
4 Florence St
Elizabeth Dr & Bathurst St
450 High Street
621-627 The Kingsway
173 Maitland Rd. Tighes Hill
Lane Cove & Waterloo Rds
George & Smith Sts
The Gateway High & Henry Sts
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125 York St
Treloar's Bldg. Brisbane St
263 Keira St

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Blacktown	671 7722
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Brookvale	93 0441
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Gosford	25 0235
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Tamworth	66 1711
Wollongong	28 3800

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Creswick Rd & Webster St
145 McCrae St
Shop 46,Box Hill Central, Main St
Hawthorn Rd & Nepean Hwy
260 Sydney Rd
1150 Mt Alexander Rd
Nepean Hwy & Ross Smith Ave
Shop 9 110, High St
291-293 Elizabeth St
Bridge Rd & The Boulevarde
Springvale & Dandenong Rds
QLD
157-159 Elizabeth St
166 Logan Rd
Gympie & Hamilton Rds
2nd Level Western Entrance
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Queen Elizabeth Dr & Bernard St
Gold Coast Hwy & Welch St
Bowen & Ruthven Sts
Kings Rd & Woolcock St
Cnr Pacific Hwy & Kingston Rd

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Ballarat	31 5433
Bendigo	43 0388
Box Hill	890 0699
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Essendon	379 7444
Frankston	783 9144
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Melbourne City	67 9834
Richmond	428 1614
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Brisbane City	229 9377
Buranda	391 6233
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Redbank	288 5599
Rockhampton	27 9644
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William St & Robinson Ave
Raine Square, 125 William St
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Shop 40A, Lower Level
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NT
17 Stuart Hwy

Adelaide	232 1200
Darlington	298 8977
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Offer concludes on 31/8/86 or until stocks are exhausted. Prices can be increased without notice due to fluctuations in currency, high interest rates, government taxes and imports.

B.219/AW

New NAD cassette deck features Dyneq and 'Play Trim'

The new NAD6240 is a mid-price cassette deck equipped with two performance-optimizing features, Dyneq and Play Trim, that previously were available only in their top-line recorders.

Dyneq (Dynamic Equalization), originally developed by Tandberg, deals with the most prevalent flaw in cassette recording: high-frequency saturation. All cassette recorders employ a steep high-frequency boost in recording, to overcome treble losses associated with the slow 1⅞ i.p.s. tape speed.

At high recording levels this pre-emphasis causes tape saturation whenever the music includes strong high-frequency sounds (brass, bells, cymbals, and percussive transients). This saturation not only produces dull sound in playback but also causes intermodulation distortion at middle frequencies.

The Dyneq circuit functions as a sophisticated high-frequency limiter to prevent tape saturation. During the moments when strong high-frequency signals are being recorded, the treble pre-emphasis is reduced — just enough to prevent the highs from saturating the tape.

As a result, regardless of what music is being recorded, the NAD6240 always makes the most efficient use of the available dynamic range of the tape, NAD say. It deposits as much high-frequency energy as the tape can take — and no more.

As a result, recordings are consistently crisp, clear, and remarkably transparent, without the distortion that saturation often adds to tapes recorded on other decks, says NAD. The circuit is completely automatic, requiring no adjustment by the user.

Play Trim is a variable equalization circuit that corrects high-frequency losses in playback. Introduced by NAD last year, Play Trim was developed in collaboration by NAD and Dolby Laboratories.

There are many potential causes of non-flat high-frequency response, especially in cassette tapes that were recorded on one machine and are being played on another. These arise from tape saturation, from biasing that didn't match the tape when the recording was made, and from differences in equalization and head azimuth among recorders.

Even if these aberrations are small, they become important when they cause mistracking in noise-reduction circuits, producing a broader and more severe dulling of the sound in playback.

The Play Trim circuit is a narrow-band equalizer that operates only at high frequencies, providing an adjustable boost or cut of up to ±3 dB at 10 kHz and ±6 dB at 20 kHz. The key to its success is its location in the playback path *ahead* of the Dolby NR decoder, so that it can restore accurate treble response before Dolby decoding takes place. The result, according to NAD, is accurate reproduction of every sound, with all of its brilliance and clarity preserved.

The Play Trim control is easy to use: simply adjust it in playback to obtain musically correct tonal balance, removing any false brightness or dulling of the sound, the company claims. In keeping with the NAD custom of providing front-panel controls that are logical and uncomplicated, seldom-used controls (bias fine-adjust, Dolby multiplex filter) are located on the rear panel of the 6240. Recommended retail price is $499.00.

Details from **The Falk Electrosound Group, PO Box 234, Rockdale 2216 NSW. (02) 597 1111.**

MAGNAVOX REVIVED

The Magnavox brand name, which has had a long and warmly remembered history having been stamped on speaker drivers manufactured in Australia for several decades, has been taken up by Eltec Pty Ltd, owned and operated by Nick Derera.

Mr Derera, ex-managing director of Amtron Tyree, acquired Magnavox after it went into receivership recently. His new company, Eltec, has extensive manufacturing and testing facilities to offer Australian speaker users for both quantity runs and customised drivers.

Eltec is also offering a range of quality Australian designed and manufactured drivers along with a variety of imported acoustic transducers, piezo-electric buzzers etc, to supplement the range.

Derera says Eltec is set up to offer a custom design service for speaker drivers and loudspeaker systems. He claims the company is the only one in Australia to offer a complete acoustic transducer design and manufacturing service. For more information, ring Nick Derera on **(02) 387 4687.**

Ortofon to Scan Audio

Melbourne-based distributor Scan Audio has, with immediate effect, been appointed Australian distributor for Ortofon cartridges.

"The change seems very logical as our company already imports several high quality audio products from Denmark. As the name of our company indicates, we are specialised in Scandinavian Audioproducts, and we feel confident that both Ortofon dealers and customers will benefit from the change in distribution. We will do our best to provide the highest possible service to all Ortofon enthusiasts in Australia", says Michael Henriksen, Managing Director of Scan Audio.

Ortofon has incorporated with their new range of moving coil cartridges many of the design features known only from their "State of the Art" models MC-30 and MC-2000.

Products that can be expected from Ortofon in the future are pre- and power amplifiers.

For more information about Ortofon, contact **Scan Audio Pty Ltd PO Box 242, Hawthorn 3122 Vic. (03) 429 2199.**

Video cabinet

Video integration cabinets pack a lot of convenience and functionality into one compact unit. Not only do they neatly organise TV and video equipment; they are also attractively designed, allowing them to take pride of place in even the most elegantly appointed home.

Systemline Furniture's V-series video cabinets have enjoyed enormous appeal both for their stylish looks and functional design. Now, Systemline has launched still another in the range which is sure to be a winner: the V-500 video cabinet.

Like its companions, the V-500 features a sleek, low-line appearance with a re-inforced top strong enough to support most large-sized stereo TVs. A shelf below, enclosed behind glass doors for full protection, houses the video recorder.

But the V-500's most innovative feature, it is claimed, is a convenient slide-out drawer for storage of cassette tapes. Measuring 355 mm in depth, the drawer can easily store tapes stacked upright, within easy reach for pulling out any tape one wants.

The V-500, as well as other popular video integrated furniture by Systemline, is available from selected outlets throughout Australia.

The Chicago Consumer Electronics Show —

Television stages a comeback!

Dennis Lingane

The successive booms in hi-fi, video and home computer have dominated the Chicago CES for a decade, but this year television staged a grand comeback. And if you're not watching television, the industry believes you'll be using the telephone, it seems! A.A. Campbell-Swinton and Alexander Graham Bell, what did you start?

THE IDIOT BOX — colour television — has become the new glamour star of the consumer electronics industry. But it's no longer an idiot box. TV sets, from pocket-size to jumbo with built-in computers and digital processing circuitry, exploded onto the floor of the 20th International Consumer Electronics Show in Chicago in June. Video, home computers and hi-fi, which have dominated the industry for the last ten years, played second fiddle to the new industry star on its comeback trail. Only compact disc created as much excitement as the new-era goggle-box.

Part of the reason for TV's rebirth as a high-tech product is the growing popularity of *home cinemas*. Yes, the home cinema has finally arrived — at least in America. Everywhere at this annual electronic extravaganza, giant-screen television sets pulsed, glowed and vibrated to the soundtracks of box office smashes and movie blockbusters. Every manufacturer was demonstrating "surround-sound" systems to couple with hi-fi systems, to turn the home lounge into a cinema. In the past, only one or two manufacturers have bothered to offer surround-sound. Now they are all on the bandwagon with a vengeance.

Yamaha scooped the pool with a new digital processor (Model SR-50) that not only provides surround-sound, but also offers you the ability to dial up any listening environment you choose; select from 15 famous concert halls, a church, cathedral (with or without a dome), jazz club or disco!

With big sound you just have to have big picture. So it seems large TV screens will be the rule for the lounge room. At this show the large screens were mostly projection, but Mitsubishi, Toshiba and Sony were showing giant cathode ray tubes, which are now referred to as "direct view TV", ranging from 40 to 43 inches — that's 1016 mm to 1092 mm, over twice the diagonal size of the 54 cm sets popular here! The other popular large screen is rear projection. Overhead projection and front projection are still very much in the minority.

However, rear projection units are becoming much more acceptable to home owners, it seems. The industry is now packaging them in deluxe-style cabinets and consoles.

Videophones at last?

TV even elbowed its way into the telephone and car exhibits. Luma (a subsidiary of Mitsubishi) released a video telephone

with camera built-in. This telephone connects into the standard telephone network and can transmit and receive a still black and white video picture. When your call somebody on your Luma telephone the camera takes a digitised picture and zaps it down the telephone line to a Luma at the other end. This picture is frozen on a mini TV screen so that the caller can see who they're talking to. Likewise, the TV camera built into the Luma shoots a picture to your telephone and you have the pleasure of seeing what the person looks like.

While this is a somewhat gimmicky feature, it is the first step to the much talked-about video telephone complete with moving pictures.

In the short term these Luma TV 'phones must become very popular with the heavy-breathing telephone trade in New York and Los Angeles. Over there telephone companies have a roaring trade in Dial-A-Lady-Who-Will-Talk-Dirty-To-You. With a Luma you can get the picture as well!

The TV invades yet further

Sony went one step better than everyone else by unveiling a rear projection console with data grade resolution using its new XRT technology. Data grade tubes will resolve up to 100 columns from a computer, while standard TVs will only resolve 40 columns.

At the other end of the scale there are increasing numbers of portable, mobile and pocket TV Sets. Sony has designed a special colour TV set for cars and recreational vehicles. This unit was installed in a camper with a prototype 8 mm car video cassette, TV tuner and AM-FM radio system. The car also included Sony's in-boot 10-pack CD player with a dashboard controller. This in-car entertainment centre would put most home electronic entertainment systems to shame, it is that good. But then it would cost in excess of $5000 when released at the end of this year! But industry people shrug their shoulders and point out that teenagers and yuppies often spend that sort of money on their car sound systems these days.

The side benefit of the 8 mm video car unit is it will also switch to play up to 18 hours of digital sound on a single cassette.

Further development

The digital TV age has arrived at last. The digital TV sets shown at this year's Chicago show were not experimental prototypes, they were all pre-production models and simply await retailers to place orders before becoming a reality in the marketplace.

These digital TV sets offer picture-in-picture facilities, and in some cases, interlace processing. In the former you can pull up a second, third, fourth and even fifth channel over the main TV channel. These secondary pictures are then displayed in the corner of the main TV picture. So, you can keep yor eye on what's happening on the other channels while watching your favorite TV show.

Interlace processing is probably one of the most exciting aspects of digital television because it basically offers 'high definition' television without changing the existing TV System. Currently, a TV picture is made up of two pictures. The first section is scanned on your TV set leaving every other line blank. The second part of the picture is then scanned in these blank lines. Meanwhile, the first set has disappeared, leaving way for the next scan. The eye is fooled into believing the complete picture is on the screen, but in fact you only ever get half a picture on the screen.

With interlace processing, a memory in the TV set takes the first scan and holds it. It then receives the second scan, marries them together and then with the complete picture intact, projects them onto the screen. The result is claimed to be nearly equivalent to the proposed world standard for PAL countries for high definition TV.

The Luma 'visual telephone' gives still video pictures of the parties at each end of a 'phone call. Arthur C. Clarke was right (see page 7, Jan. '86!)

Apparently, all that true high definition TV would offer beyond this quality of picture is a wider aspect ratio. The international committee currently debating standards for high definition TV proposes that the new HD TV should be wide screen, improving on the existing 4:3 aspect ratio currently employed.

Casio exhibited a new 12 cm liquid crystal screen colour TV about the size of a cigarette pack that can be viewed in any light and will fit in your shirt pocket. They also had a very slim black and white pocket TV that is no larger than a credit card.

No more pushbuttons, use your voice

When the 100 000 delegates attending Chicago weren't staring mesmerised at hectares of TV pictures, they were barking orders at telephones. The latest hype technology is voice control. This voice technology has been boosted from hobbyist level to practical use because of the popularity of car 'phones. Now when you are driving along, you simply command your cellular telephone to dial the person you want to speak to. It understands digits and names, and when your caller comes on line you don't even lift the handset. You talk as you drive without taking your hands from the steering wheel (presuming you can yell above the roar of the Chicago traffic). This voice control technology is claimed to be so good, and reliable, that it must ultimately replace infra-red remote controls in TV and video.

It seems telephones are now set to go just about anywhere. Prototypes were shown for cellular systems that within a few years will enable you to take telephones wherever you go. Motorola unveiled a handbag telephone for ladies that weights 66 grams. They also had a briefcase telephone for the business executive. Both work on the cellular radiophone system that is currently being introduced into Australia, beginning in Sydney, and will be available in all capital cities inside two years.

Telephones are even taking to water. A Taiwanese company is offering a cordless telephone that will go swimming with you in your backyard pool! It actually floats but doesn't mind the odd dunking if people are horsing around.

And if you know somebody who is on a diet you can now drive them mad by giving them a $30 hamburger or hot dog 'phone! For vegetarians there is an apple 'phone and a tomato 'phone. ▶

For the switched-on family

Musts for the switched-on family on the block would include solar-powered baseball caps with an electric fan in the peak (it even has back-up rechargeable batteries), a new mini underwater 8 mm video system from Sony, a sweatband with AM-FM radio for joggers and cyclists, an electronic child and pet finder, and an electronic butler/security guard.

The child/pet finder comes in two parts, both about the size of a 50 cent piece. A transmitter is fitted to the owner's keyring and a beeper module goes on the collar of the pet or child. If you press the button on the transmitter it activates the beeper. It's good up to a range that would be sufficient to cover a large shopping centre or supermarket, say its inventors. One enthusiastic customer said he wanted one to keep track of his cordless telephone as he never remembers where he left it, and frequently has to nip next door to the neighbour and ring himself to find his 'phone!

Compact disc is the other major money-spinner for the electronic industry here, as it breaks all records and seems set to repeat the video boom all over again. And personal computers have spawned a new era of home-office technology. It seems when you have a computer at home, personal photocopiers, sophisticated telephone equipment, portable facsimile machines and even electronic secretary/butler/security must follow.

The "butler" from Cypress, of California, is a central control system for your home that is totally voice controlled. When you go out you tell it to "Guard". Anyone entering is asked to identify themselves and if the sound of the voice isn't recognised, the butler sets up a burglar alarm and rings the police. Even ripping the butler off the wall won't help, he has his own survival kit to keep operating long enough to call the police.

When not playing security guard the butler is a model of servitude, responding to every command with "Yes, master". He will turn on lights in all parts of the house, close windows and curtains, open doors, and even switch on TV. But he doesn't do windows. As his inventor, former magician Gus Searcy, says: "Why should he? Human butlers won't"

And if you think having a butler waiting on you hand and foot while you sit back in your Dolby surround-sound home cinema lounge will make you fat and lazy, think again. The electronic industry is dedicated to keeping you alive and well (so you can buy more gadgets in the coming years) with a range of complex computerised exercise equipment.

They range from wrist computers, headband computers, thumb and foot computers that register your heartbeat and blood pressure, to complete modular programs for your PC that will, like a PT instructor, take you through a daily routine at all times monitoring your condition. These modular programs are coupled to exercise bicycles, rowing and jogging machines.

Maybe the computerised gym is best placed in the middle of your home cinema so you can cycle, jog, row or walk your way to health while watching your favorite movie!

As for the show itself . . .

These gadgets are only the tip of the technology iceberg that filled over 20 football fields of exhibition space in the windy city's McCormack convention centre on the edge of Lake Michigan. By day, the 100 000 delegates walked down kilometres of aisles analysing several hundred thousand new products. By night they poured an estimated $100 million into the Chicago economy (every hotel for 75 km around the city was booked out), most of it probably in Rush Street, the nightclub district. Traffic picks its way bumper to bumper through the thousands of revellers that fill the many small bars and overflow onto the street creating a New Year's Eve atmosphere every night. Impromptu conga lines erupt, usually headed by video porn queens, with dozens of ecstatic males grimly hanging on as she leads them in and out of the traffic chaos.

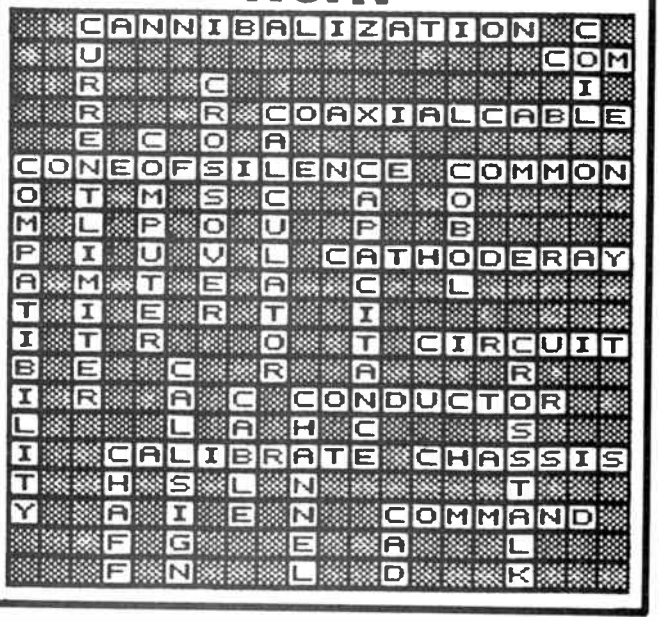
Several football field's worth of the Chicago CES. Just part of the twenty . . .

One night the Chicago police had to move in on the street with horses and crowd control barriers to disperse the bedlam. But all was done in good humour, because Chicago knows the value of letting people have a good time — it's their bread and butter.

The dealers and manufacturers from around the world have plenty to be happy about. In the last ten years the electronics industry has not let them down. Each year they leave Chicago with new technologies and gadgets that almost guarantee consumers will pour into their stores. This year it was big TV, big sound, cellular radio and mobile video.

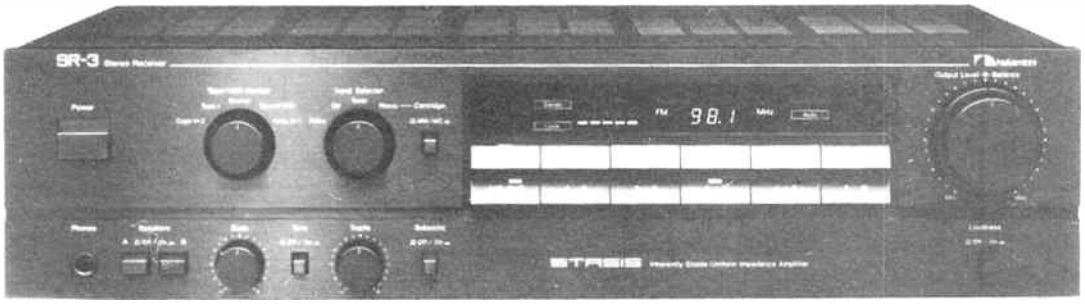
At heart, maybe consumers are all big kids, and no industry does a better job of producing 'big kid' toys.

ANSWERS TO THE WELLER CROSSWORD COMPETITION NO.11



Nakamichi

HEARING IS BELIEVING!



Until you hear the Nakamichi SR-3/SR-2 receivers, you won't know how economical a really fine sound system can be! These are no ordinary receivers. They, are the ***only*** receivers with STASIS amplification, the most important improvement in power amplifier design in recent years.

STASIS POWER AMPLIFICATION

In the SR-3 and SR-2 ***two*** amplifiers drive each speaker. One is a relatively low-power amplifier with very low output impedance and exceptionally fine performance. The other is a "Current-Mirror Bootstrap" that has high output impedance and can deliver tremendous peak current — up to 18 amperes in the SR-3, 14 amperes in the SR-2. Because of the difference in output impedance, the low-power amplifier determines the voltage across the load and, therefore, the sound quality; the "bootstrap" merely supplies the muscle.

It's an engineering fact that a low-power amplifier can be designed for nearly perfect performance ***without*** "global" feedback while it's almost impossible to achieve equivalent results from a high-power amplifier without output-to-input feedback to correct distortion. Since the ***low-power*** amplifier determines sound quality in the STASIS design, there's no need for overall feedback and none is used! Eliminating global feedback ensures that the amplifier is inherently stable with any loudspeaker at any power level so there's no need for an output coil to "isolate" the amplifier from the load. Removing it ensures uniform output impedance and enables the amplifier to control the speaker very precisely. For the first time, your speaker will deliver its ***full*** potential and sound will emerge with a new clarity and definition.

QUARTZ-LOCKED TUNER

The SR-2/SR-3 FM/AM tuner has the advantages of Quartz PLL Synthesis — precise tuning, freedom from drift and minimum distortion — without the high residual noise that plagues ordinary tuners of this type. The reason is a new synthesis system that uses a reference frequency twice as high as normal! This places the residual noise out of the audio band, The front end uses low-noise dual-gate MOS FETs for immunity to overload and the tuning system employs high-Q twin vari-cap diodes that are functionally equivalent to a 4-gang capacitor.

MULTI-REGULATED POWER SUPPLY

In ordinary receivers, a common power supply and ground system is often used for all sections. This leads to interstage interference. In the SR-3/SR-2, the preamp/power-amp, tuner and display sections are powered independently via separate power-transformer windings, rectifiers and regulators. Grounds are kept separate — even to the point of isolating the tuner ground from the preamp ground — and local subregulators are used at critcal points in the circuit. These subregulators are of a unique "discrete" design that cancels noise on the ground line. The result is a receiver that performs like a group of audiophile "separates".

A PRECISION PREAMP

We've gone to great lengths to design a preamplifier that matches the sound of a fine "separate." The phono preamp uses discrete ultra-high-gm **FETs** in a balanced differential configuration which feeds a differential gain stage. **RIAA** equalization is obtained by a precision feedback network. The gain and input impedance of the SR-3 preamp is switchable to accommodate high- and low-output **MC** cartridges as well as **MM** cartridges. A subsonic filter is built into the phono preamp — fixed in the case of the SR-2, defeatable and of an unusually effective "simulated-inductor" design in the SR-3. Bass and treble tone controls and a loudness contour are featured on both models and are defeatable so you can obtain absolutely flat response whenever you desire.

- STASIS manufactured under license from Threshold Corporation
- STASIS is a trademark of Threshold Corporation

SR-3 SR-2

STASIS Receiver

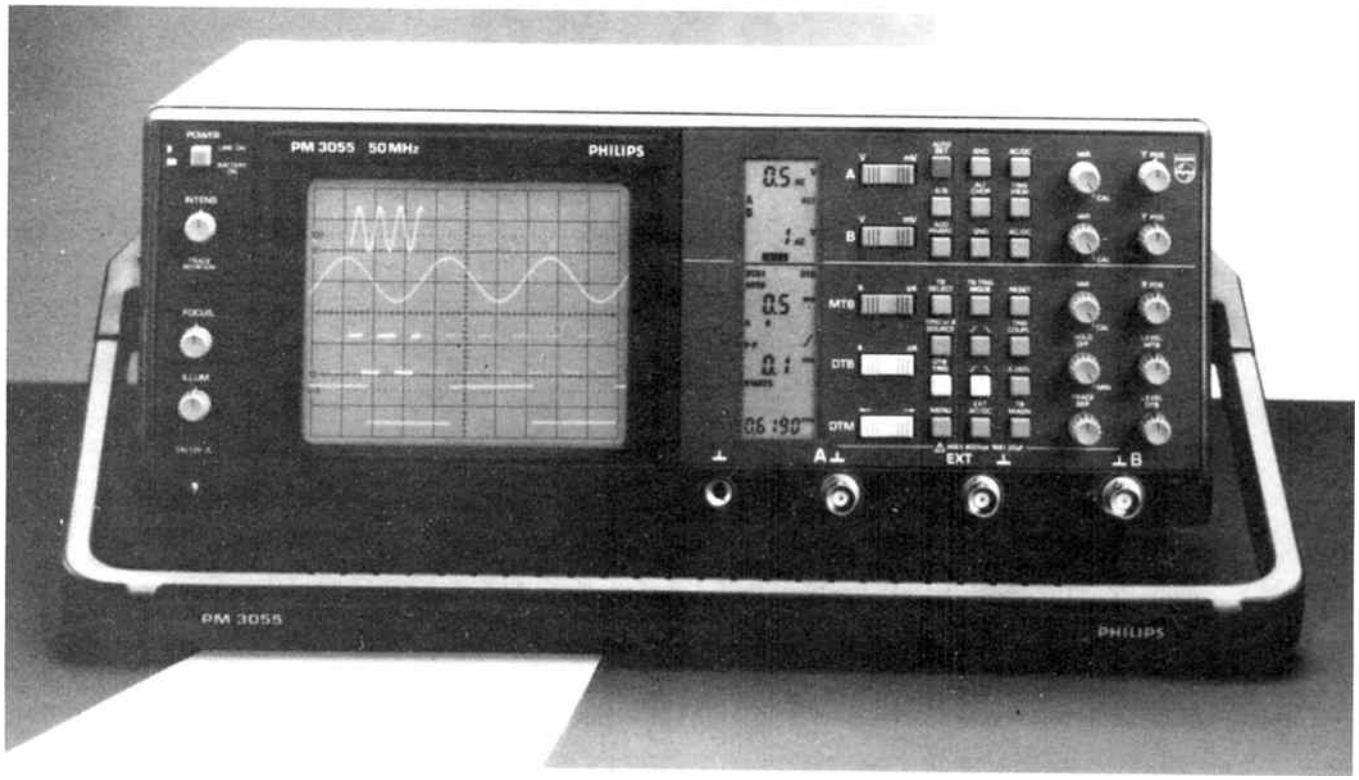
FEATURES

- STASIS power Amplifier
- Multi-Regulated Power Supply
- 10-Preset FM/AM Tuner with Manual and Auto-Seek Tuning
- Precision MM and (SR-3 only) MC Phono Preamp
- Video Input (SR-3 only)
- Defeatable Bass, Treble and Loudness
- Subsonic Filter (Defeatable on SR-3)
- Independent Input & Tape Selectors with Two-Way Dubbing (SR-3 only)
- A/B/A + B Speaker Selection

Nakamichi is distributed by **CONVOY INTERNATIONAL PTY LTD**, 400 Botany Rd, Alexandria NSW 2015.
Telephone 698 7300. Telex AA23111.

1ST BIRTHDAY CONTEST No. 2.

Win this new generation Philips microprocessor-controlled 50 MHz dual-trace CRO, model PM3050.



Here's a fabulous opportunity to own one of the world's most sophisticated 50 MHz dual-trace CROs featuring an all-new concept in front panel design. It incorporates a liquid crystal display to indicate instrument status and settings, up/down rocker controls instead of the traditional rotary switches, and multi-function 'softkeys' to reduce the overall number of controls. And you operate it as you would read a book: from left to right, and from top to bottom. An 'autoset' key automatically optimises settings for trace amplitude, plus timebase speed and triggering, to bring any connected signal in range and provide a usable display without the usual time-consuming manual settings.

The 8 × 10 cm CRT features a parallax-free graticule with variable illumination. Vertical sensitivity is variable betwen 2 mV/div. to 10 V/div. Timebase speeds range from a fast 50 ns to a slow 0.5 s. The chassis comprises a single injection moulding of engineering-grade plastic material, providing a very sturdy instrument. All major component assemblies are modular to allow fast field service or replacement.

Prize kindly donated by Philips Scientific & Industrial, PO Box 119, North Ryde 2113 NSW.

1ST BIRTHDAY CONTEST No. 2.

Q1: Who first described "... a method for the demonstration and study of currents varying with time", and in what year?

.....

Q2: The earliest attempt at constructing a linear sawtooth timebase is attributed to R. St. G. Anson in 1924 who employed a neon tube, but it suffered from slow sweep times and poor linearity. The development of the 'hard valve' timebase six years later paved the way for rapid development of the modern oscilloscope. Who developed it?

.....

Q3: In the PM3050 specifications, what is the worst-case rise time of the vertical amplifiers?

.....

Q4: The addition of a 'significant option' to the PM3050 permits operation in an automated system, including automated calibration. What is this option?

.....

Now tell us, in 30 words or less, on a separate sheet of paper, what features of the PM3050 most attract you (and we haven't listed them all here!).

Name .....

Address .....

..... **Postcode**.....

I have read the rules of the contest and agree to abide by their conditions.

Signed:.....

**The Contest Rules are set out on page 6 of this issue.*

Fluke 37 benchtop DMM

Fluke has announced the introduction of a new multimeter they claim will set new standards for price and performance in a benchtop meter. The new Fluke 37 features the combined analogue/digital display pioneered in the Fluke 70 Series, and the accuracy and input overload protection found in the Fluke 20 Series, and is backed by a two-year warranty.

The Fluke 37 offers an innovative case design specifically designed to improve ease of use and functionality, on the bench or in the field, the company says. The front panel features a 15 degree slope for optimum visibility and switch access. A large storage compartment built into the rear half of the case allows storage of test leads and small accessories inside the meter. A built-in carrying handle (molded into the case) offers portability.

With 0.1% basic dc accuracy and wide bandwidth ac response, the Fluke 37 meets or exceeds the specifications of any 3½-digit bench DMM available today, according to Fluke. Special internal design and construction techniques provide exceptional shielding against electro-magnetic interference, the company claims.

The unit has extensive overload protection and is designed to meet all requirements of U.L. Standard 1244. All current ranges, including the 10 A range, are protected by high-energy fuses. The resistance function is overload protected to 500 V RMS, and both ac and dc voltages functions are protected to 1000 V RMS.

Intended markets for the 37 include the aerospace and production test industries, schools and technical training centres and engineers and technicians who need high accuracy and a high level of safety in a bench-style instrument. Details from your nearest Elmeasco office in all state capitals, except Hobart.

Siemens SM components

To meet the increasing trend to surface mounting technology for printed circuit assemblies Siemens has released a broad range of surface mount components for direct attachment to PC boards.

All Siemens op-amps are now offered in SO packages for surface mounting, as well as the conventional DIP. Transistors of all types from AF to microwave are now available for surface mounting. For example, BFR35 in a SOT23 package has a transition frequency of 5 GHz, and at 800 MHz can provide a gain of 14 dB with a noise figure of 2 dB. The SOT23 package is particularly suitable for applications where the pc board tracks form some of the circuit elements, such as striplines.

Other Siemens surface mounting components include LEDs, KTY13 series temperature sensors, various ICs such as proximity detector TCA305G, circuits for radios, and transistor arrays.

Passive components include ceramic, metallized plastic, and tantalum capacitor chips, miniature ferrite inductors, varistors and thermistors. Various components are available in several packaging arrangements, such as reels, tapes, and stack, rod and linear magazines, to be compatible with most pick-and-place machines. Contact **Siemens Ltd, 544 Chuch Street, Richmond 3121 Vic. (03) 429 7111.**

New Vesta digital delay

Following on the enormous success of the Vesta Fire MR-10 Mini-Studio, distributor Rank Electronics is introducing another product from the Japanese company Shiino: the Vesta Fire DIG-412.

The DIG-412 is a programmable digital delay boasting a maximum 1024 msec delay time, and a 128-programme possibility, to expands one's creativity on stage or in the studio. All the parameters can be stored, edited and recalled at the touch of a finger. ▶

COMPREHENSIVE RANGE OF SOUND EFFECTS ON COMPACT DISC . . . FROM PHILIPS

Philips are marketing a unique package of sound effects on a series of 28 compact discs. This extensive library has more than 3000 different sound effects, prepared and recorded in stereo by the Canadian company Sound Ideas.

The catalogue for the complete library is presented to make selection by users — professional broadcast and post-production studios, theatres etc — remarkably easy. A full description of the effects, plus time, disc, track, playing time and index number is given by subject by disc. In addition there is an alphabetical listing by subject for the complete set of discs in the same degree of detail.

This means that by using the versatile facilities of the Philips LHH2000 Professional Compact Disc Player System, extremely rapid access to the information stored on the disc, and highly accurate, fast programming and cueing of the desired effects are possible, Philips claim.

The total package of 28 discs gives some 25 hours of high quality stereo sound effects.

For further information, contact **Charles Montesin, Philips Scientific & Industrial, 25-27 Paul Street, North Ryde 2113 NSW. (03) 888 8222.**

INTRODUCING THE TIME-SAVER/MONEY-SAVER CIRCUIT-BOARD-ARTWORK SOFTWARE

For only $1,250 smARTWORK™ lets the design engineer create and revise printed-circuit-board artwork on the IBM Personal Computer (or equivalent).

Forget the tedium of taping it yourself or waiting for the technician, draftsperson, or the CAD department to get to your project.

smARTWORK™ (Version 1.20) is the only low-cost printed circuit-board-artwork editor with all these advantages:

- ☐ Conductor spacing always correct.
- ☐ Lines don't become too narrow.
- ☐ Connecting lines do not intersect other conductors.
- ☐ Automatically seeks and draws shortest route between conductors.
- ☐ Quick correction and revision.
- ☐ Production — quality 2X artwork from a pen-and-ink plotter.
- ☐ Prototype — quality 2X artwork from a dot-matrix printer.
- ☐ Easy to learn and operate.
- ☐ Single-sided and double-sided printed circuit boards up to 10 x 16 inches.
- ☐ Multicolour or black-and-white display.
- ☐ Library storage and retrieval of your own commonly used layouts and pinouts.

- ☐ Block movement for on-screen cut and paste editing.
- ☐ Place text on either board layer.
- ☐ Separate silk screen layer.

System Requirements (smARTWORK™ Version 1.20)

- ☐ IBM PC, XT or close compatible with 384K RAM, 2 disk drives.
- ☐ IBM Colour/Graphics Adaptor with RGB colour or B & W monitor.
- ☐ Epson MX/FX80/100 dot matrix printer.
- ☐ Pen-and-ink plotters: Houston Instrument DMP42, 52 Hewlett Packard HPGL 7470, 75, 7580, 5, 6.
- ☐ Microsoft Mouse (optional), and other compatibles.

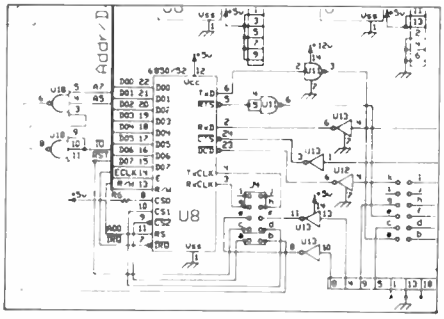
This revolutionary software package originates from the U.S.A. where it has a proven record for reliability.

Entertainment Audio of Adelaide are actually manufacturing the product locally, which has obvious benefits:

- ☐ Quicker availability of new releases and upgrades.
- ☐ Experienced engineers available to help or answer enquiries.

For a FREE TRIAL of smARTWORK™ and further information ring (008) 88 8414

PLUS... HiWIRE™: A NEW PRODUCT (A COMPANION TO smARTWORK™)



What is HiWIRE™?
A computer program designed to aid in the creation and drafting of electronic and electrical circuit diagrams

Creating diagrams — the old way
The thoughts and ideas of the design engineer are hand sketched, tediously corrected and redrawn, resulting finally in an untidy, draft sketch, which must then be sent to a skilled draftsperson for the production of a drawing of satisfactory presentation.

Problems with the old way
The production of circuit diagrams is a common "bottleneck" as a result of the time needed to produce quality drawings.
Therefore an effective Computer Aided Drawing system can not only relieve this "bottleneck", but also provide the archiving of design efforts for the future.

Enter HiWIRE™!
HiWIRE™ is a circuit diagram capture program for the IBM PC or close compatibles.
HiWIRE™ may be used throughout the design and documentation stage of a design, yet it is as easy to use as pen and paper.

HiWIRE™ — How does it work?

- ☐ HiWIRE™ is a computer based drawing editor, with the ability to work with, and "understand" electrical connections. That is, HiWIRE™ allows the user to select and draw not just lines, but wires and wire busses.
- ☐ Symbols may be loaded from a library, and the drawing may be annotated with text labels.
- ☐ Objects can be moved, copied, deleted or rotated with the click of a mouse button.
- ☐ Symbols may be defined by the user.
- ☐ The display may be divided into windows, to permit simultaneous viewing of various portions of a drawing. Windows may be quickly panned, scrolled, or zoomed.
- ☐ The program can identify the connections of a complex circuit, including device pin allocations, and device information.
- ☐ Information concerning the part number, location and other attributes for each device may be quickly entered.
- ☐ HiWIRE™ will extract this information from a drawing, providing lists that may be used by other programs such as component loading and PCB layout generation.
- ☐ Versatile plotting and printing from a wide range of popular devices.

Hardware Requirements

- ☐ IBM PC, XT, or AT or 100% compatibles.
- ☐ Two disk drives.
- ☐ 320 K of memory.
- ☐ Microsoft Mouse or compatible Colour Graphics Adaptor and RGB monitor or; Enhanced Graphics Adaptor and monitor.
- ☐ DOS 2.0 or later.
- ☐ Plotters from Houston, Hewlett Packard or; Epson FX series printer or compatible.

Availability
HiWIRE™ is expected to be available in August 1986.

Entertainment Audio P/L
A VILLAGE ROADSHOW COMPANY
59 KING WILLIAM STREET,
KENT TOWN, S.A. 5067
Phone (08) 363 0454

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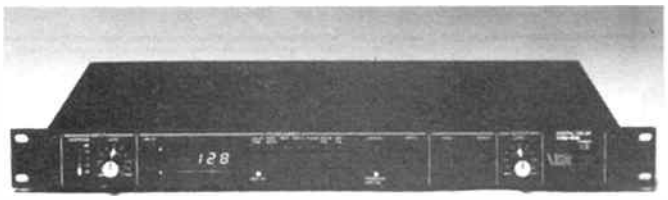
PROFESSIONAL PRODUCTS NEWS



The DIG-412 is MIDI compatible. Information on programme changes is transferred through MIDI, and the user can change programs with the MIDI keyboard.

Karl Seglins of Rank Electronics says the DIG-412 can be expected to find quick acceptance in the market by audio enthusiasts, who had also been responsible for the immediate success of the Vesta Fire MR-10 Mini Studio. For further information from Karl Seglins, **Rank Electronics Pty Ltd, 16 Suakin St, Pymble 2073 NSW. (02) 449 5666.**

Low current LED in red, yellow and green

Telefunken Electronics has released a high efficiency green LED specified at 2 mA forward current to complement the existing red and yellow devices in 3 mm and 5 mm packages.

These LEDs are ideal to run directly from CMOS and offer typically five times the brightness of standard LED technology, Telefunken claim.

The series TLL 4401 offer typically 2 mcd output at 2 mA forward current and +/–25 degrees viewing angle. Contact **Promark Electronics Pty Ltd, P.O. Box 381, Crows Nest, 2065 NSW. (02) 439 6477.**

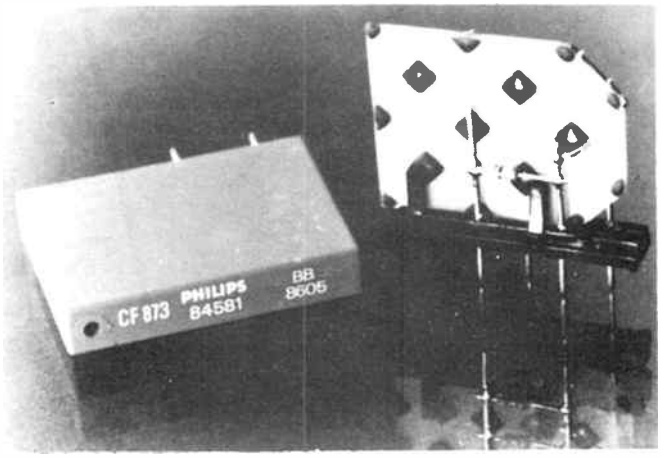
Comb filter for PAL video

Philips is introducing a comb filter for European PAL standard video recorders which offers optimum combing properties, low insertion loss and low spurious reflections. The CF873 has been developed from the company's DL872 glass delay line, the difference being that the CF873 incorporates a direct path resistor matched to the delay line.

The new vertically-mounted device compares very favourably in performance and price with equivalent comb filters from Asian manufacturers, Philips claim.

The CF873 consists of a very thin slab of zero temperature coefficient glass provided with a split transducer, mounted in a shock-proof housing. The four-pin unit is for direct soldering onto a pc board.

Further details from **Philips Electronic Components, 11 Waltham Street, Artarmon NSW. (02) 439 3322.**



JAYCAR No.1 FOR KITS

PHONE CONTROLLER
Ref: EA June 1986
Cat KA-1672

NEW $55.00

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

NEW $14.95

SCREAMER CAR ALARM
Ref: EA August 1986
Incorporates two sensors and utilizes a piezo screamer inside car
Cat. KA-1675

NEW $29.95

SHORT FORM

NEW FOOLPROOF SPEAKER PROTECTION
Ref: EA July 1986

The very latest in speaker protection. Polyswitch Protectors are based on conductive polymers and act like resettable solid state circuit breakers. When the operating current of the protector is exceeded the interior of the device partially melts which suddenly increases the volume. Then in turn reduces the current. The device stays in this state while the current is maintained because its temperature is elevated. Once the current is removed the device reestablishes itself almost immediately so that the low resistance value is restored.

Two of these devices are available from Jaycar. Simply connect them in series with the speakers you wish to protect.

RN3410 is suitable for protection of tweeters in systems up to 100 watts. It's rated at 50 volt and ½ amp. Nominal resistance is 0.4 ohms.

RN3415 will protect midrange and woofers up to 100 watts. Rated at 50 volts and 1.15 amps. Nominal resistance is 0.12 ohms.

TWEETER PROTECTOR Cat RN-3410
MID/WOOFER PROTECTOR
Cat RN-3415

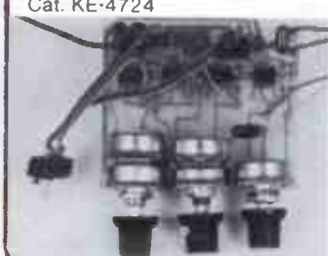
$6.98 each
10 or more $6.50 each

DIGITAL SAMPLER ETI 142
Cat. KE-4720

NEW $119.00

PARAMETRIC EQUALISER MODULE
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

NEW $16.50



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

NEW $14.99

IONISER KITS

COMPLETE
High efficiency emitter head - fits completely inside a high quality ABS box (NOT a metal lid) - only 2 core mains flex protrudes from the box - you can pay over $80 for a built-up inferior unit!
Cat KJ-6611

ONLY $49.50

SHORTFORM
Runs directly from 240V mains and has a low power consumption. Produces high intensity electric field with an output of around 7.5kV. Does not necessarily produce ozone in standard form. Ideal for those who wish to try an ioniser at an economical price.
Cat KJ-6610

ONLY $27.50

ETONE 10" SUB-WOOFER
As used in the Electronics Australia sub-woofer system

SPECIFICATIONS	
SIZE	10" (250mm)
CAST FRAME	OT=0.39 VAS=631
POWER HANDLING	100 watts rms
FREE AIR RESONANCE	32Hz ±1Hz
VOICE COIL DIAMETER	2"
MAGNET	3kg (6.6 lb)

Cat CW-2119

ONLY $119.50

SUBWOOFER AMP
Ref: EA July 1982
State-of-the-art MOSFET technology combined with a low pass filter. Around 100 watts rms drive capability. Ideal for use with the Jaycar Subwoofer speaker (Cat CW-2119). Amp will take line level (1V) input or connection direct to speakers. The Jaycar kit includes all PCB parts, heatsinks and power supply filter capacitors.
Cat KA-1452

ONLY $119.95

JAYCAR DEALER
EAGLE ELECTRONICS
54 UNLEY ROAD, UNLEY, S.A.
Telephone (08) 271 2885

SUPER HIGH POWER MOSFET AMP MODULE
Ref: EA October 1985
This mighty circuit designed by the EA engineering team is basically a 'beefed-up' version of the Playmaster 200. It consists of essentially the same power amp circuitry as the 200 except on a redesigned PCB which also incorporates a speaker protection and turn on relay. Considering the power available this is very prudent!
The Jaycar kit contains all PCB components including the heavy duty relay.
Cat KA-1622

ONLY $89.50

ELECTRIC FENCE CONTROLLER
Ref: EA December 1985

BRAND NEW MODEL NEEDS NO AUTO COIL!

This new electric fence is a considerable development over the older design (which is still currently available). Because this new circuit uses a special output transformer it is far more likely to work well into false loads such as tall grass or dirty insulators. The new circuit has also less current drain but far higher overall performance.
The Jaycar kit is supplied with a slightly different box than shown in the illustration. Also included is the length of HT cable and heavy HT connecting clip.
Cat KA-1660

ONLY $45.00

"ELECTRIC FENCE"
Ref: EA Setember 1982
Mains or battery powered this electric fence controller is both inexpensive and versatile. It should provide an adequate deterrent to all manner of livestock. Additionally its operation conforms to relevant clauses of Australian Standard 3129.
(Kit does not include automotive ignition coil which is required)
Cat KA-1109

$19.95

JAYCAR No.1 FOR WINTER BARGAINS

UNBELIEVABLE SEMICONDUCTOR BARGAINS!!!

MOTOROLA 6800 SERIES SENSATIONS!!!

6809 8/16 bit microprocessor
Cat ZZ-8055 **NORMALLY $10.00**
THIS MONTH $5.00

6821 Peripheral interface adaptor
Cat ZZ-8061 **NORMALLY $5.00**
THIS MONTH $2.00

6845 CRT Controller
Cat ZZ-8063 **NORMALLY $12.00**
THIS MONTH $5.00

6850 Asynchronous communications interface adaptor
Cat ZZ-8065 **NORMALLY $7.00**
THIS MONTH $2.00

6818 Real time clock
Cat ZZ-8057 **NORMALLY $10.00**
THIS MONTH $3.00

MEMORY

27128 EPROM Cat ZZ-8468
1-9 $5; 10-99 $4; 100+$2.50

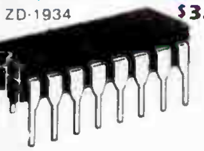
2114 RAM Cat ZZ-8414
1-9 $2; 10-24 $1.50; 25-99 $1.00; 100+$0.80 each

OPTO COUPLER MADNESS BARGAIN!!

We have purchased a large shipment of SHARP brand opto couplers. They are LED phototransistor types with a 5000 volt rating each device is a multiple unit coupler and is supplied with data

TYPE PC837 3 x optocoupler in a 12 pin DIP package.
Cat ZD-1932 **$2.00 each**

TYPE PC847 4 x OPTOCOUPLERS IN A 16 PIN DIP PACKAGE
Cat ZD-1934 **$3.00 each**



BARGAIN RF CHOKE

Heavily attenuates from 10MHz - 100MHz
Uses Philips Ferrocube bead with 3 turns of tinned wire. Will carry 2 - 3 amps so is ideal for in-line RF attenuator in power supply wiring
Cat LF-1200
$1.00 ONLY each

VIDEO LEAD

5 pin DIN plug to 5 pin DIN plug reverse
Cat AV-6532
ONLY $5.95

If you have any surplus stock contact
Gary Johnston or Bruce Routley on (02) 747 2022

TEXAS INSTRUMENTS

CALCULATOR BARGAINS!!

Jaycar is proud to announce distribution of famous Texas Instruments calculator products. To celebrate we have 3 specials for this month.

"LITTLE PROFESSOR" Famous childrens math learning aid. A fun way for your children to learn addition, subtraction, multiplication & division! AND at a NEW LOW PRICE

NORMALLY $39.95 THIS MONTHS INTRODUCTORY SPECIAL
ONLY $34.95
SAVE $5.00

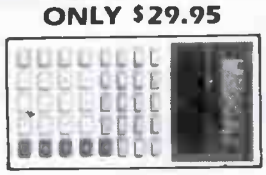
Cat QC-7160

TI-30 SLR - SOLAR POWER "SLIDE RULE" CALCULATOR

TI-30 SLR calculator will never fail you during an exam. Sunlight or electric light will keep your calculator working indoors or out

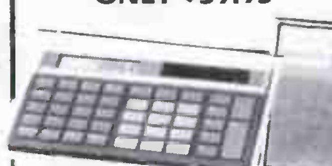
- AOS algebraic operating system
- 8 digit display
- Scientific notation 5 + 2
- 15 parantheses levels
- 4 max pending ops
- Constant
- Memory store/recall
- Sum to memory
- Exchange display with memory
- Sin cos tan and inverses
- DRG conversions

Cat QC-7164
NORMALLY $39.95 - SAVE $10
ONLY $29.95



TI-35 "GALAXY"

This 62 function scientific student calculator has an advanced design keyboard with extra large well spaced textured keys for sure fingered data entry. Helps reduce errors. It's colour-coded and slanted for comfortable and confident calculating.
New patented display indicators show pending operations to help students learn. Takes energy from any normal light source indoors or out. You'll never need batteries. The TI-35 Galaxy solar has the functions today's math and science students need - powers, roots, reciprocals, common and natural logarithms, trigonometric functions, degree/radian/grad conversions and much more. And AOS (algebraic operating system) makes it easy to use. You enter problems just as they are written, left to right.
A comprehensive student's guidebook is included to provide instructions, information, examples and problem solving specifics.
Calculator comes with a tough hard plastic clam-shell carrying case
Cat QC 7168
NORMALLY $49.95 - SAVE $10
ONLY $39.95



SAVE 88%!!!

VIDEO LEADS

Jaycar has purchased some distress stock of video leads
Rather than just buying one lead you need for a recording, this system incorporates just about all connectors you will need. You should never have to purchase another video lead. This system incorporates a lead 5 ft long with a 6 pin DIN plug on each end. You also receive 6 additional leads which plug into either end of the long lead and then into your video. The range of plugs is enormous.
EACH KIT INCLUDES:

2 x BNC plugs
1 x mini plug
1 x 5 pin DIN plug
2 x PL259 plugs
3 x RCA plugs
and MORE

NORMALLY WORTH $35.00
TOTAL 7 LEADS
FOR ONLY $6.95
Cat AV-6540

HEADSHELLS

We have noticed that headshells have become very hard to get and very expensive recently. Jaycar has purchased the entire quantity of a manufacturers stock. This is your last chance to grab one or two. Both are high quality standard ½" mount complete with hardware

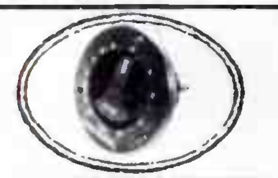
BLACK BRUSHED FINISH
Cat AA-0200
ONLY $2.95
NORMALLY $9.50

HIGH QUALITY
- Lightweight aluminium
- gold plated contacts
- one piece body for reduced latent feedback problems

Cat AA-0205
ONLY $4.00
NORMALLY $14.50

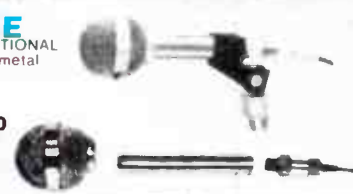
MID RANGE LEVEL CONTROL

The usual level control for mounting in speaker boxes. These are marked as MID
NORMALLY $7.95
ONLY $2.00 each
Cat AC-1680
LIMITED QUANTITY



MICROPHONE

DUAL IMPEDANCE OMNI DIRECTIONAL
Dynamic Lavalier with detachable metal mesh ball windshield
Frequency response 80 - 13kHz
Impedance 50k - 600 ohms
NORMALLY $29.00
ONLY $12.00
SAVE $17.00
Cat AM-4084



TWO MICROPHONE ATTACHMENT

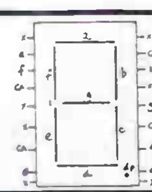
With this handy device you can use two mics (stereo) on the one stand
Cat AM-4110

NORMALLY WORTH $16.00
ONLY $2.50
LIMITED QUANTITY

★ BARGAIN ★

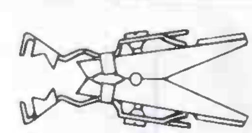
1" HIGH (25.4mm)
7 SEGMENT RED LED DISPLAY
- Right hand DP
- Common anode

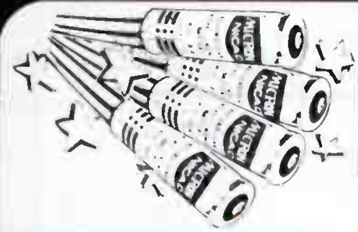
Only a small quantity available, some with slight imperfections
Cat ZD-1860
ONLY $3.00 each



ALLIGATOR LINE CLIP

3 way TV clip for fastening antenna lead in to TV
Cat HM 3050
80¢ each
10 or more 70¢ each





PENLIGHT NiCads

Don't keep wasting money buying throw away batteries. Step up to rechargeable NiCads

SUPERB "ROCKET" BRAND AA (Penlight) 450mAh

Cat SB 2452 **$2.95**

SPECIAL 4 FOR $10

DIE CAST HEATSINKS

Jaycar is proud to announce a range of Made in Australia die cast heatsinks. They are gravity cast in Aluminium, have the area where semiconductors mount milled flat and are fully finished in powdercoat black. They are low cost for the performance offered. Size: 134 x 65mm (high) x length (see below)

8FNF SERIES

Cat HH 8540 (50mm long)	$3.95
10 or more $3.75 each	
Cat HH 8541 (75mm long)	$5.95
10 or more $5.50 each	
Cat HH 8542 (100mm long)	$7.95
10 or more $7.50 each	
Cat HH 8543 (150mm long)	$9.95
10 or more $9.50 each	

MF10 - 2F - 75

74 H x 144 L x 46 W mm (bracket 34mm wide)

Cat HH 8548 **$7.50**

10 or more $6.95 each

4½ DIGIT ACCURACY - 3½ DIGIT PRICE!!

AND DIGITAL HOLD TO BOOT!!

Once again Jaycar has smashed the price barrier for a full 4½ digit multimeter. Just think a multimeter with 0.15% accuracy on most ohms ranges, 0.05% on DC volts and 0.5% MAX on DC current! STAGGERING! Plus continuity buzzer and LED symbol, auto polarity, auto zero, vinyl case and DATA HOLD as well!! NOT TO MENTION the transistor and diode tester!!

We are absolutely convinced that you will be delighted with this meter. So much are we convinced that we have extended our normal satisfaction guarantee by another week. That's right! Personal shoppers can try this superb instrument out in their own workshop for 14 obligation free days. (Mail order customers 21 days!) If you are not happy with this product in any way return it in ORIGINAL condition for a full refund (less P&P for M/O).

SPECIFICATIONS:

★ 0 - 1kV DC 0.05% ★ 0 - 750V AC (0.8% max) ★ 0 - 10A DC 0.5% (max) ★ 0 - 10A AC 1.0% (max) ★ 0 - 20M ohm 0.5% (max)

FEATURES

● All ranges fully protected ● Auto zero ● 0.5" high LCD ● Diode test (1mA fixed current) ● Audible continuity ● Data hold ● LCD display feature ● Functional annunciators ● Extremely accurate ● 27 page instruction manual included

Cat QM 1550

NEW ONLY $159.00

ALARM STICKERS

LARGE 125mm x 75mm

Suitable for house, factories, caravans etc. Will stick on the outside i.e. sticky on the back.

Cat LA 5102

ONLY $1.95 each

SPECIAL 5 for $7.50

SAVE $2.25

SMALL 73mm x 33mm

Specifically designed for cars. Sticky on the front so you can stick them on the inside glass. Thieves will not know whether you have an alarm or not.

Cat LA 5100

ONLY 95¢ each

SPECIAL 5 for $3.50

"MAINS MUFFLER" - 2 OUTLET

This fully approved Electricity Authority unit is the ultimate mains suppression device. It is fitted with a circuit breaker & 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

Cat MS-4040

ONLY $149.00

(4 OUTLET PICTURED)

NEW

MICRON TEMPERATURE CONTROLLED SOLDERING STATION

Select the temperature you require at the flick of a switch - no more changing tips to obtain correct working temperature.

Cat TS 1600

ONLY $99.50

REPLACEMENT TIPS

Cat TS 1601	Micro Chisel 1mm
Cat TS 1602	Mini Chisel 1.5mm
Cat TS 1603	Standard Chisel 3mm

ALL PRICED AT $3.95 EACH

CORE HILL OPEN UNTIL 4pm SATURDAY

HEAVY DUTY STRAP HANDLES

Overall length 250mm. Will lift a maximum weight of 50kgs!! Ideal for speakers, amps etc. made in England.

Cat HS 8020

ONLY $7.95 each

QUALITY PRODUCTS

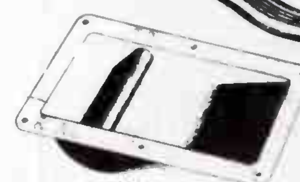
MARSHALL CABINET HANDLE

If you are having trouble lifting speaker cabinets or PA bins or any large box, try these handles. They are easy to fix, just drill holes and screw in.

Cat HS-8010

ONLY $16.50 each

10 or more $16.00 each



METAL CORNER BRACKET

Keep the corners of your PA bins or party speakers undamaged. Just screw these on to your speakers and start throwing them around.

Cat HM 3822

$2.25 each

10 or more $2.00 each

PLASTIC LOCKING CORNER PIECE

Heavy duty plastic moulded corner fitting featuring male/female inserts. These are designed to fit together so that pieces of equipment (the same size) can be stacked up and locked together. Ideal for stacking speaker boxes.

Cat HM 3826

$2.25 each

10 or more $2.00 each

IDEAL FOR PA - DISCO - HOME

AUTOMATIC TELEPHONE DIVERTER

This professional quality product will automatically transfer an incoming call to another telephone number anywhere. Your business will not lose any important calls if you move, as incoming calls can be diverted to your new office address. Two telephone lines are required.

Cat YT-6505

ONLY $159.50

ENHANCER

A MUST when you record from one video to another

- Built and designed in Australia
- 625 line 50 frame PAL D
- Features Core Gamma control
- Will drive up to 3 VCR's at once
- Standard 75 ohm coax fittings

Cat AV 6501

$69.95

12C AV power pack Cat MP 3020 *$11.95*

POLYPROPYLENE CONE WOOFERS

HIGH QUALITY AT LOW COST

12" WOOFER

★ Power handling 80 watts rms system ★ Impedance 8 ohms ★ Resonant frequency 23.2Hz ★ Sensitivity 92.3dB 1 watt 1 metre ★ Effective frequency response 23Hz - 5kHz ★ Electromagnetic Q - QES 0.481 ★ Peak cone excursion 2 x max 1.6mm

Cat CW-2130

$79.50

10" WOOFER

★ Power handling 70 watts rms system ★ Impedance 8 ohms ★ Resonant frequency 24.3Hz ★ Sensitivity 91.9dB 1 metre 1 watt ★ Electromagnetic Q - QES 0.398 ★ Peak cone excursion 2 x max 1.25mm

Cat CW-2116

$69.50

8" WOOFER

★ Power handling 60 watts rms system ★ Impedance 8 ohms ★ Resonant frequency 23.2Hz ★ Sensitivity 88.2dB 1 metre 1 watt ★ Effective frequency response 23 - 5kHz ★ Electromagnetic Q - QES 0.481 ★ Peak cone excursion 2 x max 1.6mm

Cat CW-2114

$42.50

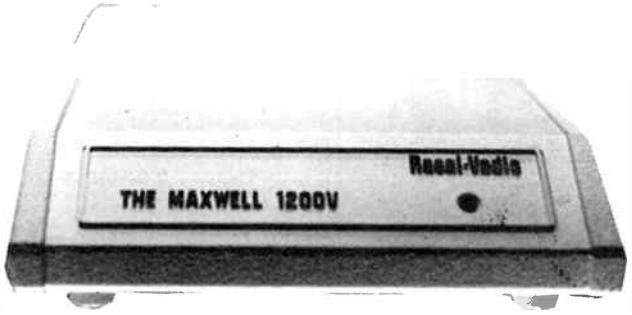
NOW AVAILABLE

5" MIDRANGE FERROFILLED	
Cat CM-2085	$29.50
LOUD PLATE TWEETER	
Cat CT-2030	$39.50
10" PASSIVE RADIATOR	
Cat CR-2180	$36.50
12" PASSIVE RADIATOR	
Cat CR-2190	$47.50

1ST BIRTHDAY CONTEST No. 3.

Win a Multitech 'Popular 500' System 1 from Dick Smith Electronics and a Racal-Vadic Maxwell Modem Model 1200V, full duplex 1200 baud modem.

Here's a fantastic opportunity to win a top-flight PC-compatible computer system from Australia's best-known electronics retailer, together with a high speed data communications modem from one of the world's leaders in data communications. Just answer these intriguing questions and write us a short essay on what you find most attractive about the prize package.



The Multitech System 1 prize kindly donated by Dick Smith Electronics, PO Box 321, North Ryde 2113 NSW. The Racal-Vadic Maxwell 1200V modem prize kindly supplied by Racal Electronics, Talavera Rd, North Ryde 2113 NSW.

The Multitech System 1 from DSE features a single 5.25" 360K disk drive, 256K RAM, multifunction card and colour video card with RGB output and 640 x 200 (mono) and 320 x 200 (four colour) pixel graphics resolution (monitor not included). The 84-key QWERTY keyboard features 10 function keys and a numeric keypad.

The Racal-Vadic Maxwell 1200V modem is a Hayes-compatible fully professional modem offering reliable high speed full duplex communications at 1200 baud over the switched telephone network. It's housed in a convenient small package that fits neatly under your 'phone.

1ST BIRTHDAY CONTEST No. 3.

Q1: A famous 19th century poet and the "princess of parallelograms" were closely associated. What were their names?

.....

Q2: What on earth has Q1 got to do with computing?

.....

.....

Q3: The word 'modem' is a contraction of two other words. Name them.

.....

Q4: Which disk operating system, and which version, is supplied with the System 1 Multitech?

.....

Q5: Racal modems intended for use on the public switched telephone network conform to a communications standard set down an international committee in which they are an active participant. Give the full title of that body.

.....

Now, on a separate sheet of paper, tell us in 30 words or less what you find most attractive about the prize package.

Name .....

Address .....

..... **Postcode** .....

I have read the rules of the contest and agree to abide by their conditions.

Signed: .....

**The Contest Rules are set out on page 6 of this issue.*

RETAIL ROUNDUP

The un-vanished thermistor!

March issue's Retail Roundup lead story bemoaned the "vanishing" RA53 thermistor. Well, it hasn't vanished, as reader David Walters of Scottsdale, Tasmania, advises — it's just hiding in the Radiospares Components catalogue!

We used the RA53 thermistor in our simple Sine/Square Audio Oscillator (Dec. '85 issue). Lack of availability of the thermistor brought a deluge of calls from frustrated readers.

Well, take that part-completed project off the shelf, because now you can order the vital RA53. Radiospares, the Perth-based component importer and distributor, who boast a magnificent catalogue, list it as cat. no. 151-114 at a current list price of $7.75 plus tax — even cheaper than last year, when it was listed at $10!

You'll find Radiospares in **Perth** (head office) on **(09) 381 4799**, in **Melbourne** on **(03) 486 1966** and in **Sydney** on **(02) 662 1233**.

For that 'black box' gadget . . .

Got a gadget that requires locating outdoors? Then you need a weatherproof box. Check out the range of beaut black boxes at David Reid Electronics, located in the heart of Sydney's 'Silicon Alley', York St.

These tough plastic cases, from Ferguson, come in two styles — best described as 'high top' and er, 'flat top'. You could house quite a substantial amount of electronics in them if you wish. They would suit TV system masthead preamps or the like, alarms, outdoors control systems, etc.

Trundle down to Sydney's Silicon Alley, right across the road from the Queen Victoria Memorial Brick Pit. Right between Tandy and Dick Smith Electronics, you'll find **David Reid, 127 York St, Sydney 2000 NSW. (02) 267 1385.**

PROJECT BUYERS GUIDE

This month's Star Project, the Commodore Modem Coupler, will be available in both kit form and fully built-up from Flexible Systems, 219 Liverpool St, Hobart 7000 Tas.

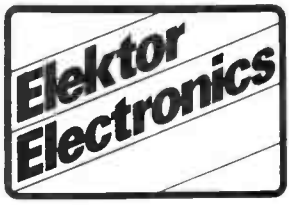
The AEM6504 Power Amp Status Monitor, as the article states, may be used with any power amp that employs dual (+/-) supply rails and rates up to 300 watts output. Most of the components are commonly available through electronics retailers with the exception, perhaps, of the National JA-type relay. This is distributed through RVB, who have offices in Sydney and Melbourne and distributors in NSW, Qld, S.A. and W.A.; see their advertisement in this issue. We understand Jaycar will be stocking the AEM6504 as a kit, as will possibly Eagle Electronics in Adelaide and All Electronic Components in Melbourne. Our pc board service will be stocking the boards, as usual.

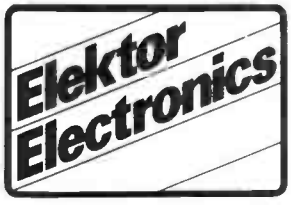
For powering a host of projects, particular those employing op-amps requiring +/- supply rails, the AEM9501 Utility Dual Rail Power Supply Module should find wide application. You should find all the components readily available through electronics retailers everywhere. It seems Jaycar, at least, will be stocking this project as a kit. Boards will be available through our pc board service.

The toroidal transformers recommended for powering the AEM6000 MOSFET Power Amp modules, as described in Part 3 of the article series this issue, are manufactured in the UK by ILP and obtainable here from Electromark, PO Box 184, Mortdale 2223 NSW. (02) 570 7287.

For those eager readers who 'phoned looking for kit suppliers who stocked kits of our popular AEM5505 Hash Harrier mains filter, we are happy to inform that once again, stocks are obtainable from Eagle Electronics in Adelaide and Geoff Wood Electronics in Sydney. There was a shortage of the cores specified for this project a month or so ago owing to an unprecedented demand for the project, but we are advised that stocks are once again available.

COMING SOON — A NEW DEVELOPMENT





The publishers of Australian Electronics Monthly are proud to announce that we have obtained the rights to publish a substantial part, of our choosing, from the monthly issues of the UK edition of ***ELEKTOR ELECTRONICS*** within each issue of Australian Electronics Monthly.

This means that, ***each month we'll be adding around 30 pages*** (often more) of projects, technical articles and features especially culled from the pages of one of the world's most widely read and respected electronics publications. And you'll get to see the latest material from Europe within weeks of it going on-sale there and months ahead of when it normally appears here!

LOOK FOR THE FIRST EDITION OF AUSTRALIAN ELECTRONICS MONTHLY CARRYING "INCORPORATING ELEKTOR ELECTRONICS" ON THE COVER IN YOUR NEWSAGENT SOON!

Projects will be specially chosen and local parts supply sought prior to publication. Printed circuit boards will be available through our PC Board Service and, with the co-operation of retailers, at selected retail outlets. We confidently expect many of the Elektor projects to be available from local suppliers in kit form.

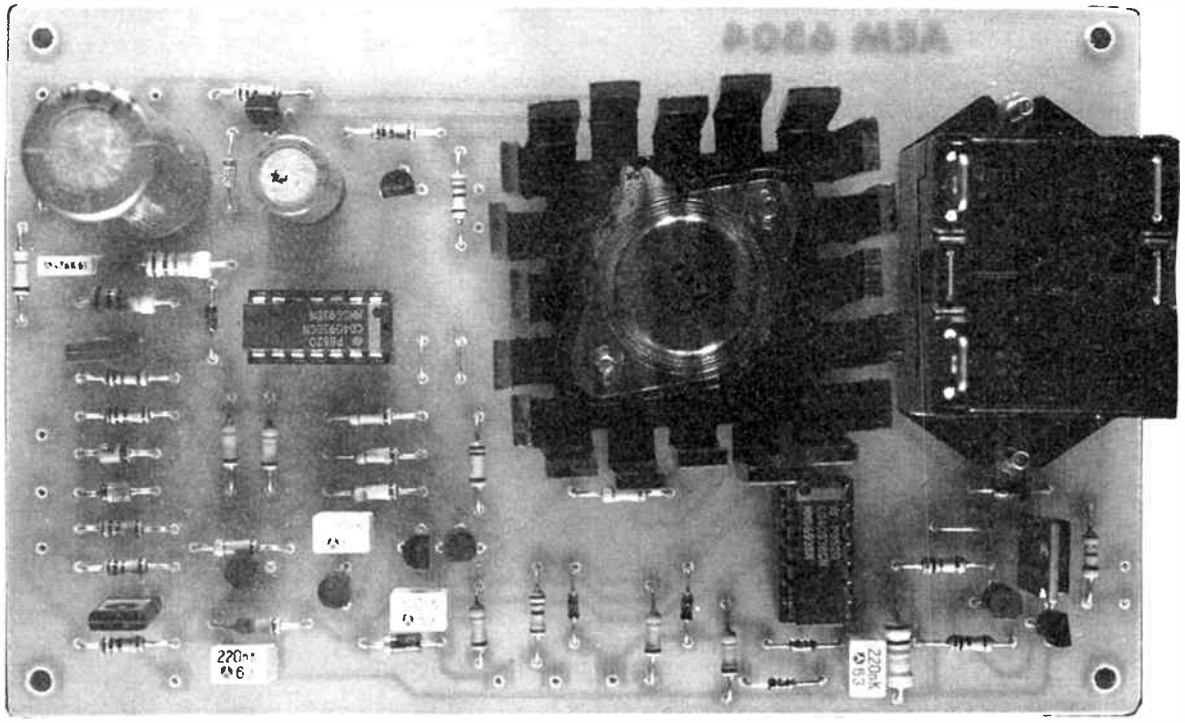
The Australian Electronics Monthly you have come to know and love will continue 'as usual' — the features, technical articles, projects and news. Elektor is planned to be incorporated ***as an additional section***.

What a tremendous BONUS!

- More projects!
- More features!
- More articles!
- More data!

And that's not all! While we're importing material from one side of the globe, we're exporting it to the other! We have also recently concluded an agreement with the US magazine ***RADIO-ELECTRONICS*** to exchange editorial material. It seems US hobbyists are particularly enthusiastic about Australian electronics projects and we expect to export more material to Radio-Electronics than vice versa. Whenever topical and relevant features appear in Radio-Electronics, we'll move swiftly to bring them to you in the pages of Australian Electronics Monthly.

Australian Electronics Monthly — bringing you the best, from around Australia and around the world.



A power amp 'status monitor'

David Tilbrook

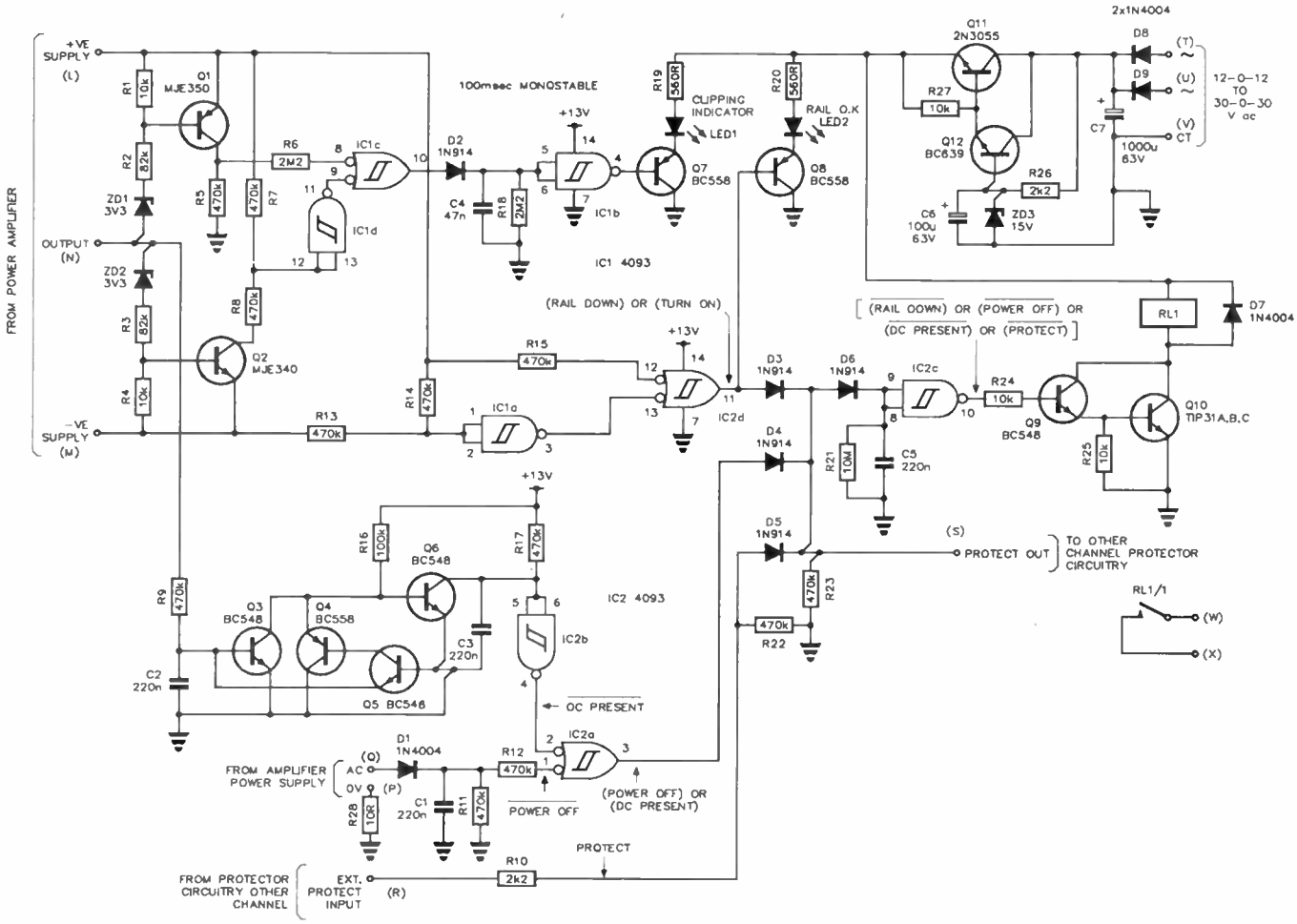
Designed to team with the 6000 MOSFET amp module, but usable with any power amp, this project prevents dc fault conditions or excessive clipping from exterminating amps and speakers alike.

VIRTUALLY ALL modern solid state power amplifiers employ dc-coupled output stages with no dc blocking capacitor in series with the output of the power amplifier. In a valve power amplifier, the loudspeaker is protected from dc by the output transformer. Similarly, earlier transistor designs, particularly those types employing a single supply rail, used an output coupling capacitor which isolated the loudspeaker from the dc supply in the event of failure. The modern transistor power amplifier, however, has neither of these and can place the loudspeaker at risk in the event of an output stage or other type of failure which results in a net dc voltage being applied to its output terminals.

A power amplifier rated to deliver 200 W RMS into an 8 ohm load will usually be provided with a supply rail of around +/- 60 volts. This means that, in the event of power amplifier failure it is possible, in fact quite likely, that there will be either positive or negative 60 volts present on the output terminal. A loudspeaker rated nominally at an 8 ohm impedance usually has a dc resistance under 6 ohms. The 60 volts dc applied to this load results in a dc current of around 10 amps through the voice coil of the bass driver which must therefore dissipate 600 watts. This level of power dissipation will destroy even the highest power bass drivers and so some method of protection against this condition must be provided for high power solid state power amplifiers.

Most modern power amplifiers employ dual supplies which are provided with independent fuses. If either of these fuses blow, the resulting output signal waveform is severely clipped on one half-cycle. This results in an enormous amount of distortion, and once again has an effective net dc offset. This is another condition from which the loudspeaker should be protected. Similarly, many power amplifiers can exhibit a significant short term dc offset at the moment of turn-on or turn-off while the power amplifier circuitry is stabilising.

This project monitors the 'status' of the power amplifier and disconnects the loudspeaker if the conditions produced by the power amp are likely to damage it. The Power Amp Status Monitor looks for the presence of dc on the output stage, monitors the two supply rails and provides the facility for turn-on and turn-off de-thump. In addition, it provides the additional feature of an accurate clipping indicator which warns when the maximum output power of a power amplifier has been achieved. At this point, the signal peaks are clipped as the output or drive stage rams against one or other of the supply rails, generating large quantities of high frequency distortion. If excessive, this can damage the high frequency driver. If the power amplifier is driven into clipping for more than 100 milliseconds the circuitry detects this and ▶



CIRCUIT OPERATION

The power amp status monitor works by detecting a number of fault conditions which can occur with power amplifiers employing dc coupled output stages. The circuit uses various detection systems to determine the presence of these faults and deactivates a relay which disconnects the loudspeaker from the output of the power amplifier in the event of a fault.

CLIPPING DETECTOR

The clipping detector operates by measuring the differnce in voltage between the power amp output and the power amp suply rails. The function is performed by Q1, Q2, resistors R1-R4 and zener diodes ZD1 and ZD2. As long as the output signal voltage is well away from either supply rail, current flows through R1, R2, R3 and R4 and the zener diodes to the output of the amplifier. This current forward biases transistors Q1 and Q2. Since Q1 is "on", the voltage across R5 is approximately equal to the supply rail of the power amplifier and this voltage is applied via a current limiting resistor (R6) to one of the inputs (pin 8) of a CMOS two-input NAND gate.

As long as Q1 remains on then the voltage applied to pin 8 of IC1c will be high and pin 10 of the CMOS gate will remain low. If, on the other hand, the output of the power amplifier approaches the positive supply rail too closely then transistor Q1 will be biased off and the voltage drop across R5 will decrease applying a low to pin 8 of IC1c.

The circuit detects clips against the negative rail in a slightly different manner. Transistor Q2 works in the same way as Q1, except that if Q2 is biased on then resistors R7 and R8 form a potential divider between the positive and negative supply rails. Since these rails are approximately equal, the voltage on the output of this potential divider will be around 0 V and this is applied to IC1d which is configured as a simpler inverter. The output of this inverter is connected to the other input of IC1c. Since the input of IC1d is low, the output will be high and hence pin 9 of IC1c will be high. If the output of the power amplifier approaches the negative suply too closely, Q2 will be biased off and the input of IC1d will be pulled toward the positive supply rail. The inverting function of IC1d results in its output going low and hence pin 9 of IC1 going low.

IC1c in this case performs the function of an OR gate for active-low signals. If either pin 8 or pin 9 goes low, indicating that a clip at either the positive or negative supply rails has occurred, then the output of IC1c (pin 10) will go high. Diode D2, in conjunction with C4 and R18, perform the function of a simple monostable. Even the shortest clip that results from a signal within the audio pass-band will result in C4 becoming charged to a voltage higher than the Schmitt level of IC1b.

The resulting low on pin 4 biases-on Q7, turning LED1 on to indicate a clipping condition. The value of C4, in conjunction with R18 is chosen so that it takes approximately 100 msec for the voltage across C4 to fall below the Schmitt level of IC1b which, in turn, turns LED1 off. This monostable function ensures that the clipping indication remains active for around 100 msec longer than the duration of the clip so that adequate indication is given, even of the shortest duration clip.

RAIL INTEGRITY SENSORS

The power amplifier positive and negative supply rails are also applied via resistors R13, R14 and R15 to the input of CMOS gates IC1a and IC2d. These gates monitor the integrity of the power amp supply rails, and together with Q8 and LED2, provide a visual indication that the supply rail voltages are intact. The positive supply rail is applied via resistor R15 to pin 12 of IC2d. Resistors R13

loudspeaker will be disconnected.

Once the loudspeaker has been disconnected it will remain in this state for approximately two seconds longer than the fault condition remains, and then automatically reconnects the load.

Although the project has been specifically designed for operation with the AEM6000 Ultra-fidelity Power Amplifier Module it has universal application and can be used virtually with any power amplifier employing dual supply rails. Unlike many clipping indicators, the 6504 features a novel circuit which detects clipping not by measuring the output signal voltage, but by *measuring the voltage between the output signal and the supply rails of the power amplifier*. The circuit will therefore validly indicate a clipping condition *regardless of whether the power amplifier is rated at 50 or 250 watts*.

The relay necessary for this unit presents particular problems. The contacts must be heavy enough to ensure to degradation of the performance of the power amplifier, and rated to break a powerful dc arc. Direct current is much more difficult to switch than alternating current and the ac rating of a relay contact must be significantly decreased when it is intended for dc operation. The relay specified for use with this project is a single pole type with heavy contacts rated for high current operation. We have included a data sheet later in this issue.

Design background

A detailed description of the operation of the project is included in the Circuit Operation section. There are however, a number of interesting problems associated with the design of this monitor which warrant particular mention because they highlight the improvement in performance that can be expected from this circuit in comparision to many older designs. I have already discussed briefly the operation of traditional clipping indicator and mentioned that this project detects clipping by measuring the difference in voltage between the supply rails and the output of the power amplifier.

The circuit shown here will reliably indicate clipping regardless of the output power of the amplifier and without necessitating any adjustments. This is a decided advantage over many earlier clipping indicator designs which tended to measure the output signal level with respect to earth, making it impossible to correct for the different rail voltages that result from different mains supply voltages. The clipping in- ▶

and R14 form a potential divider between the positive and negative supply rails.

If both rails are present then the output of this potential divider which is connected to pins 1 and 2 of IC1a will be around 0 V, hence pin 3 will be high. If the positive supply rail fuse in the power amp blows, for example, the voltage applied to pin 12 of IC2d will drop to zero. If the negative supply fuse blows, R14 pulls the input of IC1a high and hence pin 3 goes low, taking pin 13 of IC2d low.

As with IC1c, IC2d performs the function of an OR gate for active-low signals on its inputs; its output goes high if either of its inputs goes low. A high on the output of IC2d biases transistor Q8 off and the "Rail O.K." LED is deactivated. The high is also coupled via diode D3 to the input of D6 and to the protect output which is otherwise held low by resistor R23. The high applied to the anode of D6 causes C5 to charge so that the input if IC2c, which performs the function of a simple inverter, is also taken high. The output if IC2c goes low removing the drive from the current-amplifying Darlington pair, Q9 and Q10, which deactivates the relay RL1.

Components of C5, R21 and diode D6 ensure that the voltage on pin 13 of IC2d remains low for approximately two seconds after the power is switched on. This ensures that the relay remains deactivated for this time and provides a turn-on delay which allows the power amp to settle before the loudspeaker is connected.

DC SENSOR

One of the most dangerous faults that can occur with a power amplifier employing a dc-coupled output stage is one which results in a nett dc voltage being applied to the power amp output, and hence to the loudspeaker. In order to protect the loudspeaker in the event of such a failure, the AEM6504 monitors the output of the power amp for the presence of dc and deactivates the relay if a fault is detected.

The detector circuitry is based around transistors Q3, Q4, Q5 and Q6, and the associated passive components together with IC2b. Whenever the output of the power amp is driven to more than +0.6 V by an ac or dc signal, then Q3 is biased on. Similarly, when ever the output of the power amp is less than –0.6 V, then Q5 and hence Q4, will be biased on. The presence of a voltage on the output of the power amplifier, the absolute voltage of which exceeds 0.6 V, results in a low voltage being applied to the base of Q6 since the current provided by resistor R16 will be shorted to ground by the activated transistor Q3 or Q4. Q6 will therefore be biased off and capacitor C3 is allowed to charge via resistor R17.

The time constant associated with R17 and C3 causes the Schmitt input level of IC2b to be reached after approximately 0.1 sec. If the absolute value of the voltage on the output of the power amp remains greater than 0.6 V for longer than this time period then the Schmitt level of IC2b is reached and its output is taken low indicating a dc fault.

If the output voltage from the power amp is due to an ac signal with a frequency greater than around 5 to 10 Hertz, then the signal voltage will pass through 0 V within the manditory time period, biasing Q3 and Q4 off. The current flowing through R16 biases Q6 on, which discharges C4 before it has time to reach the Schmitt voltage required to activate IC2b.

IC2a functions as an OR gate for active-low signals so that a high will result on pin 3 if either pin 2 and pin 1 is taken low. A dc fault condition results in a low on pin 2 and the resulting high in pin 3 is coupled via D4 to the anode of D6, deactivating the relay.

POWER OFF DETECTOR

The other input of IC2a (pin 1) is used to detect whether the power to the power amplifier has been switched off. The ac input to the 6504 status monitor is connected to either of the secondaries of the power transformer used to supply the power amplifier.

If ac is present it is rectified by diode D1 and charges capacitor C1 to the peak voltage of the ac signal. The resulting voltage is applied to pin 1 of IC2a via the 470k current limiting resistor. If the power to the power amplifier is switched off the secondary voltage from the transformer drops to zero and R11 discharges C1 resulting in the application of a low voltage to pin 1 of IC2a causing a high on pin 3 and a consequent deactivation of the relay.

EXTERNAL PROTECT INPUT

The external protect input is connected directly to the protect out of the Status Monitor used for the other channel in the case of a stereo power amplifier. This line and the "protect out" are used so that the two status monitors can be interconnected so that a fault on either chanel will result in both relays being deactivated.

If the external protect input is unused it is held low by the 470k resistor R22 and hence does not interfere with the operation of the circuitry.

POWER SUPPLY

The supply voltage required by the status monitor is derived from a simple voltage regulator employing the zener diode ZD3 together with transistors Q11, Q12 and their associated passive components. The zener is biased on by resistor R26, while C6 filters the reference voltage. Transistors Q11 and Q12 are connected as a current amplifier and supply a voltage around 13.8 V to the rest of the circuitry. This regulator enables the pc board to be powered from a fairly wide range of transformer voltages.

dicator section also provides a pulse stretching facility which ensures that the clipping indicator LED will be activated for a long enough period so that the clipping condition can be noticed. Very short transient pulses with large amplitudes can easily drive a power amplifier into overload, and because the clipping indicator is activated for such a short time it is impossible to see that overload has occurred. To overcome this problem a monostable is included which ensures the clipping indicator LED will be activated for at least 100 milliseconds as a result of any overload that results from signals within the audio passband.

Another aspect of the design which is of particular interest is the dc detector circuitry. The problem with all dc detectors is that they must be able to separate what can be considered a dc condition on the output from what is in fact a low frequency ac signal. Some older designs employed either a first- or second-order low-pass filter with a -3 dB point set at some frequency below the audio passband. The problem with this scheme is that the filter cannot provide a fast enough rolloff outside of its passband. The circuitry must accommodate a full power 20 Hertz sine wave for example, which is equivalent to a peak signal voltage or around 60 volts in the case of our 200 watt amplifier.

If it is desired to allow no more than one volt dc to be present on the output, then the filter must provide sufficient attenuation to reduce the 60 volt peak signal present during the 20 Hertz sine wave to a voltage of less than one volt when dc is present. In other words, the filter must provide approximately 36 dB of attenuation between the 20 Hertz frequency point and the frequency at which the protector will operate if the output signal voltage exceeds one volt. If a 6 dB (first-order) filter is employed, the frequency at which the protection circuitry will operate must be approximately six octaves below the 20 Hertz frequency point. The protection circuitry would have to be set to operate at a frequency only below 0.31 Hertz.

This is equivalent to saying that if a dc voltage suddenly appeared on the output of the power amplifier, the dc protector would take over *three seconds* before it would trigger; rendering the circuit completely useless! The circuit protector must operate as quickly as possible, and preferably in less than one tenth of a second.

In order to accomplish this and still have the protector sensitive enough to disallow the application of any more than one volt to the loudspeaker, a low-pass filter with a 3 dB point at 20 Hertz must be a high order Chebyschev-type filter, necessitating multiple operational amplifiers and a considerable amount of circuitry. The circuitry developed for this project solves this problem in a different way. The solution makes use of a fundamental difference between an ac and a dc signal and that is that an ac signal periodically goes through zero as the signal voltage changes from positive to negative, or vise-versa. The repetition rate of these zero crossings is monitored and if the rate falls below the level set within the protection circuitry the relay is de-activated to protect the loudspeaker. For a more detailed description of the operation of the dc detector circuitry, read the circuit operation section.

In order to provide protection from turn-off 'thump', the circuitry monitors the presence of ac on the secondary of the power transformer.

The moment the power amplifier is switched off the secondary voltage reduces to zero and the relay is again activated. The turn-on delay ensures that the protection relay will not be activated for several seconds after the power amp is turned on. The turn-on delay time is established by a simple RC time-constant within the protection circuitry.

AEM6504 PARTS LIST

Semiconductors

IC1, IC2 4093
Q1 ..... MJE350
Q2 ..... MJE340
Q3 ..... BC548
Q4 ..... BC558
Q5, Q6 ..... BC548
Q7, Q8 ..... BC558
Q9 ..... BC548
Q10 ..... TIP31A, B, C
Q11 ..... 2N3055
Q12 ..... BC639
D1 ..... 1N4004
D2-D6 ..... 1N914
D7-D9 ..... 1N4004
LED1, LED2 ..... TL4211
ZD1, ZD2 ..... 1N746
ZD3 ..... 1N965

Resistors all 1/4W, 5% unless noted.

R1 ..... 10k
R2, R3 ..... 82k
R4 ..... 10k
R5 ..... 470k
R6 ..... 2M2
R7, R8, R9 ..... 470k
R10 ..... 2k2
R11-R15 ..... 470k
R16 ..... 100k
R17 ..... 470k
R18 ..... 2M2
R19, R20 ..... 560R
R21 ..... 10M
R22, R23 ..... 470k
R24, R25 ..... 10k
R26 ..... 2k2
R27 ..... 10k
R28 ..... 10R

Capacitors

C1-C3 ..... 220n MKT
C4 ..... 47n MKT
C5 ..... 220n MKT
C6 ..... 100μ/63 V RB electro.
C7 ..... 1000μ/63 V RB electro.

Miscellaneous

RL1 ..... single pole relay, 15 A contacts rated at 55 A inrush current, with 12 V coil — National type JA-1TMP-DC12V or similar.

AEM6504 pc board, heatsink, TO3 insulation kit, wire, solder.

Expected cost: $44-$49

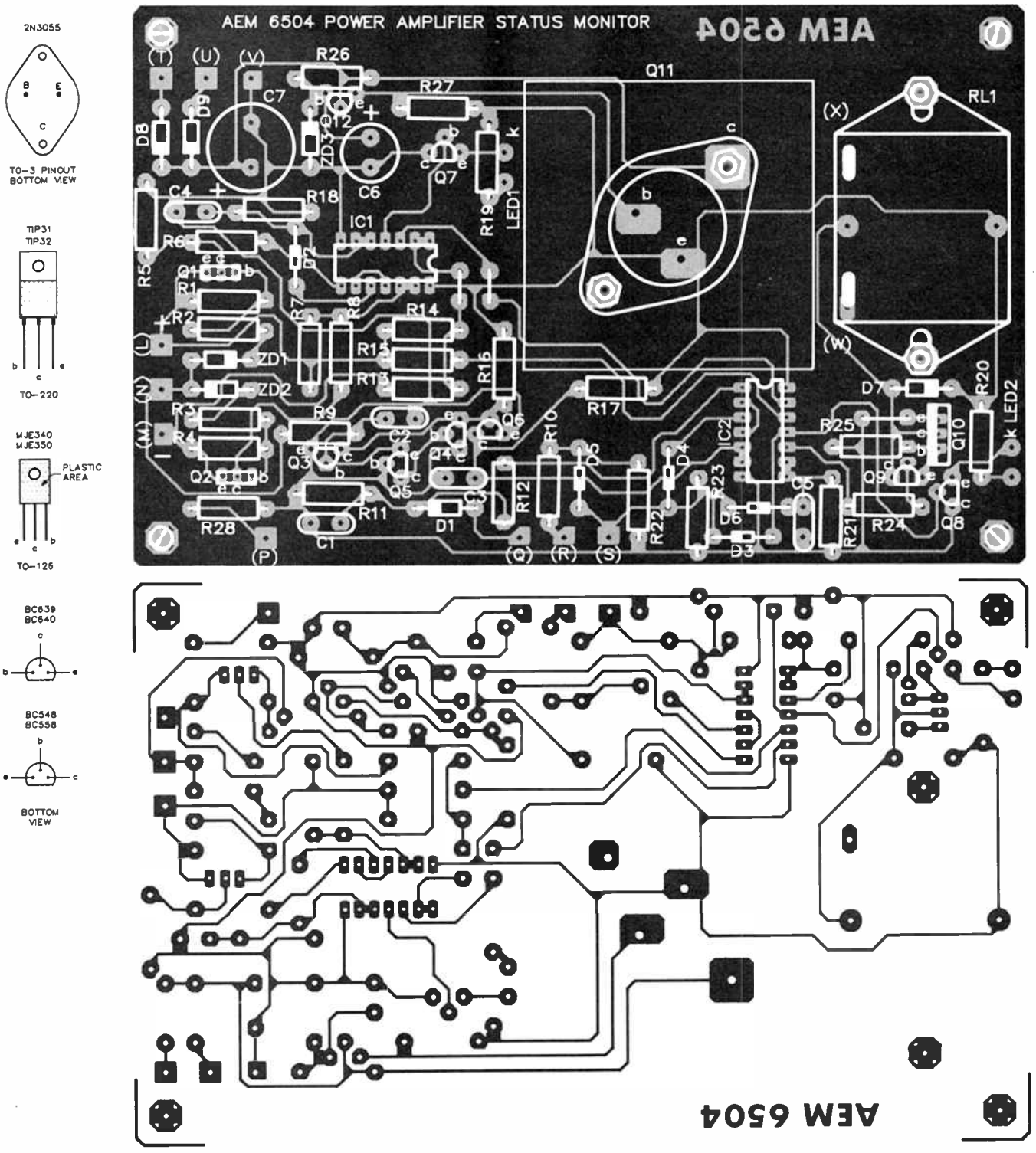
A final feature worthy of mention is the presence of an external protect input. The AEM6504 power amp status monitor is intended as a single channel monitor. A monitor is used for each channel within the power amplifier so that a stereo power amp requires two of these units. The external protect input and the protect output provided by the unit provides a facility whereby two or more power amp status monitors can be interconnected so that a fault on either channel will lead to activation of the protection circuitry for both channels simultaneously. Among other things, this ensures that the turn-on and turn-off delay for the two channels within the stereo power amplifier will be identical. If this facility is not required, the interconnection between the two Status Monitors can simply be omitted.

Construction

The project is not difficult to build or install, particularly if the AEM pc board is used. The pc board holds all of the com-

TABLE OF CONNECTIONS FOR THE AEM6504 PC BOARD

From power amp.	+ve supply	(L)
	–ve supply	(M)
	output	(N)
Power amp supply	0 V	(P)
	ac	(Q)
Status Monitor transformer	12-30 Vac	(T)
	12-30 Vac	(U)
	centre-tap	(V)
Other Status Monitor	from protect out (S) on other Status Monitor	(R)
	to ext. protect in (R) on other Status Monitor	(S)



ponents, including the power supply components and the relay itself. The relay is a pc board mounting type which provides the very convenient feature whereby the contacts for the relay coil pass through the pc board and can be soldered directly to it. The relay contact terminals are provided on the top of the relay, which simplifies the wiring from the power amplifier and to the loudspeaker output terminals.

Commence construction by soldering the resistors and the small capacitors to the pc board. Next, solder the transistors in place being sure not to confuse the BC548 and the BC558 types. These are NPN and PNP types respectively and if the unit is powered-up with these devices inserted in the wrong positions, damage can result. Similarly, be careful not to confuse the MJE350 and the MJE340 devices. The two CMOS ICs can be used. Solder the diodes in position, being careful not to confuse the zener diodes ZD1-ZD3, the small signal diodes, and the IN4004 power diodes. Be careful to insert these components with the correct orientation. Solder the electrolytic capacitors into place, again being careful to ensure that these are the right way round. ▶

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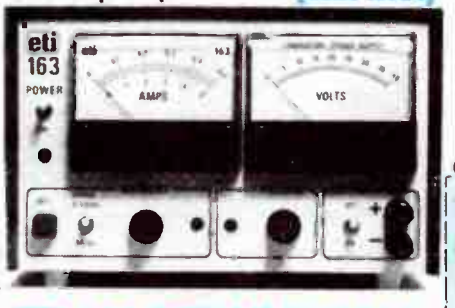

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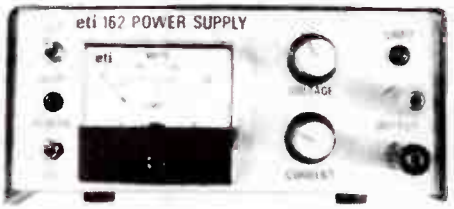

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The two LED indicators must be mounted on the front panel of the power amplifier and wired to the Power Amp Status Monitor using lengths of hookup wire. The LEDs must be connected the right way round. It is particularly easy to wire these incorrectly, so use lengths of different coloured hookup wire for this purpose.

Complete the construction by mounting the relay to the pc board. This is best accomplished by positioning the relay on the board and securing it in place using a pair of 6BA nuts and bolts. The pc board mounting pins should be soldered only after the relay has been securely fastened. If the pins are soldered first and then the relay is bolted into position it is possible to break the solder joint or lift the copper pad from the fibreglass of the pc board.

Using the Status Monitor

The Status Monitor requires connections to a transformer delivering somewhere between 15 and 30 volts. A larger voltage transformer than this could be used except that the power dissipation in the power supply pass transistor tends to become excessive. Nevertheless, if a higher voltage transformer is available and it is inconvenient to provide a small second transformer to power the Status Monitor then it is possible to use the higher supply voltage although it may prove necessary to increase the size of the heatsink to which the pass transistor is bolted.

There are three connections that must be made between the Status Monitor and the power amp. There are a further two connections to be made to the power amplifier power supply and a further two connections which must be made to the other Status Monitor where a stereo pair are employed. These connections are:

1. **+Ve supply. (L)**
   This point on the status monitor must be connected to the positive rail of the power amplifier. The connection should be made as closely as possible to the power amplifier printed circuit board, and certainly on the power amplifier side of any supply fuse in the power amplifier supply line. In the case of AEM6000 power amplifier module, this point is connected to point H on the module's board.
2. **Output. (N)**
   This point on the status monitor connects to the output of the power amplifier module. The connection should be made as closely as possible to the power amplifier module and certainly on the power amplifier side of any fuses or relays in series with the power amplifier output. In the case of the AEM6000 module this point connects to point G.
3. **-Ve supply. (M)**
   This point connects to the negative supply rail of the power amplifier. As with the positive supply, the connection should be made as closely as possible to the power amplifier module. On the AEM6000 module, this point should connect to point J.
4. **0 V. (P)**
   This point connects to the 0 volts of the power supply used to supply the power amplifier. The best point to make this connectio is at the centre point of the main power supply filter capacitors.
5. **ac. (Q)**
   This point on the Status Monitor must connect to one of the two secondaries of the power transformer used to supply the power amplifier. A convenient place to make this connection in most power amplifiers is on either of the ac terminals of the bridge rectifier.

2N3055 HEATSINKING

The 2N3055 power transistor used in the power supply for the status monitor must be mounted to a heatsink before being bolted into position on the printed circuit board. If there is no danger of this heatsink coming into contact with the chassis or any other earthed portion of the power amplifier, then the transistor need not be insulated from the pc-mounted heatsink. Use a smearing of thermal paste between the transistor and the heatsink, and bolt them in place on the printed circuit board before soldering the leads of the transistor. The connection to the collector of the transistor is made via one of the two mounting bolts.

There is sufficient area on the printed circuit board to accommodate a variety of TO3 heatsinks. The particular type specified in the Parts List provides a thermal rating of around five degrees C per watt, so when the unit is operated with the 30 volt transformer, the heatsink temperature of around 40 or 50 degrees Celsius is quite warm, but not intolerable.

6. **Ext. protect in. (R)**
   If the Status Monitor is used in conjunction with a mono power amplifier, this point is unused. In the case of a stereo power amplifier this point connects to the 'protect out' of the other power amp status monitor.
7. **Protect out. (S)**
   This point on the Status Monitor connects to the Ext. Protect of the other Status Monitor as described in note 6.

Conclusion

The AEM6504 Power Amplifier Status Monitor is a flexible and powerful power amplifier monitor which provides significant protection for the loudspeaker. When used with the relay specified it is suitable for connection to power amplifiers rated to deliver up to approximately 300 watts into an 8 ohm load. The unit does not provide protection for the loudspeaker from overpower since this is more the role of a traditional loudspeaker protector and is of course dependant on the particular loudspeakers used. The 6504 will nevertheless, protect the loudspeaker from the vast majority of faults associated with modern dc-coupled power amplifiers.

An 'ultra-fidelity' power amplifier

Part 3
David Tilbrook

Part 1 of this series of articles, published in the June '86 issue, dealt with the basic theory of operation of the new power amplifier circuit. In Part 2, published in the July issue, the construction of the power amplifier module was described in detail. This article firstly deals with the specifications of the power amp module, how they are measured and how the measurements should be interpreted, then discusses some aspects associated with the circuitry and construction of an appropriate power supply.

IN PART 1 of this series of articles I stated that the philosophy behind the design of the AEM6000 power amplifier was to provide excellent subjective and objective performance. The accent on the subjective performance is necessary because it is now widely recognised that the conventional objective measurement techniques do not adequately characterise the differences between the various power amplifier designs.

The essential point is that power amplifiers with apparently very similar objective performance as determined by the conventional measurement techniques can sound significantly different. It appears that either our perception of things like total harmonic distortion and frequency response (both of which are usually measured using sine waves) is much more highly developed than we think, or there are other types of distortion mechanisms occurring which are not measured using conventional techniques.

I think that most audio engineers would hold the opinion that the latter is probably the more likely explanation. On the surface it would appear that the conventional techniques are fairly naive, although this may be only partially true, particularly when the techniques are expanded or enhanced. An interesting example of this relates to a type of "dynamic" distortion which was originally known as TIM (transient intermodulation distortion), but now tends to come under the general heading of SID (slew-induced distortion). This type of distortion is produced when the slope of the signal to be amplified approaches the slew rate of the amplifier. The slew rate is defined as the maximum rate of change of output voltage of which the amplifier is capable.

Obviously, a measurement of the amplifier slew rate will provide some information regarding the likelyhood of SID occurring. In fact the best way to overcome the possibility of SID occurring is to design the power amp with good slew rate figures and then to limit the maximum possible signal slope by use of a simple RC low-pass filter set at a frequency well above the audio pass-band. One way of measuring SID is to carry out standard THD measurements but at very high frequencies say at around 50kHz or 100kHz. So here is an example where a "dynamic" distortion mechanism can be detected and measured using static techniques. This is not always the case, ofcourse, and it is possible that many distortion mechanisms exist which simply do not respond to static measurements.

Even though the standard specifications of a power amp do not entirely reflect the resulting sound quality characteristics, the objective performance of an amplifier is an important first step in evaluating the success of the design.

I have listed the measured specifications for the prototype amplifier in Table 1 here. These are supplemented by a ser-

TABLE 1.
SPECIFICATIONS: AEM6000

Supply voltage ..... 50 – 0 – 50 to 75 – 0 – 75 volts dc.

Power consumption ..... <300 mA at idle.

Output power 50 – 0 – 50 supply ..... >100 W into 8 ohms
>150 W into 4 ohms
75 – 0 – 75 supply ..... >240 W into 8 ohms
>360 W inot 4 ohms
(Output is measured using a continuous sine wave ("RMS"))

Damping Factor ..... >300 (100 Hz 8 ohms)
>300 (1 kHz 8 ohms)
>100 (10 kHz 8 ohms)

Frequency response (determined by passive input filters only)

Optional input capacitor	**+ Fitted.**	**Not fitted.**
+0 -0.1 dB	<20 Hz to >25 kHz	dc to >25 kHz
+0 -0.5 dB	<10 Hz to >48 kHz	dc to >48 kHz
+0 -3 dB	<4 Hz to >130 kHz	dc to >130 kHz

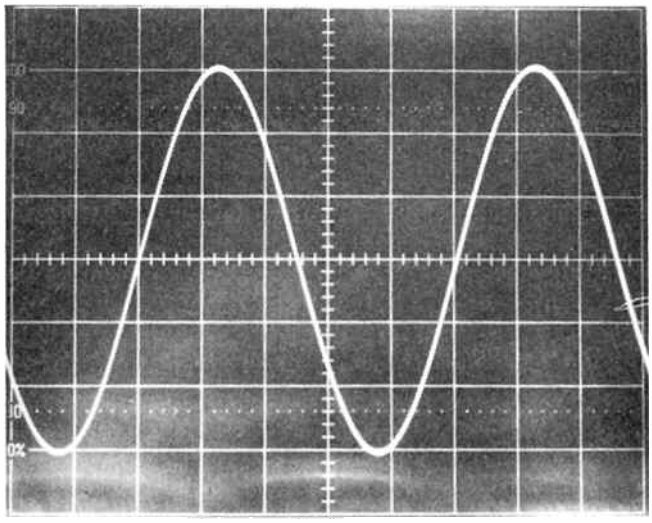
Total Harmonic Distortion 8 ohm load.

Frequency	1 W	10 W	100 W	200 W
100 Hz	<0.005%	<0.005%	<0.005%	<0.005%
1 kHz	<0.005%	<0.005%	<0.005%	<0.005%
10 kHz	<0.006%	<0.006%	<0.006%	<0.006%

Signal-to-noise ratio
(re full power output
with a 200 ohm source impedance connected)
400 Hz – 20 kHz noise bandwidth ..... >118 dB A-weighted
20 Hz – 20 kHz noise bandwidth ..... >105 dB A-weighted

Total equivalent input noise
20 Hz – 20 kHz noise bandwidth ..... <5.3 μV A-weighted
i.e: <103 dBm A-weighted

Slew rate (input filter removed) ..... > 60 V[usec



X = 0.2 msec/div, Y = 20 V/div; 1 kHz full power sine wave.

This CRO photograph shows the amplifier's output when driven by a 1 kHz sine wave at just below full power (around 220 W into an 8 ohm load).

ies of CRO photographs which are helpful in establishing the performance of the amplifier under a variety of operating conditions.

Power supplies

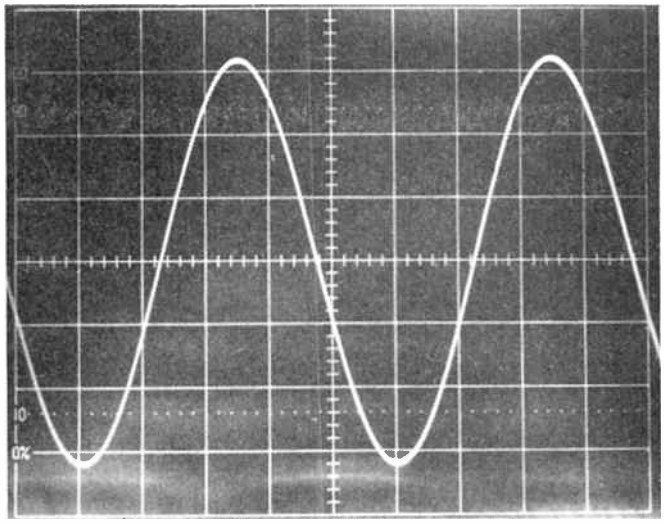
One crucial area that affects both the objective and the subjective performance of the amplifier is its power supply. Many otherwise good power amplifier designs are ruined by inadequate power supplies which often represent too high a source impedance to the supply rails of the circuit. In this design I elected to provide independent power supplies for the two channels. This helps to ensure good individual channel performance and facilitates the provision of high current supplies using commonly available components. Many commercial manufacturers of power amplifiers place great importance on the ability of the power amp to source very large currents. It should be remembered, however, that the amount of current that the power amp will be called upon to deliver is determined by its maximum output voltage and the impedance of the load.

Most of the enormous current supply ability of some power amps can never be used as long as 8 ohm, or even 4 ohm, loads are connected to them. I believe that the dominant reason for the subjective improvement in sound quality that results from this design approach is due primarily to the improved power supply regulation.

The dc power supply rails of all power amplifiers are modulated by the output signal and by 100 Hz hum if a full-wave bridge rectififer has been used in a stabilized power supply. This modulation of the power supply is often coupled into the signal path within the power amp by various parts of the circuit which attach directly to the rails. This power supply interaction can often seriously degrade the performance of the power amplifier. The ability of a power amp design to reject the supply signals is sometimes referred to as the power supply rejection ratio (PSRR) and is a very important, although infrequently measured or stated parameter of a design.

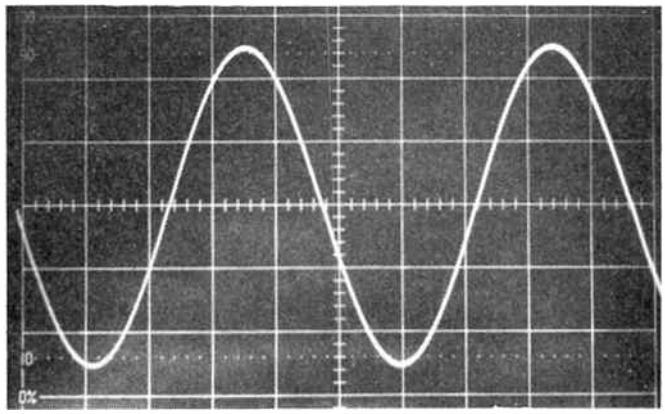
The AEM6000 power amplifier module has benn specifically designed to maximize the PSRR through the use of fully differential circuitry and through a careful design approach which enables successive stages within the power amp to cancel the power supply injected signals inserted from previous stages. This design approach decreases the dependence of the amp on the power supply regulation although good regulation is still an advantage. This is one of the factors which contributes to the excellent subjective performance of this design.

The power supply recommended for use with the 6000 is a fairly conventional one featuring a pair of low-impedance toroidal power transformers rated at 50 – 0 – 50 V and 300 VA. An important point often misunderstood about trans- ▶



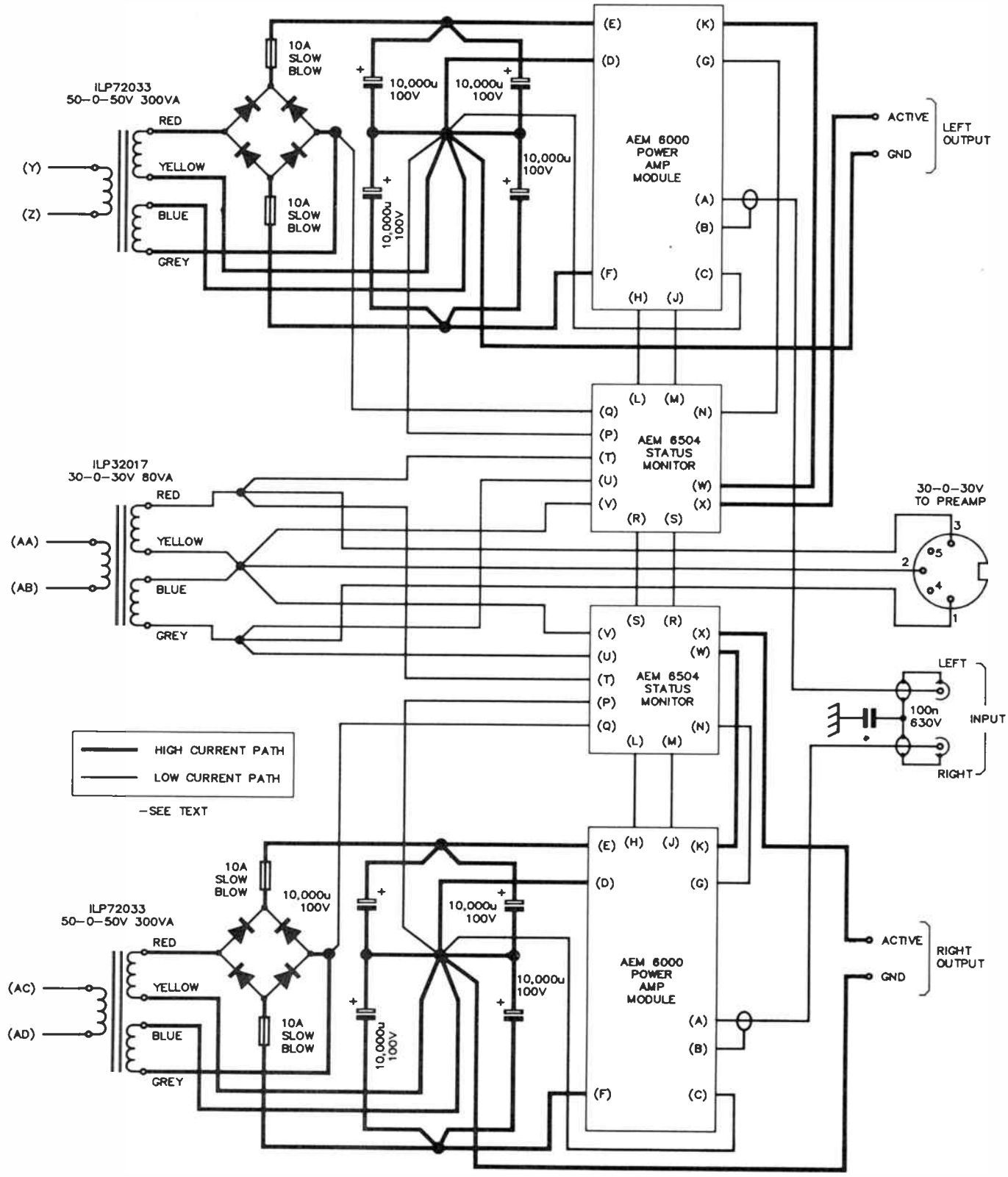
X = 20 usec/div, Y = 20 V/div; 10 kHz full power sine wave.

Showing a 10 kHz sine wave with the amplifier driven to full power output (around 220 W into an 8 ohm load).



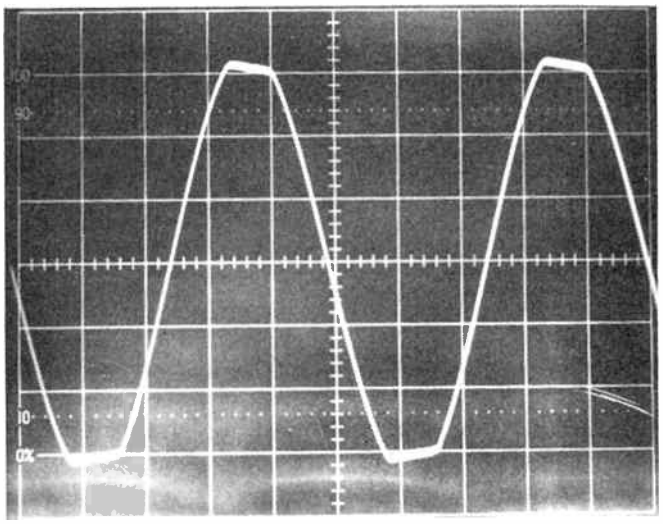
X = 2 usec/div, Y = 20 V/div; 100 kHz full power sine wave.

Output of the power amplifier when driven by a 100 kHz sine wave with the same input amplitude as that used for the 10 kHz and 1 kHz photographs. Notice that the amplitude here has decreased. This is due to the passive RC low-pass filter fitted to the input of the power amp. The maximum signal slope of this sine wave is around 33 V/usec which occurs at the zero crossing of the waveform. The ability of the power amp to reproduce such a high frequency sine wave cleanly is a result of its excellent slew rate performance of around 60 V/usec.



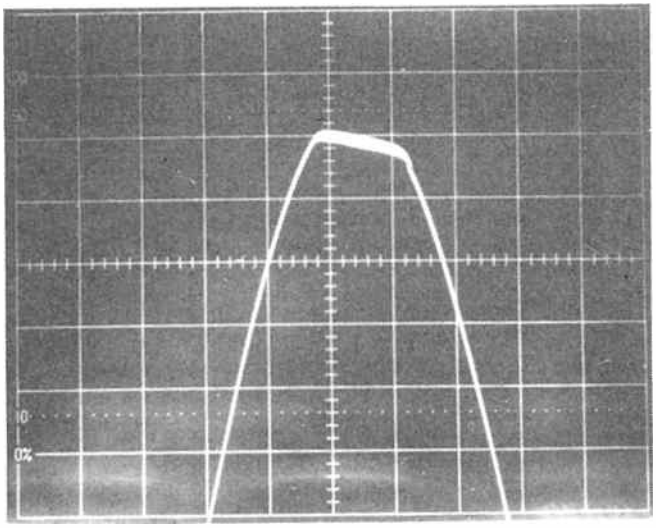
former VA ratings is that this rating does not represent the maxiumum amount of power that can be pulled from the transformer. Most transformer maufacturers use the VA rating of the transformer to represent the power at which the output voltage of the transformer has dropped 5% below its no-load voltage. Considerably more power can be drawn from the transformer, although at the expense of lower output voltage. For many power transformers, the relationship between the secondary voltage and the power pulled remains approximately linear well beyond the rated VA. A 300 VA transformer, for example, is quite capable of delivering 600 VA, albeit with a consequently decreased secondary voltage.

The transformer secondary is connected to a high current bridge rectifier and then to the main electrolytic filter capa-



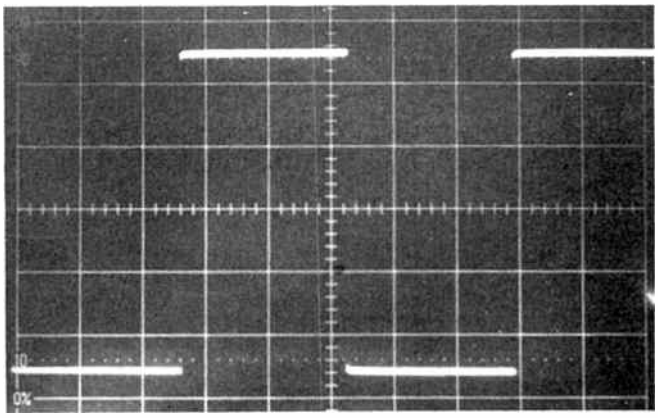
X = 0.2 msec/div, Y = 20 V/div; 1 kHz full power sine wave, driven into overload (clipping).

This photograph shows the resulting waveform when the output of the power amplifier is driven hard into clipping with a 1 kHz sine wave. The slightly sloping, clipped peaks of the waveform are due to the power supply used during the prototyping of the power amp which employed only a single pair of 10 000 uF capacitors. Clipping occurs at aproximately 62 V which is equivalent to around 240 W "RMS" into an 8 ohm resistive load.



X = 5 usec/div, Y = 1 V/div; overload recovery.

This shows a close up of the output waveform that results when the amp is driven hard into clipping using a 2 kHz full power sine wave. Note that the power amplifier goes into and comes out of overload quickly and with no sign of oscillation or instability. The thickening of the top of the waveform is a result of hum on the power supply rails and is normal. The slight glitch that is evident as the power amp comes out of clipping results from the fact that during the overload the negative feedback loop of the power amp is also overloaded, being driven hard against the opposite rail in an attempt to overcome the non-linearity caused by the overload.



X = 2 msec/div, Y = 2 V/div; 100 Hz square wave.

This photograph shows a 10 Vp-p square wave on the output of the power amp at a frequency of 100 Hz with an 8 ohm resistive load. Notice that the top and bottom of the waveform are flat and do not show the usual downward slope associated with most 100 Hz square wave tests. This results from the fact that this amp employs a dc-coupled feedback loop and input stage. If the optional input capacitor is used, a slight downward slope will be introduced. This in itself does not represent a fault and the addition of a good quality capacitor to the input of the power amp is unlikely to degrade performance.

citors. Obtaining good quality large-value high-voltage electrolytic capacitors can be difficult. There are some excellent units manufactured by Siemens rated at 33 000 μF available, but unfortunately these are rated at 63 V and therefore unsuitable for use with the 6000 power amp module when the 70 V rail is employed. These capacitors would be perfect if you are constructing the module in the 100 W version and are therefore using the 50 V rail.

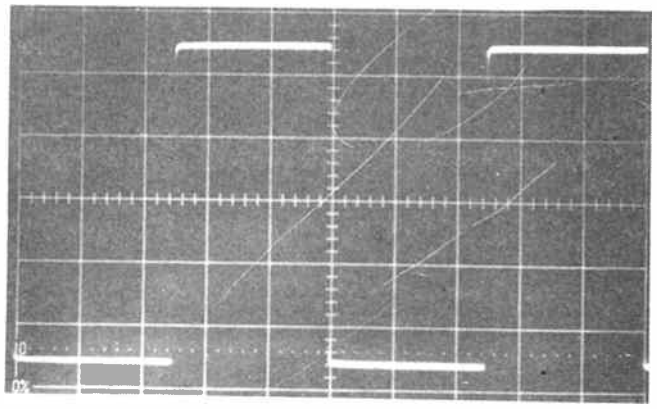
The power supply filter capacitors used in the prototype power amplifier are again Siemens types, rated at 10 000 μF[100 V. In order to achieve sufficient capacity, four of these capacitors must be used for each channel. Some other makes are also available, such as Elna types which are also rated at 10 000 μF[100 V rating. Unfortunately, it seems quite difficult to obtain anything substantially bigger than this at the present time.

A circuit diagram for the recommended power supply is included here. Construction details of the power supply for application in the AEM6000 Ultra-fidelty Stereo Power Amp will be included with next month's article, although it is not complicated and should be able to be constructed by experienced builders.

One of the most important points to be considered is the type of hookup cable used for the power supply wiring. The common "heavy duty" hookup wire (24 × 0.2 mm) is not sufficient for this purpose. Use at least the 32 × 0.2 mm plastic insulated wire but preferably, something even heavier. Heavy duty automotive cable can be used or alternatively, use lengths of one of the low resistance audio cables. In the prototype unit I used Monster Cable (Monster Cable is a registered trademark of Monster Cable Products Inc., distributed in Australia by Convoy International Pty Ltd), which is sold through various hi-fi outlets.

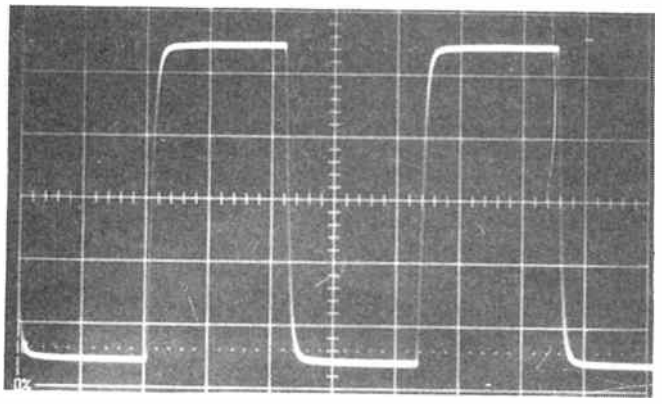
The cable I used comes in a figure-8 cross-section but it is easily split and used for the wiring between the bridge rectifier and the filter capacitors, and then from the filter capacitors to the MOSFET power amplifier stages. The total im- ▶

aem project 6000



X = 0.2 msec/div, Y = 2 V/div; 1 kHz square wave.

This photograph shows the output at 10 Vp-p into an 8 ohm resistive load with a 1 kHz square input. Notice that the leading and trailing edges of the waveform are free of ringing which might otherwise indicate instability.



X = 20 usec/div, Y = 2 V/div; 10 kHz square wave.

Again, output at 10 Vp-p into an 8 ohm resistive load, but driven at 10 kHz this time. The slightly rounded leading and trailing edges are due to the band limiting introduced by the input RC filter which attenuates very high-frequency Fourier components well in excess of 20 kHz, which are necessary for fast leading and trailing edges. Since the human ear is a low-pass filter also and will not respond to frequencies well beyond 20 kHz, the absence of these harmonics has no audible effect on the performance of the power amplifier. In fact, if the input filter is removed, the possibility exists that the power amp can be driven into slew-induced distortion which will seriously degrade its acoustic performance. The purpose of the input filter is to limit the maximum possible signal slope so that it cannot approach the slew rate of the power amplifier circuitry. The curve shown here is a perfect band-limited square wave .

pedance from the power amp modules back to the main filter capacitors must be kept as low as possible. The distortion performance of the power amplifier will be seriously degraded if the impedance in this wiring is not kept to a minimum.

In next month's article the remainder of the construction details for the AEM6000 'Ultra-fidelty' Stereo Power Amplifier will be discussed. We have arranged for the manufacture of a high quality diecast front panel heatsink for use with the amp and we will be describing the construction of the associated chassis, 240 V wiring, standby power-on circuit and surge current limiter.

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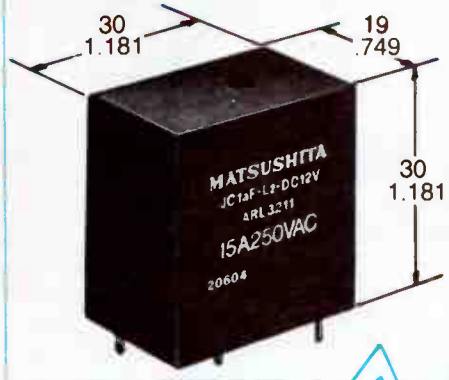

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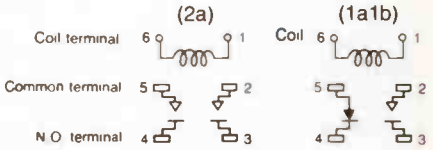

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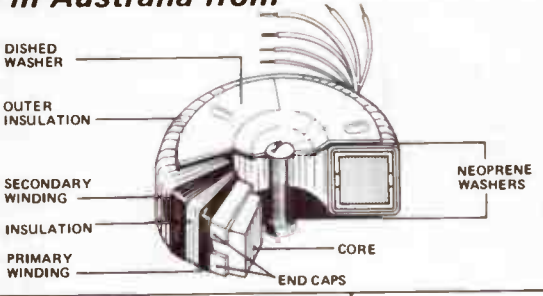

15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA
70 x 35 mm 0.45 kg
Regulation 18%

1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA
80 x 40 mm 0.9 kg
Regulation 13%

2x010	6+6	4 16
2x011	9+9	2 77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0 83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
95 x 40 mm 1 kg
Regulation 12%

3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA
95 x 45 mm 1.2 kg
Regulation 11%

4x010	6+6	10 00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0 50

160 VA
110 x 45 mm 1.8 kg
Regulation 8%

5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2 28
5x026	40+40	2 00
5x028	110	1 45
5x029	220	0 72
5x030	240	0 66

225 VA
110 x 50 mm 2.2 kg
Regulation 7%

6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA
110 x 57 mm 2.6 kg
Regulation 6%

7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA
135 x 60 mm 4 kg
Regulation 4%

8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA
140 x 70 mm 5 kg
Regulation 4%

9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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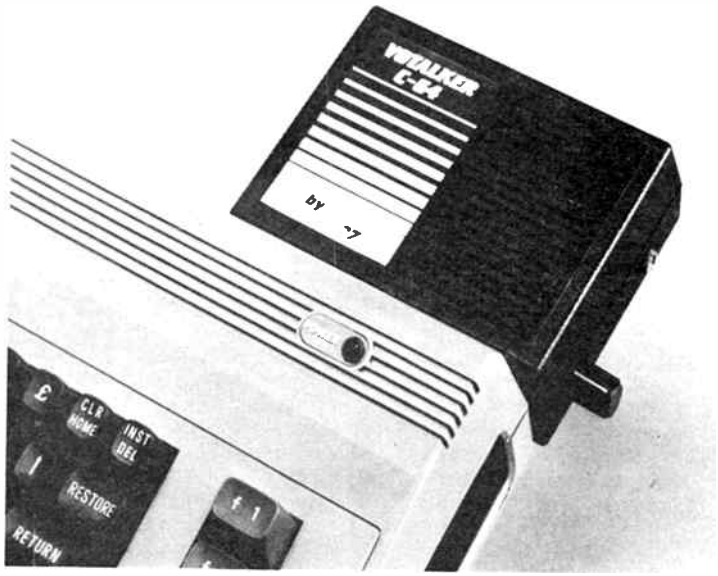

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THREE SPEAKING MODES
Different situations require different types of text-to-speech translation. VOTALKER C-64's MODE command lets you chooose between conversational, verbatim, and character modes The conversation mode speaks text as though you were reading it, pausing appropriately at punctuation marks. The verbatim mode is similar; however, all symbols are spoken, including punctuation. The character mode pronounces each character separately. The MODE feature is extremely important when VOTALKER C-64 is echoing the screen during the conversation mode. The verbatim and character modes are useful for program listings and disk directories.

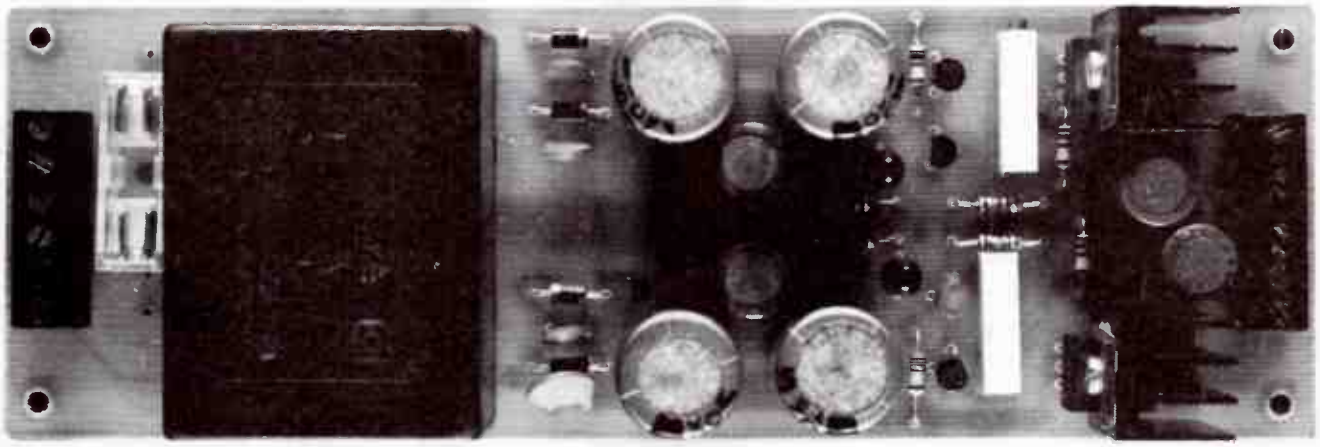
SINGLE KEY ACCESS TO MANY FUNCTIONS
VOTALKER C-64 allows you to easily toggle speech, echo, upper/lower case, and translation modes using the four standard functin keys. This is a definite time and keystroke saver.

NO SOFTWARE TO LOAD
All of VOTALKER C-64's powerful features are immediately available when you turn your computer on. The inconvenience of having to load text-to-speech software and BASIC enhancement routines is eliminated. All required programs are contained in on-board ROM, thereby eliminating the need for computer memory. VOTALKER C-64 is so quick and easy to use it practically talks right out of the box!

INVALUABLE AID TO THE VISUALLY IMPAIRED
With its screen echoing feature, VOTALKER C-64 will speak program listings, disk directories, and screen messages. A special set of translation rules has been added to insure that abbreviated BASIC commands, functions, control characters, and messages are vocalised correctly. The character-by-character mode of translation may be used to determine exactly what a spoken line contains. Single key access to many functions and the ROM-based software also simplify use by the visually impaired.

BUILT-IN AMPLIFIER AND SPEAKER
The unit contains its own amplifier and speaker to provide the best possible sound quality. An external speaker jack also is provided.

COMPLETE WITH COMPREHENSIVE USER GUIDE
VOTALKER C-64 comes complete with a detailed User Guide that fully explains all features and new BASIC commands. Many examples and programming tips will make you a VOTALKER C-64 expert in no time at all. Adding a voice to your computer has never been so easy and so much fun!



A utility dual power supply module

Anthony Tilbrook

So many circuits call for regulated dual power supply rails, one positive, one negative of modest current capacity. While the circuitry to deliver such a requirement is virtually commonplace and varies little, individual voltage requirements vary widely. This project is designed around the commonly available Ferguson PL5VA pc-mount transformer range – just select the transformer to suit the rail voltages required. Presets provide independant voltage adjustment and the circuitry employs bog-standard bits.

FOR SOME TIME we have received numerous requests for a small "universal" dual rail dc power supply module. The requirement was for a clean, easy to set up and dependable supply which could be used as a component in a large number of projects. The many circuits requiring a split (+/-) supply makes this an essential feature. Accordingly, we have provided the 9501 with independantly adjustable positive and negative supply rails.

The design of the power supply employs discrete transistors in a simple voltage regulator configuration rather than three-terminal IC voltage regulators. This was done to help ensure that the project could be built from components most likely to be commonly available off-the-shelf in the majority of electronics retail stores or found in many experimenters' workshops.

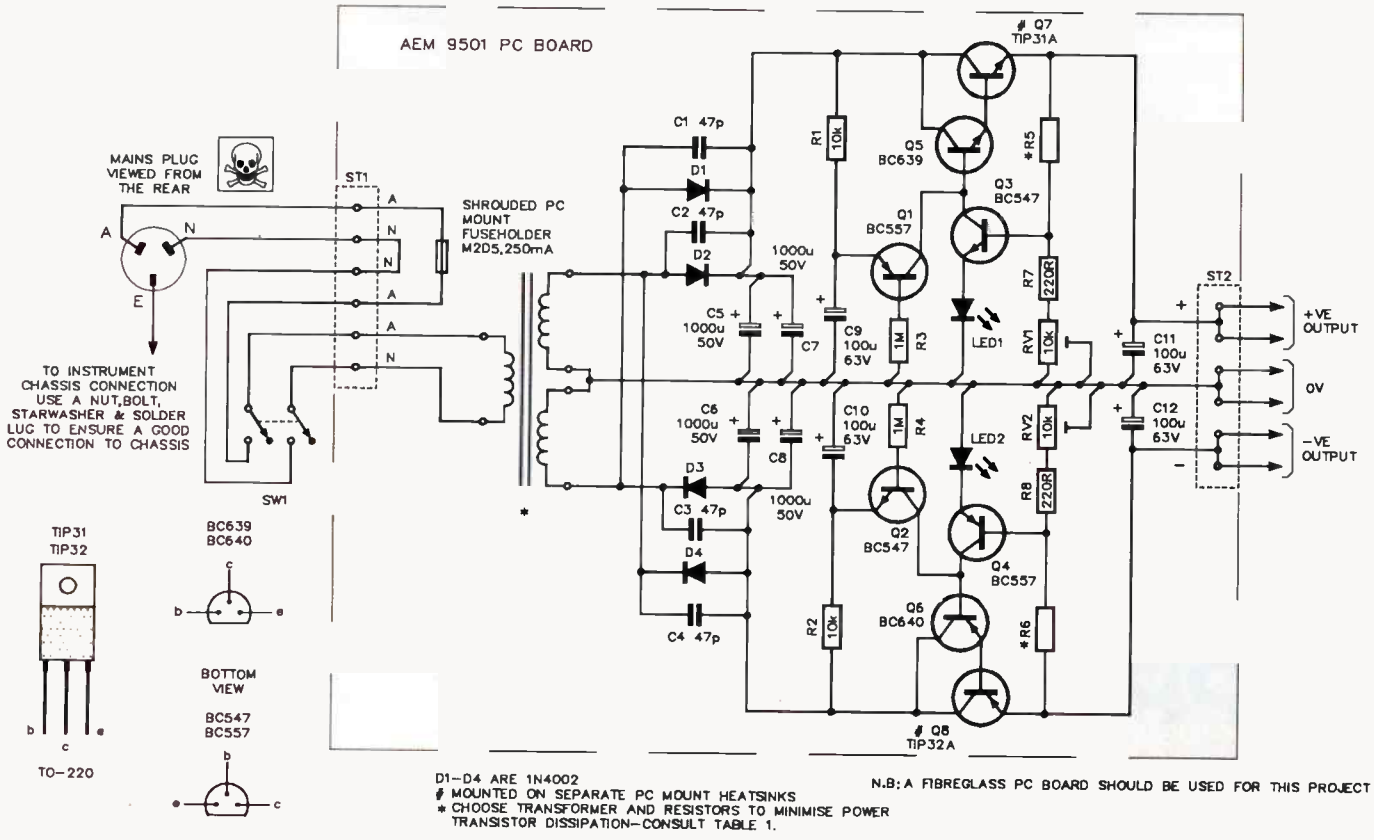
The output voltage can be set over a range from as low as about 2.5 V up to 26 V, depending on the secondary output of the transformer selected. Ten-turn preset potentiometers in each rail regulator circuit permit independant adjustment of each rail. Furthermore, the vernier range of adjustment can be enhanced by optimising the value of one of the resistors in each regulator's output potential divider.

Although the minimum voltage to which the supply can be set is determined by the operation of the circuit, the maximum voltage is determined by the choice of power transformer. Table 1 sets out the appropriate choice of transformer and output vernier range resistors for the required rail voltage range.

TABLE 1.

OUTPUT VOLTAGE REQUIRED	TRANSFORMER REQUIRED	VALUES OF R5/R6 REQUIRED	MAX. CURRENT
+/-2.6 to 4.3 V	PL9/5VA	2k2	560 mA
+/-2.6 to 7 V	PL12/5VA	2k2	420 mA
+/-4.5 to 8.6 V	PL15/5VA	10k	330 mA
+/-4.5 to 10.7 V	PL18/5VA	10k	280 mA
+/-4.5 to 15 V	PL24/5VA	10k	210 mA
+/-10 to 19 V	PL30/5VA	33k	170 mA
+/-10 to 26 V	PL40/5VA	33k	130 mA

A special feature of the design is the slow turn-on, ensuring that the supply rails "ramp up" slowly after the mains is switched on. This is a particularly useful feature of the project, especially when used in conjunction with audio equipment since it helps to eliminate turn-on thump. In fact, most audio circuits will turn on completely silently when used with this supply. ▶



CIRCUIT OPERATION

The supply uses Ferguson PL-series transformers which are readily available through the major electronics retailers. Diodes D1 to D4 provide full-wave rectification in a standard bridge configuration. The small value capacitors C1 to C4 are used to decrease the radio frequency interference (RFI) that can be generated as a result of diode switching.

The main supply filtering is provided by the four 1000 uF/50 V RB electrolytic capacitors. This type of capacitor was used for their ease of mounting and the saving of board area that results over that occupied by axial types. Components R1 and C9 in the positive supply, plus R2 and C10 in the negative supply, provide a time constant which is used for the slow turn-on feature. Using the format t = 1/RC, the values of R1, C9 and R2, C10 yield a time-constant of around one second.

The operation of each half of the circuit is identical so I will describe the operation of the positive supply only. As C9 charges via resistor R1, the voltage on the emitter and hence on the base of Q1 ramps up. Transistor Q1 applies a voltage to the base of Q5 and the collector of Q3. Now, Q5 and Q7 form what is known as a Darlington pair which has a large current gain and slightly less than unity voltage gain. The voltage applied to the base of Q5 results in the current which turns on the Darlington pair. The output voltage increases, increasing the voltage on the base of Q3 since it is derived from the potential divider formed by R5, R7 and the ten-turn preset, RV1. The output voltage continues to increase until the voltage applied to the base of Q3 is sufficient to turn on Q3 and LED1 in series with it's emitter. When this happens, current is robbed from the base of Q5 and the output voltage stabilises. LED1 is used as a voltage reference. Most red LEDs will generate a voltage drop of approximately 1.65 V when used in this circuit. The resulting output is that applied to the base of Q3 via the potential divider, which is around 2.25 V. Capacitors C11 and C12 are included to ensure the stability of this feedback loop as well as supplying final power supply filtering.

This brings us to the setting of the output voltage. I found during development that the vernier range of the preset was only usable for certain ranges of supply voltages. After a small amount of experimentation I found that by adjusting the value of R5 and R6 the vernier could be improved. This restricts the supply voltage range and the correct values of these resistors for the available supply rails (depending on the transformer) can be established from Table 1. Thus the minimum output voltage that can be obtained when using the higher output power transformers will be restricted, however. This is not an important problem since it is wiser to use lower voltage transformers where lower output voltages are required to ensure minimum power dissipation in the pass transistors Q7 and Q8.

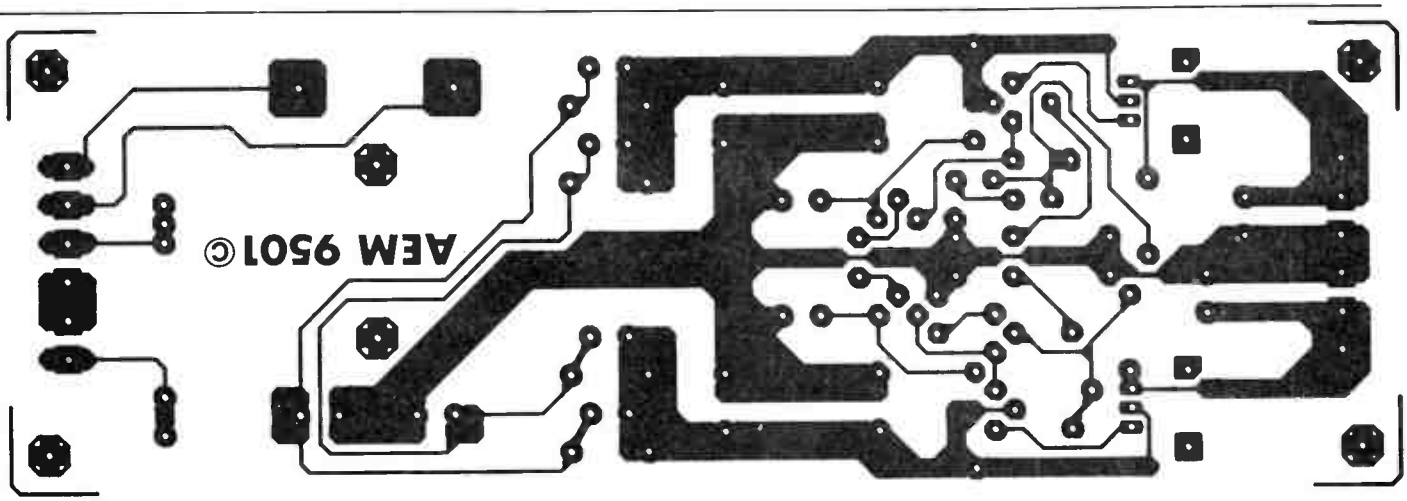
Construction

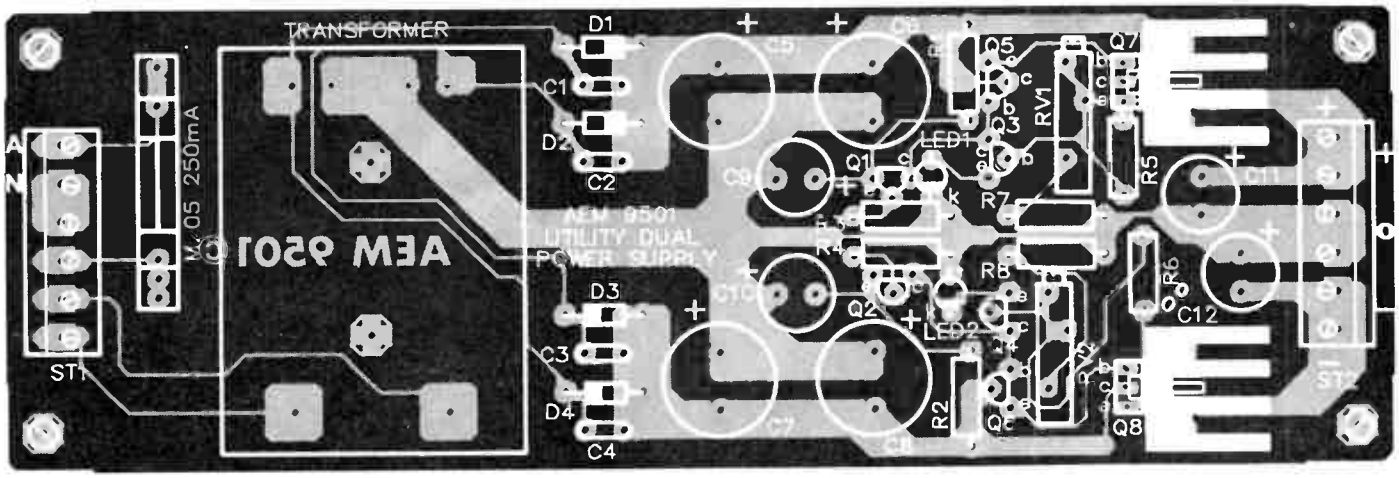
Special care was taken during the board layout phase to ensure the board could be readily fitted into the widely available, and popular, plastic instrument cases. The final board design, presented here, will fit two sizes of these instrument cases, held vertically by the internal slots in the small version, or screwed to the base in the larger.

The mains input and supply output are each connected via a 6-way pc-mount screw terminal block, each located at opposite ends of the board. An on-board mains fuse is included. for safety's sake, I used a shrouded pc-mount fuseholder that takes a 20 × 5 mm fuse. The type shown on the prototype is an IMO Series 10 from C&K Electronics (see *Retail Roundup*, AEM July '86.)

Although this project is a relatively simple one, there are some aspects of the construction that I should specifically draw to your attention.

Firstly, whether you've made your own pc board or purchased a ready-made one, it is a good idea to check it for any signs of copper "bridges", especially between closely-spaced pads or tracks. Problems caused by this are not uncommon,





AEM9501 PARTS LIST

Semiconductors

Q1	BC557
Q2, Q3	BC547
Q4	BC557
Q5	BC639
Q6	BC640
Q7	TIP31A
Q8	TIP32A
D1, D2, D3, D4	1N4002
LED1, LED2	TL4213 or similar

Resistors all 1/4W, 5% unless noted.

R1, R2	10k
R3, R4	1M
R5, R6	chosen to suit output voltage, see Table 1.
R7, R8	220R
RV1, RV2	10k ten turn preset potentiometers.

Capacitors

C1-C4	47p ceramic
C5-C8	1000μ/50V RB electro.
C9-C12	100μ/63V RB electro.

Miscellaneous

SW1	DPDT Mains-rated switch
ST1, ST2	6-way pc mount screw terminals.

AEM9501 pc board; two metres mains cable; mains plug; M205 pc-mount shrouded fuse holder; M205 fuse; transformer to suit voltage needs, see Table 1; two pc mount heatsinks (DSE H-3490 or similar), thermal paste, mica washer and insulating washer for mounting bolt; two bolts, nuts and washers.

Expected cost: $52-$58

and are not always simple to find after assembling the board. If you find any such bridges, use a hobby knife or fine-bladed screwdriver to scratch it away.

I recommend you begin construction with the resistors, followed by the small capacitors and the diodes. Check that the diodes are correctly oriented. The ten-turn presets have been designed to face the same direction and are located slightly offset to provide access to each screw adjustor. Very useful when the unit's mounted in a box.

Next, solder the transistors and LEDs, excepting the TIP31 and TIP32. You should ensure that the LEDs have been positioned correctly and that none of the transistors have been interchanged. The BC547 is an NPN device while the BC557 is a PNP device; they both have the same pinout, while the BC639 has an altogether different pinout. If you mistakenly interchange any of these, you risk damaging the project when you first turn it on.

Next on the list are the rest of the capacitors, which all happen to be electrolytics. Be sure to orient these correctly as reversing them will almost certainly result in their destruction.

The screw terminals and fuseholder can now be positioned and soldered in place. The two regulator series-pass transistors, TIP31 and TIP32, should be mounted on their heatsinks and insulated using mica washer and thermal paste. The bolt used should either be a nylon type, otherwise use an insulating washer. This is to ensure that the heatsink does not become "active" via the case of the transistor, which has the collector connected to it. If the heatsink is not insulated, be sure that it does not come in contact with other componentry after mounting.

Last of all, the transformer of your choice can be mounted and soldered in place. These pc-mount transformers are designed with two plastic lugs underneath which may be used to secure them mechanically to the board so that no unnecessary stress is applied to the pins. These lugs can be melted with a soldering iron to lock the transformer into place. However, I strongly recommend that, if you intend to use the project with different voltage transformers from time to ▶

time, these lugs be left alone. I have found, from bitter experience, that it is extremely difficult to remove the transformers after the lugs have been melted!

Finally, when wiring the 240 Vac mains, be sure to follow the wiring diagram *to the letter*. (We like to avoid charred readers or damaged equipment, it's bad for sales!). I might also mention it is essential to use a fibreglass pc board as it forms the heart of the mains wiring. This reduces the number of flying leads, thus making the project that much safer. It is also important to use a fibreglass board due to the amount of stress that the board may be subjected to from the transformer's weight.

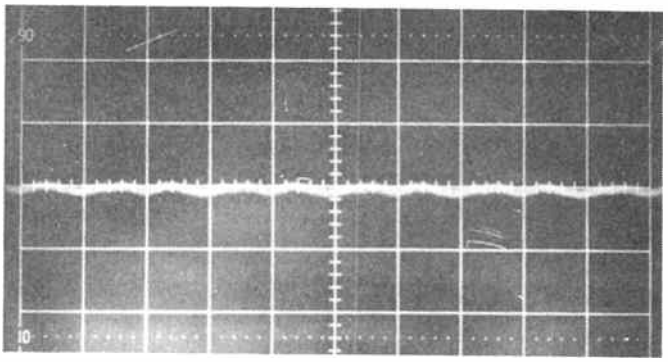
Note that the 6-way screw terminal on the output employs two terminals for the positive rail, two terminals for the zero volt connection and two terminals for the negative rail.

Setup procedure

Before applying power to the project for the first time, there are a couple of safeguards that should be observed. Check that the board is clear of any unwanted solder bridges or copper bridges between tracks or pads. Especially check the mains wiring and see that a fuse (250 mA, "slow blow" type) has been placed in the fuse holder.

When powering-up, if you apply the probes of your multimeter to one or the other supply rail output, you will observe the slow turn-on. The rails should take approximately one second to ramp up.

To set the voltage simply apply the probes to the output and adjust the ten — turn preset until the desired voltage is achieved. If the preset is too sensitive to set the voltage accurately then check that the appropriate value of R5 and R6 has been used in conjunction with the desired transformer according to Table 1.



Performance of the unit depends on the transformer used but at worst case, with a PL40/5 VA the 9501 delivers 1.4% regulation from 0-130 mA, and hum and noise less than −85 dB. This CRO picture shows hum and noise on the output with y-axis sensitivity of 5 mV/div., x-axis 10 ms/div.

In the entire circuit, there is only one voltage that will remain constant. This is the voltage between the base of Q3 or Q4 and zero volts. This should remain at around 2.2 to 2.5 volts. Before applying the output of the supply to any circuitry, be sure you set the voltage to that required. After applying a load the voltage may drop slightly, so simply adjust it again while the load is applied.

1ST BIRTHDAY CONTEST No. 4.

What an incredible opportunity to win a top quality professional soldering station! All you have to do is answer these simple questions and tell us what features of the Ersa MS1500 soldering station most attract you.

Q1: Who first applied for a patent on an electrically-heated soldering iron, and in what year?

.....

Q2: What is the 'eutectic point" temperature of "60/40" solder?

.....

Q3: Components sensitive to voltage 'spikes' may be damaged by on-off switch type soldering iron heater temperature control systems. What is the name given to the widely used alternative temperature control system that avoids such voltage spike problems?

.....

Now tell us, on a separate sheet of paper, using 30 words or less, what features of the Ersa MS1500 most attract you?

Name .....

Address .....

..... Postcode .....

I have read the rules of the contest and agree to abide by their conditions.

Signed: .....

**The Contest Rules are set out on page 6 of this issue.*

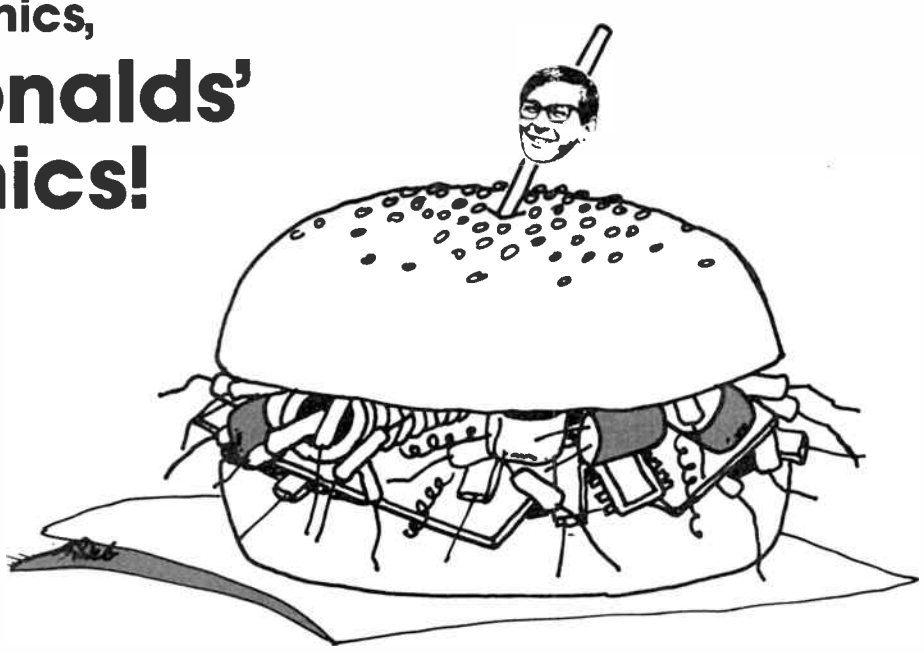
Win this Ersa temperature-controlled soldering station with two irons, Model MS1500 from Meltec Pty Ltd

The Ersa MS1500 miniature soldering station is ideal for precision electronic soldering on today's high density pc boards. It comes with a 'Minor soldering needle' rated at 5 W, for very fine work, and the 8 W Multitip for general use. Fully variable temperature control setting is featured, providing temperature ranges of 100-340 degrees C for the Minor iron and 100-350 degrees C for the Multitip. The irons operate from a safe 6 V supply via a safety isolation transformer. The holder and sponge can be mounted on the left or right. An earthing terminal on the station provides for operator earthing while working on static sensitive equipment.

Prize kindly donated by Meltec Pty Ltd, PO Box 20, Greenacre 2190 NSW.

Dick Smith Electronics,

The 'McDonalds' of electronics!



THE STORY of Dick Smith, the man and the company he founded and developed into a multi-million dollar business, is well-known to just about everybody involved in electronics. However, in 1980 Dick Smith sold 40% of the company to Woolworths. In mid-1982, he sold the balance to Woolworths, staying on as Chairman of the board, then as a director until he finally resigned and left the company, apparently content it was 'in good hands'.

Those good hands were Ike Bain's, who had been General Manager for some years then. He was followed by Mike Wilson, and Ike left to open Dick Smith Electronics' American operation in February 1985.

With the departure of the founder and a succession of changes 'at the top', the mid-'80s were quite turbulent times, you might say? True, but according to Graham Foster, Marketing Director for DSE, this has meant a strengthening of the company.

The company's metamorphosis since Dick himself departed is an interesting story. On analysis DSE, like many firms, can be thought of as having an inner and an outer shell. Their outer shell is their 'customer interface'. Basically, this appears to have undergone the least change. Their internal structuring, though, has undergone the greatest mutation.

All the people I spoke to at Dick Smith said the same thing, that is, that the company's infrastructure has changed from a very loose one to a more conventional organisation, with more specific definition of peoples' roles and 'tighter' business practices.

Bob Johnson, the National Training Manager and one of the company's longest-serving employees, reflected on the days when "... Dick would grab you walking down the aisle and say, 'Bob, do this' — totally not your job but you'd do it because he was the boss." Jobs and responsibilities are now clearly defined and formally structured, something noticed by all in the company. "We know where we are going", Bob said, "and we'll be around till the twenty-first century. I don't know if I will be, but the company will!"

Dick Smith, the man, tended to do half the jobs in the company and arbitrarily delegate the rest, very much a one-man band. This was by no means a fault. In fact, everyone I spoke to saw it as a great achievement of Dick's. But both people and the market change. Australia has now seen its electronics and computing industry grow from very small, highly entrepreneurial businesses to larger scale, formally structured ones, like DSE is now.

But that doesn't mean DSE has lost the "fun", slightly crazy, image that Dick inspired. DSE still have things like the familiar "... any excuse for a sale" ('May Madness', 'Looney June', 'We Goofed', etc). The "Little Dick" character was introduced a few years back and is now a familiar sight at store promotions, in their adverts and publicity stunts etc, like last year's World Record Big Christmas Bon-bon which made the Guiness Book of Records (see *AEM*, Feb. '86 page 9).

These things maintain the same, fun type customer communication that has long characterised Dick Smith Electronics. In this regard the close, all-in-the-family atmosphere that existed between the staff in the Dick Smith days is also still present and held in proud regard.

Paul Beaver, the Computer Training Manager, commented on this family-like attitude. "Staff are involved, very much so, in the buying and selling of products and general running of the company. If somebody (staff) doesn't like the way a particular product is selling, or performing, they have a chance to comment on this. The company look after the staff and vice versa. People are not just hired, put into a position, designated responsibilities and expected to fulfill them. They are given a hand ... and are encouraged to participate in the company far beyond their normal working capacities." ▶

'Australian Electronics Profile' will be an occasional column that examines Australian companies operating in the broadly defined electronics and computing industry, focussing on how the companies operate and the people behind them. To kick-off, we decided to look behind a familiar face – Dick Smith Electronics, so our ace-technial-writer/reporter-in-training ***Jamye Harrison*** was packed off to poke inside DSE with a brief to find out where the firm has been, and where it's headed, since The Man himself departed some years ago.

Paul Beaver, Computer Training Manager at DSE. He's lucky enough to be employed to puruse his hobby as a vocation! Paul trains DSE sales staff, writes manuals, guides and demonstration programs, as well as handling software problems. He drives a Multitech on his desk and a big red motorbike and sidecar on the street. Paul's been with DSE some six years.

For this reason probably, Dick Smith Electronics attracts a certain type of employee, one who is enthusiastically involved in the area in which they are employed. For instance, Paul Beaver mentioned "I'll knock off here . . . go home, and I'll play with my computer tonight for relaxation . . .". Gary Crapp, the General Manager of Technical and Enthusiasts Products, says "I'm a hobbyist. When I go home at night, I go into my workshop and I build things, I design things and I fiddle around, just as thousands of our customers do, so I experience first hand the joys and frustrations that (others) might experience . . .".

Attitudes like this seem to be the rule rather than exception at DSE, I found.

Graham Foster probably best described DSE's policy in terms of the company's outer shell. He said "We see ourselves as the 'McDonalds of electronics'. We like people to bowl up to you and say 'hullo welcome to Dick Smith, its nice to see you here'. We believe people like friendliness, they like to be treated properly and they like people not to look scruffy." It is for this reason DSE have a "middle of the road" approach on dress for store staff.

Dick Smith Electronics have a deliberate policy of employing and training young people. The average age is around 20-21. The training process involves emphasis on manners and speaking properly to people, and this, apparently, pays off. Graham Foster commented that Dick Smith spends a lot of time, money and effort on training young people. "We found some serious problems of motivation coming from schoolkids; they leave school depressed. The two main things we get in job interviews are they think the world is going to end with a nuclear explosion tomorrow and that there are no job prospects for them anywhere. Both are rubbish."

Graham Foster, DSE Marketing Manager; the 'brains' behind many of the firms zany and popular promotions. Graham is one of the 'new team' within the company's inner shell. Or maybe he's at the core.

For these reasons DSE's training process involves teaching staff a positive mental attitude, goal setting and sales skills, along with product knowledge. From here they can become system managers, training course manager, state manager, and so on. There is a

positive progression through the company which allows people to see that there is a future for them and they want to be stuck in the same job for the rest of their life. They can also be transferred to New Zealand or America or Head Office or into a specialised function.

If you're young and enthusiastic there's little impediment to rapid advancement in DSE. Bob Johnson mapped it out: "We employ people from 15 onwards. Age is immaterial, it's output that really matters. From sales they can progress to trainee assistant manager, then assistant manager to store manager. A good sales person, within two years, should be a trainee assistant manager. It's fast from there, providing (they) satisfy our management programme. From the bottom of this programme they could be a store manager in about 15 months.'

So, virtually about three and a half years from joining the company, you can reach the store manager level. As Bob Johnson pointed out to me, if you joined at 15 or 16, you could be a store manager by the age of eighteen and a half, nineteen or so. Many store managers in the smaller stores are under 21, apparently.

From there, you can progress to manage a medium store, then to a larger store, with higher turnover. Progression from there would be to supervisor and then possible state manager. ". . . you should really run a store, I consider, for about five to six years before you are suitable for supervisor", says Johnson.

Bob Johnson — another long-time DSE employee. Bob started with the firm some 11 years ago. As the then store manager, Bob 'opened' the York St store in Sydney. Later he established Dick Smith's Hong Kong base, then followed a stint as NSW manager. Bob is now National Training Co-ordinater, setting up and co-ordinating training courses for store staff for all Australia and New Zealand.

Garry Crapp, DSE's General Manager of Technical and Enthusiast's Products — another who's lucky enough to be paid to pursue his hobby! Garry started with the company as its one and only service technician, which makes him one of DSE's longest-serving employees. His job encompasses ". . . everything that isn't a computer . . . or consumer products".

The future

Dick Smith Electronics is expanding, both product-wise and geographically. This year they will open more stores here, in New Zealand and the US. They will also venture further afield into the Pacific and South East, according to Graham Foster.

DSE in the US has been quite successful, especially in kits. Says Garry Crapp, ". . . the Americans jump up and down with glee and say when can I have some more . . ."

Quality and variety of components is gaining increasing attention. "My major thrust for the past 18 months (has been) to improve the quality of components", says Garry Crapp. And it's reflected in customer response, he says. More 'hi-tech' items are becoming available, too. "For instance," says Garry, ". . . we've just started stocking . . . a gallium arsenide FET (GaAsFET — Ed.). Now, two years ago, these were $40 each; today they're six dollars. That's quite affordable, and the performance they give is now available to hobbyists. So that's sort of an indication that things can only get better if you're an electronics hobbyist. It's going to be fascinating in years to come!"

In part 1, we covered fundamental capacitor characteristics and the various capacitor categories, then took a look at electrolytic types. Here, we continue with special electrolytics, tantalums, plastic, and paper types.

Modern fixed capacitors

— what the textbooks never told you.

Part 2
Les Ferdinand

IN NON-POLAR electrolytic capacitors, a second foil which is anodised during production is added — it has the same capacitance as the anode. This construction allows the capacitor to withstand dc of either polarity, as well as ac. Since alternating voltages cause inherent heating the ac rating is considerably lower than the dc voltage rating. Because of the construction (effectively, two capacitors in series), the capacitance is halved for a given case size, and the leakage current is doubled.

Extremely pure materials are used in the manufacture of aluminium electrolytic capacitors. The higher the quality, the lower the leakage.

Reverse polarisation of polar electrolytics causes a dielectric film to be produced on the cathode and anode, causing high internal heating, high leakage and gas formation which destroys the capacitor with a loud bang. Reverse voltage is permissible to only about 2 V maximum.

The capacitance of an electrolytic capacitor does not remain constant under all operating conditions. Temperature has the greatest influence on electrolytic capacitors, which generally have a temperature coefficient of around 500 ppm/C. At low temperatures the viscosity of the electrolyte increases, increasing the ESR. At high temperatures the leakage is increased and the ac current rating is reduced. Life of the capacitor can be reduced by 50% at high operating temperatures.

Application of ac causes self-heating within the capacitor. This becomes a major consideration with capacitors used for smoothing, energy storage and filtering as high ripple current causes considerable heating within the capacitor. The temperature in the hottest part of the capacitor is called the "hot-spot", this hot-spot has a major influence on the operational life of the capacitor.

Problems can be caused by:

ac current

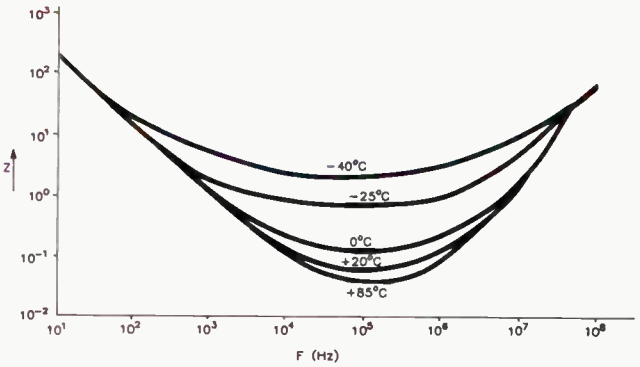
ambient temperature

Location — big electrolytics must be located where air can flow around them.

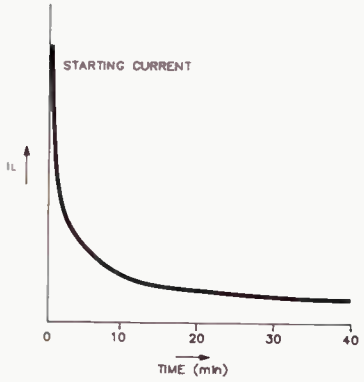
The capacitance of electrolytic capacitors decreases with increasing frequency, and the dissipation factor increases with frequency.

Capacitance drift (change in capacitance) in electrolytic capacitors is caused by high temperatures and high ac loads. Drift is greater with low voltage electrolytics. So to minimize drift it is advisable to use capacitors of a higher voltage rating.

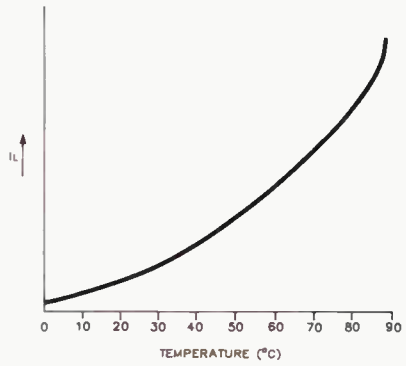
The impedance characteristics of electrolytic capacitors are determined by the ESR, ESL the dissipation factor, temperature and frequency. The true impedance of an electrolytic is very complex as even the circuit it is used in effects its impedance.



The impedance variation of a 100 μF/63 V electrolytic capacitor versus frequency and temperature.



Electrolytic leakage current versus time.

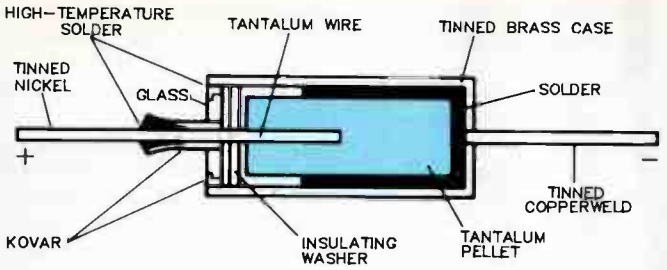


Electrolytic leakage current versus temperature.

At low frequencies and temperatures from 15 to 40 degrees C, the ESR and capacitive reactance are the dominant factors; at low frequencies and low temperatures below -5 C the electrolyte resistance starts to rise significantly with reducing temperatures and ESR becomes the dominant factor.

At temperatures between 10 — 40 C and increasing frequency the capacitive reactance decreases till it reaches the same order of magnitude of the ESR; at still higher frequencies a resonance minimum is reached. At higher frequencies than that the ESL and ESR become the dominant factors.

All electrolytics have a leakage current (I/V L/). This leakage level depends on several factors, including the purity of the materials used, type of electrolyte used, the ambient tem-



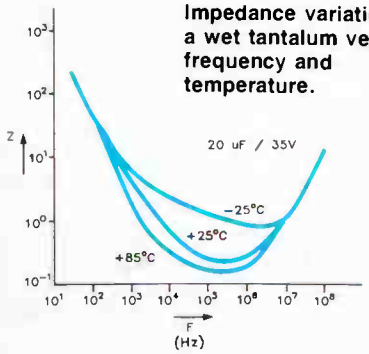
Typical construction of the solid electrolyte tantalum capacitor.

perature and the applied voltage. Leakage current is measured at 20 degrees C.

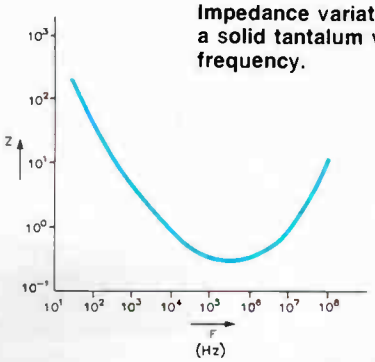
Leakage current plays an important part in maintaining the quality of a electrolytic capacitor by maintaining the oxide layer. This is done by the water in the electrolyte being broken into oxygen and hydrogen. The oxygen reacts with the aluminium ions rebuilding the dioxide layer. The hydrogen is stored in the free space in the can — high quality electrolytics have breathing vents to get rid of excessive pressure, and these should always be at the top of the can when the capacitor is mounted.

Modern electrolytics can be stored from two to ten years with no degradation in performance. The only effect is a large increase in leakage current till the dioxide layer has built up. Always remember that the current handling capabilities of electrolytic capacitors varies with frequency and temperatures, and don't ever exceed the maximum voltage rating of the capacitor.

The most important factor in ensuring long capacitor life is to keep the temperature of the capacitor low. Capacitor life is doubled for each 15 degree reduction in operating temperatures. Electrolytics should ideally not be used on low level signal inputs, with little or no dc biasing, as the performance of these capacitors will be effected after a period of time. For ac feedback or output capacitors bipolar types give much better performance and longer life.



Impedance variation of a wet tantalum versus frequency and temperature.



Impedance variation of a solid tantalum versus frequency.

It is good practice to bypass large electrolytic capacitors with a 10n or 100n plastic film capacitor, as this will offset the inductive reactance of large electrolytic capacitors at higher frequencies.

Tantalums

Tantalum electrolytic capacitors come in two basic types. They have a sintered body of tantalum powder which is the anode, with a solid or liquid electrolyte as the cathode. The dielectric tantalum oxide is generated electrochemically by oxidation on the anode.

In solid tantalum capacitors, the second layer is usually the cathode — a semiconducting metal oxide, typically manganese dioxide, which is applied to the anode oxide foil. The cathode contact is a graphite and conductive silver foil sealed to the case.

In liquid electrolytes the cathode is a highly conductive acid with teflon spacers; the cathode contact is a fine silver housing with platinum black inside (sounds like my sort of car — Ed.) Both solid and wet tantalum capacitors have similar impedance characteristics.

Solid tantalum capacitors have no significant change in impedance with temperature. The dissipation factor of solid and wet tantalum capacitors are similar to high quality electrolytic capacitors. Both solid and liquid tantalum capacitors have very low ESR and very good frequency response characteristics. Solid tantalum capacitors can be connected back to back provided that they are of the same type, voltage and capacitance. They should be connected cathode to cathode to enable locking in each polarising direction. This will halve the capacitance, but enables their use where high polarity reversals occur, at twice the superimposed ac voltage of the value permitted for one capacitor. Back to back tantalums can be used for pure ac provided the upper temperature limit is not exceeded. ▶

Incorrect polarisation of solid tantalum capacitors must not exceed values stated in manufacturers data sheets, other wise the capacitor might explode. Under no circumstances should wet tantalum capacitors be incorrectly polarised or connected back to back as the silver cathode connected in the forward direction causes excessive heat and oxygen which can cause the capacitor to explode — spraying concentrated acid around.

YOU HAVE BEEN WARNED!

Solid and wet tantalum capacitors can be stored for over ten years with little or no effect on leakage or performance. High purity tantalum is used in the manufacture of tantalum capacitors, which means a low failure rate and leakage currents approximately 10 per cent the value for aluminium electrolytics.

Wet tantalums feature the lowest leakage currents of any electrolytic capacitor. Leakage in a wet tantalum capacitor causes the anions in the electrolyte to continuously reform the tantalum oxide dielectric. The leakage current in a solid tantalum capacitor is about 30 percent greater than for wet types, and this is due to the lower reforming capability of the manganese dioxide layer. Solid types also have a higher leakage current at high temperatures.

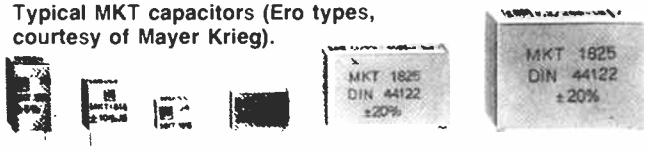
All tantalum capacitors have to be voltage derated at temperatures above 85 C — see the manufacturer's data sheets. Tantalum capacitors have a positive temperature coefficient of +1000 ppmc. The maximum capacitance change is approximately +15% at 125 C. Like aluminium electrolytics, low voltage types have a higher capacitance drift.

Tantalum capacitors are excellent for use for bypass, filtering and RC timing circuits, but care should be taken when using them as coupling capacitors, especially at audio frequencies as some types can introduce audible distortion. Care should also be taken when tantalum capacitors are used in multivibrator circuits as their temperature and reverse voltage characteristics can be exceeded.

Tantalum capacitors should not be used in circuits where the impedance is below two ohms, as their current handling capabilities are limited. To my knowledge at the present time only "Kemet" manufacture high quality non-polar solid tantalum capacitors — types T111 and T213. These capacitors are ideal for low frequency tuned circuits, phasing, low voltage ac motors, very low level audio input stages, low level coupling capacitors, in servo systems and any other applications where reverse polarity is a primary consideration.

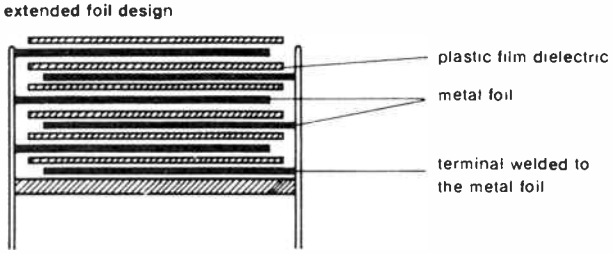
Tantalum capacitors are widely used in professional, medical, military and aerospace applications, where due to their small packaging density, low leakage, low dissipation factor, excellent frequency response and ruggedness they are preferred above all other types. The high price of tantalum capacitors is their only real disadvantage.

Typical MKT capacitors (Ero types, courtesy of Mayer Krieg).

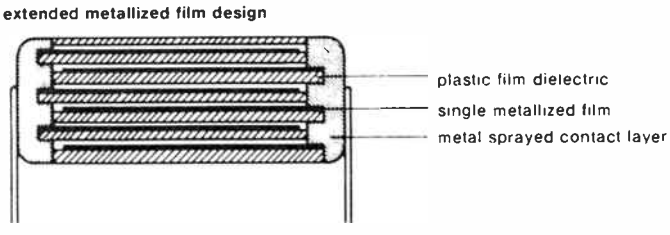


MKT 1818 MKT 1825

The older foil-and-film type plastic capacitor construction; typical of KP capacitors (courtesy of Mayer Krieg).



Typical modern metallised plastic film (and paper) capacitor construction, typical of MKT types (courtesy of Mayer Krieg).



Metallised plastic film and paper dielectric capacitors

Metalised plastic film (MK) and metalised paper (met paper) capacitors are characterised by their dielectric materials:

MP — Paper with a vacuum-deposited metal layer

MKU, MKL — Lacquer films, typically with cellulose acetate as the dielectric and using vacuum deposited metal layers

MKT — Poly-ethylene-tere-phthalate (PEPT) (also known as mylar or polyester) as the dielectric, and vacuum-deposited metal layers

MKC — Polcarbonate as the dielectric and vacuum-deposited metal layers

MKP — Polypropylene as the dielectric and vacuum-deposited metal layers

MKY — Very high insulation, low loss polypropylene as the dielectric and vacuum deposited metal layers

KP — Plain polystyrene film and extended foil

KS — Polystyrene dielectric

MP capacitors consist of a winding of two strips of metalised dielectric, and are either in tubular or flattened form.

A hot metal spray technique is used to make electrical contact to the edges of the winding. This contributes gives low loss and inductance. In capacitors intended for higher voltages one or more layers of plain paper is inserted between the metalised layers to reinforce the dielectric (this is called a 'multi-layer' MP type). Terminating wires are attached to the ends by welding or high temperature soldering. The capacitor is then impregnated with epoxy resin under vacuum.

MP capacitors are unique in their pulse handling capabilities — they can handle about 40 times larger pulses than metalised polyester. Self-healing in MP capacitors works differently to other types of metalised film capacitors, A breakdown caused by a transient normally results in an *improvement* in the insulation resistance. In metalised plastic film a breakdown causes a *reduction* in insulation resistance. The reason for this is that a breakdown in a metalised plastic film dielectric leaves a bigger carbon deposit in the breakdown channel than a paper dielectric does. Because of this, where uncontrolled transient voltages can occur — as on the mains — met paper capacitors are the preferred type.

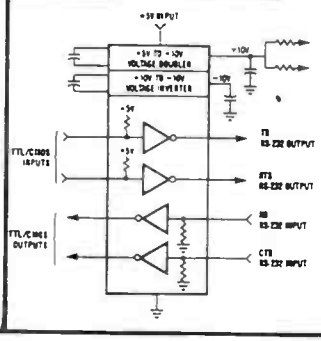
MP capacitors have a temperature coefficient of approximately +/- 500 ppm per degree, are made in values from 1000 pF to 100 uF, in voltages from 200 V to 10 kV. They are ideal for use in dc and ac applications for contact protection, transient protection and motor suppression. Multi layer MP capacitors are used in delta interference suppressors, protection for scr and triacs, and are used for mains applications.

— continued next month

NEW CHIPS IN STOCK

Phone us for prices

SY6502A CPU
SY6520A Peripheral Interface Adaptor
SY6521A Peripheral Interface Adaptor
SY6522A Versatile Interface Adaptor
SY6532A RAM I/O Timer Array
SY6551A Asynch Comms Interface Adaptor
MC6845P CRT Controller



5V POWERED DUAL RS232 TRANSMITTER/RECEIVER MAX232

Yes it meets all RS232C specs but only needs a 5V supply because it has built-in converters for the +10V and -10V power supplies. Can also be used as a voltage quadrupler for input voltages up to 5.5V.

Also contains 2 drivers and receivers. Uses low power CMOS. Handles 30V input levels and provides a ±9V output swing. Ideal for battery powered systems. **$12.16.**

TALKING CHIPS FOR UNDER $30

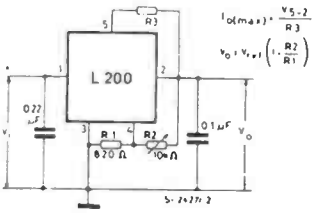
Our code-to-speech chip set consists of two chips - the SPO256A-AL2 an allophone-based speech synthesiser and the CTS256A-AL2 an 8-bit microcomputer programmed with a letter-to-sound based algorithm. The chip set translates English characters into speech.

Two projects use these chips - the AEM4505 Speech Synthesiser (Feb 86) which includes Microbee software plus an article on Speech Synthesis in general. The other project is in June's AEM and converts ASCII text files into speech - ideal for talking word processors. This one is for the IBM PC and works just like a printer.

Buy the chip set for **$28.00** or the synthesiser SPO256A-AL2 only for just **$15.95.** Yes the price is right!!

ADJUSTABLE VOLTAGE & CURRENT REGULATOR L200C

Handles output currents up to 2A and voltages in the range 32V down to 2.85V. Thermal overload and short circuit protected. Input over-voltage protected to 60V. **Only $2.50.**



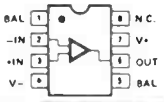
Programmable voltage regulator with current limiting

LOW NOISE PRECISION OP AMP OP27

Continuing our policy of stocking the latest high tech IC's, the OP-27 provides excellent performance in low noise applications such as pre-amps, stable integrators, precision summers, comparators etc.

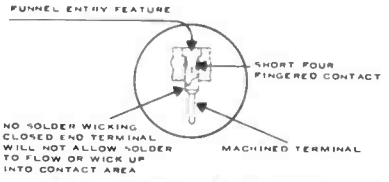
Features —
Low Noise 80nV p-p from 0.1Hz to 10Hz
3nV/√Hz
Low Drift 0.2uV/° C
High Speed 2.8V/uS slew rate
8MHz Gain Bandwidth
126dB CMRR
Open Loop Gain - 1.8 million

The OP27GZ gives you outstanding specs at **$16.27.**



MACHINED PIN WIRE WRAP SOCKETS

Due to the enormous popularity of our GOLD PLATED low profile IC sockets we have now added Wire Wrap types - again at ridiculously low prices. Remember these aren't the cheap tin plated variety these are GOLD PLATED.
8 pin **82¢**, 14 pin **$1.50**, 16 pin **$1.72**, 18 pin **$1.95**, 20 pin **$2.15**, 24 pin **$2.58**, 28 pin **$3.00**, 40 pin **$4.50**.



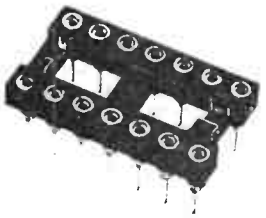
CONVERT YOUR MULTIMETER INTO A THERMOMETER

See ETI June 83 which features a project using the AD590JH (ETI-153). The AD590JH produces an output current proportional to absolute temperature. It's ideal for remote sensing as long cable runs have negligible effect on accuracy over a hundred metres or more! The simplest circuit requires one resistor and one pot and a battery, but better to build the proper circuit and get an accurate 10mV/degree centigrade output to put into your DMM. The AD590JH is only **$5.95.**

SINGLE IN-LINE SOCKETS & ADAPTORS

SIP sockets feature four finger GOLD PLATED beryllium copper contacts with tin plated brass terminals. 20 pin strip can be easily snapped apart to form shorter lengths. Maintains spacing when mounted end to end or end to side. Socket strip **$2.50.** Adaptor strip **$2.00.**

OPEN FRAME LOW PROFILE IC SOCKETS



Highest quality glass filled polyester with MACHINED contacts. Four finger GOLD PLATED contact. Terminals are tin plated for easy soldering. Open frame ensures good cooling, easy cleaning and checking. Available in 8 to 40 pin configurations.
8 pin **56¢**, 14 pin **98¢**, 16 in **$1.12**, 18 pin **$1.26**, 20 pin **$1.40**, 24 pin **$1.68**, 28 pin $1.96, 40 pin **$2.80.**

Eddystone Die Cast Boxes

The original die cast box!! Ideal for r.f. shielding and heavy duty applications. Sizes given are outside dimensions -

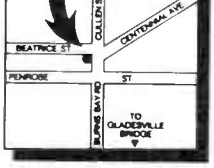
ED7969P	92.1 x	38.1 x	27.0mm
ED6809P	119.1 x	93.6 x	52.4mm
ED9830P	119.1 x	93.6 x	30.0mm
ED6827P	187.1 x	119.5 x	52.4mm
ED6357P	187.7 x	119.5 x	77.8mm

8.30 to 5 Monday to Friday, 8.30 to 12 Sat.
Mail Orders add $5.00 to cover postal charges.

All prices INCLUDE sales tax.

Tax exemption certificates accepted if line value exceeds $10.00.

BANKCARD, MASTERCARD, VISA, CHEQUES



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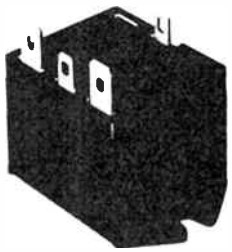
specialising in electronic components for the professional and hobbyist.

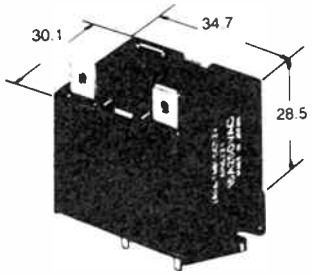
aem data sheet

National JA-RELAYS

1 HORSE-POWER COMPACT POWER RELAYS



"TM" type



"TMP" type mm

- High switching capacity
  —55 A inrush, 15 A steady state inductive load (1 Form A)
- Two types available
  "TM" type for direct chassis mounting
  "TMP" type for PC board mounting
- UL/CSA recognized
- TV-rated types available

We would like to thank RVB Products Pty Ltd, 56 Regent St, Oakleigh 3166 Vic., distributors for National Relays in Australia, for permission to publish the information contained in this Data Sheet.

SPECIFICATIONS

Contacts

Arrangement	1 Form A, 1 Form B, 1 Form C
Initial contact resistance, max.	30 mΩ
Contact material	Silver alloy
Rating (resistive load)	
Maximum switching power	3750 VA
Maximum switching voltage	250 V AC
Max. switching current	15 A
UL/CSA rating	10 A 250 V AC, 15 A 125 V AC, 1 HP 125, 250 V AC
Expected life (min. operations)	
Mechanical (at 180 cpm.)	5×10^6
Electrical (at 20 cpm.)	10^5 (at rated load)

Coil

Nominal operating power	1.2 W 1.4 VA (50 Hz)/ 1.3 VA (60 Hz)
Minimum operating power	0.77 W 0.90 VA (50 Hz)/ 0.84 VA (60 Hz)

Characteristics

Maximum operating cycle rate	20 cpm.
Operate time	Approx. 15 msec
Release time	Approx. 15 msec
Initial insulation resistance	more than 100 MΩ at 500 V DC
Breakdown voltage	
Between open contacts	1500 V rms
Between contacts and coil	2000 V rms
Temperature rise (at nominal voltage)	Max. 65°C
Ambient temperature	−50°C to +50°C +40°F to 122°F
Shock resistance Functional	10 G
Destructive	100 G
Unit weight	44 g

COIL DATA

DC Type at 20°C

Nominal voltage	Pick-up voltage (max.)	Drop-out voltage (min.)	Coil resistance, Ω (±10%)	Nominal operating current, mA (±10%)	Nominal operating power	Maximum allowable voltage (at 60°C)
6 V DC	4.8 V DC	0.6 V DC	30	200	1.2 W	6.6 V DC
12	9.6	1.2	120	100	1.2	13.2
24	19.2	2.4	480	50	1.2	26.4

AC Type

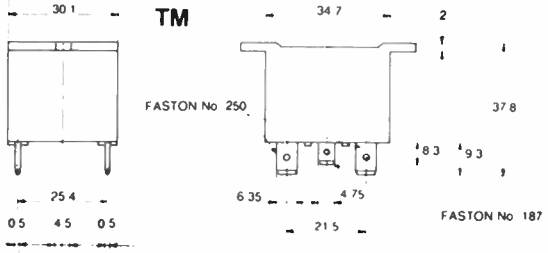
				50 Hz	60 Hz	50 Hz	60 Hz	
6 V AC	4.8 V AC	1.8 V AC	—	233	217	1.4 VA	1.3 VA	6.6 V AC
12	9.6	3.6	—	117	108	1.4 VA	1.3 VA	13.2
24	19.2	7.2	—	58	54	1.4 VA	1.3 VA	26.4
115	92	34.5	—	12	11	1.4 VA	1.3 VA	126.5

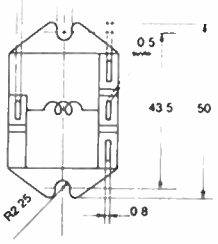
NOTES

1. The range of coil current for AC relay is ±15% (60 Hz) For DC relay it is ±10% at 20°C
2. The JA relay will operate in a range from 80% to 110% of the nominal coil voltage It is however recommended that the relay be used in the range of 85% to 110% of the nominal coil voltage with the temporary voltage variation taken into consideration
3. When the operating voltage of AC relays drops below 80% of the nominal coil voltage the relay will generate a considerable amount of heat which is not recommended for maximum efficiency
4. The coil resistance of DC types is the measured value of the coil at a temperature of 20°C (68°F) If the coil temperature changes by ±1°C the measured value of the coil resistance should be increased or decreased by 0 4%

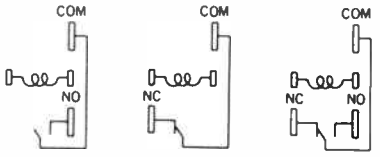
DIMENSIONS TOLERANCE: ±0.3

TM





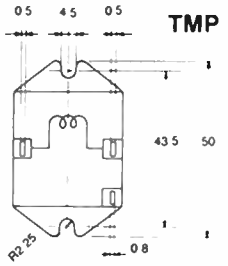
Terminals—.187" quick connect terminals for coil and .250" for contacts



1 Form A 1 Form B 1 Form C

Schematic (Bottom view)

TMP

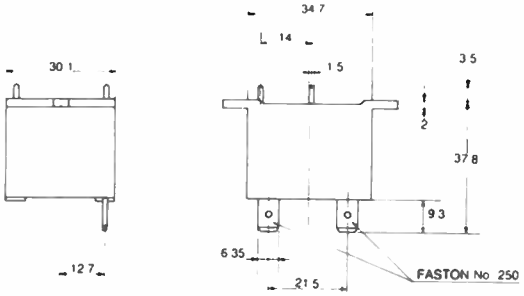


Terminals—PC board terminals for coils and .250" quick connect terminals for contacts

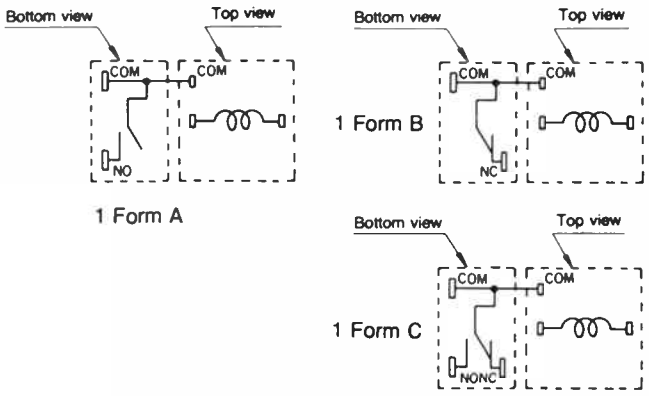
Tested to 3.5 kVac RMS isolation, coil to contacts.

Telecom approval on JA-1-TMP: No. RA84/128

SECV approved, No. CS82146V



Schematic



TDK to do amazing things to your computer

Leading magnetic tape maker, TDK, is now going to do the same "amazing things" to computer systems that it is famous for doing to audio and video systems, the company boasts.

TDK floppy disks have been available overseas for some time, but not here. TDK began marketing a selected range of floppy disks in Australia from June, two varieties in the 3.5" range and three 5.25" disks.

In the 3.5" range, both single (MF-1DD) and double (MF-2DD) sided double-density disks are available with 500K and 1M storage capacity respectively.

All disks in TDK's 5.25" range come with a super-white hub ring for added strength at the centre hole, which normally receives a lot of heavy wear, they say.

The M1D offers 164K storage and is a single-sided double-density floppy, whilst the M2D is a double-sided double-density type providing twice the storage of the M1D (both with 256 bytes × 16 sectors).

The high flier of TDK's 5.25" range being offered in Australia is the M2HD. It features Avilyn, a magnetic particle mixture specially developed by TDK for high density recording, and has 985K of available storage (with 256 bytes × 16 sectors).

TDK floppies are produced with every single track of every disk tested and certified error-free; with drive compatibility ensured by 1200 hours running tests on fully automatic system under clean room conditions, the company claims.

See your local computer accessories dealer.

The ultimate disk to disk transfer facilities?

When you need to transfer data and programs to a lot of different disk formats, there is now one program that's "got the lot," according to Logo Computers. The latest version of *XenoCopy Plus* from Logo Computers of Drummoyne covers an incredible 235 formats, including many 80 track and special formats.

The software runs on IBM PCs and compatibles and allows the user to read, write and format in any of the "foreign" formats. The computer that Logo recommend is the Logitec IBM compatible, manufactured in Japan. Logo can supply the Logitec with an optional 80 track drive for reading these formats.

The model pictured sports no less than four drives! Two 40 track drives allow normal floppy disk copying. A half height 10 Megabyte winchester holds programs and data and the 80 track drive handles the special formats. As Logo say, this is the ultimate disk transfer and production machine. The computer also reads, writes and formats most Apple formats with the addition of the "Apple Turnover" card, fitted on this machine.

Logo can supply a wide range of disk-to-disk transfer software and suitable hardware. For further information, call **Logo Computers, Suite 203 Henry Lawson Business Centre, Birkenhead Point NSW (02) 819 6811.**

Enhancement for PC's

Computer company, HELP ON TAP, has introduced a range of products from the USA which provides greater hard disk peforformance for your PC, XT or AT, they claim.

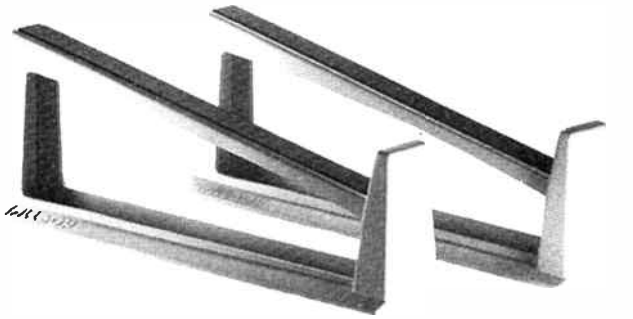
V-Cache is a budget-priced hard disk super charger which increases the speed of hard and floppy disk drives three times or more normal speeds; in many cases performance approaches that of a RAM disk, they claim.

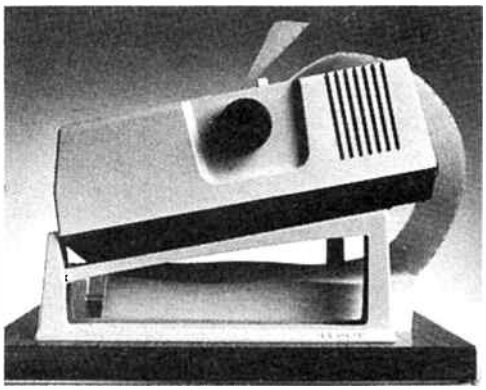
Super Processor Kit increases your PC speed up to three times, they claim (rated Norton utilities), for less than $60. It can be installed by the user or on-site by Help On Tap's technician.

V-Feature Deluxe beats the DOS 33 megabyte limit by allowing 500 megabytes in a single drive letter and allows non-standard drives on the PC/XT/AT. Drives can be combined or split into as many as twenty four logical drives. It also provides optional security features, low-level and high-level formatting, bad track mapping, and user-selectable cluster size for optimum performance.

For further information about these and other computer enhancements contact **Help On Tap, P.O. Box 361, Bexley 2207 (02) 502 2860.**

'PREVIEW' PRODUCT OFFER





Exclusive to Australian Electronics Monthly readers

The distributor of Allsop products in Australia, Communications Power Inc., will launch this versatile 'universal' printer/monitor/computer stand on the Australian retail market during the last quarter of this year. Right now, however, they have a strictly limited quantity of these stands which they are willing to offer to AEM readers for just

$39.95!

plus $10 post and handling

This offer is made by the Australian Allsop distributors, Communications Power Inc., and the magazine is acting as a clearing house for orders.

Don't delay, take advantage of this offer now.

Complete this coupon and send it to: "Allsop Printer Stand Preview Offer" PO Box 289, Wahroonga 2076 NSW.

Allsop have long been known for their innovative and well-designed products in audio and video. Now they bring their expertise to the computer field.

The ALLSOP UNIVERSAL PRINTER STAND is designed for the home or office with limited work space. The two-piece construction is durable and stable and readily adjustable to fit most printers and portable computers. The product provides convenient paper storage and a comfortable viewing angle. You can even stay seated and see what you're printing.

We grabbed one of these printer stands to install under the high speed dot matrix printer on the 'editorial desk' here at the magazine and it has proved a real space saver. Now the paper sits tidily beneath the printer and not underfoot on the floor! The stand tilts the printer so the controls are readily seen and reached now, as well as making paper loading much easier. And now the printer is quieter, too!

But it's not just a printer stand. You can stand your video monitor on it or prop up a transportable computer for better screen viewing and disk drive access.

PLEASE RUSH ME.....Allsop Printer Stand(s)

I enclose payment by: Cheque ☐ Money Order* ☐

Credit Card:.....

Card No:.....

Expiry date:.....

Cheque or Money Order No:.....

*Please make cheques or Money Orders payable to 'Australian Electronics Monthly'

Name:.....

Address:.....

.....Postcode:.....

Phone No:.....

Signature:.....

(Unsigned credit card orders cannot be accepted)

Please allow up to 20 working days for normal mail turnaround and cheque/credit card clearance delays.

The Microbee 'Premium' — well-named

At regular intervals since the first Microbee was first released, the manufacturers have brought out 'upgrade' models, running through the Series I, II, III and the PC85. Each time, more features were included – many of which were previously offered as options, while the basic price was pretty well maintained around the same level. The new Premium Series continues the 'tradition', albeit with something of a price hike, but offering substantail gains in many functional areas.

The Microbee Premium Series is available in the same formats as the 'standard' series. For review, we obtained a 64K system with twin 3.5" disk drives, the latter being housed side by side in the twin-drive box that take 5.25" drives, as shown here. Both colour and monchrome monitors are available to team with the computer.

Hayden Brotchie

MICROBEE's Premium Series offers all the standard features of the previous models, and then some. The exciting new features will immediately appeal to the computer enthusiast, Microbee owner/enthusiast or not.

'New' features on the Premiums include: Improved colour circuitry, four extra cursor control keys, new hi-res graphics capabilities, built-in Viatel capability and a volume control for the internal speaker.

The basic style of the keyboard unit has been maintained, the model designator decal on the right hand side of the apron being varied for the three models — 32K, 64K and 128K. The 32K is a ROM system, the latter two disk-based. With disk drives you can now 'mix-and-match', choosing between a single 3.5" or dual 3.5" drives (mounted in the old dual 5.25" drive box), or a dual 5.25" system. We chose to review a dual 3.5" system.

Improved colour

The new colour circuity in the premium makes it possible to have 16 foreground and 16 background colours instead of the usual 16 foreground and only eight background colours as in the standard model.

The variety of colours for background and foreground are:

Black	Red
Green	Brown
Blue	Magenta
Cyan	Light Grey
Dark Grey	Light Red
Light Green	Yellow
Light Blue	Light Magenta
Light Cyan	White

The extra colour schemes you can obtain on the Premium are more in keeping with the current industry standard.

Additonal control keys

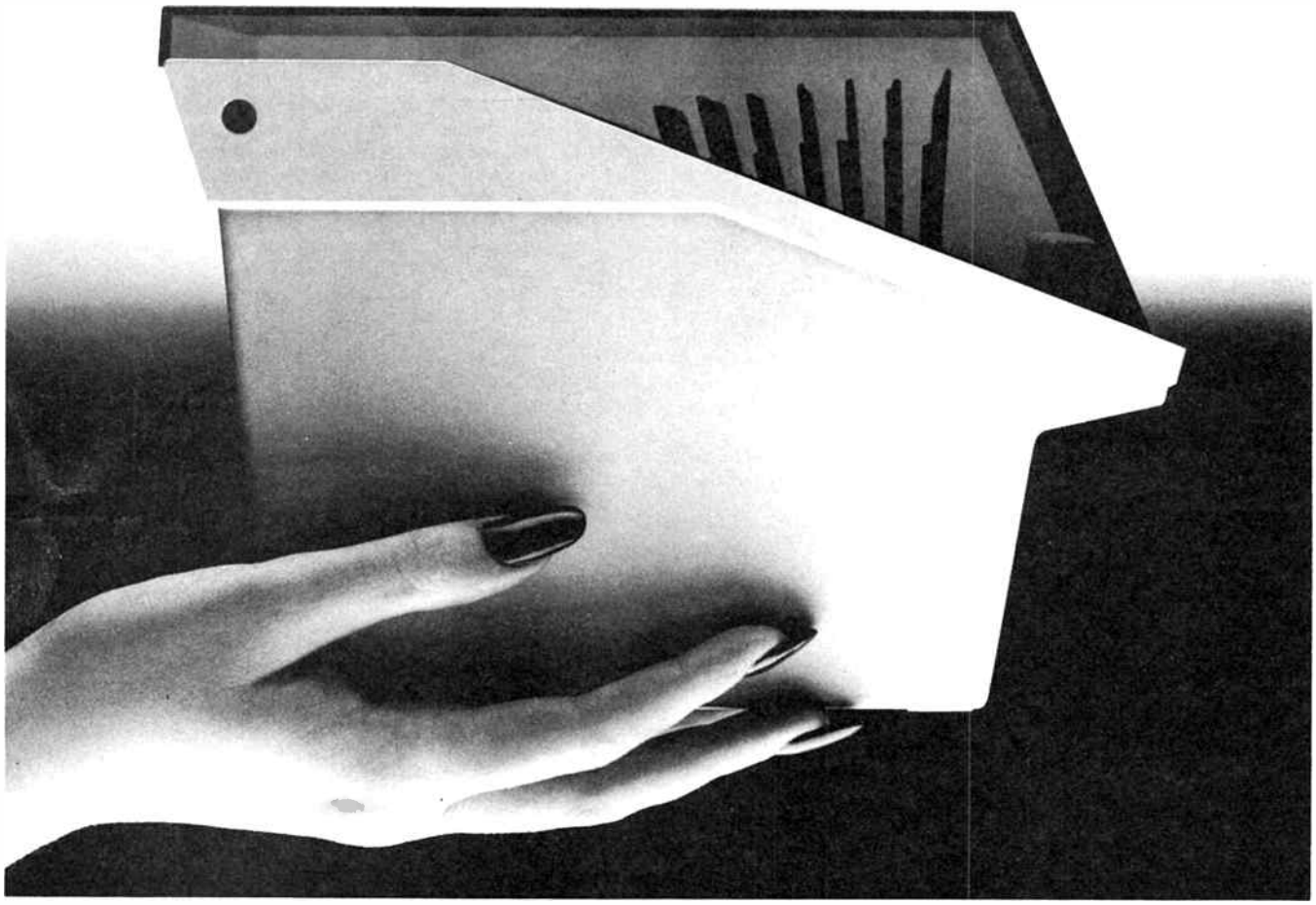
The four extra cursor control keys can be used in MultiPlan, WordStar, BeeArtistic and many other popular Microbee software packages. They consist of keys, down, left, right mimicking the "Control E-X-S-D" diamond.

The arrow keys make it easier to move around in your data base or word processor, which should encourage the novice computer operator.

Volume control

A small volume control has been added to the Premium series. Placed on the rear apron of the keyboard unit, and adjustable with a small screwdriver. This has a number of advantages. In the classroom, for example, a teacher can set ▶

Small is Beautiful.

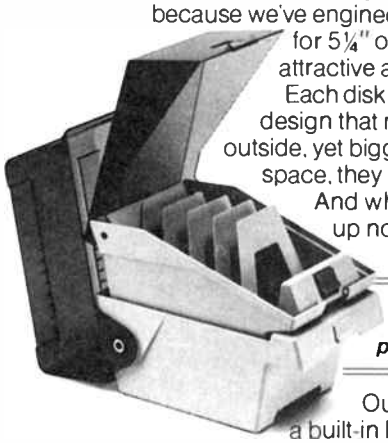


New Disk Organizers From Allsop Are An Engineering Triumph of Form and Function.

With Allsop, beauty is more than skin deep. That's because we've engineered our new disk organizers for 5¼" or 3½" disks to be both attractive and practical.

Each disk organizer features a compact design that makes them smaller on the outside, yet bigger on the inside. So in less space, they hold more disks.

And when the lid is open, they take up no more room than when it's closed.



The Allsop disk organizer is so small it fits inside our competition, yet holds more disks.

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Trade inquiries welcome.

ALLSOP®

a few students work on the Premium and continue teaching the class without the distraction of the computer's sound channel output.

Built-in Viatel

As with the earlier PC85, Viatel comes as a standard feature on the Premiums. Viatel provides relatively low-cost, flexible access to a comprehensive range of information and services. It can be accessed for business or personal applications. (See *AEM*, May '86).

Viatel operation on the Premium has been improved, compared to the earlier implementations, to handle the double-height and mosaic characters (for graphics). This couldn't be properly implemented on a standard model. Also, a downloading feature has been added (not a 'page caputre') to receive Viatel files.

For Viatel operation, you need a modem. Microbee still offer the cheapest modem on the market with viatel capability, and they recently released a new auto-dial/auto-answer model.

The 'new' graphics

I found the most exciting feature of the Premium was the new graphics capabilities. If you are familiar with the standard Microbee you will be aware that it has 128 ASCII characters with which to produce graphics (known as 'PCG graphics'). While this has been quite adequate, the upgraded version offers a vastly improved and expanding field to explore.

The Premium not only has the original 128 ASCII characters (making it compatible with standard Microbee software), but means that you have 1024 programmable characters at your disposal, which adds up to 131 072 individually programmable pixels. This obviously allows a far wider scope for using graphics than previously available.

For the hardware enthusiasts, each of the Premium Series has eight banks of 2K PCG memory, one 2K bank of colour RAM, one 2K bank of character RAM and one 2K bank of attribute RAM. This effectively gives your Premium the capability of 32K of PCG RAM, and 8K each of colour, character and attribute RAM, all in 2K banks. This provides a total 22K of screen, character and colour RAM. This extra memory can be bank-switched, like the technique used in the Series III 128K Microbee.

The Premium's Microworld BASIC (version 6.26e) has been improved over that offered in the earlier 'Bees, so that you now have a HIRES2 command as well as HIRES. HIRES2 allows you to *plot* in hi-resolution on the screen. Now, it virtually never runs out of graphics and plots much faster.

Using the following programme, I tested the Premium for screen plotting speed.

```
00100 HIRES
00110 FOR A=0 TO 255
00120 PLOT 0,A TO 511,A
00130 NEXT A
```

On a standard Microbee it fills the screen in just over two minutes. I then changed line 100 to HIRES2 and ran the program on the Premium. The result was an amazing 15 seconds to fill the screen!

Compatibility

This is one of the great things about the Premium series. Software written for the earlier Microbees will run on the Premium — I tried some of the commercial packages, without grief.

The earlier standard Microbees will run some software that has been written for the Premium, but will not run software specifically written for the Premium using its graphics or extra colours.

In an upcoming *BeeBuzz* column in AEM, I will present some software specially written for the Premium. Look out for it.

Pricing

The Premium Series is priced at $100 above the standard 64K and 128K models. If you want to upgrade, you 'trade-in' your existing keyboard for a 'discount' of $150 on a Premium.

Summary

I feel the upgraded graphics capabilities of the new Premium to be an outstanding feature which will instantly appeal to the computer enthusiast. The Premium has also a new way of de-glitching (removing flickers from the screen). The old method of de-glitching slowed down the Microbee some 5%.

Either as a new computer or as an upgrade to your existing Microbee, I can highly recommend the Premium Series to all existing or would-be Microbee users.

WORK WANTED: Audio design engineer recently returned from overseas contract, specialising in 'state of the art' audiophile and broadcast equipment design, seeks interested individuals, companies, contracts. (09) 474 1894.

SELL: S100 floppy disk controller. Single density 5.25" drives. Uses 1771 controller and contains two 2K EPROM sockets for boot. Suitable for SBC-2650, DSE Super 80, TRS-80, Sorceror and System 80 with S100 expander $50. Phone Ron, (02) 487 2619.

HP USERS: Are you interested in joining Australia's fastest growing users group? Then join the Hewlett packard Users Group. For more information, write to: Darren Stokes, 3 Buckley Drive, Coonamble 2829 NSW.

WANTED: Moray fuel flow sensor, working or not. 9 Wyclif Ave., Springwood Qld. (07) 208 0106.

FOR SALE, QUAD FM3 stereo FM tuner. Mint condition. Original packing. $250. Jeff. (02) 66 9702.

COMPONENTS surplus to needs: 14-pin and 16-pin DIL sockets 17c, 555 timers 40c, 1N4148 diodes $2.50/100, WO2 bridge 40c. All brand new. Call Russ, (02) 639 0615. 79 Seven hills Rd, Baulkham Hills.

SELL: OLIVETTI PRAXIS Model 45D electronic typewriter, 8K memory expansion cartridge. Never used. $300 new, will sell for $200. (077) 72 1342.

SELL: Eleven very good quality S100 computer boards, case with front panel and power supply, one 5.25" disk drive with case, all manuals, $1100. Norm Wheeler (02) 709 3962.

SIEMENS M100 teleprinter, good condition, $40. R. Vowels, 93 Park Drive, Parkville 3052 Vic.

SELL: Ultrasonic detector — Hyperwave Mk III. Detects movement. Switch type N/O, needs 12 V power supply, $60. Vernon Van Duijnhoven. (07) 379 7354. 3 Elizabeth St, Sherwood 4075 Qld.

SELL: One gross assorted radio, TV, audio amp valves, mostly in original boxes $120 plus. C.O.D. Call (09) 91 1459.

TRS-80 COLOUR COMPUTER. 64K, extended basic, disk drive, joysticks, DMP105 printer, cables and manuals. Original Packing. software includes Scripsit, Flightsim, Database. $750. Will separate. Norm McMillan. (044) 22 1473.

WANTED: VHF signal strength meter, solid state, any condition. Bruce Rushton, Nandi St, Coonabarabran 2357 NSW. (068) 42 1894.

VZ USERS: Monthly newsletter for VZ200/VZ300 users, including BASIC, assembly language and hardware. Share your ideas. Send SAE to PO Box 154, Dural 2158 NSW for more information.

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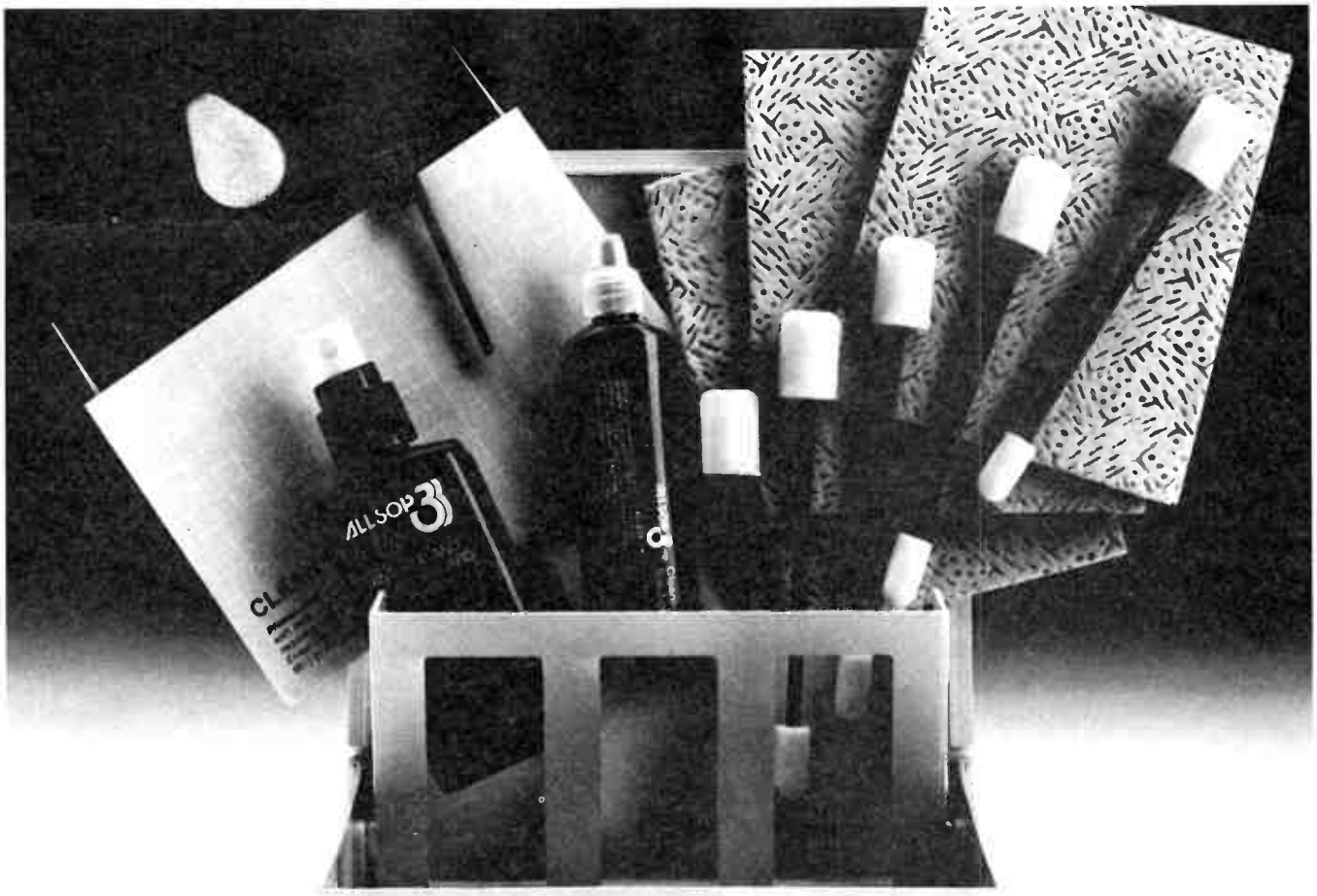
CONDITIONS You must include your name and 'phone number and/or address within the 32 words (for amateurs, 'QTHR' is acceptable). Accepted abbreviations such as DSDD, 100 W RMS, ONO etc. may be used. Please include you name and full address plus 'phone number with a covering letter. **Private advertisements only** will be accepted. We have 'small ads' for traders, who should contact our advertising representatives.

Send your adverts to **AEM ADMARKET**
Australian Electronics Monthly
PO Box 289 WAHROONGA 2076 NSW



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Allsop Introduces the Computer Cleaning Kit That Turns Into a Free Disk Organizer.

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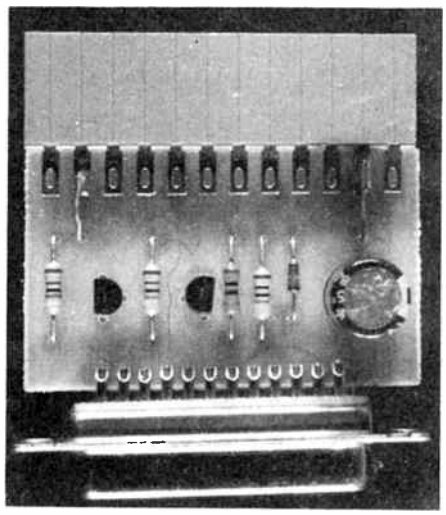
Find out how this little wonder can work wonders for you.

ALLSOP®

A 'modem coupler' for the Commodore 64 and 128

Tom Moffat
Flexible Systems, Hobart, Tas.



With computer communications all the rage, Commodore owners are at something of a disadvantage when it comes to 'doing it on the cheap'. For a start, just about every modem on the market requires an RS232 interface on your computer – which Commodores have not got. When they were available, they weren't cheap. But apparently, they have now 'gone off the market'. This simple, low-cost project will provide that 'missing link' between a modem and your Commodore. It plugs into the User Port and derives its power from the computer – no external supply needed!

IF YOU'VE BEEN FOLLOWING AEM over the past nine months, you will have noticed that computing interest has moved strongly in a new direction: remote communications. It seems everyone wants to get into the act — dialling up other computers over the phone; exchanging messages, software, classified ads, jokes, the lot.

There has been much discussion about "remote bulletin board systems", and the gadgets needed to let your computer talk to them: MODEMs. This has all culminated in the AEM4610 Supermodem project, an all-singing, all-dancing you beauty intelligent state-of-the-art modem. This project seems to be about as far as you can go with present technology available off the shelf.

However, there are many of us who must compute on a shoestring. We can't afford the ultimate, or the type of computers that go with the ultimate. That explains why Commodores are so popular. They're quite cheap, they are great games machines with glorious graphics, and in the right hands they can be mighty computing tools. So, dear Commodore owner, don't ever let anyone tell you you're using a "toy computer". At a deep-down machine code level they are more sophisticated than some rivals costing many times the price! Now we are going to make the Commodore's internal cleverness turn it into a real *el-cheapo* data terminal for accessing remote computers.

Computus interruptus

Almost everything that happens in a Commodore takes place because of interrupts. This is a classy way of sharing microprocessor time among various external functions, as and when it is needed. When something happens outside the computer, such as a character arriving on the RS232 line, the computer drops what it's doing, stores the character in an internal queue, and then picks up where it left off. Less efficient computers must be programmed to wait, doing nothing, while a character is expected from an external line.

The interrupt ability makes it seem that the computer is able to do several things at once, even though it is really attending to only one at a time. Telephone links between computers are generally "full duplex", meaning data travels between them in both directions simultaneously; so each computer must be able to transmit and receive at the same time. Interrupts allow the Commodore to do this.

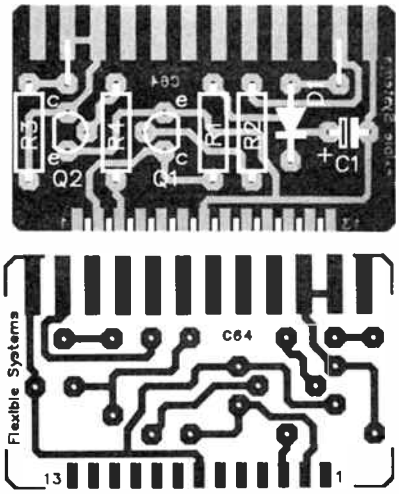
For all input/output the Commodore 64 has two well-named "complex interface adaptor" chips. Each one of these has 16 individually programmable in/out lines, handshaking lines to go with them, two interval timers and a time-of-day clock, plus a shift register arrangement which is used for serial communication. One of the chips has most of its lines brought out to the "User Port", and this is what we will use to talk with other computers.

My record with the CIA

Several times I have had to attack one of these CIA chips directly in machine code. I have become convinced they are inventions of the devil. They are champions at misinterpreting what I have considered to be well thought-out instructions, and every time I have hurled disgusting profanity at them, finally to swear off them altogether. But if you want to do jazzy things with Commodores, they just keep coming back. And here we go again!

Actually, it's going to be a bit easier this time. The Commodore contains a library of pre-written machine code drivers for the CIA chips, and we can access them from BASIC. So a simple BASIC program (see Listing 1) is all that's

This month's ★ Star Project ★ is from Flexible Systems, 219 Liverpool St, Hobart, Tas. 7000, who will be marketing kits by mail order for $24.95, $34.95 built-up, post paid.



COMMODORE MODEM COUPLER PARTS LIST

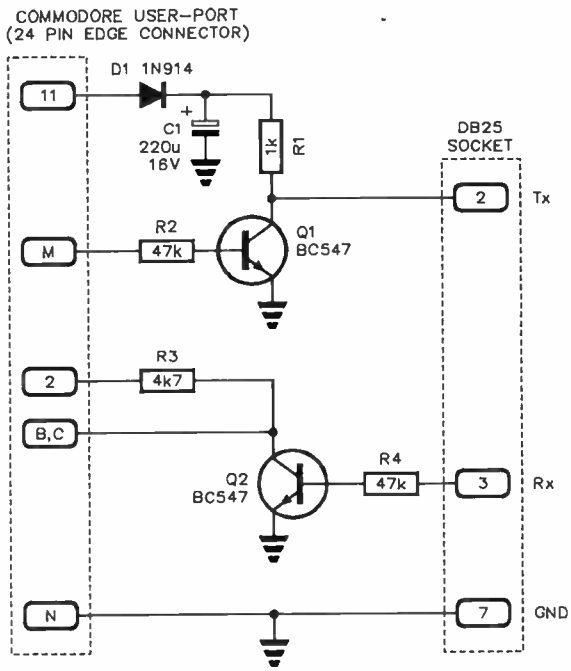
Semiconductors
Q1, Q2 ..... BC457
D1 ..... IN914

Resistors all ¼W, 5%
R1 ..... 1k
R2 ..... 47k
R3 ..... 4k7
R4 ..... 47k

Capacitors
C1 ..... 220u/16 V RB electro.

Miscellaneous
24-pin edge connector (to suit C64); DB25 socket; CMC pc board.

Kit Price: $24.95



needed to let the Commodore talk with other computers. Well . . . almost! We haven't mentioned the extra hardware yet!

Although the C64 contains what Commodore calls an "RS232 Interface", it isn't. The RS232 standard is a system for sending big strong data signals down long twisted-pair cables. What comes out of the Commodore's User Port is a gentle little signal that doesn't have the "guts" to drive anything. As well, it's upside down, so that a logic high appears low, and a logic low appears high. This is true for both the transmit and receive lines.

So the Commodore Modem Coupler is really a pair of buffers, to turn incoming and outgoing signals upside down, and to put a bit of strength into the outgoing one. Although the circuit doesn't properly meet the RS232 standard itself (since it can't generate negative voltages as required by the RS232 standard), it has worked quite all right with every modem with which we've tried it.

Construction

This is quite an easy project, even for the inexperienced, but if you can't be bothered messing around with a soldering iron, it's available ready built to plug-in-and-go.

If you're building the kit, you should have a little bag of parts consisting of four resistors, two transistors, one diode, an electrolytic capacitor, two connector plugs, and the circuit board (see the Parts List).

It's probably best to start with the connectors. The metal 25-pin socket (DB25S has two rows of pins); 12 in one row and 13 in the other. The 13-pin row matches up with 13 pads on one edge of the circuit board. Slide the circuit board between the two rows of pins, and then carefully solder each pin onto each pad. It's easiest to do each end pin first, making sure everything is centred and even, and then solder the rest of them. The pins in the row of 12 don't connect to anything, they just sit there above the component side of the board, clamping it.

LEVEL

We expect that hobbyists who are

BEGINNERS

in electronics construction should be able to successfully complete this project.

CIRCUIT OPERATION

The Commodore 64's User Port interface employs a Complex Interface Adaptor — a TTL device with I/O lines which are individually programmable. The outputs of this device cannot drive heavily capacitive loads — which would be the case when having to drive a long twisted-pair cable. Also, being a TTL device, inputs need to have a logic low under a volt and a logic high above about 2 V or so, while outputs swing between about +0.7 V (low) and +3.5 V (high). This creates problems when attempting to drive a modem, because the majority of modems have an RS232 interface which employs signal voltage levels which are quite different, apart from the ability to drive long lengths of cable. In addition, the logic sense is inverted, being active-low.

Now, while the RS232 standard calls for logic high signal levels between +3 and +12 V, and logic low levels between –3 and –12 V, the +3 to –3 volt range being undefined, experience shows most modems will happily work with logic lows in the undefined region and highs above +3 V. Thus, quite simple level-shift circuitry is all that's necessary to provide an interface.

The 24-pin Commodore 64 User Port sets up pins B-C as a serial input (designated 'receive') and pin M as a serial output (designated 'transmit').

The serial output is buffered by Q1, its base driven by pin M via R2. To provide a logic high around +12 V, the collector of Q1 is provided with a voltage of around +12.5 V, rectified from the 9 Vac available on pin 11. Diode D1 and capacitor C1 provide a half-wave rectifier for this. The collector of Q1 drives pin 2 (Rx) of the DB25 RS232 interface socket.

The serial input is buffered by Q2, driven from pin 3 of the DB25 (Tx). The collector drives pins B, C of the User Port, the collector supply being sourced from the +5 Vdc available on pin 2.

The RS232 ground, pin 7, and the interface ground, pin N, are linked.

The larger plastic connector also has two rows of pins, one row numbered and the other row identified by letters. There are 12 pads in a row on the circuit board, onto which you solder the *lettered* row of pins. Again, the numbered pins will be left hanging above the component side of the board but this time, two of them — pin 2 and pin 11 — connect via short jumpers to nearby pads on the board. ▶

All that's left to do now is insert the four resistors, two transistors, the diode, and the capacitor. Carefully follow the parts location diagram and make sure the transistors, diode, and capacitor are in the right way around.

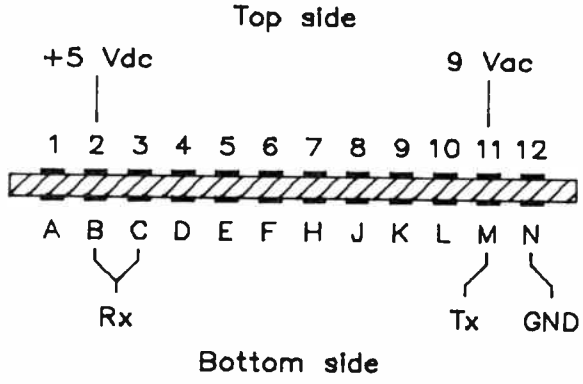
When the board is finished, plug the big connector into your Commodore's User Port (with the components facing up), and then plug your modem cable into the 25-pin connector on the CMC board. You should now be in business.

Using the CMC

Before you can use the CMC you must type in the program in Listing 1, save it on disk or cassette, and run it. The program will announce its presence, and then sit there waiting to communicate via your model at *300 bauds*. This is the only speed for which this simple program is set up, but there are plenty of 300 baud bulletin boards to choose from. Also note that this simple software has no facility for sending or receiving whole files; you can only type to the remote computer, and receive "live" responses from it. But there's plenty of fun in that!

```
10 REM 300 BAUD TEXT DRIVER - COMMODORE
20 REM MODEM COUPLER, MAY 22, 1986
30 REM
40 PRINT CHR$(147);CHR$(5): REM CLRSCRN
50 PRINT "              FLEXIBLE SYSTEMS"
60 PRINT "       BULLETIN BOARD ";
70 PRINT "COMMUNICATOR"
80 OPEN 1,2,0,CHR$(38)+CHR$(235)
90 GET£1,A$: IF A$="" THEN 120
100 A=ASC(A$): IF A>95 THEN A=A-32
110 PRINT CHR$(A);
120 GET K$: REM KEYBOARD INPUT
130 IF K$<>"" THEN PRINT£1,K$;
140 GOTO 90
```

The May issue of AEM contained a list of phone numbers of just about every known bulletin board in Australia. There's also a list in the Dick Smith catalogue, and many bulletin boards themselves contain lists of other bulletin boards. These are updated frequently.



THE COMMODORE USER PORT

The 24-pin User Port on the C64 and the C128 are identical in both hardware and software aspects. Hence, this project can be used on both of these Commodore machines.

The VIC-20 User Port is somewhat different, the major variation being the lack of 9 Vac on pin 11. However, +9 Vdc is available on pin 10, so merely shifting the link to D1's anode from pin 11 to pin 10 will provide a suitable collector supply for Q1. The serial input/output pins are apparently identical, although addressing may be different.

```
 9.00 am                                  Tuesday
 Sydney      OVERSEAS MARKETS


                    New York
 DOW JONES Close          1758.18   -1.62

                    London
 FT SHARE INDEX Close     1294.3    +4.8

                    Toyko
 NIKKEI DOW Close         15697.53 +23.50

                  Hong Kong
 HANG SENG Close          1765.02   -22.06
```

```
 ++++++++++++++++++++++++++++++++++++++
           This is BERT your
 BUSINESS & ECONOMIC REPORTING TERMINAL
 ++++++++++++++++++++++++++++++++++++++

 9.00 am                                  Tuesday
 Sydney        ALL ORDINARIES
        Year high 1247.0  low 1010.8
1250
   -                                +
   -                              + +
   -                            ++   +
   -          +   +++         +      + +
   -           + +   ++++++           +
1180         +  +                      +++
   -
   -
   -
   -     ++++
   - + ++
1110  +
 Date''''4'''11'''18'''28''''5'''12'''19
  ++++++++++++++++++++++++++++++++++++++
    ADVERTISE ON BERT VIDEOTEX 671760
  ++++++++++++++++++++++++++++++++++++++
 9.00 am                                  Tuesday
 Sydney        DOW JONES INDEX
        Year high 1855.03  low 1502.29
1860
   -              + +
   -             + +     +
   -                 ++++ +
   -
   -           ++                      +
1775 ++      ++              +  ++ ++++
   -       ++                ++  +      +
   -    +                                ++
   -
   -     ++
   -
1690
 Date''''7'''14'''21'''28''''5'''12'''19
  ++++++++++++++++++++++++++++++++++++++
    ADVERTISE ON BERT VIDEOTEX 671760
  ++++++++++++++++++++++++++++++++++++++
```

These pages contain some examples of material you can access on various 300 baud bulletin boards. One that looks particularly nice on the Commodore's 40 column screen in the BERT financial reporting service. Every budding tycoon should have this set up running on his desk, just to impress important visitors!

Tasnet is a system run by the Island State Credit Union in Tasmania. It's a private system; you must be a member of the credit unit and be issued with a password and phone number before you can use it. It's loaded with lots of goodies (see the menus), and you can even write cheques and do your other banking transactions from your home computer. It's only a local phone call away in Hobart, Launceston, or Burnie, and it's the first of what may be a very familiar

```
9.00 am                                Tuesday
Sydney        US/AUST DOLLAR
Aust cents per US Dollar
 80
  -
  -
  -
  -                    +++++++++++++++
  - ++++++++++++++++++++                +++++
 70                                     +++
  -
  -
  -
  -
  -
 60
Date''''4'''11'''18'''28''''5'''12'''19
 ++++++++++++++++++++++++++++++++++++
   ADVERTISE ON BERT VIDEOTEX 671760
 ++++++++++++++++++++++++++++++++++++
11.30 am        NATIONAL          Tuesday
Sydney    SHARE MARKET TURNOVER
          ++++++++++++++++++++
TOTAL VOLUME    13.261  MILLION SHARES
          INDUST MINING    OIL    TOTAL
UP          36      18      12      66
DOWN        85      44      10      139
UNCHANGED   152     86      30      268
TOTAL       273     148     52      473
       INDUSTRIALS    M$   30.178
       MINING         M$    5.248
       OIL            M$    1.414
       TOTAL          M$   36.840


   VIEW VIDEOTEX WITHOUT TIME CHARGES
    FOR MORE INFORMATION ABOUT BERT
  THE FREE FINANCIAL VIDEOTEX SYSTEM
  PHONE RESOURCE DATA ON (03) 67 1760
Welcome to TasneT.

Island State Credit Union's
Home Financial System.

Username ? 5589MOFF
Password ?
Terminal ? Z

Good afternoon !
According to me your last logon was
on 10 JUN 1986 at 03:15PM

Thank you for waiting ...

     TasneT HOME FINANCIAL SYSTEM
5589MOFF     * * * * * *        03:17PM
          TasneT MAIN Menu
  1.Please Read Me                09 JUN
  2.The Home Financial System.
  3.Member BULLETIN Boards.
  4.Members SOFTWARE Library.
  5.TasmaiL Electronic Mail.
  6.TasCHAT.
  7.Access Private Boards.
  8.TasneT System NOTICES
  9.TasneT UTILITY Menu.
 10.TasneT Documentation.

Selection ?___3___

     TasneT HOME FINANCIAL SYSTEM
5589MOFF     * * * * * *        03:17PM
          USER BULLETIN BOARDS
  1.Computer User Groups.
  2.General COMMENTS.
  3.JOKES and Graffitti.
  4.Information Exchange - GEN
  5.Information Exchange - COM
  6.ADVENTURERs and Role Playe
  7.TasneT - Computer Widows
  8.FOR SALE.
  9.WANTED.
 10.Personal.
 11.SUGGESTions about Tasnet.

Selection ?___3___



     TasneT HOME FINANCIAL SYSTEM
5589MOFF     * * * * * *        03:18PM
          JOKES & Graffitti
  1.Joke Of The Month - June    01 JUN
  2.Joke Of The Month - April   14 APR
  3.Aero-space #1               14 MAR
  4.What Do You Call A Man #4   28 JAN
  5.What Do You Call A Man #3   28 JAN
  6.What Do You Call A Man #2   28 JAN
  7.What Do You Call A Man #1   28 JAN
  8.Darts and Farts             17 DEC
  9.  **  CAR SALESMAN  **      02 DEC


Selection ?___9___

ITEM #    624
(C)apture, (E)xit or (S)creen ?_S

     The gentleman   worked    at    a
Mitsubishi car sales yard but he had a
small problem!                          ▶
```

```
     He was troubled by wind!!
     As if that wasn't enough, every
time he would 'let off' it would go
"HONDA".
     (Very difficult when you're
trying to sell Mitsubishi!)
     He visited his doctor who
examined him and referred him to a
little Chinese dentist who had a
surgery next door.
     So off he goes....
     Arriving in the Chinese dentist's
surgery he tells the dentist of his
problem.
     Upon examining him the dentist
finds a tooth with an abcess. The
Dentist extracts the tooth and sends
him on his way.
     "How do you know that I will have
no more trouble?" asks the salesman.
     "Old chinese proverb," replies
the Dentist, "he say 'Abcess make the
fart go Honda'"

Strike any key to continue ?_

Selection ?___ OFF
Session terminated,
   Thank you, please call again.
```

service in other states in the future. There are many hundreds of users on Tasnet, possibly because in most parts of Tasmania it's the only game in town. To get anywhere else costs us trunk charges.

In other parts of Australia there are bulletin boards run by user groups of most types of computers. There is one in Sydney that looks in the listings like it might be especially for Commodore users, but we can't show you this one. This article was prepared during school holidays, and every time we tried to ring the "Commodore" board it was busy; this went on for days on end.

Other interesting bulletin boards to try are those listed as "RCPM". These are computers running the CP/M operating system which you can operate as if they were sitting in your own home. Commodore users, who aren't usually into CP/M, will find this a good way to get a taste of what is probably the world's most frequently used operating system.

What you can't do, with this simple software, is access Viatel. If you've got the right model the CMC circuit will work with Viatel, *providing* you've got the right software running in your Commodore. However a quick ringaround of Commodore dealers in Tasmania indicated there's no Viatel package yet available. There you go, software developers, go for it! The market is waiting . . .

Other software packages

For different baud rates, screen formats, file transfer capabilities, etc, there is a disk package available for the Commodore called "VIP Terminal". This is apparently being sold through most Commodore dealers.

AUSTRALIAN ELECTRONICS
Monthly

PC BOARD SERVICE

As a service to our readers, we offer quality pc boards for our projects featuring fibreglass substrate with roll-tin over copper tracks and a silk-screened overlay printed on the component side.

Project	Retail Price
1500 Metronome	$ 4.67
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9500 Beat-triggered Strobe	$ 11.32
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6510 4-Input Mixer	$ 20.40
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Set of 4	$ 74.90
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6502 Order 6500 and 6501	
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5502 Microwave Oven Leak Detector	$ 9.12
2500 Sine/Square Audio Generator (add $12 for RA53 thermistor)	$ 9.65
6503 Active Crossover	$ 23.06
4504 Speech Synthesiser	$ 11.53
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5504 Electromyogram	$ 15.88
3502 Signal-operated Cassette Controller	$ 9.16
2600 Peak RF Power Meter	$ 10.46
5505 Hash Harrier Mains Filter	$ 17.72
4610 Super Modem (includes EPROM)	$139.00

Note: The boards found in this issue are also available, price on application.

Please rush me the following boards

Project No. **Price**

. . . . . $ . . . . .

Allow a minimum of 4 weeks delivery
Price includes postage & packing
New Zealand, add $1.00 to these charges

All cheques or money orders should be made payable to Australian Electronics Monthly

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I enclose my cheque/money order for . . . . .

Please tick payment method

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Card No . . . . . Expiration . . . . .

Signature . . . . .

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You can buy the boards at our offices if you wish, at any time during business hours We're located at WB Building, Cnr Fox Valley Rd and Kiogle St, Wahroonga NSW, the entrance is in Kiogle St.

SPECIAL AEM READER OFFER

Microbee Owners! Get into these MODEM GAMES

Challenge your friends to a *person-to-person* computer game!

These games, from P&A Software, Sydney, provide "... a whole new dimension of amusement." Link two Microbees with modems via the 'phone lines, or via the serial I/O ports, and play these challenging games of skill and strategy with friends.

THREE GAMES TO CHOOSE FROM

- **Warships.** Warships is the newest game. It follows the lines of the old favourite pen and paper game *battleships*, where each person places five battleships on a matrix. Each player takes turns at guessing the co-ordinates of their opponent's ships, thus trying to hit, or sink it. Two grids are drawn up on the screen, one shows the positioning of your ships and where your opponent has hit, the other shows only the co-ordinates you have hit or missed in.
- **Concentration.** Concentration, a memory and pattern recognition game, consists of 50 numbered cards being presented to both players. Each player then takes turns in selecting two cards to view their flip-side (a small picture). These are displayed for a few seconds then the other player chooses two. The object is to remember, and select, as many pairs of cards as possible.
- **Four-in-a-Row.** Most of you will be familiar with the strategy game Four-in-a-Row, being a follow-on from noughts and crosses, only you need to get four, rather than three, markers in a row to win.

ALL WITH ON-SCREEN GRAPHICS & SOUND

Now with Hayes-compatible communications!

* As reviewed in AEM, June '86, p. 99. *

You need a disk-based Microbee, using either 3.5" or 5.25" drives (single or dual drive systems).

Offer closes 30th September 1986

PACK 1	PACK 2	PACK 3
One game — your choice of the three.	Two games — your choice, any two.	All three games!
$29	**$49**	**$69**

Post & handling $3.50, sent certified post.

Each pack is supplied on a single disk with a documentation sheet. A HELP FILE is included with each game. P&A Software offer a 12 month warranty on all software.

These games normally retail for $34.50 on 5.25" disk, $39.50 on 3.5" disk.

SEND COUPON TO: AEM Modem Games Offer
PO Box 289, Wahroonga 2076 NSW

PLEASE RUSH ME:

☐ Pack 1 ☐ Pack 2 ☐ Pack 3

I enclose payment by: Cheque ☐ Money Order* ☐

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Philips to deliver communications systems for Kosciusko Skitube project

Experts working on Australia's new Skitube project, linking Thredbo Valley to the popular Perisher snowfields by underground railway, admit even world-class technology will not stop trains from breaking down.

They rate emergency communication — between the base terminal set just inside the Kosciusko National Park and the four trains running underground to and from Perisher — so highly they are installing a sophisticated new $500 000 communications system from Philips this month.

Designed fully in Australia by Philips, the microcomputer-based system comprises FM900 series mobile radio equipment and FM814 base repeater stations, connecting all trains to technical advisers in base control rooms.

The fully synthesised VHF/UHF FM mobile radio telephones feature microcomputer control of prime functions, including adaptive mute hysteresis and delay time, and enhanced receiver mute performance. The FM814 VHF FM base station comes as two separate units for transmitting and receiving.

Radio signals will be transferred via a radiating cable system installed throughout Skitube's 3.3 km tunnel. A Philips DLS-110 PABX will pick up communications between all three station complexes — Bullocks Hut, Perisher and Blue Cow. This 16-bit, 48K memory microprocessor system offers failsafe provision for emergency situations and power supply fluctuations.

To keep ski enthusiasts and onlookers fully informed on developments, both public address facilities and individual handsets will be installed in passenger compartments.

The modular SQ6 public address system interfaces with the mobile radios to communicate on board. With handsets, travellers have the opportunity to speak to the control room on a two-way basis — a breakthrough for passengers used to being ignored in breakdowns.

Normal communications will also be open to all drivers, advising them of any changes. At Skitube's three station complexes, too, Philips SQ6 public address systems will allow the broadcast of emergency news from control rooms to waiting travellers.

The new Philips emergency communications system, the first of its kind in Australia, is designed to be used by non-experts in emergency situations.

Philips, the largest manufacture of communications equipment in Australia, won the contract to design, install and service this integrated Skitube communications system from electrical systems supplier, Brown Boveri Australia.

VICOM VINS

Vicom Australia has won a substantial contract to supply the Overseas Telecommunications Commission (Australia) with MF and HF communications receivers at OTC(A)'s receiver facility at Bringelly, NSW.

The contract is worth $526,000, and the equipment will come from Dansk Radio AS of Denmark. OTC(A)'s Bringelly facility is currently undergoing a programme to upddate its MF/HF equipment with state-of-the-art technology.

The total system to be installed comprises 24 model RX4000 receivers, 13 model RC4000 controllers, matrix switching and associated equipment, including specialised custom software which integrates the system to OTC(A)'s particular requirements. Vicom has represented Dansk Radio here for the past ten years.

Apart from such a plum contract, Vicom has won in another arena recently. The company has represented IFR in Australia and New Zealand for some years, very successfully marketing their portable communications service monitor. So successful have they been that IFR has awarded them their prize for being the best distributor world-wide. Vicom claim the IFR monitor represents 80% of the Australian market and 92% of the New Zealand market.

This is the first time Vicom has received the award, which has been claimed for the past five years by IFR's UK distributor who service most of Europe.

IFR recently released a new range of precision spectrum analysers, the first being the Model A7550 which covers the range to 1GHz. Vicom say the interest is such that they have trouble keeping up supplies. Further details from Vicom Melbourne, on (03)62 6931

Kensor open in Victoria

West Australian-based radio communications equipment manufacturer Kensor has opened an office in Preston, Melbourne, headed by Peter Vaskess.

The Kensor range of products includes VHF and UHF directional antennas, diplexors, multi-couplers and transmitter combiners. They have a new product targetted at the air safety market, a low power non-directional beacon for rural airports and off-shore installations.

Kensor, apart from being manufacturers, also represent Antenna Engineering of Asia who offer a range of antenna products including tunnel/mine radiating cable equipment. Sinclair Radio Laboratories of Canada who are well-known for their filters and ferrite isolators, and lastly, Larsen Electronics of Washington USA who manufacture a range of mobile antennas for bands up to 960 MHz.

For Kensor products, your eastern states contact is **Kensor Pty Ltd, 13/417 High St, Preston 3072 Vic. (03)470 2664.**

Mobile antenna base

Haben Corporation markets a high strength HF antenna base targetted at the commercial and amateur radio user.

The solid brass, nickel-plated base features a steel spring with an internal electrical conductor suitable for antennas in the 2-30 MHz range.

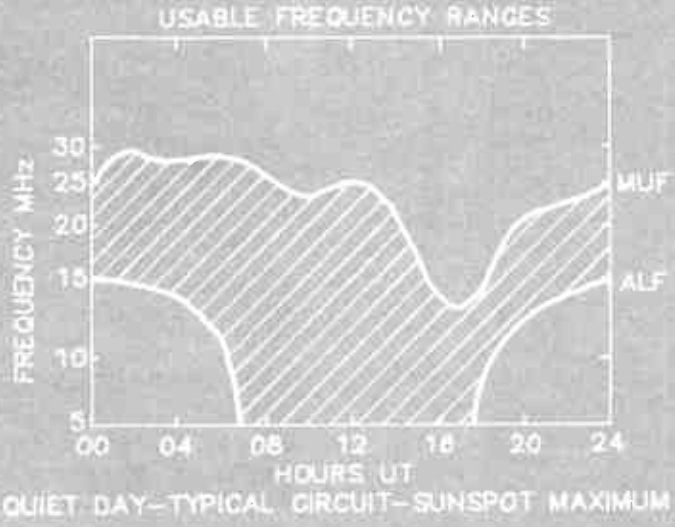
Trials are said to have shown little or no movement of the spring section at speeds of 100 km/h when fitted with a 2.4 metre long antenna, maintaining it near vertical for efficient operation.

Details from **Haben Corporation Ltd, 46 Ord St, West Perth 6005 W.A. (09)481 1388.**

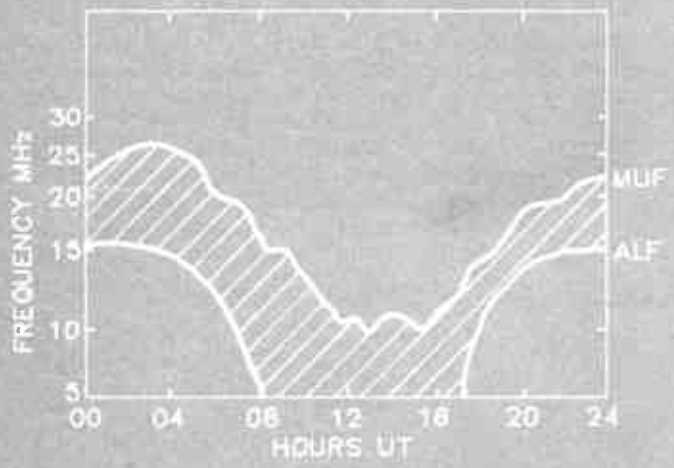
Radio communicators guide to the ionosphere

Part 8
Leo McNamara and Roger Harrison

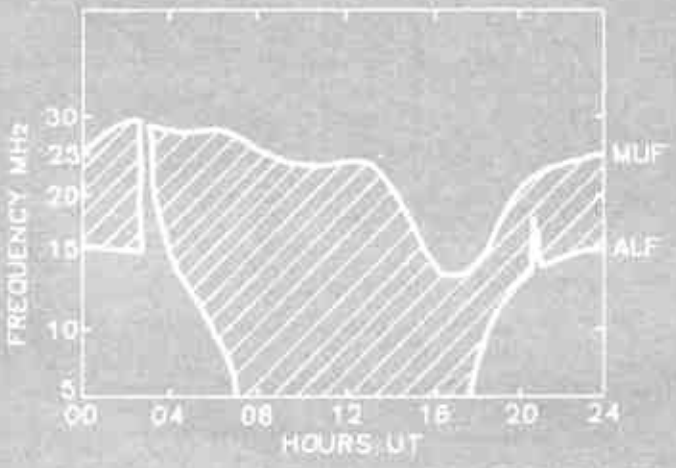
Disturbances to normal communications



QUIET DAY–TYPICAL CIRCUIT–SUNSPOT MAXIMUM



MODERATE TO SEVERE IONOSPHERIC STORM



MODERATE AND SEVERE SHORTWAVE FADEOUTS

IF THE HF predictions of usable frequencies at a particular hour are correct, if we are then using a frequency between the optimum working frequency and the lowest usable frequency, if our equipment is in good condition, if we have chosen appropriate transmitting and receiving antennas and these are in good order, if the level of radio noise at our receiving site is sufficiently low, and if there is no-one else sitting on our frequency, then we would expect to have reliable communications on 90%, or 27, of the days of the month at that hour.

What we shall be concerned with in this article is the other three or so days of the month when, on the average, communications at predicted usable frequencies will fail. These are the days of the month when the ionosphere reacts to the sun as it changes from being "quiet" to "disturbed", with these changes leading indirectly to disturbances to HF communications.

Some of the effects of these disturbances are controlled to a large extent by the earth's magnetic field, and in turn modify this field. Even the quiet solar wind has dramatic effects on the earth's magnetic field. We saw in Part 4b (Mar. '86) that the field is similar to that of a large bar magnet, and we showed what the magnetic lines of force of this magnet would look like. However that was an old fashioned view of what things are like, which prevailed before the solar wind was discovered. In fact, because of the flow of the solar wind over the earth, the magnetic field lines look more like those in Figure 8.1. The field lines on the day side of the earth (the side facing the sun) are compressed, whereas the field lines on the night side are stretched out into a long tail.

Figure 8.1 also indicates the position of the van Allen belts, which are belts of particles trapped by the earth's magnetic field, and the *ring currents*. The latter arise when particles of opposite electric charge in the solar wind go in opposite directions around the earth. It is the ring current which causes geomagnetic storms (see "Geomagnetic effects" later). Features of the sun-earth environment such as the van Allen belts and the ring current were among the first discoveries made by scientific satellites. Note that Figure 8.1 ignores the tilt of the N-S axis of the earth's magnetic field with respect to the sun-earth line.

There are three disturbances on the sun which affect HF communications. These are solar flares, high speed solar wind streams from coronal holes, and sudden disappearing filaments. The occurrence rates of each are shown in Figure 8.2 for the present solar cycle.

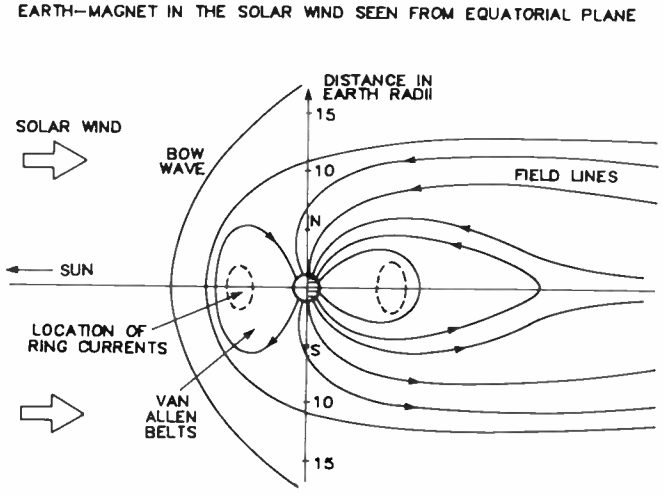


Figure 8.1. The solar wind distorts the earth's magnetic field so that it is compressed on the day side and stretched out into a long tail on the night side. A few details of the features shown in this highly simplified diagram are given in the text.

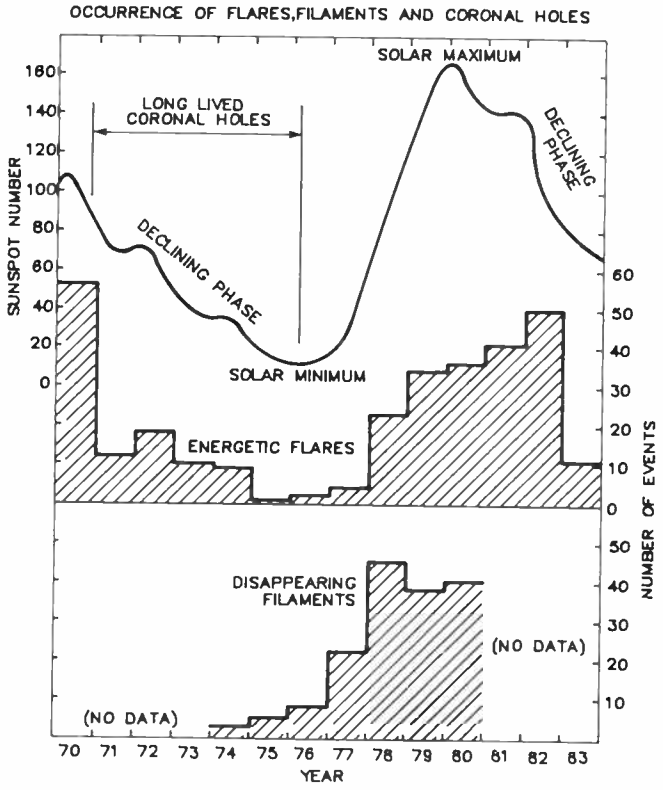


Figure 8.2. The occurrence rates since 1970 of the three solar phenomena which affect the ionosphere and therefore HF communications — coronal holes, energetic solar flares and disappearing filaments. The sunspot number is also shown, from an average maximum of around 100 in 1970, through a minimum near zero in 1976, through another (high) maximum of around 160 in 1980, and then declining towards a minimum expected in 1987/88.

Solar flares and their effects

A solar flare is a large explosion on the sun, apparently caused by a sudden release of magnetic energy when the magnetic field at some position gets so contorted that it takes less energy to blow out the offending material and settle back to a less contorted state than it does to stay contorted. A solar flare can be seen by any of the techniques used to observe the sun, but a flare must be exceedingly large and bright before it can be seen in white light.

Flares have a large range of sizes and can last for different lengths of time. A large flare can occupy 500 to 1000 millionths of the sun's disc and can last for a few hours. Flares have traditionally been classified according to their area and brightness as seen in H-alpha, but a more useful classification is the intensity of the X-rays emitted. This intensity can be measured by satellites orbiting above the atmosphere of the earth (which absorbs X-rays) and is one of the best indicators of how much energy a flare has released.

Flares occur most often during periods of high solar activity, as illustrated in Figure 8.2. Most are only small, or minor, and only a few per cent have any effect on the ionosphere.

Flares have three major effects on HF communications, each caused by different things emitted or ejected from the site of the flare — *X-rays*, *protons* and a *plasma cloud*. ▶

WELLER CROSSWORD COMPETITION NO. 12.

Each of the clues in this our twelfth Weller Crossword begins with the letter D. The prize for this month's winner is the superb Weller WTCPN Controlled Output Soldering Station which would have pride of place on any enthusiast's workbench. Post us your answer no later than August 25.

Our crosswords are prepared using 'Crossword Magic' available from Edsoft Pty Ltd of Blackburn Victoria.

The winner of Weller Crossword No. 9 (May) was Steve Lockett of Parmelia W.A.

The winner of Weller Crossword No. 10 (June) was David Chisolm of Christchurch N.Z.

Answers to Crossword No. 11 (July) are on p.24.

CooperTools

THE PRIZE

A transformer powered soldering station complete with a low voltage temperature controlled soldering pencil. The special Weller "closed loop" method of controlling maximum tip temperature is employed thereby protecting temperature sensitive components while the grounded tip and non inductive heater protects voltage and current sensitive components. The soldering pencil features stainless steel heater construction a non-burning silicon rubber cord and a large selection of iron plated tips in sizes from 8 mm diameter to 6 mm diameter with a choice of tip temperature of 315°C/600°F 370°C/700°F and430°C/800°F. The transformer case features impact-resistant norvl for durability and protection against accidental damage. a quick connect/disconnect plug for the soldering iron, extra large wiping sponge, tip tray to store extra tips plus an improved on/off switch with a long-life neon indicator light a [illegible] sinking soldering pencil holder, and a 2 [illegible] 3-wire cord

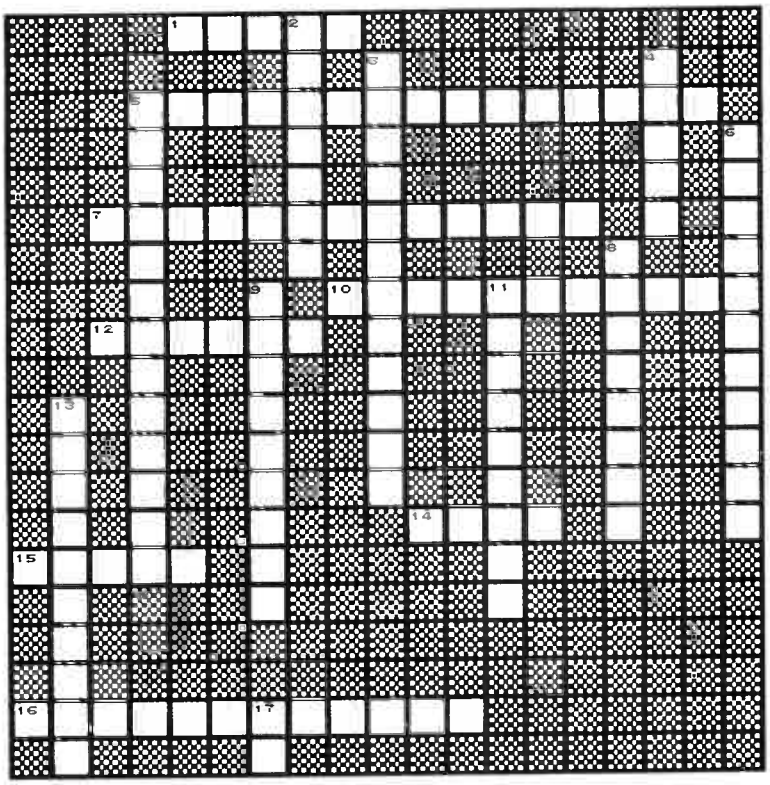
We will accept entries postmarked no later than August 26.

ACROSS

1. An electron tube having two electrodes.
5. Also called a radio compass. (2)
7. The apparent change in the frequency of radio wave reaching an observer due to the motion of the source toward or away from the observer or to the motion of the observer. (2)
10. A device which operates on a carrier wave to recover the wave with which the carrier was originally modulated.
12. To deaden vibrations.
14. Free from any electrical connnections.
15. Gradual reduction in quantity.
16. The process of soldering by placing the 'bottom' of a PCB in molten solder. (2)

DOWN

2. dB
3. The difference between two levels.
4. In a magnetic cell the difference between the partial-select outputs of the same cell in a one state or in a zero state.
5. A straight radiator antenna usually fed in the centre (2).
6. The bending of radio waves as they pass through an object.
8. A library of data (2)
9. Isolating and removing malfunctions from a computer.
11. A flexible membrane.
13. The insulating medium between the two plates of a capacitor.
17. Direct current.



This is the last of the Weller Crossword Competition series — so get those entries in! Look for another opportunity to win a superb Weller soldering station in AEM each month.

The competition is open to all persons normally resident in Australia or New Zealand, with the exception of members of the staff of Australian Electronics Monthly, the printers, Offset Alpine, and/or associated companies.
The winning entry will be drawn by the Editor, whose decision is final; no correspondence will be entered into regarding the decision.
Winners will be notified by telegram the day the result is declared and the winner's name and contest results published in the next possible issue of the magazine.

Cut out or photocopy the entry form, complete it and send to:

"Weller Crossword"
Australian Electronics Monthly
PO Box 289,
Wahroonga NSW 2076

In case two or more entrants correctly complete the crossword we'll have to judge who's best at waxing lyrically, in 30 words or less, over: ***"Why I think the Weller WTCPN is the soldering station for me".***

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

Name . . . . . .

Address . . . . . .

. . . . . **Postcode** . . .

Effects of X-rays — the shortwave fadeout

Provided a flare is sufficiently energetic, some of the X-rays which it emits will hit the earth's atmosphere, penetrate down into the D region and cause increased ionization by the process of photoionization. A large flare can increase the electron density of the D region by a factor of 10. This increase does not help us one little bit at HF — what it means is that there are now ten times more electrons to take energy from the radio waves and lose it in collisions with the countless millions of neutral atoms. In practice, the effect is often disastrous, all of the energy of a radio wave being absorbed by the D region, leaving none to continue on to the receiver. This phenomenon is known as a *shortwave fadeout* (called SWF for short). It is also called the *Dellinger fade*, after J.H. Dellinger who in 1937 first explained the cause of fadeouts.

A SWF can last as long as the flare which is causing it (up to an hour or so) and the size of its effect will depend on the size of the flare. A small flare will have only a small effect and will affect only the low frequency end of the HF band. Absorption increases as the frequency decreases, which means that SWFs are more detrimental to lower frequencies. It also means that during a SWF we should attempt to communicate using the *highest* allocated frequency below the normal OWF.

Because a SWF is caused by X-rays which always travel in straight lines, a SWF can be observed only on the face of the earth facing the sun, i.e: on the part of the earth which is in daylight. For this reason, a SWF is also sometimes called a *daylight fadeout*. The main features of a SWF are illustrated in Figure 8.3.

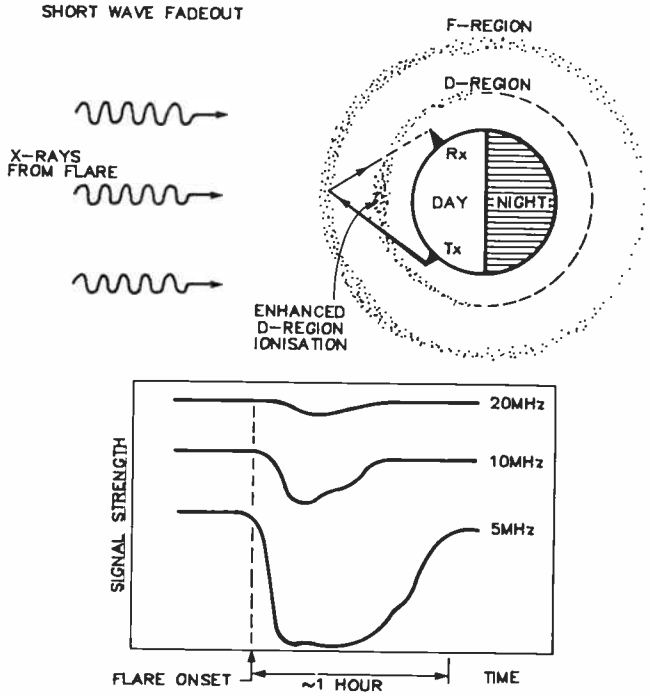


Figure 8.3. The effect of a shortwave fadeout (SWF) on the dayside ionosphere and on the signal strengths at frequencies of 5, 10 and 20 MHz on a circuit passing through the dayside ionosphere. X-rays from the flare cause a large and sudden increase in the density of electrons in the D region, which causes a corresponding increase in the absorption suffered by an HF Signal passing through it. The low frequencies on an HF circuit are affected most, and are the last to recover from the SWF. The night-time side of the ionosphere is not affected by X-rays.

Being basically an absorption effect, a SWF is more effective when normal absorption has its greatest values, i.e: at low or equatorial latitudes and in the middle of the day. This means that a given flare can have a very severe effect on one circuit, but only a minor effect on another. As far as a SWF is concerned, the important parts of the circuit are where the raypath cuts through (or attempts to do so) the D region on its way up to the E or F layers and on the way down again. If either of these points is heavily affected by increased absorption due to a flare, a SWF will result, even though the ionosphere at the reflection point is not affected.

Effects of solar protons — the PCA

Some of the very energetic flares also eject a stream of protons which can hit the earth if they are ejected in the right direction. [Protons are just hydrogen atoms which have been ionized (stripped of their single electrons) by processes within the flare site.] On their way to the earth, the protons can cause severe damage to unshielded satellites or astronauts, since they travel at speeds up to about 80% of the velocity of light, or about 2.5×10^8 metres/second, and are thus highly penetrating.

The stream of protons can arrive at the earth anything from ten minutes to a few days after the start of the flare, depending on how big the flare is and where abouts on the sun it is located. When they arrive at the earth, the protons encounter the earth's magnetic field. Being a charged particle, a proton cannot cross the lines of force of the field, but must gyrate or revolve around them. The lines of force are horizontal near the equator, and vertical near the poles. This means that any protons on a path towards the equatorial ionosphere cannot penetrate down into the ionosphere and the equatorial ionosphere is thus spared from their disruptive effects.

The situation at higher latitudes towards either poles is, however, somewhat different. Here the field lines are almost vertical and electrons gyrating around them can penetrate right down into the ionosphere. Once they have penetrated into the D region, they cause a dramatic increase in the electron density by ionizing atoms of the neutral atmosphere in a process known as *collisional ionization*. What happens is that the very energetic and fast protons just knock electrons off atoms with which they collide. As we saw in the previous section, increased ionization of the D region causes increased absorption. In the case of ionization by solar protons, the absorption is very severe but is confined to the polar caps or within about 20 degrees of the poles themselves. The whole event is known as a PCA or *Polar cap absorption event* and sometimes as a *polar blackout*, and is illustrated in Figure 8.4.

The effects of the PCA can last for several days, depending on the size of the flare, and usually completely destroy HF communications within and to the polar regions. The PCA will also prevent communications on any circuit which has one of its reflection points within the polar cap. On these circuits, communications can be maintained by the use of *relay stations* and a dog-leg circuit which bypasses the disturbed area. For circuits with a terminal within the polar cap, the only choice for an HF communicator is to wait until the stream of protons has been turned off and the D region has recovered. This can be anything up to a week or so for a large flare. If reliable communications are vital, consideration should be given to the use of orbiting satellites.* The very high frequencies used in satellite communications are much less affected by the absorption of the PCA than frequencies in the HF band.

There are, however, other things that can go wrong at the very high frequencies.

*Geostationary satellites are not much use near the poles because they are usually too close to the horizon.

Fortunately, PCAs are rare events, and large ones are even rarer. They occur most often at solar maximum when there are more flares on the sun, and about seven or eight can then be expected each year.

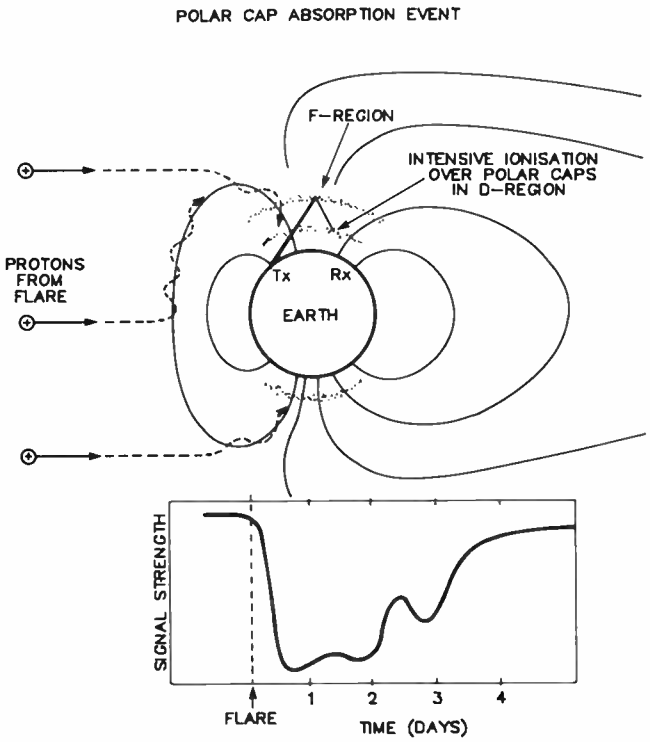


Figure 8.4. A polar cap absorption event (PCA) is caused by high-energy protons from large flares which penetrate to lower altitudes of the atmosphere over the polar regions of the earth, thus causing large increases in the electron density in the polar D region. This increase in density leads to a large increase in HF absorption, which is known as PCA. A PCA can last for days, depending on the output of protons from the causative flare. There is usually some recovery of the signal strength during the hours of darkness.

Table 8.1 gives the number of principal polar cap absorption events (events with peak absorption greater than 20 dB) which occurred during 1957-1963 solar cycle. Note that is the highest cycle yet recorded. Also included is the sunspot number for each year, the average duration of each event, the average peak absorption at a reference frequency near 30 MHz with respect to a reference path not suffering any increased absorption, and the maximum peak absorption with respect to the reference path. The absorption during a PCA is usually much less during hours of darkness than it is during the daylight.

Effects of a plasma cloud — the ionospheric storm

The third effect of a large solar flare on the ionosphere and on HF communications, which can in many cases be more important than the SWF or PCA, is called an *ionospheric storm*. An ionospheric storm is analogous to the familiar atmospheric storm which brings rain and wind, and the term is used to describe the condition of the ionosphere when unusual things are happening to it. In the case of an ionospheric storm, the ionosphere is changed, sometimes severely, especially as far as the critical frequency foF2 is concerned. As a direct consequence of the ionospheric storm, conditions for HF propagation are changed, with resulting effects on HF communications. The effects are, naturally enough, usually detrimental.

Ionospheric storms are caused whan a cloud of *plasma* (i.e: a mixture of positive and negative ions) ejected from a large flare hits the earth. There are many things that must go right (or wrong, depending on your viewpoint) for this to happen, but basically the flare must first eject such a cloud and the cloud must then hit the earth. This normally happens only for large energetic flares situated near the centre of the face of the sun as seen from the earth — in other words, near the *central meridian* (CM) of the sun. When a plasma cloud hits the earth, it causes changes to the electric fields in which the ionosphere is embedded and also to the chemistry and large-scale movements of the F2 region. The result of all these changes is that the critical frequency in the F2 layer can be either increased or decreased. Whether the critical frequency is increased or decreased at a particular location depends on such things as the time of day when the plasma cloud hits the earth, the local time, the season and the latitude at the point in question, and how long the storm has been going on. ▶

TABLE 8.1.

The number of principal polar cap absorption events (events with peak absorption greater than 20 dB) occurring during solar cycle 19. Included also is the smoothed sunspot number for each year, the average duration of each event, the average peak absorption at 32.2 MHz with respect to an unaffected reference path, and the maximum peak absorption with respect to the reference path.

Year	1952-5	1956	1957	1958	1959	1960	1961	1962	1963
Smoothed Zurich sunspot number	6 to 38	142	190	188	160	114	55	38	28
Number of principal polar cap events	0	4	13	9	5	12	3	0	2
Average duration (hours)	—	104	60	76	149	54	69	—	72
Average peak absorption with respect to the reference path (dB)	—	54	41	79	143	57	76	—	31
Maximum peak absorption with respect to the reference path (dB)	—	104	74	190	190	160	136	—	37

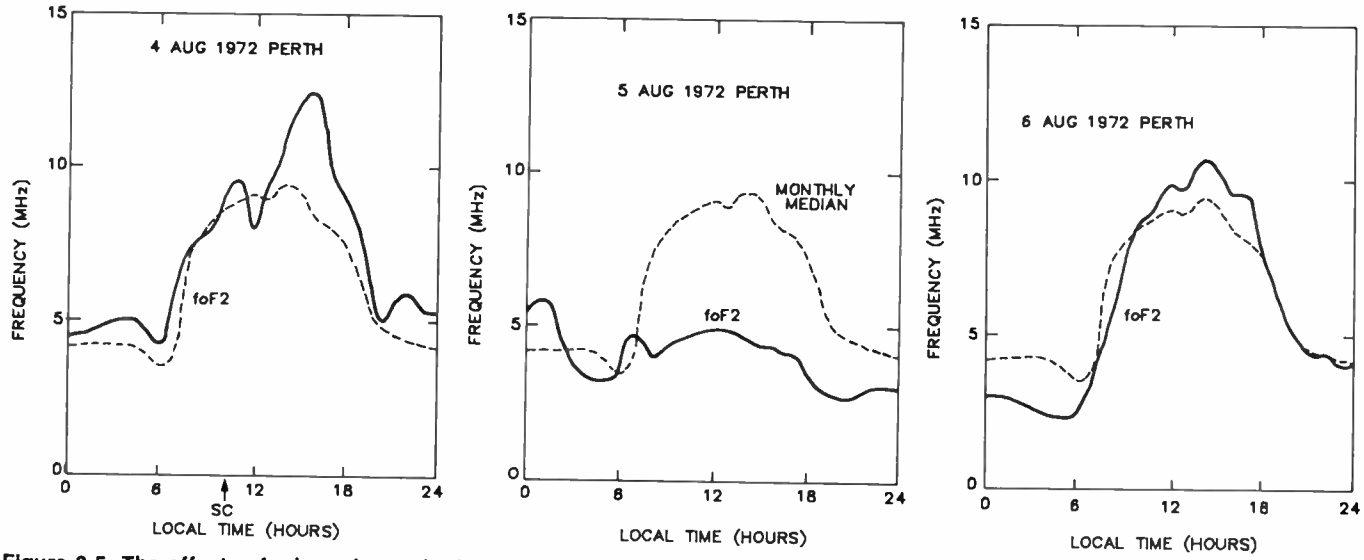


Figure 8.5. The effects of a large ionospheric storm on the F2 region over Perth, caused by several large flares which occurred two days earlier on 2 August. The shock front from the flare hit the earth at about 1100 local time on 4 August, the plasma cloud itself following a few hours later. The effect on the ionosphere that day was an increase of foF2 to a value about 50% higher than the normal monthly median value. This increase lasted about six hours. For the whole of the next day, foF2 remained below 5 MHz, which represented a decrease of foF2 by up to 50%, relative to the expected median behaviour. The ionosphere completely recovered following sunrise on 6 August.

The effects of ionospheric storms are greater in the equinoxes and summer than in winter and are greater at higher latitudes i.e: the equatorial regions are less affected than the polar regions. During winter, the main storm effect is an increase in foF2, although a severe storm can result in a following decrease of foF2 (and MUFs).

Increased absorption will occasionally occur at mid-latitudes during a storm because of ionization of the D region by charged particles (mainly electrons). Recall that absorption at *high* latitudes will be very severe on most occasions.

Figure 7.5 shows what happened to the ionosphere over Perth (Western Australia) following the large solar flare of 2 August 1972.

Summary — effects of solar flares

Figure 8.6 illustrates the three ways in which a flare can affect the F region and thereby affect HF communications, by X-rays, protons and a plasma cloud.

An ionospheric storm will normally commence about two days (give or take a day or two) after the flare which caused it. This means that it is possible to get ample warning that the storm will take place. Any increases in critical frequency usually go unnoticed by a communicator since they usually just make things a little easier. It is the decreases in critical frequency which are important to the HF communicator since these can lower the MUF for the circuit below the frequency at which you would normally be operating.

During a large ionospheric storm, the critical frequency of the F2 layer can drop by a factor of two, causing a corresponding drop in MUFs on a circuit passing through the disturbed region. In general, the D, E and F1 regions are not affected by ionospheric storms. When the F2 region is severely depleted of electrons during major storms, the critical frequency of the F2 layer (foF2) can drop below that of the F1 layer (foF1). The highest frequency propagated is then supported by the F1 layer, rather than by the usual F2 layer.

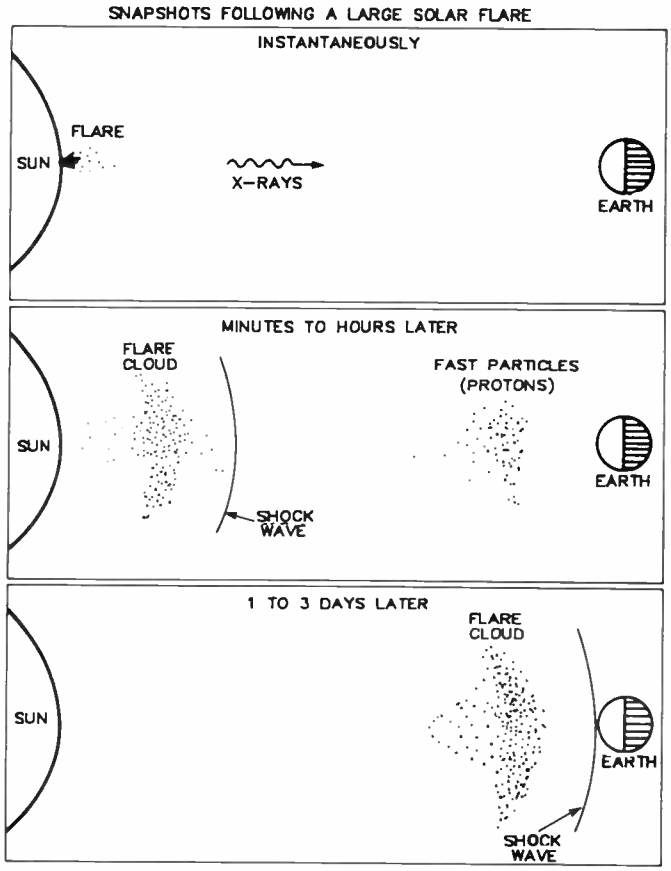


Figure 8.6. The three events in interplanetary space which follow a large solar flare:.

(a) Top. X-rays are one form of radiation emitted by the flare. These travel in straight lines at the velocity of light, taking about 8 minutes to reach the earth.

(b) Middle. Fast protons reach the earth after a delay which can be as short as a few minutes. These are followed by the more slowly moving flare cloud, which is preceded by a shock at the position where the cloud hits the quiet solar wind.

(c) Lower. The flare cloud reaches the earth a few days after being ejected from the flare.

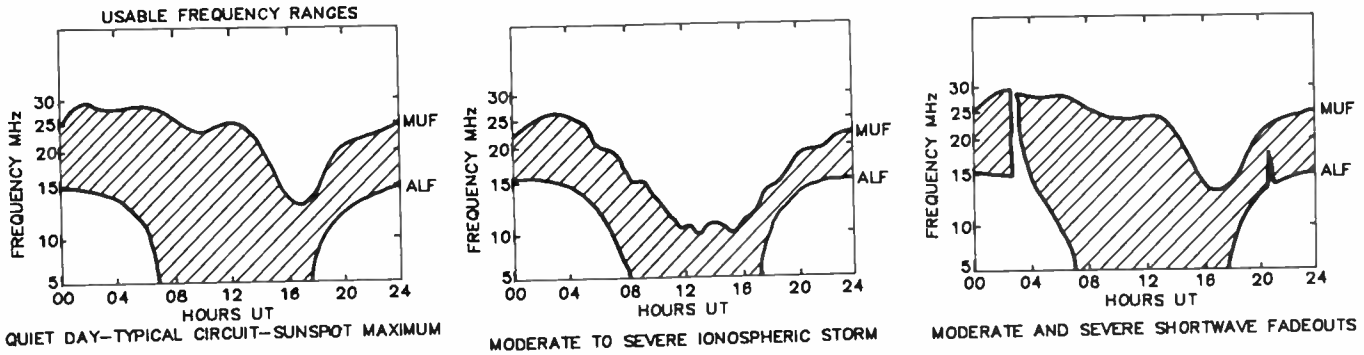


Figure 8.7. The effects on a communications circuit of (a) two SWFs and (b) an ionospheric storm. In general, communications are possible at any frequency/time within the shaded areas. The severe SWF occurring at around 03 UT (local afternoon at the reflection point) caused a complete loss of communications at all frequencies for about 20 minutes. As expected, recovery started at the highest frequencies. The minor SWF at around 21 UT (local morning) affected only the lowest frequencies. The ionospheric storm shown in panel (b) decreased the nighttime MUF from over 20 MHz to around 10 MHz. Note that the lowest useable frequency was unaffected by the storm.

The effects on communications on a circuit of a SWF and an ionospherric storm are illustrated in Figure 8.7.

Coronal holes and HSSWS

We saw in Part 2 (Oct. '85) that coronal holes are relatively cool "open" structures in the solar corona which can be observed using special techniques. By "open" we mean that the lines of force of the sun's magnetic field stretch out into space, rather than folding back down to the surface of the sun. Because the field lines stretch out into space, and because ionized material can travel along field lines, but not across them, ionized material pours out of a hole into interplanetary space in what is called a *high speed solar wind stream* (HSSWS for short — this can be read as hiss-wiss). Solar wind flows out from the sun over the whole surface, but above coronal holes the streams are faster. Typical speeds are 300 km/sec. for a slow speed solar wind and 500 km/sec. for HSSWSs. Material in a HSSWS therefore takes about four days to travel from the sun to the earth. This may be compared with the two days (roughly) that it takes for material ejected from a solar flare to reach the earth.

Figure 8.8 illustrates a "plan view" of HSSWSs, which is best understood by comparing it to the action of a rotating garden water sprinkler. Matter leaves the sun in a radial direction, straight out from the surface, but while it is travelling out into space the sun has rotated, so that the new material flowing into the HSSWS comes out from the sun in a direction different from that of the material which left earlier. Every HSSWS therefore ends up curved, the material which left the sun earlier being delayed with respect to later material. Slow streams are more curved than faster streams.

HSSWSs are important because as they sweep over the earth, they cause ionospheric storms, just as the plasma cloud from a solar flare causes storms. However HSSWSs are different in that their effects are not usually as marked or as devastating as those of a larger solar flare, partly because the solar wind does not travel as fast as the cloud from a flare. The effects also tend to last longer because they are felt for the whole time that it takes for the HSSWS to sweep over the earth, which is typically a few days.

Coronal holes and their associated HSSWSs are a feature of declining solar activity, as illustrated in Figure 8.2. Particular hole/stream combinations have been observed to last almost a year, reappearing every 27 days or so in step with the rotation of the sun. The fact that HSSWSs are associated with long-lived features on the sun makes it

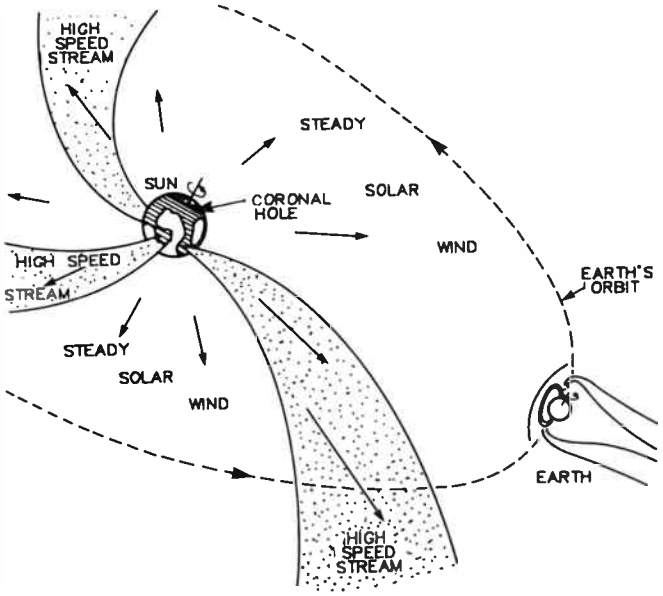


Figure 8.8. View from above of high speed solar wind streams (HSSWS) emanating from coronal holes on the sun. Matter flows radially out from the sun, but the rotation of the sun gives rise to spiral streams. A HSSWS causes a geomagnetic and possibly an ionospheric storm as it sweeps over the earth. Note the way the quiet solar wind has stretched out the lines of force of the earth's magnetic field on the night-side of the earth into a long tail.

relatively easy to predict their return, and in turn to predict their effects on the earth. The only problems which arise are when a new hole appears, when a hole disappears, or when the HSSWS speeds up or slows down. If the HSSWS speeds up, it will straighten out to some extent and will overtake the earth in its orbit around the sun a little earlier than expected. The reverse holds if the HSSWS slows down.

Sudden disappearing filaments

Disappearing filaments are the last of the three solar phenomena which have been found to affect the ionosphere. We encountered filaments in Part 2 (Oct. '85) where we saw that they are relatively cool and large structures in the solar chromosphere which are seen as prominences when viewed on the edge of the sun. Filaments are often seen to disappear within a few hours, and it is surmised that all or part of the material of the filament has been blown out into space, ▶

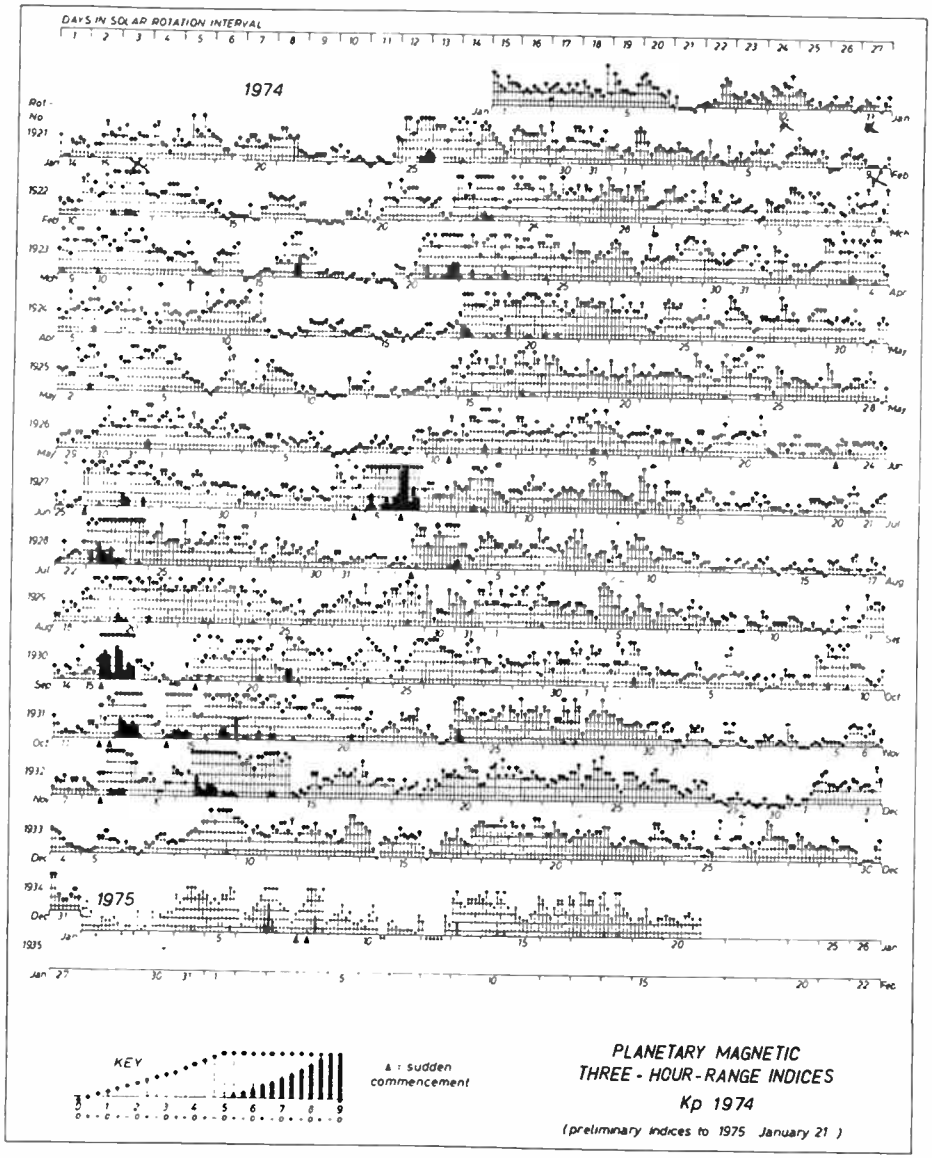


Figure 8.11. Bartels charts of the planetary average 3-hourly values of the magnetic disturbance index, Kp, for a year of declining solar activity (1974). Each row of the plot is 27 days long, corresponding to the rotation period of the sun. Thus large values of Kp which occur vertically below each other can be attributed to a feature of the sun which returns to face the earth every 27 days. This feature is usually a coronal hole which is the source of a high speed stream in the solar wind.

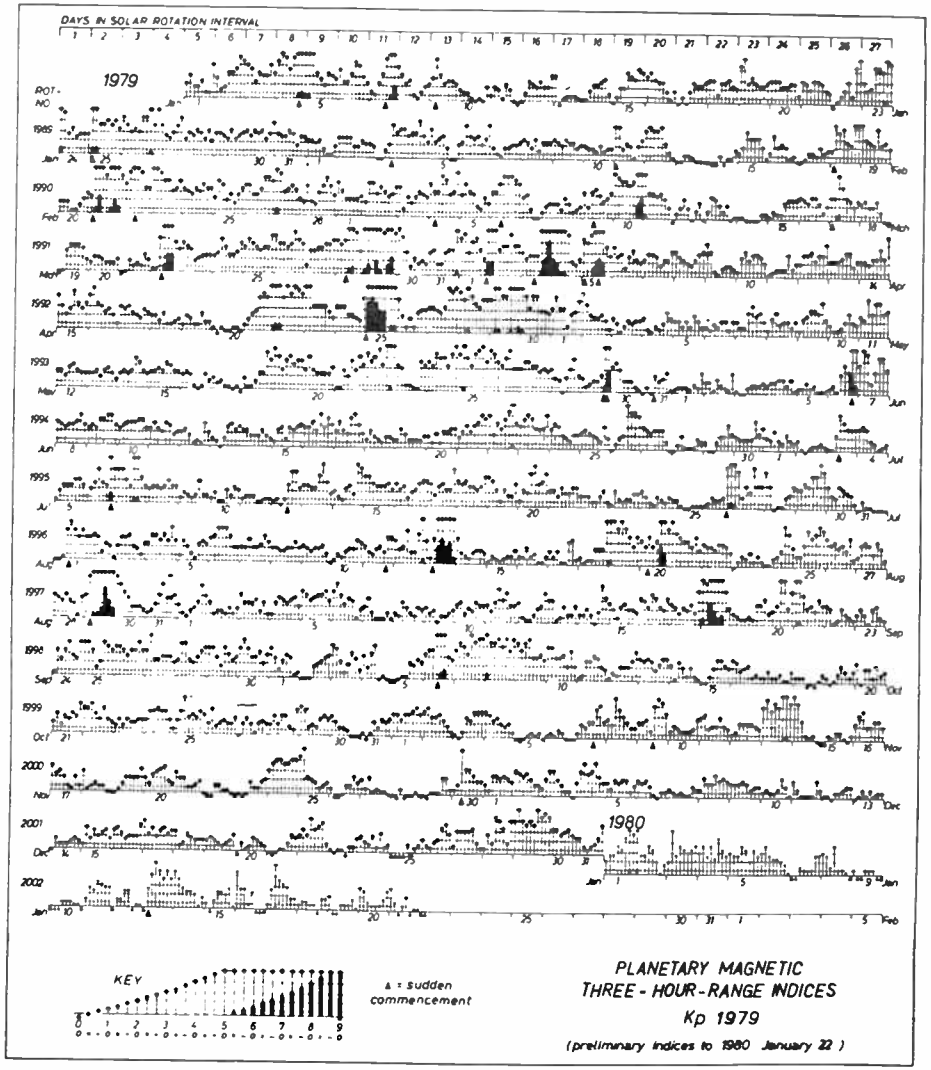
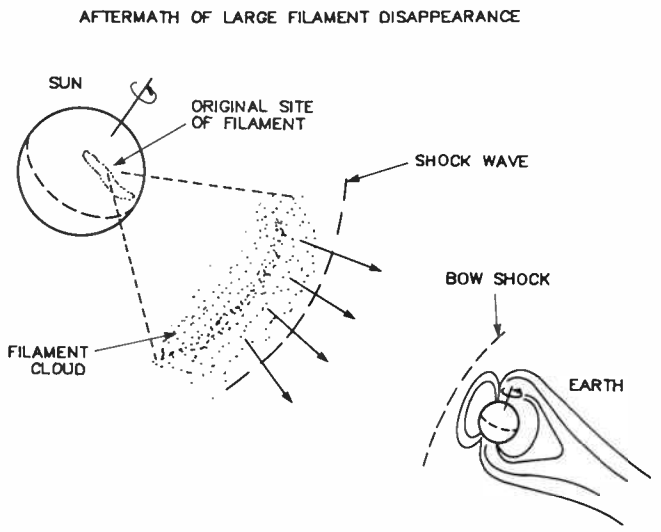


Figure 8.12. Bartels chart of the planetary 3-hourly average values of the disturbance index, Kp, for a year of high solar activity (1979). The very disturbed periods, indicated by the thick black vertical bars, are attributable to either disappearing filaments or flares. There is no evidence of any recurrent activity in the field caused by high speed streams from coronal holes.



PHENOMENA	SUN – EARTH DELAY	TERRESTRIAL EFFECT
SHOCK WAVE	3–4 DAYS	Sudden commencement
FILAMENT CLOUD	3–10 DAYS	• Magnetic storm • Ionospheric storm • Aurora

Figure 8.9. The matter from a large disappearing filament, ejected into interplanetary space and preceded by a shock wave. If the shock wave hits the earth, it will compress the earth's magnetic field and give rise to a sudden commencement. The following plasma cloud, like the cloud from a large flare, can cause a magnetic and possibly an ionospheric storm. The bow shock illustrated is a permanent feature of the earth's magnetic field and marks its boundary with the magnetic field of the solar wind.

in a fashion similar to solar flares. This is illustrated in Figure 8.9. Recent research has confirmed that these sudden *disappearing filaments* (SDFs) can affect the earth's magnetic field although the effects are often small and hard to confirm. SDFs also affect the ionosphere and HF communications to some extent, but no detailed studies have yet been made of these effects. SDFs are a feature of high levels of solar activity.

Geomagnetic effects

We have concentrated so far in this article on the effects of solar disturbances on the ionosphere and HF communications. The disturbances also affect the earth's magnetic field, causing what are called *geomagnetic storms*, which are important to anyone such as geophysical prospectors concerned with measuring the earth's magnetic field. Our main interest in the geomagnetic effects is that they are somewhat easier to talk about than ionospheric effects, many of the terms used in discussing the effects of solar disturbances arising from a consideration of what happens to the earth's magnetic field.

Geomagnetic storms occur in conjunction with ionospheric storms and have the same causes — solar flares, HSSWSs and SDFs. A geomagnetic storm usually consists of a small increase in the earth's magnetic field, called the *initial phase*, followed by a large decrease, called the *main phase*. A geomagnetic storm is not really much of a storm — the field may change by only 100 units (called nano-teslas) out of a total of 30 000. Recall that a major ionospheric storm can drop foF2 down by 50%.

A geomagnetic storm caused by a solar flare usually starts off with a sudden increase at the start of the initial phase. This is called a *sudden commencement*, or SC for short, and arises when the shock front from the flare hits the earth's magnetic field and suddenly compresses it. A storm caused by a HSSWS, on the other hand, usually starts off gradually as the HSSWS overtakes the earth. The onset of the storm is more insidious than for a flare-induced storm, and consequently it is described as a *gradual commencement storm*. Because storms caused by HSSWSs tend to recur every 27 days or so, they are also called *recurrent storms*.

Figure 8.10 illustrates how the horizontal component of the earth's magnetic field varies during a typical geomagnetic storm due to (a) a large flare, and (b) a HSSWS.

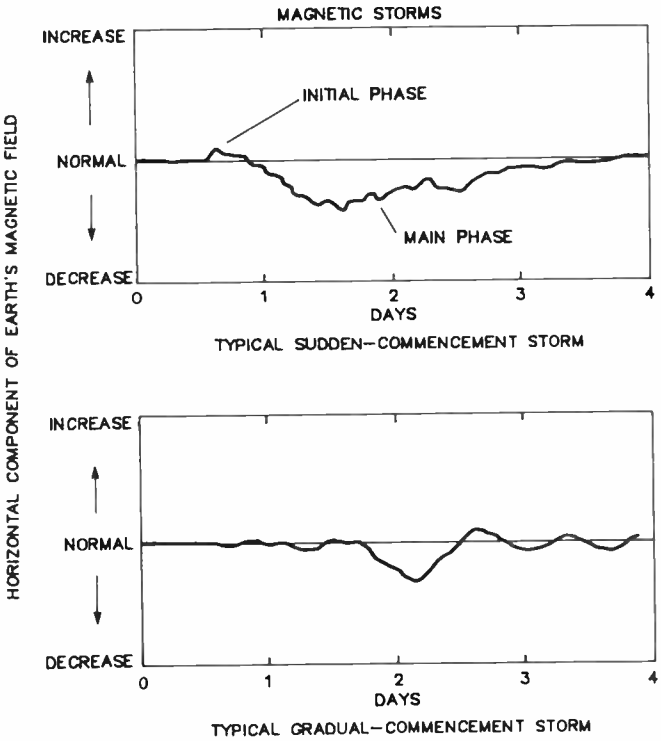


Figure 8.10. Typical sudden commencement and gradual commencement magnetic storms. The former would be caused by flares or disappearing filaments, while the latter would be caused by HSSWSs. Note that even the largest decrease in the earth's magnetic field during a storm is usually less than 1% of the undisturbed value.

Bartels charts

Figures 8.11 and 8.12 give the *Bartels magnetic charts* for 1974 (low solar activity) and 1979 high (high solar activity). Knowledge of these charts is not necessary for an understanding of the rest of this book, but they are very useful because they contain such a large amount of information presented in a very clear fashion. They were invented by J. Bartels, a pioneer in the study of the earth's magnetic field. They are also known as "musical charts".

The horizontal axis in the charts is a 27-day period corresponding to one rotation of the sun, with about 14 full rotations each year. The vertical lines in each of the 14 rows of plots represent the values of the quantity Kp, which is a measure, or index, of how disturbed the earth's magnetic field was in a 3-hour period. Kp is called the *planetary magnetic K index*. Each chart represents very disturbed periods (Kp greater than 5) as black vertical bars, so the more disturbed the magnetic field, the longer the black bar. ▶

Magnetically quiet conditions, when the field is not disturbed, are represented by short thin bars. Without worrying about the detail, we can summarise the charts by noting that solid black areas denote magnetically disturbed periods, while a lot of white space denotes magnetically quiet periods. The arrowheads denote storm sudden commencements which were described earlier. The beauty of the Bartels charts is that if magnetic storms are caused by the same feature on the sun on successive rotations, the disturbed (black) areas will lie one under the other.

The 1974 Bartels chart shows two long-lived series of storms which were due to HSSWSs from coronal holes. One series has disturbed periods starting on January 25, February 20, March 20, April 18 and May 15, with magnetically quiet periods preceding each of the disturbed periods. In fact, the white space corresponding to the quiet periods probably stands out better than the recurrent disturbed periods. This particular series of disturbances was broken on July 4, 5 and 6 by a major storm which was caused by a large solar flare on July 3. A second series of recurrent storms due to a HSSWS started up on June 28, with recurrences on July 23, August 19, September 15,

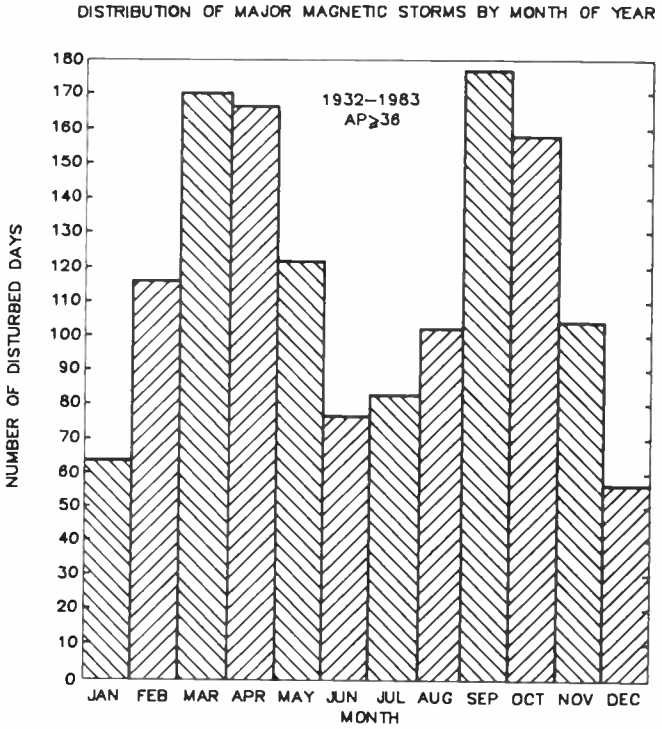
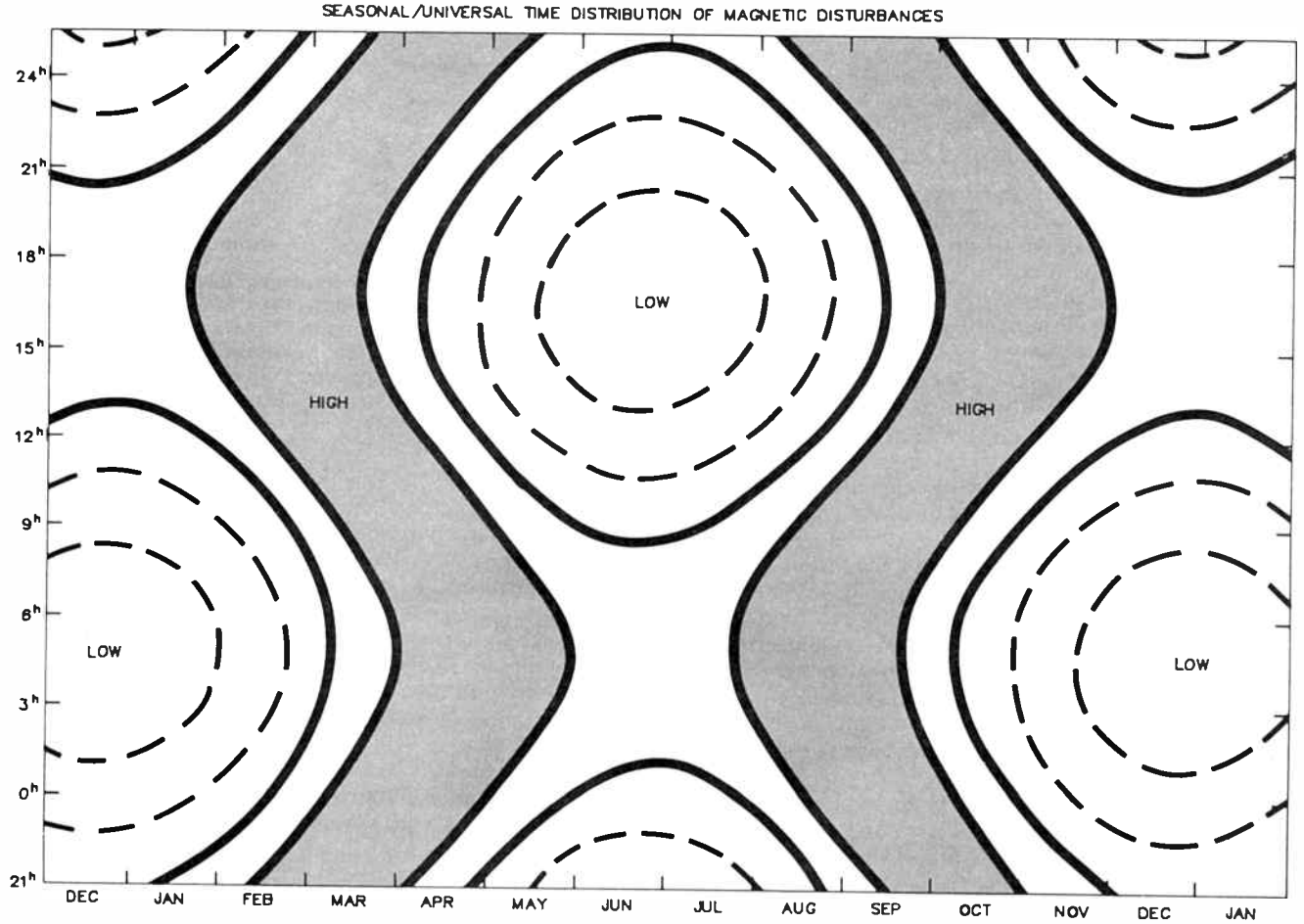


Figure 8.13. The number of magnetically disturbed days in each month of the year, averaged over the years 1932 to 1983, for which the magnetic disturbance index, Ap, exceeded 36. The number of disturbed days is twice as great in the equinoxes as it is in the solstices. In other words, during the equinoxes the geomagnetic field is twice as susceptible to being disturbed by events on the sun.

Figure 8.14. The susceptibility of the geomagnetic field to being disturbed by events on the sun, as a function of universal time and month of the year. The values plotted in Figure 13 represent the values for a particular month, integrated across the 24 hours.



October 12 and November 8. The given starting times of the disturbances are only approximate, since the disturbances commence gradually.

The starting times of the January to May series of storms are not aligned exactly one under the other, indicating that the speed of the HSSWS decreased from one rotation to the next, with the result that the stream took a little longer than 27 days to overtake the earth. Other series of disturbed periods may suggest themselves. The magnetically quiet periods before the recurrent storms, as exemplified by the values of Kp for 18 and 19 March, support the contention of many HF operators that a very good period for communications can indeed signify an oncoming disturbed period.

The 1979 Bartels chart does not show any of the recurrent features evident in the 1974 chart. During periods of high solar activity, most storms are caused by flares which are short-lived phenomena not lasting for a full solar rotation. Consequently the very disturbed periods are distributed more or less at random throughout the chart.

UT and seasonal control of geomagnetic disturbances

The probability that a given solar event (flare, HSSWS or disappearing filament) will cause a geomagnetic effect depends on the season of the year and universal time, as well as on the solar event itself. Figure 8.13 gives the number of disturbed days between 1932 and 1983 for which the magnetic index Ap exceeded 36. Ap is a planetary average (over the surface of the earth) of an index A which is somewhat similar to Kp, except that it is a *daily* index. The number of disturbed days can be seen to be twice as large during equinoctial months (March, April, September, October) as during solstitial months, indicating that the earth's magnetic field is twice as susceptible to being disturbed by events on the sun during the equinoxes. This increased susceptibility is attributed to the fact that during the equinoxes the direction of the axis of the earth's magnetic field is more nearly at right angles to the direction of the flow of the solar wind.

The rotation of the earth (and therefore its magnetic field) about its axis also leads to situations in which the axis of the field is more nearly at right angles to the direction of the solar wind. This leads to a variation of susceptibility throughout a 24-hour period, as illustrated in Figure 8.14. Note that the time is Universal Time, the effect having nothing to do with whether it is day or night. The susceptibility is high during the two shaded S-shaped areas of Figure 8.14 and low during the areas within the closed contours, especially in the centres of these areas, which are marked LOW in the diagram.

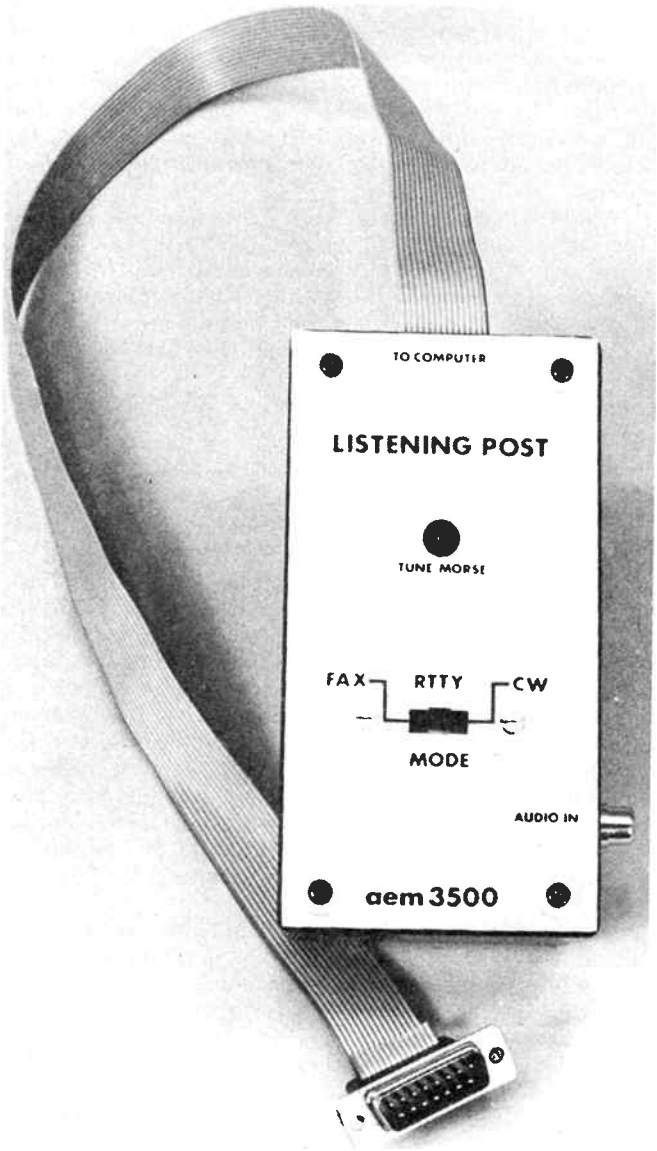
For example, if a flare cloud hits the earth at 15 to 18 UT in June, there is only a small chance of the magnetic field being disturbed. On the other hand, if the same cloud were to hit the Earth at the same UT, but in February or March, there would be a much higher probability that the earth's magnetic field will be disturbed. In general then, the geomagnetic effects of a given flare, HSSWS or disappearing filament will be greater during the equinoxes than during the solstices, with a similar story for effects on the ionosphere. A corollary to this statement is that it is quite possible for a small flare (HSSWS, filament) to have a larger effect on the earth's magnetic field than a larger flare, if the small one occurs during the equinoxes and the large one occurs during the solstices.

The two recurrent storm sequences apparent in the Bartels Kp chart of figure 8.11 support these conditions, the storm effects being stronger (more thick black bars) during the equinoctual months.

Using the AEM3500 Listening Post on the BBC Model B

Andrew Boon VK7AW

Here's software and hookup details on using our popular Listening Post project with the BBC Model B computer to decode Morse, radioteletype and radio facsimile (FAX) picture transmissions. In this instance, on FAX transmissions the BBC prints the pictures on a printer as they're received, in similar fashion to a real FAX receiver.



THE BBC Model B microcomputer is widely used in schools around Australia (and elsewhere), at all levels. In Tasmania, some schools have placed BBCs in preparatory class, and their use continues through the secondary grades. The very good graphics capabilities and a versatile sound generator enable it to hold the attention of even the youngest students, while leading them through a course of instruction in mathematics, spelling, social science, and many other areas. The BBC was selected for use in schools for several reasons; its sound and graphics capabilities, very good documentation, the increasing availability of 'educational' software, and value for money. The fact that the machine was developed specifically for the British Broadcasting Corporation's Computer Literacy Project (resulting in *The Computer Programme* series on TV) ensured that the documentation and software would be good. There have also been hardware peripherals developed for classroom use; for example, file servers and printer servers.

But the BBC has not been overly popular with home-computer buffs or hobbyists. Teachers and parents of school-aged children seen to be the main owners, and their purchases are based on educational reasons. Compared with machines like the Commodore 64, Microbee and 'plastic' Apple II, the BBC is expensive, and price is usually a prime factor when it's your own money being handed over. Expansion to enable the BBC to run CP/M is also expensive.

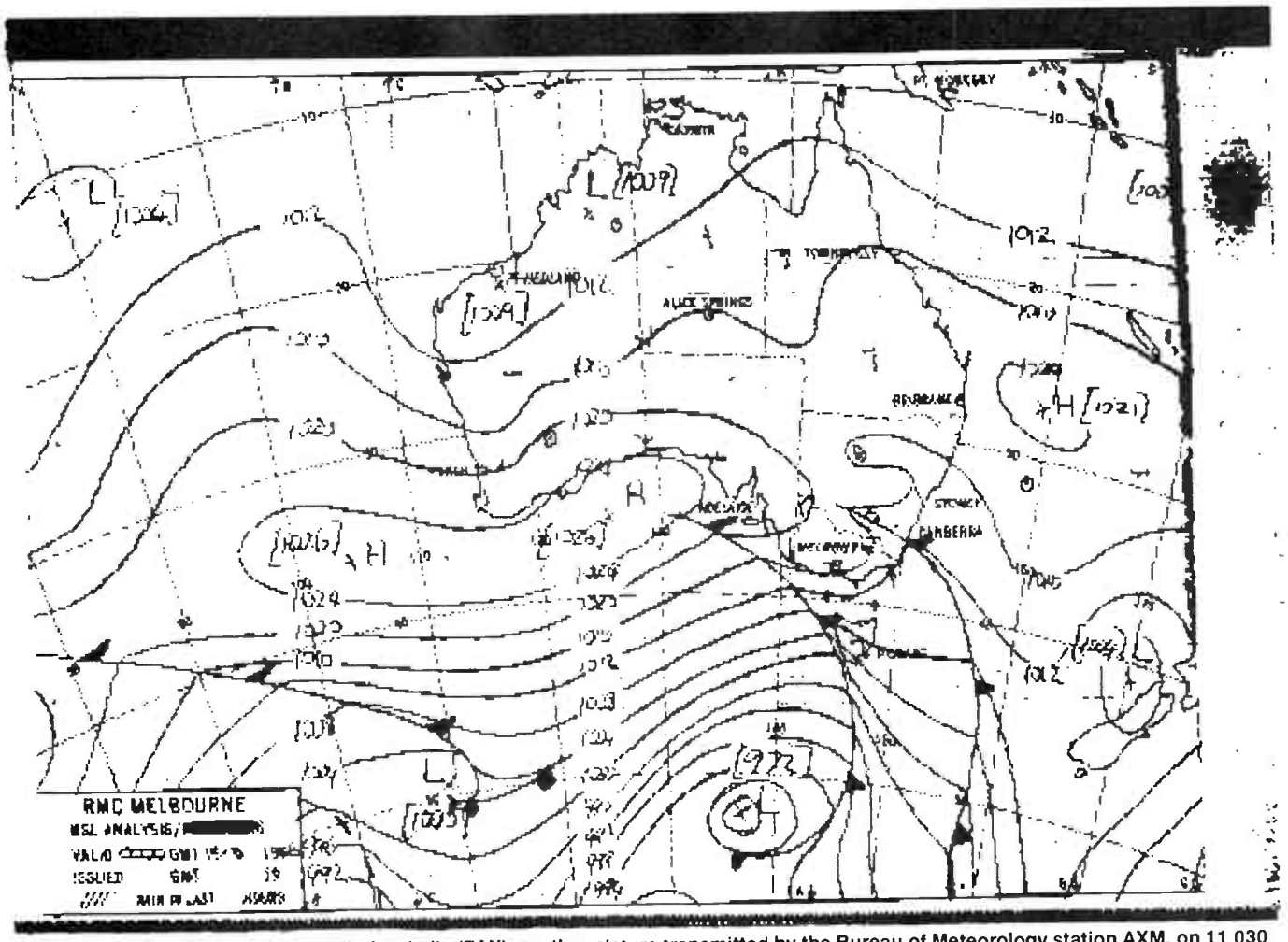
Nevertheless, the basic BBC offers a lot: seven modes of screen display, from Mode 0 which gives high resolution graphics (640 x 256 in two colours) or 25 lines of 80 characters of text, through other modes which give up to 16 colours, to Mode 7, which is the Teletext mode. It has four analogue inputs and an analogue-to-digital converter, a serial port, a parallel printer (Centronics) interface, an uncommitted parallel port, a floppy disk interface and provision for a local area network interface. It also has two high speed interfaces: the first is a 1 MHz bus, to enable high speed specialist hardware to be connected, and the second is the 'Tube', which enables a second processor (e.g.: a Z-80 or a high speed 6502) to be connected and use the basic BBC as a terminal and I/O handler.

The BBC Model B has 32 kilobytes of RAM — the remaining 32K of the 64 kilobyte addressing range is used by read-only memories and memory-mapped I/O devices. The machine operating system resides in a 16K ROM, and is always in place. Other ROMs contain the disk filing system, the BASIC interpreter, word processors, communications program, and so on. These ROMs are switched in whenever they are called by keyboard or program command; it is usual to have several 16K ROMs installed, but only one of them would be in use at any time.

Unfortunately, not all of the 32K bytes of RAM is available for user programs. With a disk filing system in use, locations 0000-1900 (hex), i.e: over 6K bytes, are taken up by the operating system and filing system. Locations from 7FFF (hex) downwards are used for the screen memory. For example, in the high resolution Mode 0, locations 7FFF down to 3000 (hex), 20K bytes, are required for screen memory. Add this to the memory

FOR THOSE WHO CAME IN LATE . . .

The AEM3500 Listening Post was the feature project in our first issue, July 1985. Software was presented originally for the Microbee then, later, for the Commodore 64 and Apple II. Copies of the original constructional article are obtainable from the magazine for $3.60 post paid. Printed circuit boards are also available for $8.06, inc. postage. Order from *AEM, PO Box 289, Wahroonga NSW 2076.*



Mean sea level ('msl') analysis radio facsimile (FAX) weather picture transmitted by the Bureau of Meteorology station AXM, on 11 030 kHz, 1215 EST, 15/3/86. The print resolution of FAX pictures using the BBC computer software is somewhat better than that from the Microbee. Here, on the original printout you can clearly read most of the place names on the map. The print reproduction process may degrade them somewhat

required by the operating system and you have only 6K bytes in which to store and run your program. If more memory is required to run a program, the mode must be changed to one which requires less memory. Mode 7, the Teletext mode, gives 25 lines of 40 characters and uses memory from 7FFF to 7000 (hex), leaving over 24K bytes for the user's program, but with very limited graphics capability.

When writing machine language programs for the BBC, the assembly language is embedded in a BASIC program. Whenever a square bracket ([ ) appears in a BASIC program, the assembler is entered; the corresponding closing bracket ( ]) causes the program to exit the assembler and return to the normal BASIC interpreter. This is a very powerful facility and makes it very easy to experiment with machine code routines, also to incorporate them into BASIC programs. The usual procedure of Edit, Save, Assemble, Save and Run is replaced by Edit and Run. The text is prepared using the editing facilities of the BASIC interpreter, which are good, except for the annoying requirement to type all commands in upper case.

The manufacturers of the BBC have laid down certain standards for machine language programmers, to ensure that the resulting programs will run on all versions and all configurations of the microcomputer. There are two main restrictions: firstly, use only those sections of the zero page which have been specifically reserved for users, and secondly, do not directly access screen memory or memory-mapped I/O devices. System calls should be used to read and write to all of these locations; the *User Guide* gives a list of these system calls and the addresses through which they can be accessed. Following these guidelines ensures that programs will run on second processors (connected to the 'Tube'), which may have their own 64K bytes of RAM.

One problem with the use of these system calls is that they take a longer time to execute than a sequence of instructions directly addressing the memory-mapped I/O devices. For example, to store a value into the output register of the VIA (Versatile Interface Adaptor) parallel interface:

Direct Method:

```
LDY value     \get value                4
STY &FE61     \store in VIA register    4
                                  Total   8   cycles
```

Using a System Call:

```
LDY value     \get value                4
LDA #WRIO     \Write to I/O             2
LDX #VORA     \Destination register     2
JSR OSBYTE    \System Call            270
                                  Total 278   cycles
```

i.e.: the system call method requires 278 cycles, or 129 microseconds, to complete. This delay becomes very significant in real-time applications, such as the Listening Post where samples are being taken every 840 microseconds, and several system calls may be required between samples. At times it is very tempting to ignore the manufacturers' recommendations (I'll never have a second processor anyway!), but the Listening Post program does conform to them. ▶

SOFTWARE FOR THE SATELLITE FAX DECODER

July 1986

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By arrangement with the author, Tom Moffat, we are able to offer you software on cassette tape or diskette for just:

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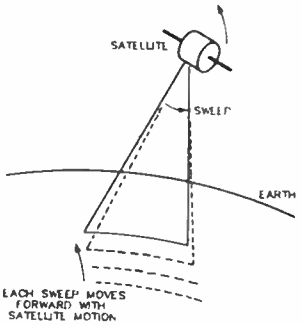

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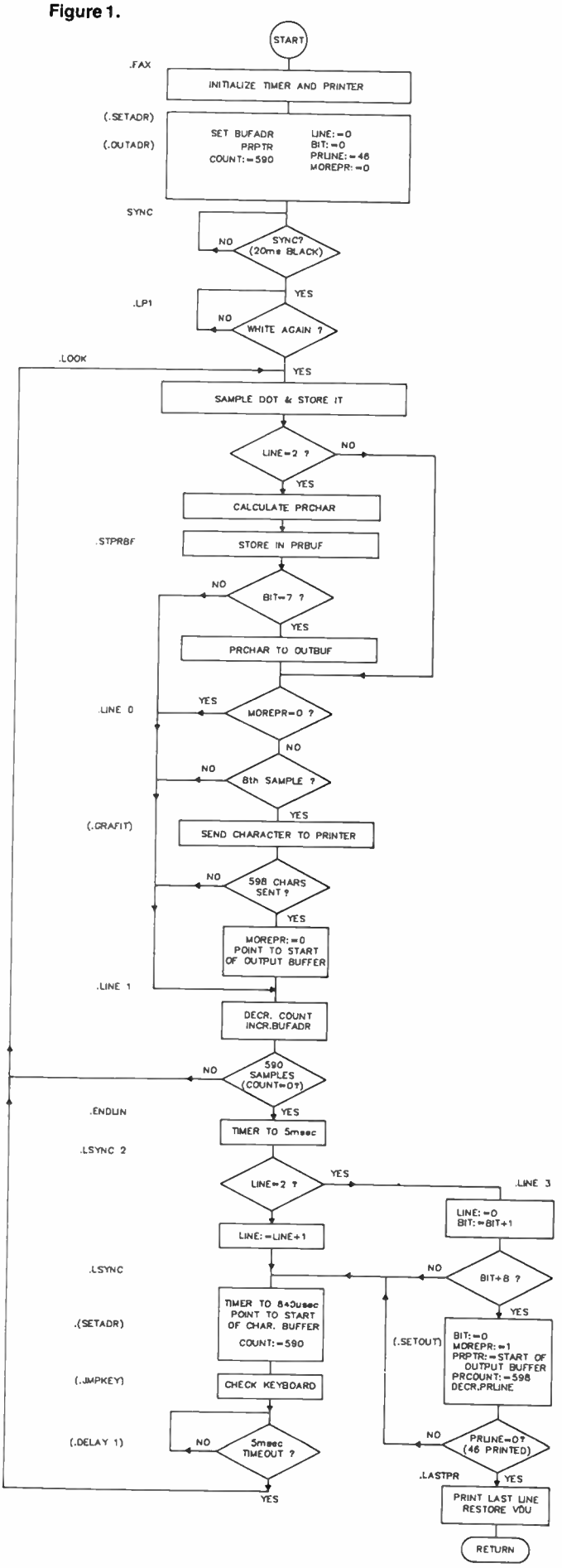
Figure 1.



CQ DE VIS67/69/84 OSX 8/12/16MHZ 4/6/22MHZ ON REQUEST• K CQ DE VIS67/69/84 OSX 8/12/16MHZ 4/6/22MHZ ON REQUEST• K CQ DE VIS67/69/84 OSX 8/12/16MHZ 4/6/ 2 2 M H

Morse received from Sydney Radio on 13 080 kHz, 1445 EST, 8/3/86.

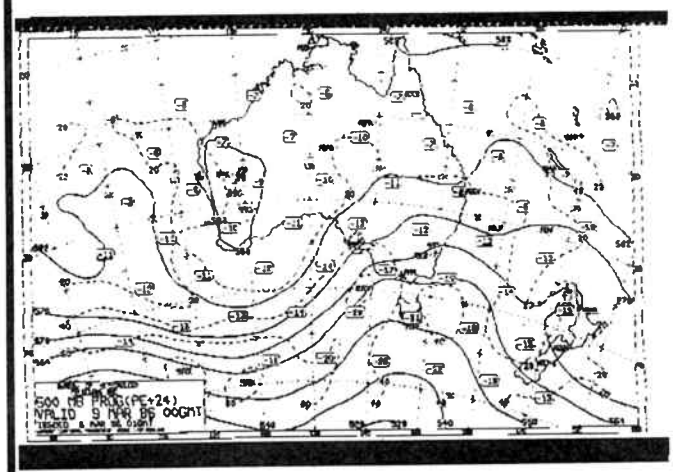
A VERY GOOD AFTERNOON TO YOUR FRIENDS IN THE SHACK THERE FROM BRISBANE IN QUEENSLAND ...I HOPE THAT YOU WILL RECEIVE THIS OK AND THEY GO AWAY WITH A GOOD IMPRESSION OF AMATEUR RADIO IN PARTICULAR RADIOMTIJNMYPE ....SO BTU ALFONS 9M6MU DE VK4AAT PSE KKK

ZAIO VK4AU

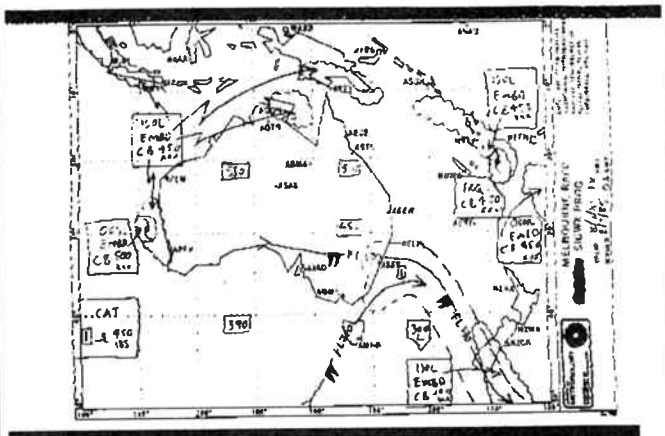
Portion of a radioteletype contact received on the amateur '20 metre' band, 14 090 kHz, 1730 EST, 15/3/86. The Listening Post 'MODE' switch was set to the CW position in this case as narrow-shift frequency-shift keyed (FSK) transmission is employed.

CQ CQ CQ DE HMF36/HMF52 FREQ 13580/11476 KHZ KCNA PYONGYANG VVV VA T T T I A VVV CQ CQ CQ DE HMF36/HMF52 FREQ 13580/11476 KHZ KCNA PYONGYANG VVV VVV VVV CQ CQ C ET K DE HMF36/HMF52 FREQ 13580/11476 KHZ KCNA PYONGYANG VVV VVV VVV CQ CQ CQ DE HMF36/HMF52 M T T EE Q 13580/11476 KHZ KCNA PYONGYANG VVV VVV VVV C Q CQ CQ DE HMFM EE EEE N T T GET TTTT TT EETE EEEEE EETM FREQ 13580/11476 KHZ KC NA PYONGYANG VVV VVV VVV CQ CQ CQ DE HMF36/HMF52 A TT EREQ 13580/11476 KHZ A T T

Morse code on 13 580 kHz from Korea. This was an FSK transmission. Print made at 0925 EST on 9/3/86.



Another FAX weather chart from AXM, 11 030 kHz again, 1400 EST, 8/3/86.



AXM again, with another type of weather chart; 1345 EST on 11 030 kHz, 8/3/86.

NOTE OF INTEREST: An ingenious method of picking-up the audio from a receiver which avoids electromagnetic interference from a computer being 'back-coupled' into the receiver was detailed in a letter published on page 62 of the March '86 issue of *Electronics & Wireless World*. The reader, A.F. Abbey, employed a telephone pickup coil taped to the centre of his receiver's loudspeaker grille, which gave several tens of mV output which would probably prove sufficient for direct input to the Listening Post. Use shielded cable and locate the AEM3500 and computer some metres from the receiver to minimise radiated interference.

A final characteristic of the BBC which is relevant to real-time applications is the method used to service its peripherals. Interrupts are used extensively. The disk interface and the local area network interface use non-maskable interrupts, and the serial and parallel interfaces cause interrupts which are maskable. Every 10 milliseconds an interrupt occurs whether you like it or not. The processor checks to see whether a key has been pressed on the keyboard, updates its 'Time' clock, increments several interval timers, and checks the interrupt status of several peripherals. Consequently, if you wish to build a software delay into your program (decrementing a counter in a loop) and the delay is less than, say one millisecond, you might find that the period of the delay varies depending on whether or not an interrupt occurred during the delay interval. Fortunately, however, the parallel interface (VIA) has counter-timers which can be set to provide an accurate delay period.

The Listening Post software

By this stage you should have the idea that the differences between a Microbee program and a BBC program are more than simply the differences between Z80 and 6502 machine code instructions.

The BBC program for RTTY and Morse code reception follow the original Microbee program reasonably closely. The same labels have been used where appropriate. The software delay loops have been removed, and the VIA (a 6522) interval timers are used in their place. Some additional memory locations (in page zero) are used to make up for the smaller number of registers of the 6502. The ability to switch a printer on and off during RTTY and Morse code reception has been provided: CTRL/B turns the printer on, and CTRL/C turns it off, i.e.: the same keys as are used by the BASIC system. Page mode in the RTTY section is not implemented.

The FAX reception section has undergone something of a transformation. The original program required 26K bytes of memory to store the picture information. As discussed earlier, there just isn't that much RAM available for user programs, and as a consequence the information must be sent to the printer as it is received. The flow-chart for the BBC FAX program is shown in Figure 1. I considered sending the information to the screen as well as to the printer, and may yet incorporate it in a future revision; but as I do have a printer, I would rather print the FAX as it is received and be able to see it all, rather than be able to see and subsequently print only 256 lines of a 360 line picture.

One variation from the original program is the method used to combine the three FAX lines into one printed line. The BBC looks at four lines, the fourth being the last line of the previous trio. If two adjacent samples out of the four are black, then a dot is printed; if all three are black, a dot is printed; otherwise no dot is printed. I believe that this method gives slightly better reproduction, evident in the legibility of the location codes on the weather maps. These names, and the text on the facsimile schedule, are five dots high on the printed result — compared with eight dots on a normal dot-matrix printout.

The program as listed will not run — it occupies too much memory. To run it, you must remove all of the REM statements and comments from line 1000 to line 1900, saving the resulting program under a different filename (e.g.: "NOREMS"). Press the 'BREAK' key, type 'PAGE = &2100' followed by 'RETURN', then 'LOAD "NOREMS" ' and 'RUN'. The machine code program is then saved as 'FAX'. To run this program, hit BREAK again, then type '*FAX' and you're away.

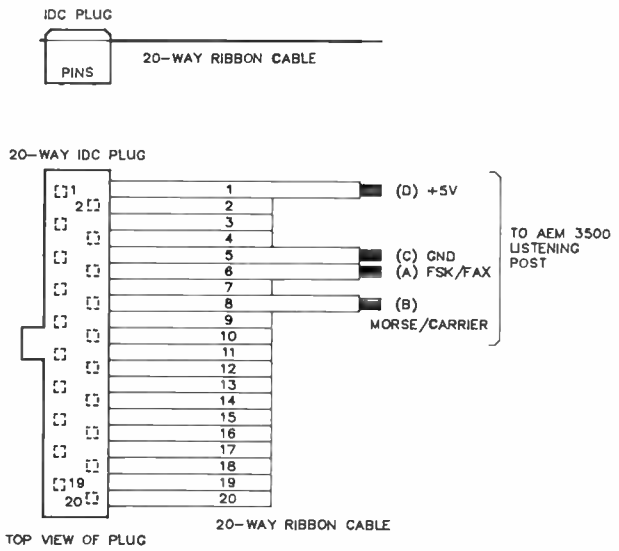
If you have an MX-80 (or similar) printer, different control sequences are necessary. The changes for an MX-80 are listed after the main program listing; once these changes have been made, operation is the same as for an ITOH printer. ▶

Pressing the RTTY or Morse code keys will cause characters to appear on the screen as soon as your receiver is correctly tuned; pressing CTRL/F for FAX reception will cause the printer to Line Feed once immediately, then once more when a sync pulse has been detected. Twelve seconds later, the first line will be printed. If you abort in mid-picture by pressing 'ESCAPE', you will have to reset your printer, by switching it off then back on again.

Connecting to the BBC

The Listening Post is connected via a length of 20-way ribbon cable to a 20-pin IDC plug, which plugs into the 'user port' underneath the keyboard of the BBC. The connections are shown in Figure 2.

Figure 2.



Connecting cable for AEM 3500 Listening Post to BBC User Port

I endorse the comments of Neil Duncan regarding the fitting of RF chokes into the audio leads from the receiver, even in the plastic box version.

Performance

The best results are obtained when AXM is strong, to over-ride interference, and stable, i.e: without any multipath fading. One of the most interesting charts I received was the 'Melbourne AXM Radiofacsimile Schedule', giving the times for sending of the different weather charts, also of the RTTY data transmissions.

The schedule is sent between 0115 and 0130 UTC daily. If you can make sense of that transmission, then your system is working well. Of course, once you have the schedule, you don't have to wait around hoping another chart might be sent . . . soon . . .!

Just a word about the values stored at lines 4760 and 4780. These should be adjusted to give a rectangular plot with the BBC warm, i.e: make sure that it has been on for an hour or so. I have found that my plots drift a little, and I can only put it down to variations in the microprocessor clock frequency with temperature. A total of 100 Hz drift in the 1 MHz clock frequency would cause the plot to slope by about 20 mm from top to bottom.

The coarse value for the five millisecond delay resides at location &1BAE, and the fine value at &1BB2. These can be examined and changed using 'P.?&1BAE' and '?&1BAE = &09' respectively, then '*SAVE "FAX" 1900 20FO'. When the correct value for your BBC is found, edit the source file.

```
1000 REM ********************************************************
1010 REM *      LISTENING POST SOFTWARE FOR THE BBC MICRO        *
1020 REM *              WRITTEN BY ANDREW BOON                   *
1030 REM *        BASED ON THE ORIGINAL MICROBEE PROGRAM         *
1040 REM *                    BY TOM MOFFAT.                     *
1050 REM *                                                       *
1060 REM *                      14.3.86                          *
1070 REM ********************************************************
1080 REM N.B. Type  PAGE=&2100  before loading program. ******
1090 RDIO=&9e: REM OSBYTE parameter to read from Mapped I/O.
1100 INKEY=&81: REM Read key with time limit.
1110 WRIO=&97: REM OSBYTE parameter to write to Mapped I/O.
1120 REM Define User VIA Register Offsets.
1130 IRB=&60:VORA=&61:DDRB=&62:T1CH=&65:T1LL=&66:T1LH=&67
1140 ACR=&6B:PCR=&6C:VIFR=&6D:IER=&6E
1150 REM Operating System Routines.
1160 OSASCI=&FFE3:OSNEWCH=&FFEE:OSBYTE=&FFF4
1170 REM Page zero variables.
1180 line=&70: mode=&70:ref=&70
1190 bit=&71:  code=&71:refmk=&71
1200 butadr=&72:figur=&72:refsp=&76
1210 count=&74: char=&73:last=&77
1220 prline=&76:dischr=&74:lastmk=&78
1230 morepr=&77:            lastsp=&7A
1240 prptr=&78
1250 prcount=&7A
1260 addrhi=&7C:addrlo=&7D:baud=&7E
1270 FOR opt%=0 TO 3 STEP 3
1280   P%=&1900: REM Start address of Assembly Language Program.
1290   [
1300   OPT opt%
1310   .start  LDA #WRIO     \Set all VIA lines (PB0-7) as inputs.
1320           LDX #DDRB
1330           LDY #0
1340           JSR OSBYTE
1350           LDA #6         \Set up printer.
1360           LDX #&FF
1370           JSR OSBYTE
1380   .tellit LDA mess,Y     \Display sign-on message.
1390           JSR OSASCI
1400           INY
1410           CMP #0         \End of message?
1420           BNE tellit     \No - write next character.
1430   .choose JSR jmpkey     \Loop until a key is pressed.
1440           JMP choose
1450   \
1460   \PTTY RECEPTION
1470   \
1480   .rtty   LDA #0         \Start in Letters shift.
1490           STA figur
1500           LDA #&27       \Initialize RTTY speed to 50 baud.
1510           STA baud
1520           LDA #&10
1530           STA baud+1
1540           LDA #&10       \Initialize Code for Baudot.
1550           STA code
1560   .rtty1  JSR jmpkey     \Jump or Get Key.
1570           BCS inchr      \Skip next if no key pressed.
1580           AND #&5F       \Kill lower case.
1590           CMP #ASC"F"    \Is it an 'F' (Figures shift) ?
1600           BNE P%+6       \Skip next if not.
1610           LDX #1          figur =1 means Figures.
1620           STX figur
1630           CMP #ASC"L"    \Is it an 'L' (Letters shift) ?
1640           BNE P%+6       \Skip next 2 if not.
1650           LDX #0         \figur=0 for Letters.
1660           STX figur
1670           CMP #ASC"B"    \Is it a 'B' (Baudot code) ?
1680           BNE P%+6       \Skip next if not.
1690           LDX #&10
1700           STX code       \code = &10 means Baudot.
1710           CMP #ASC"A"    \Is it an 'A' (ASCII code) ?
1720           BNE P%+6       \Skip next 2 if not.
1730           LDX #&80       \code=&80 for ASCII.
1740           STX code
1750           SEC
1760           SBC #&11       \Subtract &11 to prepare speed change offset.
1770           BCC inchr      \Branch if less than ASCII '1'.
1780           CMP #&09       \Check whether greater than ASCII '9'.
1790           BCS inchr      \Branch if so.
1800           ROL A          \Now have &0-&10 corresponding to '1'-'9'.
1810           TAY
1820           LDX spd,Y      \Get speed value (using offset) from table.
1830           STX baud
1840           INY
1850           LDX spd,Y
1860           STX baud+1
1870   .inchr  LDA #RDIO     \Look for start bit.
1880           LDX #IRB
1890           JSR OSBYTE
1900           TYA            \VIA input data to AccA.
1910           EOR #&FF       \Invert for Mark = Low Tone.
1920           AND #3         \Bit 0 or 1 Low?
1930           BNE rtty1      \If circuit idle -or- no carrier.
1940           JSR tsetup     \Set timer for 0.5 * bit period.
1950           LDA #WRIO      \Disable VIA Timer 1 interrupts.
1960           LDX #IER
1970           LDY #&40
1980           JSR OSBYTE
1990           LDX #ACR       \Set VIA Timer 1 for continuous flags.
2000           LDY #&40
2010           JSR OSBYTE
2020           LDA code       \Set up bit counter (BAUDOT = &10)
2030           STA char
2040           JSR delay1     \Wait for half a bit period.
2050   .shift  JSR delay2     \Wait for one bit period.
2060           LDA #RDIO      \Read data.
2070           LDX #IRB
2080           JSR OSBYTE
2090           TYA
2100           EOR #1         \Invert data bit.
2110           ROR A          \Shift data into carry.
2120           ROR char       \Shift data bit into char.
2130           BCC shift      \Repeat until counter bit out.
2140           JSR delay2     \One bit time.
2150           LDA char
2160           AND #&7F       \Mask off bit 7.
2170           STA dischr     \Save for displaying ASCII.
2180           LDA #&10       \Test if Baudot or ASCII.
2190           BIT code
2200           BEQ vdu        \Straight to vdu if ASCII.
2210           CLC
```

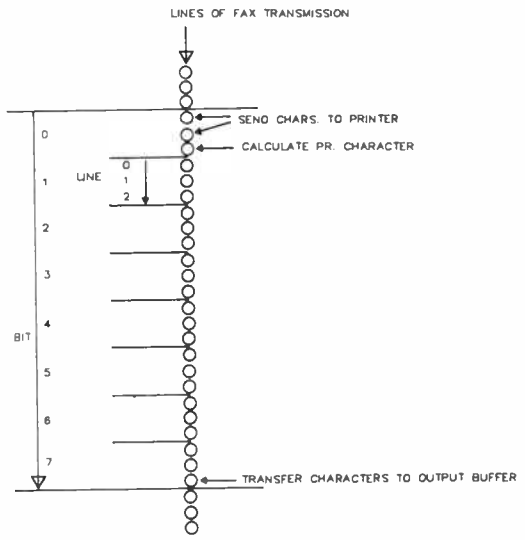
```
2220            ROR char        \Get Baudot char into bits 1-5.
2230            ROR char
2240            LDA char        \Conversion to ASCII.
2250            CMP #&3e        \Is Baudot code (FIGS) ?
2260            BNE P%+6        \Skip next if not.
2270            LDX #1
2280            STX figur       \Set flag to 'FIGS'.
2290            CMP #&3E        \Is Baudot code (LTRS) ?
2300            BNE P%+6        \Skip next if not.
2310            LDX #0
2320            STX figur       \Clear flag for 'LTRS'.
2330            CLC
2340            ADC figur       \Add char to flag.
2350            TAX
2360            LDA tttbl,X     \ASCII char into ACCH.
2370            STA dischr
2380 .vdu       LDA dischr
2390            CMP #&0B        \Trap out vertical tabs.
2400            BEQ P%+5
2410            JSR OSWRCH
2420            JMP rtty1       \Go back to the start.
2430 \
2440 \ MORSE CODE RECEPTION
2450 \
2460 .morse     LDA #&0F        \Set up timer delay.
2470            STA baud
2480            LDA #0
2490            STA baud+1
2500 .morse0    LDA #&FE        \Clear character.
2510            STA char
2520 .morse1    JSR jmpkey      \Check keyboard.
2530            LDA #RDIO
2540            LDX #IRB
2550            JSR OSBYTE
2560            TYA
2570            AND #2
2580            BEQ morse1      \Wait for mark.
2590            LDX #0
2600            STX figur
2610 .mark      INC figur       \Measure mark pulse.
2620            JSR jmpkey
2630            JSR mordly
2640            LDA #RDIO
2650            LDX #IRB
2660            JSR OSBYTE
2670            TYA
2680            AND #2
2690            BNE mark        \Wait for end of mark pulse.
2700            LDA refmk
2710            ASL A
2720            SEC
2730            SBC figur       \Clear C if new mark > 2*ref mk.
2740            BIT char        \More than 7 dots or dashes?
2750            BMI notful      \Branch if not.
2760            LDA char        \Is it '<' (........) ?
2770            BEQ P%+16
2780            LDA #&7F        \For '>' if full of rubbish.
2790            STA char
2800            BNE P%+10
2810 .notful    ROL char        \Store 1 for dash, 0 for dot.
2820            LDA #1
2830            EOR char
2840            STA char
2850            JSR adjust      \Update receiving speed.
2860            LDA ref         \Swap mk and sp values.
2870            STA refmk
2880            LDA last
2890            STA lastmk
2900            LDA lastsp      \Switch into space values.
2910            STA last
2920            LDA refsp
2930            STA ref
2940            ASL A
2950            SEC
2960            SBC refmk
2970            BCS P%+6        \Branch if ref mark < 2*ref space.
2980            LDA refmk       \Else load ref mark into ref space.
2990            STA ref
3000            LDA #0
3010            STA figur
3020 .space     INC figur       \Measure space pulse
3030            BEQ word        \if sending has stopped.
3040            JSR mordly
3050            LDA #RDIO
3060            LDX #IRB
3070            JSR OSBYTE
3080            TYA
3090            AND #2
3100            BEQ space
3110            LDA refsp
3120            ASL A
3130            CMP figur
3140            BCS dot         \Branch if new space < 2*ref space.
3150            ASL A
3160            CLC
3170            ADC refsp
3180            SEC
3190            SBC figur
3200            BCC word        \Branch if new space > 5*ref space.
3210            JSR adjust      \Letter space starts here.
3220            JSR search
3230            JMP out
3240 .word      JSR search      \Word space starts here.
3250            LDA #&20
3260            JSR OSWRCH      \Print a blank.
3270 .out       JSR exback      \Exchange registers.
3280            JMP morse0
3290 .dot       JSR adjust      \Dot space.
3300            JSR exback
3310            JMP morse1
3320 \
3330 .adjust    LDA figur       \Update ref mark or space.
3340            ASL A
3350            SEC
3360            SBC last
3370            BCS adj1        \If last < 2*new then branch.
3380            LDA figur       \Load new into ref.
3390            STA ref
3400            BCC adj2        \Always branches.
3410 .adj1      LDA last
3420            ASL A
3430            SEC
3440            SBC figur
3450            BCS adj2        \If new < 2*last, branch.
3460            LDA last        \Load last into ref.
3470            STA ref
3480 .adj2      LDA figur       \Load new into last.
3490            STA last
3500            RTS
3510 \
3520 .search    LDX #0          \Search &34 characters.
3530 .srch1     LDA mortbl,X
3540            CMP char
3550            BEQ srch2
3560            INX
3570            TXA
3580            CMP #&34
3590            BNE srch1
3600            LDA #&23        \Print '#' for unknown char.
3610            BNE srch3
3620 .srch2     STX char        \Offset where char found.
3630            LDA #&2F
3640            CLC
3650            ADC char
3660 .srch3     JSR OSWRCH      \Print the character.
3670            RTS
3680 \
3690 .exback    LDA ref         \Exchange registers.
3700            STA refsp
3710            LDA last
3720            STA lastsp
3730            LDA refmk
3740            STA ref
3750            LDA lastmk
3760            STA last
3770            RTS
3780 \
3790 \FAX at 120 lines per min., output to C-ITOH B510 printer.
3800 \
3810 .fax       LDA #3          \Enable printer, disable VDU.
3820            LDX #&A
3830            LDY #0
3840            JSR OSBYTE
3850            LDA #3          \Timer variables for 840 usec.
3860            STA baud
3870            LDA #&48
3880            STA baud+1
3890            LDA #WRID       \Timer for continuous flags.
3900            LDX #ACR
3910            LDY #&40
3920            JSR OSBYTE
3930            JSR preamb      \Initialise printer.
3940            JSR tsetup      \Start timer.
3950            LDA #100        \Wait 80 msec for preamble to end.
3960            STA bit
3970 .delay3    JSR delay1
3980            DEC bit
3990            BNE delay3
4000            JSR setadr
4010            LDA #WRIO       \Send LF to set flag.
4020            LDX #VORA
4030            LDY #&0A
4040            JSR OSBYTE
4050            LDA #outbuf2 DIV 256
4060            STA prptr+1     \Pointer for transferring
4070            LDA #outbuf2 MOD 256
4080            STA prptr       \chars to output buffer.
4090            LDA #0
4100            STA line        \0-3, lines to be combined.
4110            STA bit         \0-7, bits per graphics char.
4120            STA morepr      \Don't print first time.
4130            LDA #46         \46 lines gives 9 mins. of fax.
4140            STA prline      \No. of lines printed.
4150 .sync      LDA #&14
4160            STA bit
4170 .sync1     JSR sample      \Find phasing or 20 msec sync pulse.
4180            BCS sync        \Branch if white.
4190            DEC bit
4200            BNE sync1
4210            LDA #WRIO
4220            LDX #PCR
4230            LDY #&A
4240            JSR OSBYTE
4250            LDX #VORA
4260            LDY #&A
4270            JSR OSBYTE
4280 .LP1       JSR sample
4290            BCC LP1         \Wait for white.
4300 \(FAX) Start of picture, phasing or sync pulse OK.
4310 .look      JSR sample      \Sample a dot.
4320            LDY #0
4330            LDA (bufadr),Y
4340            ROL A           \Store sample until have 3.
4350            STA (bufadr),Y
4360            LDY #2
4370            CPY line        \How many dots so far?
4380            BNE line0       \One or Two.
4390            AND #&0F        \Three. Combine them.
4400            EOR #&F         \White becomes '0'.
4410            SEC
4420            SBC #3
4430            BCC stprbf      \Bit 0 or 1 set, print 0.
4440            BEQ stprbf      \Bits 0 and 1 set, print 1.
4450            SBC #3
4460            BCC stprbf      \Bit 2 or 0 set, print 0.
4470            BEQ stprbf      \Bits 1 and 2 set, print 1.
4480            SBC #1
4490            BEQ stprbf      \Bits 0 and 1 and 2 set, print 1.
4500            SBC #4          \Bits (3 and 0) or (3 and 1 ) set, print 0.
4510 .stprbf    LDY #1
4520            LDA (bufadr),Y
4530            ROR A
4540            STA (bufadr),Y
4550            LDY bit
4560            CPY #7          \Last bit of char.?
4570            BNE line1
4580            LDY #0
4590            STA (prptr),Y \Transfer to out buffer if so.
4600            JSR incout
4610            JMP line1       \No printing on line 2.
4620 .line0     LDA morepr      \If 8th sample, print char.
4630            BEQ line1
4640            LDA count
4650            AND #7
```

```
4660            BNE line1
4670            JSR grafit
4680            BNE line1
4690            STA morepr      \All characters printed.
4700            LDA #outbuf2 DIV 256
4710            STA prptr+1     \Pointer for transferring
4720            LDA #outbuf2 MOD 256
4730            STA prptr       \chars to output buffer.
4740  .line1    JSR incbuf      \590 samples?
4750            BNE look        \Read> for ne t sample.
4760  .endlin   LDA #&09        \Timer to 5 msec.
4770            STA baud        \For line sinc.
4780            LDA #&e0        \Fine tune this value.
4790            STA baud+1
4800            JSP tsetup      \Start timer.
4810  .lsync2   LDA #2
4820            BIT line
4830            BNE line3       \Branch if 3rd line.
4840            INC line
4850  .lsync    LDA #&3         \Set timer values for 840 usec.
4860            LDA #WRIO
4870            LDA #T1LH
4880            JSR OSBYTE
4890            LDA #&48
4900            LDX #T1LL
4910            JSR OSBYTE
4920            JSR setadr      \Point to start of buffer.
4930            JSR impke>
4940            JSR delay1      \Wait for 5 msec to end.
4950            JMP look
4960  .line3    LDA #0
4970            STA line        \Set line to 0 (from 2).
4980            LDA bit         \Last bit in character?
4990            CLC
5000            ADC #1
5010            AND #7
5020            STA bit
5030            BNE lsync       \Branch if not.
5040            JSR setout
5050            DEC prline      \How many lines printed?
5060            BNE lsync       \Br if not last.
5070  .lastpr   JSR grafit      \Print last line.
5080            BNE lastpr
5090            LDA #WRIO
5100            LDX #PCR
5110            LDY #&E
5120            JSR OSBYTE
5130            LDX #0
5140            LDY #8
5150  .pr3      LDA data3,X
5160            JSR OSWRCH
5170            INX
5180            DEY
5190            BNE pr3
5200            LDA #3          \Restore VDU, disable printer.
5210            LDX #0
5220            LDY #0
5230            JSR OSBYTE
5240            LDA #WRIO
5250            LDX #PCR
5260            LDA #&E
5270            JSR OSBYTE
5280            LDA #&D
5290            JSR OSASCI
5300            LDY #0
5310            JMP tellit      \End of FAX picture.
5320  \
5330  \Morse Code subroutines.
5340  \
5350  .mordly LDA #WRIO         \Set timer to one-shot mode.
5360            LDX #ACR
5370            LDY #0
5380            JSR OSBYTE
5390            JSR tsetup
5400            JSR delay1      \Wait for timer.
5410            RTS
5420  \RTTY time delay subr, delay length in 'baud'
5430  .delay2 JSR delay1        \Wait for one bit period (2 * 0.5).
5440  .delay1 LDA #RDIO
5450            LDX #VIFR       \Is flag set?
5460            JSR OSBYTE
5470            TYA
5480            AND #&40
5490            BEQ delay1
5500            LDA #WRIO       \Clear flag.
5510            LDY #&40
5520            LDX #VIFR
5530            JSR OSBYTE
5540            RTS             \Exit if set.
5550  \
5560  .tsetup LDY baud+1        \Set up timer from (baud).
5570            LDX #T1LL
5580            LDA #WRIO
5590            JSR OSBYTE
5600            LDY baud
5610            LDX #T1CH
5620            JSR OSBYTE
5630            RTS
5640
5650  FAX routines.
5660  \
5670  .setadr LDA #prbuf DIV 256 \Point to start of pr. buffer.
5680            STA bufadr+1
5690            LDA #prbuf MOD 256
5700            STA bufadr
5710            LDA #2          Initialise counter to 590.
5720            STA count+1
5730            LDA #&4E
5740            STA count
5750            RTS
5760  .setout LDA #outbuf DIV 256 \Start of output buffer.
5770            STA prptr+1
5780            LDA #outbuf MOD 256
5790            STA prptr
5800            LDA #2
5810            STA prcount+1   Counter to 598.
5820            LDA #&5e
5830            STA prcount
5840            STA morepr      Set flag.
5850            RTS
5860  \Fn  time delay & sample routine.
5870  .sample LDA #RDIO         \Check timer flag.
5880            LDA #&1FF
5890            JSR OSBYTE
5900            TYA
5910            AND #&40
5920            BEQ sample      Br. if not set.
5930            LDA #RDIO       Read a pixel.
5940            LDA #IRB
5950            JSR OSBYTE
5960            TYA
5970            PHA
5980            LDA #WRIO       Clear flag.
5990            LDA #&1FF
6000            LDX #&40
6010            JSR OSBYTE
6020            PLA             Point it to Carry.
6030            RTS
6040  Printer preamble, for unidirectional graphics.
6050  .preamb LDA #0
6060            LDX #2
6070  .pr1      LDA data1,X
6080            JSR OSWRCH
6090            INX
6100            DEX
6110            BNE pr1
6120            RTS
6130  Send char. to printer, incr pointer, decr counter.
6140  .grafit LDA #RDIO         Printer flag set?
6150            LDX #&1FF
6160            JSR OSBYTE
6170            TYA
6180            AND #&2
6190            BNE pread>      Branch if read>.
6200            LDA #1          Clears Z flag.
6210            BNE notset      Always branches.
6220  .pread> LDX #0
6230            LDA (prptr,X)
6240            TAY
6250            LDA #WRIO
6260            LDX #VDRA
6270            JSR OSBYTE
6280  Increment output buffer pointer.
6290  .incout INC prptr
6300            BNE P%+4
6310            INC prptr+1
6320            SEC             Decrement counter.
6330            LDA prcount
6340            SBC #1
6350            STA prcount
6360            BCS P%+4
6370            DEC prcount+1
6380            ORA prcount+1   Z=1 if prcount=0 on exit.
6390  .notset RTS
6400  \Increment buffer pointer, decrement counter.
6410  .incbuf CLC
6420            LDA #2
6430            ADC bufadr      \Incr. buffer ptr by 2.
6440            STA bufadr
6450            BCC P%+4
6460            INC bufadr+1
6470            SEC
6480            LDA count
6490            SBC #1          \Decr. counter.
6500            STA count
6510            BCS P%+4
6520            DEC count+1
6530            ORA count+1     \Exit with Z=1 if count=0.
6540            RTS
6550  \
6560  \Selects if RTTY,Morse or Fax Reception.
6570  \
6580  .impke> PLA               \Save return address.
6590            STA addrhi
6600            PLA
6610            STA addrlo
6620            LDX #0          \No delay when reading character.
6630            LDY #0
6640            LDA #INPKEY
6650            JSR OSBYTE      \Read char. from keyboard, if any.
6660            TXA
6670            BCC check       \Carry =0 means a char. read, except 'ESC'.
6680            TYA
6690            CMP #&1B        \Check for  'ESC'
6700            BNE nokey
6710            LDA #3          \Restore output to VDU.
6720            LDX #0
6730            LDY #0
6740            JSR OSBYTE
6750            LDA #&7E        \Mandatory if an ESC is pressed.
6760            JSR OSBYTE
6770            RTS             \Return to BASIC.
6780  .check    CMP #&12        \CTRL/R ?
6790            BNE P%+5
6800            JMP rtty
6810            CMP #&0D        \CTRL/M ?
6820            BNE P%+5
6830            JMP morse
6840            CMP #&06        \CTRL/F ?
6850            BNE P%+5
6860            JMP fax
6870            CMP #2          CTRL B ?
6880            BNE P%+14
6890            LDX #8          \Turn on printer.
6900            LDY #0
6910            LDA #3
6920            JSR OSBYTE
6930            JMP nokey
6940            CMP #3          \CTRL C ?
6950            BNE P%+14
6960            LDX #0          \Turn off printer.
6970            LDY #0
6980            LDA #3
6990            JSR OSBYTE
7000            JMP nokey
7010            TAX
7020            LDA addrlo      \Restore return address
7030            PHA
7040            LDA addrhi
7050            PHA
7060            TYA             Restore A
7070            CLC
7080            RTS
```

```
7100    .nokey  LDA addrlo      Restore return address.
7110            PHA
7120            LDA addrhi
7130            PHA
7140            SEC             Set Carry Flag - no key pressed.
7150            RTS
7160    .mess
7170    ]
7180 'mess=&0D0D0D0D
7190 P%=P%+4
7200 $P%="     LISTENING POST:  Select function:"
7210 P%=P%+LEN($P%)
7220 ?P%=&0D
7230 P%=P%+1
7240 $P%="      'P=RTTY      M=MORSE      F=FAX"
7250 P%=P%+LEN $P%)
7260 ?P%=&0D
7270 P%=P%+1
7280 $P%="                ESC=EXIT  ... ?"
7290 P%=P%+LEN($P%)
7300 'P%=&0D0D0D0D
7310 P%=P%+4
7320 ?P%=0
7330 P%=P%+1
7340    [
7350    OPT opt%
7360    .spd
7370    ]
7380 REM *
7390 REM * RTTY speed table.
7400 REM *
7410 ?spd=&2A: REM RX) 1,  45.45 BD   60 WPM
7420 spd?1=&F8
7430 spd?2=&27:REM RX) 2,     50 BD   66 WPM
7440 spd?3=&10
7450 spd?4=&22:REM RX) 3,     57 BD   75 WPM
7460 spd?5=&44
7470 spd?6=&1A:REM RX) 4,     75 BD  100 WPM
7480 spd?7=&08
7490 spd?8=&11:  REM RX) 5,    110 BD
7500 spd?9=&C1
7510 spd?A=&0E: REM RX) 6,  134.5 BD
7520 spd?B=&85
7530 spd?C=&0D: REM RX) 7,    150 BD
7540 spd?D=&05
7550 spd?E=&0C: REM RX) 8,    300 BD
7560 spd?F=&83
7570 spd?&10=&03:REM RX) 9,   600 BD
7580 spd?&11=&41
7590 P%=P%+&12
7600    [
7610    OPT opt%
7620    .ttytbl
7630    ]
7640 REM *
7650 REM * RTTY ASCII lookup table arranged by reverse BAUDOT.
7660 REM *
7670 ttytbl=&33450505: REM (BLANK) E 3
7680 ttytbl'4=&2D410A0A: REM (LF) - A
7690 ttytbl'8=&27532020: REM (SPACE) S
7700 ttytbl'&C=&37553849: REM I 8 U 7
7710 ttytbl'&10=&00440D0D: REM (CR) D
7720 ttytbl'&14=&074A3452: REM R 4 J (BELL)
7730 ttytbl'&18=&2546C4E: REM N , F %
7740 ttytbl'&1C=&28483A43: REM C : K (
7750 ttytbl'&20=&225A3554: REM T 5 Z "
7760 ttytbl'&24=&3257294C: REM L ) W 2
7770 ttytbl'&28=&3o590048: REM H (STOP) Y o
7780 ttytbl'&2C=&31513050: REM P 0 Q 1
7790 ttytbl'&30=&3F42394F: REM O 9 B ?
7800 ttytbl'&34=&04042447: REM G $ (FIGS)
7810 ttytbl'&38=&2F582E4D: REM M . X /
7820 ttytbl'&3C=&080B3D56: REM V = (LTRS)
7830 P%=P%+&40
7840    [
7850    OPT opt%
7860    .morttbl
7870    ]
7880 REM *
7890 REM * (MORSE) Morse code character table.
7900 REM *
7910 'morttbl=&CAADD69E:     REM ' ( ) +     +=(AR)
7920 morttbl'4=&95A183C8:    REM * , - .     +=(AS)
7930 morttbl'8=&C7CFDFD2:    REM / 0 1 2
7940 morttbl'&C=&D0C0C1C3:   REM 3 4 5 6
7950 morttbl'&10=&88DEDCD8: REM 7 8 9 :
7960 morttbl'&14=&7FD100AA: REM ; < = >   <=ERROR  >=OVERFLOW
7970 morttbl'&18=&E8F9858C: REM ? @ A B   @=(SK)
7980 morttbl'&1C=&E2FCF4EA: REM C D E F
7990 morttbl'&20=&E7F8E0F6: REM G H I J
8000 morttbl'&24=&FAF8E4F5: REM K L M N
8010 morttbl'&28=&F2EDE6F7: REM O P Q R
8020 morttbl'&2C=&E1F1FDF0: REM S T U V
8030 morttbl'&30=&ECEBE9F3: REM W X Y Z
8040 P%=P%+&34
8050    [
8060    OPT opt%
8070    .data1
8080    ]
8090 REM *
8100 REM * ITOH Printer sequences
8110 REM *
8120 'data1=&3631541B:  REM ESC T 1 6  Line feed pitch 16/144".
8130 data1'4=&0A0D3E1B: REM ESC > CR LF Unidirectional mode.
8140 P%=P%+8
8150    [
8160    OPT opt%
8170    .outbuf
8180    ]
8190 'outbuf=&53180A0D:  REM CR LF ESC S Graphics preamble.
8200 outbuf'4=&30393530: REM 0 5 9 0 No. of graphics bytes.
8210 P%=P%+8
8220    [
8230    OPT opt%
8240    .outbuf2
8250    ]
8260 P%=P%+590
8270    [
8280    OPT opt%
8290    .data3
8300    ]
8310 'data3=&1B3C1B0D: REM ESC < ESC = Bidirectional, 1/6" LF.
8320 data3'4=&0D0A0A41: REM A LF LF CR
8330 P%=P%+8
8340    [
8350    OPT opt%
8360    .prbuf          Print buffer for fax graphics (2*590 bytes).
8370    ]
8380 NEXT opt%
8390 *SAVE "FAX" 1900 20F0
8400 END
```

MODIFICATIONS FOR MX-80 PRINTERS

```
4530            POL #
5140            LDA #12
5910            ETX prcount+1  Counter to 602.
5920            LDA #25A
6100 REM * MX-80 Printer sequences
6110 REM *
6120 'data1=&0E411B0D:  REM CR ESC A CHR$(8)  LF Pitch 8 72"
6130 data1'4=&0D01551B: REM ESC U CHR$(1) CR  Unidirectional mode.
6190 'outbuf=&0A0D0000:  REM NUL NUL CR LF
6195 outbuf'4=&000B411B: REM ESC A CHR$(8) NUL  8 72" LF Pitch
6200 outbuf'8=&024E4B1B: REM ESC K 590  Graphics preamble.
6211 P%=P%+12
6220 'data3=&0D0D0000: REM NUL NUL CR LF
6225 data3'4=&0000551B: REM ESC U CHR$(0) NUL  Bidirectional mode.
6230 data3'8=&00321B: REM ESC 2 NUL LF  1 6" LF Pitch
6240 P%=P%+12
```



literature review

SILICON VALLEY. HIGH TECH WINDOW TO THE FUTURE. Text by Gene Bylinsky, photography by Charles O'Rear, design by Lawrence Bender. A Kevin Weldon Production, 1985. Hard covers, 278 pages, 318 x 253 mm. ISBN 0-962276-001-5. $39.95. Review copy from Weldon-Hardie Pty Ltd, PO Box 40, Dee Why 2099 NSW.

FOR ANYONE with the slightest interest or involvement in electronics this unashamedly coffee-table production is a must. It's a big book in every way — 318 mm tall by 253 mm wide by 30 mm thick and weighing 2.13 kg, covering a big subject in an impressive, but factual and informative style. The show-off cover in silver cloth with impressed silver-sheen and white lettering sports a central black square in which is embedded an IC beneath a transparent epoxy bubble. It's a video controller chip, we are told inside. It provides a focal point for both the cover and the contents.

In 11 chapters it covers, in words and graphic pictures, the background, history and development of California's Silicon Valley, spawning ground of a modern industrial, technological and commercial revolution, which has had, and will continue to generate, far-reaching changes in lives the world over.

Author Gene Bylinsky identifies Frederick E. Terman as the 'father' of Silicon Valley. I remember a certain textbook I had as a student during the 60s when I studied Communications Enginering at RMIT. It was *Radio Engineering* by one F.E. Terman. However, the area's genesis is identified as 1912 when Lee De Forest, inventor of the three-element vacuum tube, discoverd how to employ the vacuum tube as an audio amplifier and RF generator. At the time, he lived at 913 Emerson St, San Jose — now marked by a plaque boldly declaring it as "the birthplace of electronics".

The Federal Telegraph Company seems to have been the seminal 'startup' company of Silicon Valley, kicked-off by a graduate of nearby Stanford University, Cyril Elwell. It became an 'incubator' for other startup ventures in the area during the 20s, a model often followed in later times. However, Bylinksy says Silicon Valley's real establishment and growth as a technology breeding ground grew from Terman's efforts from the late 1930s onward.

Silicon Valley's most-famous early startup was the Hewlett-Packard Company. With Terman's encouragement, two of his bright graduates, William Hewlett and David Packard, developed and commercialised an audio oscillator, operating from the one-car garage where Packard and his wife lived at 367 Addison Ave, Palo Alto. It was 1937. The company now employes over 85 000 people worldwide.

Terman's successful proteges are legion, but it's worth mentioning the Varian brothers, Russell and Sigurd, who invented and commercially developed the klystron microwave oscillator so widely employed in air-to-air and ground-to-air radar in World War II. Stanford kicked-in financially ($100!) during the Varian's development years, in return for a share of any future royalties. It paid off.

Such experiences have provided models for the many 'technology perks' springing up around the world, where cross-fertilisation between technical teaching and research institutions and technology companies is a major ingredient of their formation.

However, it took a team of seven young enthusiastic and visionary scientists and engineers to put the 'silicon' into Silicon Valley. Gordon E. Moore, Sheldon E. Roberts, Eugene Kleiner, Robert N. Noyce, Victor H. Grinich, Julius Blank, Jean Hoerni and Jay Last departed the Shockley Semiconductor Laboratory (set up by William Shockley, one of the inventors of the transistor) and with venture capital from the Fairchild Camera and Instrument Co., set up Fairchild Semiconductor in Mountain View in 1957. Not only did they pioneer silicon transistor technology such as the planar process, but were the first company to commercially manufacture and market an integrated circuit.

The IC was invented nearly simultaneously by Bob Noyce of Fairchild and Jack Kilby of Texas Instruments, says author Bylinsky. Mass production of the first IC made Noyce the 'Henry Ford' of the semiconductor industry. Noyce and Gordon Moore left Fairchild in 1968 to found Intel, raising $2.5 million capital in a matter of hours. Intel started by making memory chips, replacing the large, slow core memories of the time. Later, in 1971, Intel's 'Ted' Hoff designed the world's first microprocessor, launching Intel and the world down a path upon which we'll never turn back.

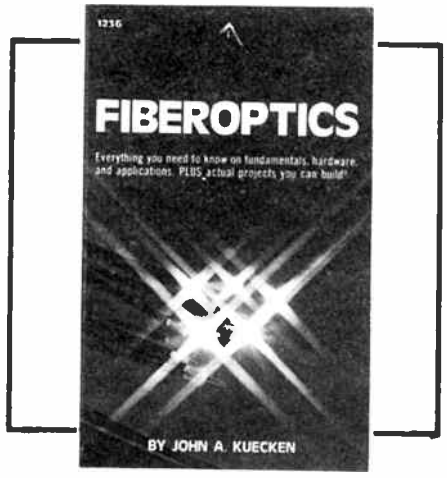
In chronicling the story of Silicon Valley, Bylinsky examines some 15 companies. He does not restrict himself to just the chip developers and manufacturers, but covers equipment manufacturers, the necessary service companies like venture capitalists and marketing firms, and the 'new era' biological and medical engineering firms now arising. He examines not just firms as entities, but the people behind them as well — the 'movers and shakers'. There are some strange and interesting contrasts to be found.

While we marvel at the enterprise of Silicon Valley, and the benefits it has brought, Bylinsky returns some perspective with one short chapter on some of the effects of the Silicon Valley success, environmental and social.

The text seems thoroughly researched and well-organised and the illustrative photography — the majority in colour, just marvellous. The text would be generally readable and understandable to anyone with a high school education. However, on a critical note, I found the text to be clumsy and technically inaccurate in a few places.

You can read the book from cover to cover, or just 'dip into it' as you fancy. It's a mine of fascinating reading, information and statistics. Try this — "If Silicon Valley were a country, it would rank 12th in the world in gross domestic product. About 1.3 million people live in Silicon Valley, and the 400 000 of them who create high technology products influence how the rest of the world works and plays." Is that just a demographic truism or a profound comment of tremendous socio-economic insight?

Roger Harrison



FIBEROPTICS
by John A. Kuecken, TAB Books 1980. Soft covers, 364 pages, 130 x 210 mm. ISN 0-8306-9709-8. Review copy from Dick Smith Electronics. $26.50.

THE DATE of publication would seemingly mark this book as a bit 'long in the tooth', but prospective readers should not be put off by that. It's a fairly thorough coverage of the subject, presented in a 'practical textbook' style.

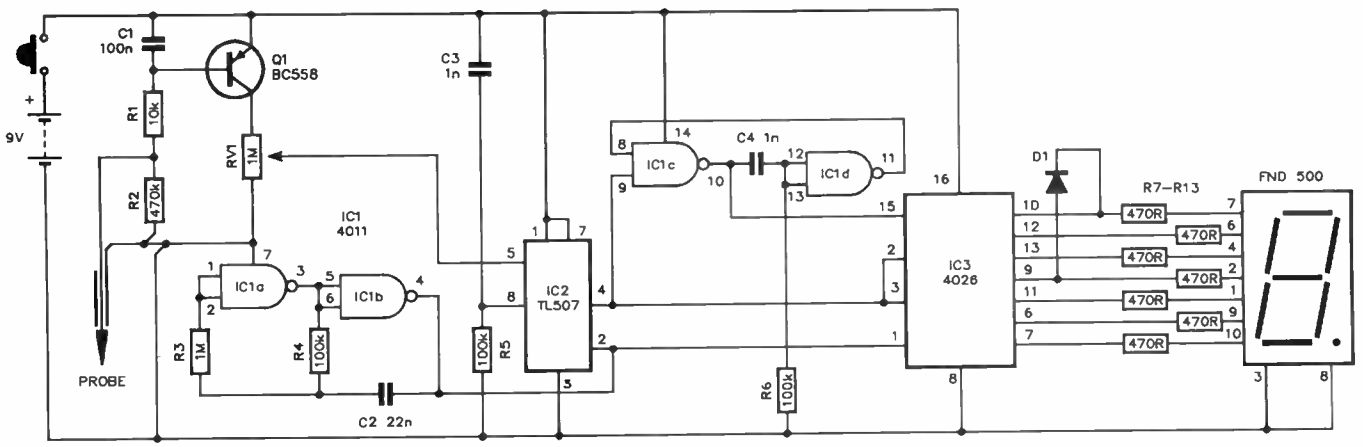
In 21 chapters, the author provides a detailed coverage of every aspect of fiberoptics (his spelling — American) theory and applications. Some of it, to my mind, is a little obscure — possibly irrelevant these days. The chapters on wave mechanics would require an understanding of calculus, but if you're not interested, you can readily skip it.

The two practical chapters provide some useful information, circuits and application suggestions, although you may need to apply some resourcefulness to find some of the devices mentioned.

If your bag is fiberoptics, this book is well worth a 'bo-peep'.

— Roger Harrison

BenchBook



Digital moisture meter

This handy moisture meter will display a number between 0 and 9 depending on the level of moisture in the soil into which the probe is thrust.

The sensor probe is a metal tube with an insulated 'pointy' metal end. The resistance across the probe will vary with soil moisture, varying the base current of Q1, thus varying the collector current and the voltage drop across RV1. I have used an analogue-to-digital converter chip (IC2, a TL057) to sense Q1's collector voltage and to drive a 4026 (IC3) decimal counter/7-segment display decoder-driver which drives an FND500 (or equivalent) 7-segment LED display.

The unit is powered-up by pressing the pushbutton. IC2 is initially reset by the RC network of C3-R5. IC1a and b (two gates from a 4011 quad NAND gate) and surrounding components make an oscillator giving out pulses at around 400 Hz from pin 4 of IC1b. This provides clock pulses for the ADC (IC2) and the counter/display driver IC3.

The more moisture in the soil, the less resistance across the probe contacts, which increases the base current to Q1. The collector voltage will rise toward the positive rail, raising the input to IC2, tapped off the wiper of RV1.

The output of IC2 (pin 4) remains low for a certain number of clock cycles, depending on the input voltage. This duration is measured by IC3 and shown on the 7-segment display. IC1c and d, plus surrounding components, form a one-shot which resets IC3 just as the output of IC2 goes low, readying IC3 to count the duration of the ADC's output.

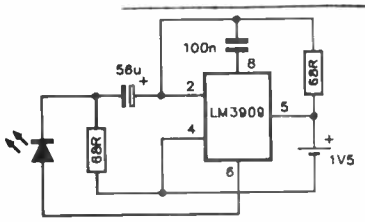
Diode D1 improves the look of the '6' display by turning on the top bar (segment a) whenever segment d is on, otherwise the 6 looks more like a 'b'.

Trimpot RV1 provides for adjustment of the 'full-scale' reading. It should be adjusted so that drenched soil (or whatever you determine as maximum moisture), will just read 9.

Although this project was originally intended to measure the moisture content of the soil in pot-plants, it can easily be adapted for numerous other purposes. e.g.: temperature sensor, etc. It can also be adapted to a three-digit display, although the TL057 ADC chip only counts to 127. You can cascade further displays by simply connecting the 'carry out' pin of IC3 (pin 9) to the clock pin (pin 1) of another 4026 driving the second display.

The TL057 chip I obtained from Tandy.

Brian Murray,
Gorokan NSW



LED light booster

LEDs pulsed with high current at high repetition rates appear brighter, which can be a distinct advantage, of not a necessity, under some circumstances.

This circuit employs the common LM3909 LED Flasher IC operating at 20 kHz or so to provide high current pulses to the LED. The LED's output is very bright with each pulse, much brighter than with a steady current applied, and the eye's 'persistence of vision' at the high repetition rate makes it appear as though the LED has a continuous high brightness output.

Darren Stokes,
Coonamble NSW

Listening Post FAX pictures with a Microbee and CPA-80 printer

The following information will assist those readers who, like myself, tried to use a CPA-80 printer to print decoded Listening Post FAX pictures with the Microbee running the Epson printer output software.

The CPA-80 printer, though "Epson compatible", produces reverse images as the print head fires in the reverse order. Thanks to the assistance of Roy Vietch of Digital, the problem is easily solved by changing the program at address OB95 from CB01 to CB09. By doing so, the C register is now rotated to the right. This now produces good FAX pictures with the CPA-80 printer.

P.J. Lawler VK3DCN,
Dandenong 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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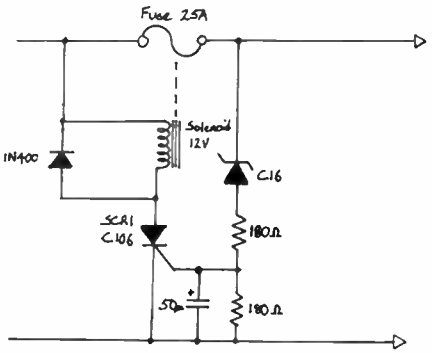
The Last Laugh

An improved overload protection scheme for power supplies

This is an absolutely foolproof method of protecting high current power supplies from damage from over-current, and of protecting equipment in the event the power supply loses regulation.

The components in Figure 1 are mounted somewhere near the power supply's output terminals. This is necessary since the total power supply current must flow through the fuse (A). The fuse is selected to go to the open-circuit condition when the power supply current drain exceeds the design maximum by about 20%.

Adjacent to fuse (A) is solenoid (B). This is connected to the silicon controlled rectifier (C) such that any overvoltage condition causes the zener diode to conduct, turning the SCR on.



When the SCR conducts, current flows through solenoid (B) causing plunger (D) to move in an outward direction. This in turn moves the conical-shaped protrusion on plunger (D) into the space occupied by the fuse. Within a few milliseconds the wire within fuse (A) goes to a very high resistance, limiting the current flow to a safe value.

Figure 1b shows the operation of the circuit in the fault condition.

Figure 2 depicts a different fuse arrangement suitable for higher current power supplies, in the 200 amp class. Here the overvoltage circuit requires more power to activate the resistance increase in the fuse.

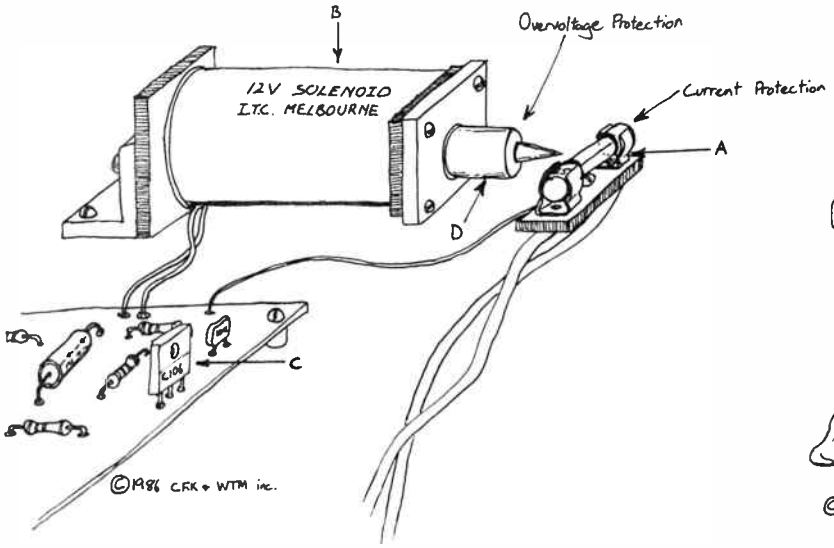
This is provided by a small quantity of plastic explosive cast around the fuse holder during manufacture. Operation of the circuit is similar to the one in Figure 1a, except that the SCR output is connected to a detonator embedded in the substance surrounding the fuse.

Operation of this circuit is even faster than the lower current version, and it is even possible to hear a sound as the fuse goes into its higher resistance mode. Figure 2b shows the appearance of this circuit during a fault condition.

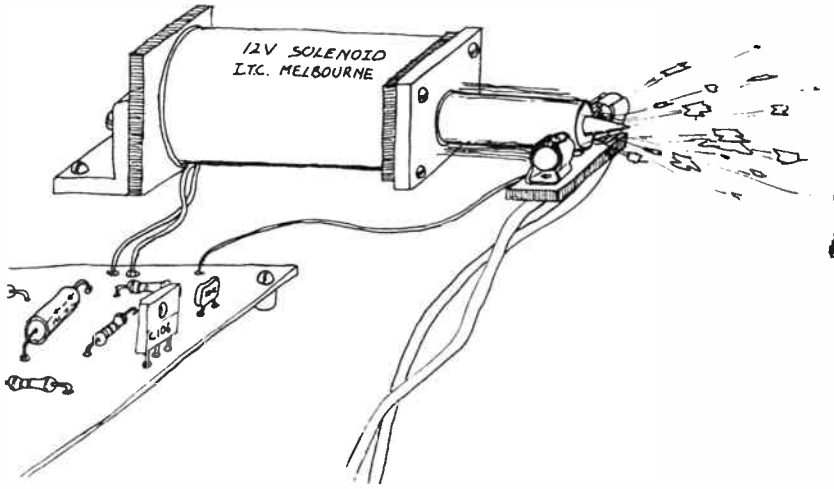
It is suggested that these circuits only be used in completed equipment properly housed in metal cabinets. In addition it is suggested that the higher current version be housed in an enclosure made of matted hessian rope. This material is sometimes referred to as "blasting mat".

(Concept developed by Tom Moffat and Craig Ford-King for possible use in Hydro-Electric Commission installations.)

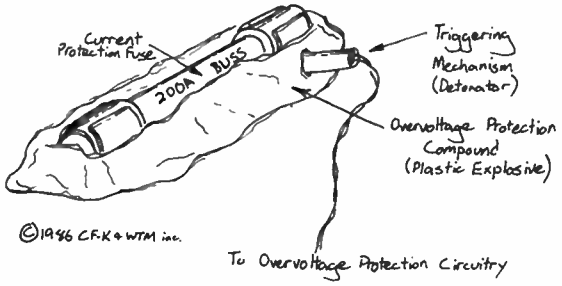
(Fig 1a) NORMAL CONDITION



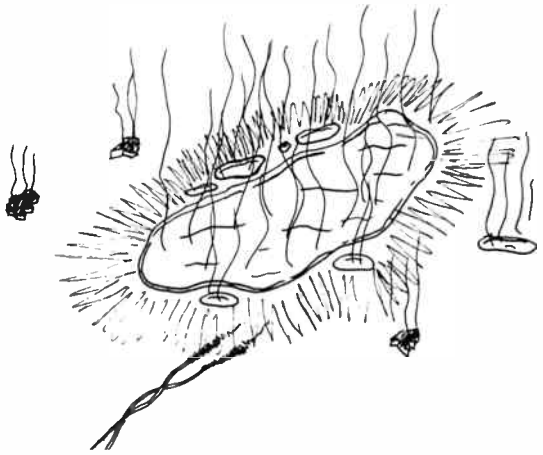
(Fig 1b) FAULT CONDITION



(Fig 2a) NORMAL CONDITION



(Fig 2b) FAULT CONDITION



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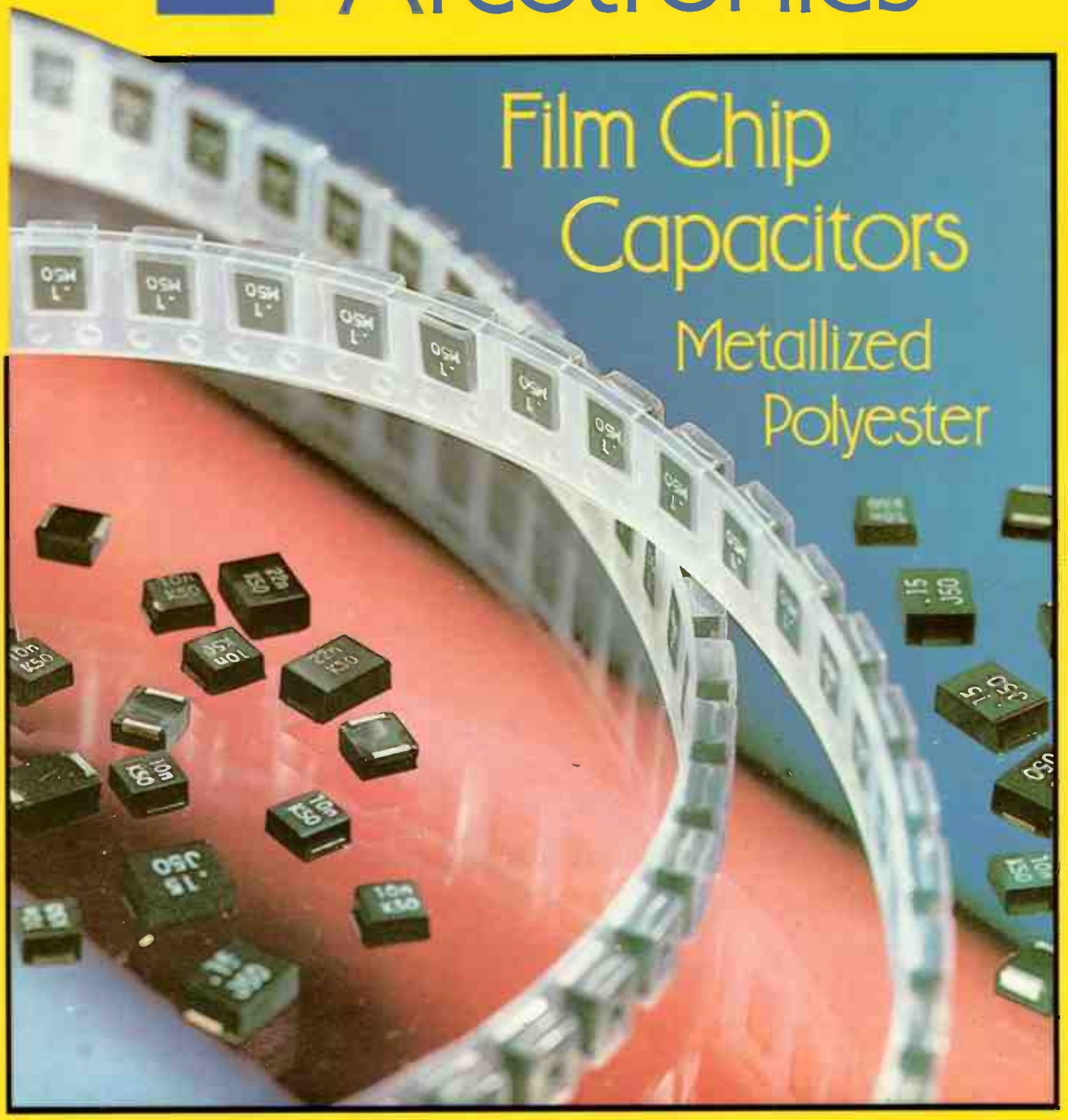

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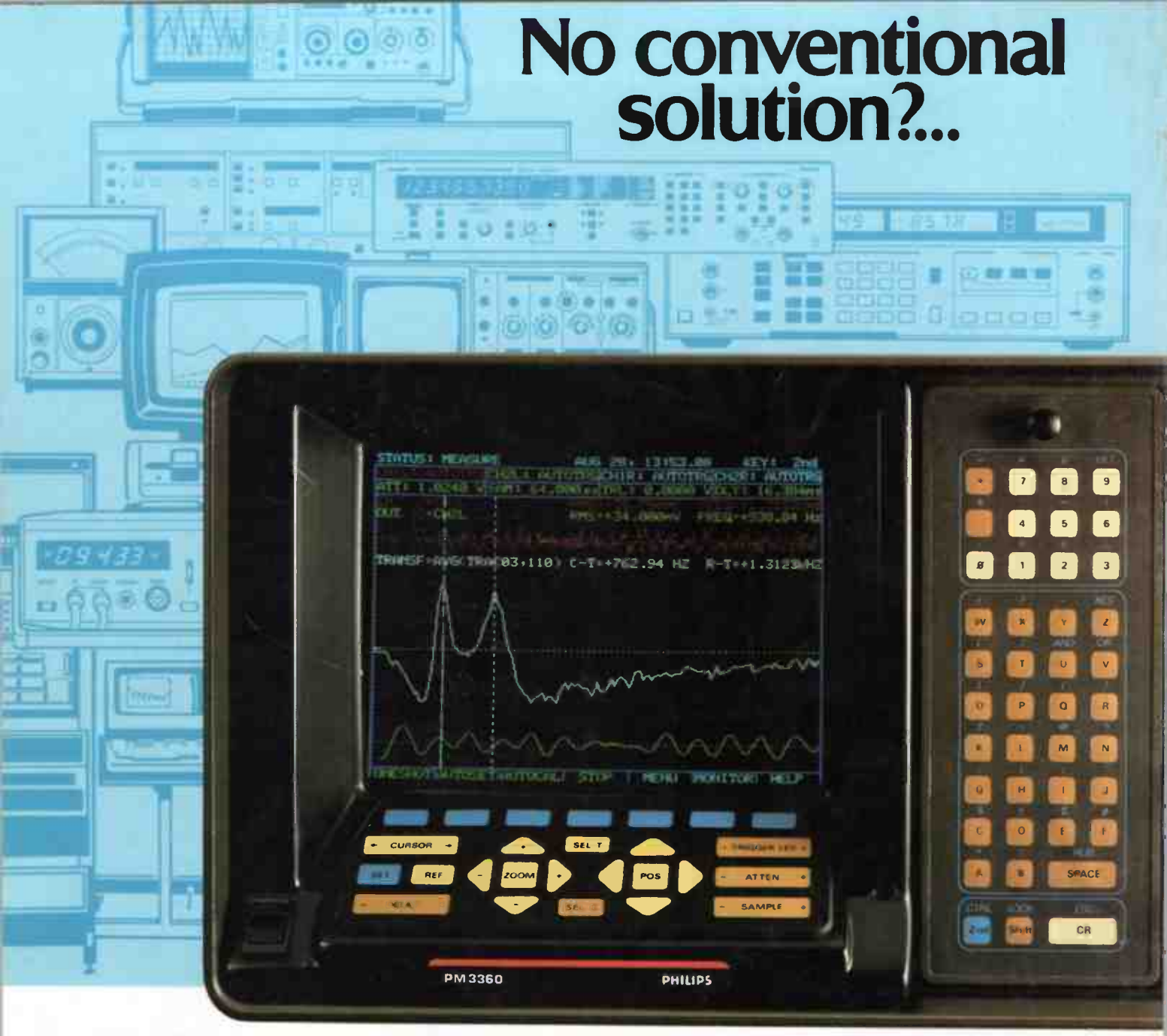

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