AUSTRALIA'S TOP ELECTRONICS MONTHLY

SEPTEMBER|1986 $3.30 NZ$4.50

The AUSTRALIAN ELECTRONICS Monthly

Build our SUPER SIMPLE MODEM

RELAYS – Technology & Applications

"IMAGING WARS": The audio/video technology battle

BEGINNERS: Three chime doorbell

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.

All of them will give you years of performance, long after cheaper meters have pegged their fishhook needles for the last time.

That's because they're built to last, inside and out. So they're tough to break. They don't blow fuses all the time. You don't even have to replace batteries as often.

And they're backed by a 3-year warranty. Not the usual 1-year.

Of course, you may only care that the world-champion 70 Series combines digital and analog displays with more automatic features, greater accuracy and easier operation than any other meters in their class.

You may not care that they have a lower overall cost of ownership than all the other "bargain" meters out there.

But just in case, now you know.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE®

FLUKE 73	FLUKE 75	FLUKE 77
Analog/digital display	Analog/digital display	Analog/digital display
Volts ohms 10A diode test	Volts ohms 10A mA diode test	Volts ohms 10A mA diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" function
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
		3-year warranty
		Multipurpose holster

ELMEASCO

Instruments Pty. Ltd.

N.S.W. 15 McDonald St. Mortlake Tel (02) 736 2888
VIC. 12 Maroondah Hwy. Ringwood. Tel (03) 879 2322
QLD. 243 Milton Rd. Milton. Tel (07) 369 8688
S.A. 241 Churchill Rd. Prospect. Tel (08) 344 9000
W.A. 46-48 Kings Pk Rd. West Perth Tel (09) 481 1500

Talk to your local distributor about Fluke

• ***A.C.T.*** Actiec Pty Ltd (062) 80 6576 • George Brown 80 4355 • ***N.S.W.*** Ames Agency 699 4524 • George Brown (02) 519 5855 Newcastle 69 6399 • Bryan Catt Industries 526 2222 • D.G.E. Systems (049) 69 1625 • David Reid 267 1385 • W.F. Dixon (049) 61 5628 • Macelec (042) 29 1455 Ebson 707 2111 • Selectro Parts 708 3244 • Geoff Wood 427 1676 • ***N. TERRITORY*** Thew & McCann (089) 84 4999 • ***QUEENSLAND*** L.E. Boughen 369 1277 • Colourview Wholesale 275 3188 • Fred Hoe & Sons 277 4311 • Nortek (077) 79 8600 • St Lucia Electronics 52 7466 • Selectro Parts (Qld) 394 2422 • ***S. AUSTRALIA*** Protronics 212 3111 • Trio Electrix 212 6235 • A.W.M. Wholesale • ***TASMANIA*** George Harvey (003) 31 6533, (002) 34 2233 • ***VICTORIA*** A.W.M. Electrical Wholesale • Radio Parts 329 7888 • G.B. Telespares 328 3371 • Browntronics 419 3986 • R.K.B. Agency 82 7704 • A.J. Ferguson 347 6688 • SIRS Sales (052) 78 1251 • Mektronics 690 4593 • ***W. AUSTRALIA*** Atkins Carlisle 321 0101 • Dobbie Instruments 276 8888 • Cairns Instrument Services 325 3144 • Willis Trading 470 1118

The Australian Electronics Monthly

THE PLUNGE OF OUR DOLLAR'S VALUE against major currencies like the US dollar and Japanese Yen brings both good and bad fortune. Bad fortune for those relying on imported goods, good fortune for those exporting local product. While, in the past, this situation has traditionally meant a boost for our primary industries — farming and mining, the current state of affairs presents an excellent opportunity for our secondary industries, which have languished for over a decade. The time is ripe for vigourous effort among local electronics and computing manufacturers (which includes hardware and software) to take locally designed and manufactured products to foreign markets.

Currently, our labour costs are competitive with our major trading partners and, thanks to 'the accord', wage increases have been at historically low levels. Innovation and entrepreneurship, largely stifled until recently and now receiving some measure of government incentive, should grasp the opportunity presented. Tackling overseas markets is never an easy task, stories abound of local firms 'getting their fingers burned' attempting it in the past. But the sooner it's done, the better placed we'll be for the future.

A special opportunity exists, in fact. As our local electronics manufacturers are geared to supplying a relatively small local market, they aren't set up for huge volume runs. This situation is best suited to manufacturing low production volume, high value-added products. Here's where we can capitalise on some local expertise. Geophysical instrumentation, laser tools, hybrid semiconductors, and specialised computer devices are just some areas that come to mind.

Bemoaning the 50% devaluation of our dollar will not make it rise or the attendant problems go away. It's cliche, but true here, that "it's an ill wind that blows nobody any good". Here's an opportunity to build substantial growth in our local electronics/computing industry and build some special skills which will be of importance in the long term. Holland, with a similar population base, did it years ago and has benefitted thereby. Here's our opportunity. Go for it!

Roger

Roger Harrison
Editor

NO CHANGE OF 'PHONE NUMBERS — YET

Our apologies, but our 'phone numbers won't change just yet. So, until further notice, it's still 487 2700 for general enquiries and 487 1483 for technical enquiries (after 4.30 pm, please).

CONTENTS →

Roger Harrison VK2ZTB **EDITOR**

David Tilbrook B.Sc. **PROJECT DIRECTOR**
PROJECT ENGINEER
Tony Tilbrook
ADVERTISING SALES
Steve Collett
PUBLISHER
Adrian Farrow
DRAUGHTING
David Currie
PRODUCTION
Val Harrison
Angelika Koop
CAMERA WORK
Clayton Folkes
ACOUSTICAL CONSULTANTS
Robert Fitzell Acoustics Pty Ltd, AAAC
EDITORIAL ASSOCIATES
Neil Duncan VK3AVK
B. App. Sci., Dip. Ed., M. Ed. Studs
Alan Ford FIAADP MBIM VK2DRR/G3UIV
Tom Moffat VK7TM
Jonathan Scott VK2YBN
B. Sc./B.E. (Hons)
Bill Thomas B.A.
Kerry Upjohn M.A. (Hons.)
TYPESETTING
Authotype Photosetters Pty Ltd
397 Riley St. Surry Hills 211 5076

Published by: Kedhorn Holdings Pty Ltd. an associated company of Westwick-Farrow Pty Ltd. **Ph:** (02) 487 2700. **Tlx:** AA71460 Sydney Whats New; International AA10101 Whats New.

Subscriptions: $39.60 Australia. NZ$57 New Zealand; overseas rates on application.

Australian Electronics Monthly is published the 1st full week each month; printed in 1986 by Offset Alpine, Cnr Wetherill & Derby Sts. Silverwater, NSW, and distributed by Network Distributing Co. *Cover price $3.30 (maximum and recommended Australian retail price only; recommended New Zealand retail price. $4.50). Registered by Australia Post, Publication No. NBP 7435. ISSN No. 0815-5046.

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

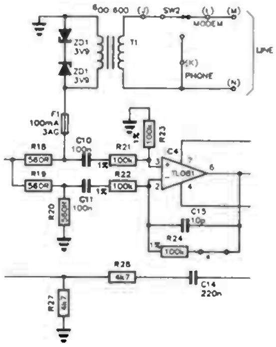
ENQUIRIES
Advertising: Steve Collett (02) 487 2700.
Editorial: Roger Harrison (02) 487 2700.
Technical: Only after 4.30 pm EAST, David Tilbrook (02) 487 1483.

Vic. Ad. Sales: R. T. Wyeth & Assoc. (Rowan Wyeth); 355 Moray St (PO Box 273), Sth Melbourne 3205 Vic. (03) 699 9044, Telex: 36611
Melb Correspondent: Ian Boehm, c/o R. T. Wyeth & Assoc.
Qld Ad. Sales: Geoff Horne Agencies, PO Box 247, Kenmore Qld 4069; (07) 202 6813. Telex: AA41398. (Geoff Horne).
W.A. Ad. Sales: Hugh Scott, 22 Aberdeen St, Northbridge WA 6000. (09) 328 9204.

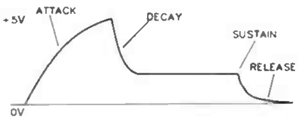
ADVERTISERS INDEX

COVER
Illustration from National's relay catalogue, courtesy RVB. Design, Angelika Koop.

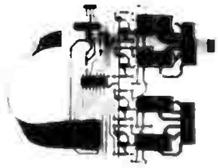
PROJECTS TO BUILD



CIRCUITS & TECHNICAL



PRACTICAL COMPUTING



SPECIAL OFFERS

COMMUNICATIONS SCENE

CONSUMER ELECTRONICS

NEWS & GENERAL

NEXT MONTH!

CAD — HARD & SOFT OPTIONS
An overview of computer aided design as it applies to electronics — from the 'budget' packages for personal computers on up. Where word-processors and spreadsheets are the tools of the modern office worker, CAD is the tool of today's electronics engineers.

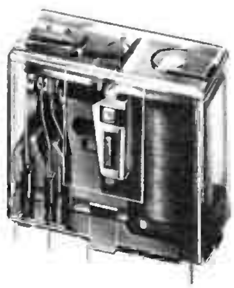
A 'SOFT-START' LAMP SWITCH — THAT WORKS!
Spot lamps, track lights and other incandescent lamps are expensive to replace at regular intervals. Incandescent lamps fail because of stress on the filament created by the in-rush current at switch-on. This project eliminates that problem and can double as a dimmer!

BUILD A RELATIVE FIELD STRENGTH METER
Here's a simple, versatile portable RF field strength meter for checking transmitters and antennas. It's especially useful for use with mobile transceiver installations.

ELEKTOR IS COMING!

See pages 6-7.

FEATURE



More BRAIN FODDER

We believe one of the fundamental roles of an electronics magazine is to provide ***brain fodder*** for enthusiasts and engineers, hobbyists and hardware hackers, amateurs and audiophiles.

Practical projects and articles that stimulate the mental 'taste buds' and satisfy the cranial cravings, are ever in demand.

Our reader survey showed that you, our readers, purchase a wide range of magazines each month, seeking ever more brain fodder. By far the most popular and widely respected of the international journals was ***Elektor Electronics.***

Hence, to bring you more brain fodder, we obtained the rights to publish a substantial part, of local relevance, from the monthly issues of the UK edition of Elektor Electronics.

From the October issue, we'll be adding to the magazine a special ELEKTOR ELECTRONICS SECTION featuring:

- More projects! From one of the world's most widely read and respected electronics magazines.
- More features! To explain the new technologies and developments as they arrive.
- More articles! Covering the technologies and application techniques of devices and circuits.

HERE'S A PREVIEW OF OCTOBER'S ELEKTOR SECTION

Will components be checked for local availability?

Yes. Prior to publication we will seek out sources of component supply where necessary and/or suggest suitable substitutes.

Will project pc boards be available?

Yes. We will be making pc boards available for the Elektor projects we publish through our normal PC Board Service, along with our own project pc boards as usual.

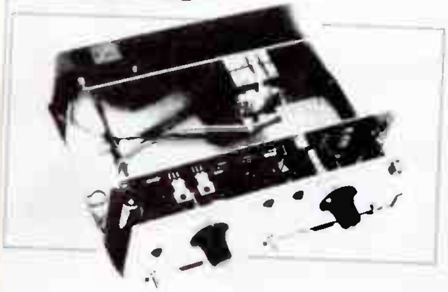
Is it going to cost more?

Yes it will. From October, our cover price will be $4.75.

But, if you already buy Elektor and AEM, as we know many do, instead of paying $8.05 total, you'll get BOTH magazines for the price you were paying for Elektor alone! If you're the sort of reader who buys those magazines which have contents of interest to you that month, now you'll get more for your money AND spend less!

— with Elektor Electronics incorporated in Australian Electronics Monthly — coming October!

LOUDSPEAKER IMPEDANCE METER



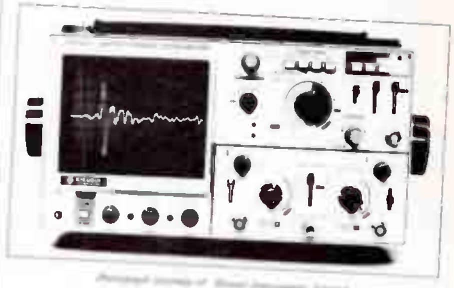
A simple, yet interesting and useful, instrument for measuring the resistance and the inductive reactance of a loudspeaker.

UNIVERSAL PERIPHERAL EQUIPMENT: SERIAL DIGITIZER

Have you ever wished it were possible to read analogue voltages on your computer while sighing in dismay at the intricacies of bus connecting the design of your choice?

This design of an eight-channel analogue-to-digital converter board goes round the hardware problems by utilizing the computer's serial I/O port, and so becomes a universal unit for straightforward incorporation in almost any type of computer system.

STORAGE OSCILLOSCOPES



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

JUST WHAT YOU WANT — MORE BRAIN FODDER!

Make sure you reserve yours from your newsagent or favourite electronics store.
Better still — **subscribe!**

SUBSCRIPTION FORM

Subscribe, and you could win this superb Weller WTCPN Soldering Station courtesy of Cooper Tools. Each month, we'll award this prize — worth over $140! — to the new subscriber who best answers the questions here.

Q1: Weller irons employ ". . . . ." point temperature control.

Q2: On a separate sheet of paper, in 30 words or less, what was it that prompted you to subscribe to AEM this month?

Annual subscription price: $57.00 (overseas prices on application).

Complete this coupon, cutout or photostat and send to:

Subscriptions Dept.
Australian Electronics Monthly
PO Box 289, WAHROONGA 2076

Please forward 12 issues of Australian Electronics Monthly
Please tick payment method:
Bankcard ☐ Visa ☐ Mastercard ☐
American Express ☐ Cheque/money order ☐
(Please make cheques or money orders payable to Australian Electronics Monthly)

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 and 430°C/800°F. The transformer case features impact resistant noryl 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 off/on switch with a long life neon indicator light, a non heat sinking soldering pencil holder, and a 2 m flexible 3 wire cord.

Card No. . . . .
Expiry date . . ./. . ./. . .

Signature . . . .

Name . . . .

Address . . . .

. . . . Postcode . . . .

*Unsigned credit card orders cannot be accepted.

Radio data network links remote schools

Some 44 remote Victorian schools are linked via a high frequency signal sideband voice radio system, set up some years ago to ensure that remotely located students would not be disadvantaged through the lack of personal contact with their tutors, which inevitably occur when subjects are conducted purely by correspondence.

The scheme is administered by the Victorian Education Department's Correspondence School who recently decided a further improvement of services could be obtained by introducing computer networking via the public telephone system to these same remote schools.

The network, employing Apple IIe and IIc computers, was used both for tuition in computer subjects as well as for returning work to the Correspondence School in Melbourne. Although highly successful, STD telephone charges made operating costs prohibitively high.

Casting around for a low-cost alternative, the Department looked at the HF network, but it presented problems with noise levels and propagation distortion that were likely to cause significant error rates in data transference.

The solution was provided by a locally-made radio data modem manufactured by GFS Electronics of Mitcham, in Melbourne's eastern suburbs.

GFS's model CPU-100 packet radio modem operates as a master-slave system using a specially developed error detection and correction scheme known as Block Exchange Compelled Sequence Protocol (BECSP). It can network up to 64 slaves in a full duplex (two-way) format using a single radio channel.

The CPU-100 can handle the full ASCII character range of text, control and object codes and can operate in an FEC (forward error correcting) one-way broadcast mode to reduce error rates while broadcasting to all slaves simultaneously. These features provided facilities previously unavailable, particularly the ability to broadcast to all participating schools in the network.

Trials were conducted in late 1985 between the Correspondence School's Mt Waverley centre and a number of NW Victorian schools. The trials proved the system completely successful with error-free data communications. Orders for CPU-100s were placed in early 1986 and installation commenced soon after.

Further details on the CPU-100 are available from Greg Whiter at **GFS Electronics, 17 McKeon Rd, Mitcham 3132 Vic. (03) 873 3777.**

The radio data network setup at Murrayville High School in NW Victoria uses an Apple, a CPU-100 and Codan HF SSB radio.

Instrument makers consolidate

Two of the oldest companies operating in the electrical and electronic instrumentation field in Australia merged in July.

University Graham Instruments acquired Paton Electrical in a takeover a move calculated to strengthen University's position, according to Jack Rutherford, Executive Chairman of University Graham.

"This acquisition will help revitalise the electrical instrument manufacturing industry in Australia and introduce a scale of manufacture that will be more effective in the Australian marketplace," Rutherford said.

Patons have an arrangement with the CSIRO to undertake R&D which is expected to lead the company into new instrumentation and export opportunities.

Digital VCR

Sony, living up to its reputation as an innovation leader, will launch a digital video recorder in the second quarter of next year. It will conform to a recently agreed world standard called "D1", and will probably cost around US$100,000.

Storage for the digital video recorder system will be on 19 mm wide tape housed in a cassette. Digital recording gives a number of advantages, chief amongst them being virtually no loss of picture quality even after recording copy-from-a-copy many times.

D1 is a world standard, because a D1 cassette recorder anywhere in the world will play back on any other D1 system.

Although there are three different cassette sizes, offering recording times of between 10 and 90 minutes, the recorder automatically adjusts its drive mechanism to match whichever size of cassette is playing.

The coding standard will also work equally well with 525-line pictures (as broadcast in the US and Japan) and 625-line pictures (as used here and in Europe).

For analogue transmission, three components signals (one for black and white and two for colour) are midxed together to give a composite signal. This composite signal is split into either 525 or 625 lines per frame, depending on where it is broadcast. For the D1 standard, the component signals, not the composite, are coded in digital form.

The analogue black-and-white signal is chopped up, or sampled, at 13.5 MHz and both the colour signals are sampled at 6.75 MHz. This sampling of the component signals is equivalent to breaking each picture line down to 720 pixels.

The problem with this is the large amount of data which must be stored on tape. Each sample is described in an eight-bit code, and when extra error correction bits are added to protect the signal against tape blemishes, recording engineers are left with a stream of 216 million bits of data to record every second.

The signals are recorded, as in a conventional analogue video machine, by heads on a rapidly rotating drum which obliquiely scan the tape. But there are four heads on the drum instead of the usual two, so twice as many information tracks are recorded across the tape.

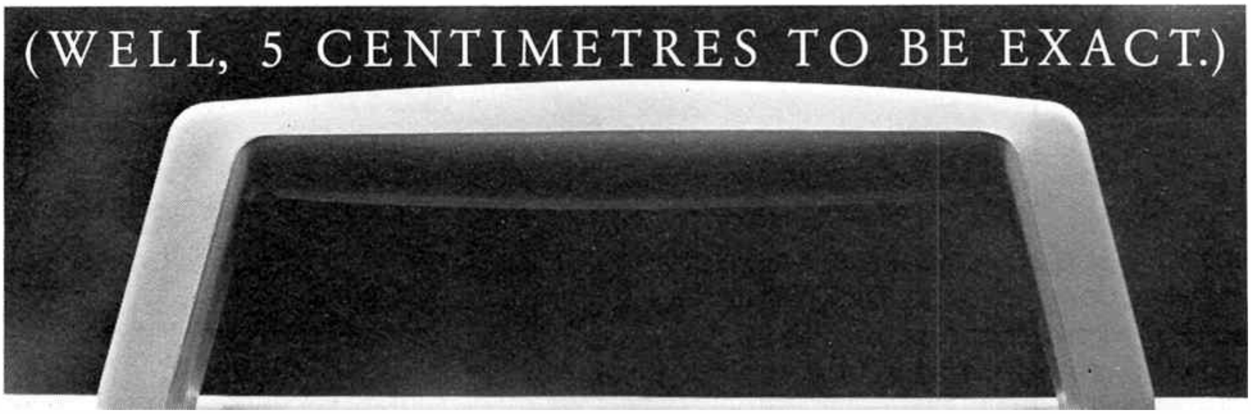
Space research seminars

Space Test Inc., a US-based company is planning a seminar in Sydney to explain to Australian business and industry how they can take advantage of US space programmes.

The company has been heavily involved in the NASA space programme and says there are immediate opportunities for Australian companies.

Speakers from companies involved in both US and Australian space research will address the seminar, to be held at Sydney's Southern Cross Hotel on September 10 and 11. Further details from **Lisa Detheridge on (02) 438 2955.**

THE ADVANTAGE OF THE NEW MICROBEE MS-DOS* COMPUTER STICKS OUT A MILE.



The more powerful a computer, the more it seems to be desk-bound.

Not so with the new Microbee/Mitac Portable PC.

Unlike most MS-DOS computers, you don't need a physique like Charles Atlas to move it from one place to another.

It's light, weighing in at barely 4.9 kilos. And, by virtue of a handle, it's also easy to carry.

The keyboard and 5¼" disk drive are ingeniously incorporated into one unit, with up to 640K of RAM.

So, if you need to take your Microbee/Mitac Portable PC somewhere, all you need is a free hand.

This new computer opens out to Microbee users the vast range of IBM† PC compatible software.

In fact, the Portable PC uses the internationally accepted Phoenix BIOS.

So, unlike some compatibles, this one is truly compatible.

The inbuilt floppy drive can store 360K bytes per diskette.

If that's not enough, however, a second optional 360K byte floppy disk drive can plug into the rear of the case.

You can also add a 20 Megabyte hard disk when you require large volumes of external storage.

There's a colour graphics adaptor built in as standard.

Microbee/Mitac Portable PC
with 256K RAM - $1,495.
(Monitor not included.)

It also includes two serial communication ports (not just one), plus a parallel printer port as standard.

Other standard features include a real-time clock and calendar, with a battery pack.

You'll also find that it's compatible with the range of Microbee peripherals.

So, no matter what use you have for a personal computer, the new Microbee/ Mitac Portable PC can (dare we say it) handle it.

For more information, contact Microbee Computers now.

microbee computer

Sydney; Ryde 886 4444, Waitara 487 2711, Newcastle 611090, Melbourne (03) 817 1371, Brisbane (07) 394 3688, Adelaide (08) 212 3299, Perth (09) 386 8289, A.C.T. (062) 51 5883.

MS-DOS is a registered trademark of the Microsoft Corporation
† IBM is a registered trademark of IBM Corporation

C&MA MBS 0028/A

The 'imaging wars'

Malcolm Goldfinch

Video and audio imaging combine — the new 8 mm video format provides convenience in cassette size and offers digital audio capability that may prove a rival to the coming digital audio tape (DAT).

The consumer electronics manufacturers are battling for prime position in the audio and video markets, with high technology as the weapon.

IMAGINE a boxing ring with five fighters, all of whom use different rules to Marquis of Queensbury, belting the daylights out of whoever is nearest; even the umpire (us poor consumers) gets bashed regularly. This is a good picture of the present state of the battle for what has become the biggest single industry on earth, *Imaging*.

Imaging is the buzz word to describe the following, (in the order in which they originated):

1) GRAPHIC ARTS IMAGING. Originally portrayed through and by writing and drawing symbols; lately by mass reproduction of these graphics by printing, photography and copying, on a variety of substances.

2) AUDIO IMAGING, by calligraphic symbols for accent, music melody and metre; lately, mass phonography by disc, tape or chips.

3) VIDEO IMAGING, implies mechanical imaging of vision, commenced by photography and advanced to 3D holography, lately by electronics, and combining with 1) and 2) for nearly the ultimate in imaging; by allowing fully coordinated reproduction for the human sensory functions of synchronised sight and sound, in colour and in stereo sound. Video imaging is now capable of adding the human senses of smell and movement, by synchronised olfactory and environment imaging (acceleration sensing by the middle ear using controlled unstable platforms for audiences.)

4) COMPUTER LOGIC IMAGING embraces all the functions of 1), 2) and 3) by the constant sampling of all these human sense sources and converting and storing them in binary codes, thus enabling an almost infinite number of generations of image copies, and mutations, without loss of the original material when reconverted to human compatible analogue material. The *ultimate* comes from inclusion of *logic* in the imaging chain, which is humanity's remaining function to image, in replicating fully the function of our awareness. The majority of human senses may now be both recorded in reality, then processed by logic programs; reality is either forecast forward, or even back in time, based on experience or random chance, or manipulated into new directions by selected or random (if) factors. This function in human terms is very ancient. It has always been known as *imagination* — the nuclear fuel of our progress!

The inestimable value of the power to control "the ball and the ballpark" where this imaging game is being played is why the great "war" now rages between the biggest international consortiums of large and small industrial groups. So vital is a share of this vast global "game" of imaging that governments have also become heavily involved.

In the past, AEM has kept you well aware of these imaging format battles being waged across a very wide front. Every day it is becoming more obvious that the final objective of all parties will be for the control, or part control of "Megabyte Heights" from which the winner will be able to dominate the imaging planes below.

My trip to Japan last year (reported AEM Oct, '85, *View from Japan*, page 13) and a recent three months in Europe and America including the Vancouver Expo, has prompted me to attempt an analysis of most current imaging formats of significance. I make no attempt to cover those individual systems promoted by one group, or the many computer DOS formats littering the world. I only cover here formats supported by significant international groups.

When considering the new format battle we must acknowledge that the ultimate user is the "referee": no money up front, no format. Consumers are very wary characters, after being hit by 45 rpm records, quadraphonic hi-fi, 8-track endless cartridges, defunct audio cassettes, dead and dying video formats, and lately, hundreds of unservicable orphan computers of all sizes and values. Anyone who looks like hurting the referee again looks like being sent straight off the field, and why not? Failed formats are a sickly waste.

But, how do you tell who is winning and who is fouling if there are no rules? The following, added to previous AEM articles will give some understanding of the present and expected future in imaging formats.

IMAGING 1: GRAPHIC ARTS

Thanks to people like the Wapping Wallopers there are few signs of standard formats emerging in the transition of a major section of the print industry to video imaging and computer logic imaging. The Linotype only became a world printing standard in hot metal composing after many years of consumer preference. Purchasers of electronic equipment will also decide any formats in graphic arts. The physical violence now opposing the use of such modern equipment can delay and distort the final formats chosen.

The chemical-based photographic industry is showing signs of concern that CD and magnetic imaging could win a guernsey in the photography game and defeat film. Consumers seem willing to discount some definition for cost and convenience.

At present, I cannot see any new format emerging in photography for either disk or magnetic imaging, but the industry is trying.

IMAGING 2: AUDIO

For two decades, consumer-imaged audio has been overwhelmingly on the Philips compact audio cassette. Philips handled this first "world format" with great wisdom and skill. They shared it with everyone who was willing to conform and charged peppercorn royalties. They forced Nakamichi to abandon a half-speed deck, other double-speed decks, even though they all exceeded Philips' minimum specs easily. This format will continue in use for many more decades as so many players are in existence, with up to 20 years expected life in home use, and with millions of old cassettes to record over.

Like piano rolls, some 33 rpm microgroove vinyl records will continue to be made and marketed, but there is a legitimate demand for an entirely new, pre-recorded audio reproduction format distinct from a recording/playback medium. It must make use of the digital sampling method of eliminating spurious background noise and the mechanical restraints and distortions inherent in the stylus-on-vinyl format. At the same time it must allow a dynamic range and transient response close to real-life sound. At present, it appears that the compact disc meets all these requirements and is the undisputed replay imaging format.

The last audio format change was when the 78 rpm shellac record (short-play-SP) was replaced by the vinyl, extended playing (EP) 33 rpm microgroove record. The decisive transition is shown in Figure 1.

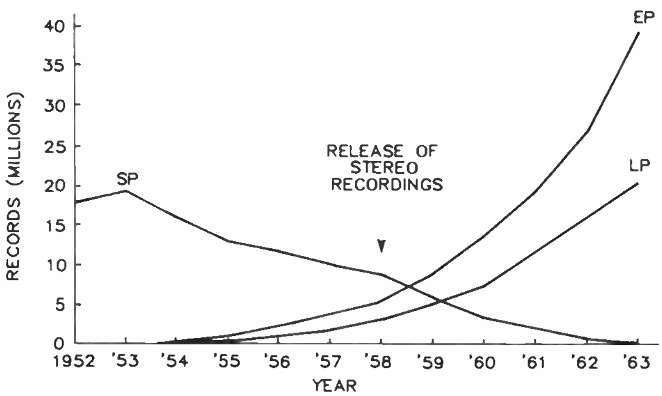


Figure 1. While short play (SP) 78 rpm records declined, extended play (EP) and long play (LP) microgroove records took off. (Source: Japan Phonograph Record Association).

	SP record	LP record	compact disc
Speed (rpm)	78	33⅓	200-500
Max. playback time	about 5 minutes	about 30 minutes	up to 60 minutes
Frequency response	200 Hz to 3 kHz	30 Hz to 15 kHz	5 Hz -20 kHz flat
Signal-to-noise	about 30 dB	about 50 dB	better than 92 dB
Weight	380 g	140 g	15 g
Fragility	fragile	strong	very strong

Figure 2. Comparison of SP (78s), LP and CD recordings.

The sharp fadeout of SP demand and steep rise of EP is likely to be closely followed by the rise in CD sales and fall in EP, now taking place, as CD shows a similar product improvement over the vinyl record, as that did over 78s.

For a new format to succeed against an established one, it must show a similar dramatic improvement to that in Figure 2, so it will mean a lot to consumers. Figure 3 shows the current digital format offering in hi-fi audio imaging.

Format	Digital Factors	Sampling frequency (kHz)	Quantization (bits/sample)	Linear or non-linear
CD		44.1	16	L
AHD		44.1	16	L
DAS-900		44.1	16	L
8 mm		(NTSC) 31.5	8	NL
Satellite Broadcast	Mode A	32.0	10	NL
	Mode B	48.0	16	L
DAT (both S & R)	STD	48.0	16	L
	P.B. only	44.1	16	L
	Option	32.0	12	NL

Figure 3. Comparison of digital imaging formats.

The up and running CD and 8 mm (V8) video formats are factual, but the others could be far from firm format figures. V8 is the odd one out and does not either keep up or offer the big "plus" that makes new formats go. AHD (Advanced High-density Disc) is not well defined and could be the disc referred to as a CD-ROM in my article *(View from Japan)* last December. Significantly, it is compatible in these specs with the current CD and is worth watching.

Another, professional, format I have been expecting is DAS-900, which means Digital Audio Mastering System for professional use. Surprise, surprise! It uses the ubiquitous VHS rotary-head, hyperscan described in AEM April '86, "*Hail the Vidi-fi*", but it has gone digital and could replace the currently used professional S-DAT with tape rushing past stationary heads at about half the speed of hyperscan. S-DAT,using multiple slot, stationary heads with logic delay and assembly of digital data, is a proposed option (not yet finalised) to R-DAT using VCR mechanics. (AEM April '86, page 8.)

The CD has just come under attack from the magnetic imaging interests, launching their counterattack with a tiny new R-DAT format cassette as their new weapon. Hardware is not yet visible and BASF is opposing this format, saying it does not have the plusses to make this DAT format succeed. I agree.

This came to a head in London recently, when on a dull newsday, a correspondent for the Sunday Times filed a story saying, "*Compact Discs are about to be made obsolete by a new generation of audio cassettes DAT.*" This story was carried here in *The Australian* recently and could mislead some people about to purchase CD players.

Although the London story said Mr Bhaskar Mennon, UK Chairman of Capitol EMI, ". . . voiced widespread fears when he says compact discs are not sufficiently advanced to withstand a new technology that will immediately create a feeling of product obsolescence. Compact discs have so far won a 4% market share in Britain. Experts say a product can be regarded as having a firm base only when it passes 5% of the market and they do not think this will happen by October."

The UK is a small segment of the potential world market and very poor for mobile sound players. The in-auto CD is having a sellout elsewhere. Sony alone reports its new Disc Jockey car CD completely sold out of stock two months after launch in the US. ▶

Compact disc offers the finest quality consumer audio imaging format developed to date but has, as yet, low market penetration.

A very successful South Australian public company in the commercial video production and copying field, Pro-image Studios Limited, has recently acquired funds for the establishment of a subsidiary, Disctronics Ltd, the only CD production unit in Australia. Capable of 5 000 000 discs per year, it is expected to come on stream by early next year. The production package is costed at around $15 000 000. Orders for this facility are being booked now. There are plans for doubling the plant capacity if demand is warranted. If overseas trends are followed it may not be long before this happens. The plant will be part of the 'buy Australian' movement to create employment and help reduce the import deficit.

I asked Disctronics Managing Director, Roger Richmond-Smith, to comment on the reports in the Sunday Times story, firstly on DAT's ". . . quality far superior to that of compact discs." He said, "This is a totally incorrect claim. Just one example, 12-bit DAT system (this shown as an option to 16-bit — M.G.) yields a dynamic range of 73.7 db, while the 16-bit CD system yields a range of 97.6 db. Increasing the sample rate from CD's 44.1 kHz to DAT's 48.0 kHz will have marginal effect only. (DAT will also have 44.1 kHz playback for pre-recorded tapes; part of the tricky bits to prevent digital piracy; a free go in analogue — M.G.) Sony is on record that DAT will yield sound quality, "about midway between a vinyl LP and a CD".

In regard to the report that size of the new consumer DAT system is smaller than currently available CD systems, he commented, "This is not correct, Sony has developed a CD player and CD deck in Walkman format and report that it is technologically impossible to further reduce player size for the DAT format.

The Sunday Times contradicts its own suggestion that duplicating DAT cassettes will be cheaper than CD production, quoting Sony in UK as saying DAT copies will cost $A22 giving it a retail cost of about $A44, whereas CD's cost $A3.50 and sell for $A24.

Mr Richmond-Smith concluded his comments on the article by quoting Mr Emiel N. Petrone, senior V.P. of Polygram Records, Los Angles, saying, "It took 25 years for compact disc technology to come about. For the foreseeable future, I do not see anything coming down the line that will even come close the quality."

I do not suggest that the CD will always have the same information format, but the huge international investment in plant, equipment and knowhow to supply the existing and rapidly growing demand from CD players already in the pipeline and consumer use, ensure the CD's long term existence as an impeccable, cheap audio source. There is little doubt CD is the dominant format for the foreseeable future; consumers are voting for CD every day with more dollars for decks and discs.

The DAT attack on CD is only a peripheral skirmish. Where this donnybrook is really taking place is in other imaging areas of record/playback. CD is being struck blows below the belt because of its incursion into what has been the preserve of big interests in computer logic imaging, said to be the most lucrative area of this high-tech industry. The spoils involved are massive. Multi-billion dollar shares of the audio, video and computer market will be tied up in the CDs of the future. Some fear magnetic media could suffer badly. Others take the more optimistic view that CD and video hi-fi go together: like love and marriage.

IMAGING 3: VIDEO

This review of imaging should be read in conjunction with *Hail the Vidi-fi*, AEM April '86, Pages 14-22, as it clearly interrelates CDs with vidi-fi, currently the highest grade of audio analogue recording and playback on offer.

Item / Format	8 mm	VHS	Beta	FM Broadcast
Carrier Frequency (MHz)	1.5	L 1.3 R 1.7	L 1.38, 1.53 R 1.68, 1.83	—
Max. Freq. Modulation	± 100 kHz	± 150 kHz	± 150 kHz	± 75 kHz
Dynamic Range	More than 78 dB	More than 80 dB	More than 80 dB	More than 74 dB
No. of Channels	1	2	2	2
Equipment	Mandatory	Option	Option	—
Recording Method	Frequency-multiplex recording method	Depth-multiplex recording method	Frequency-multiplex recording method	—

Figure 4. Comparison of the audio channels of various video formats. Broadcast FM provides a reference.

It can be seen from Figure 4 that there is no distinct line anymore between hi-fi audio and video recording, just a great grey area where the media merge into one piece of hardware and one piece of software. The video component is remaining stubbornly analogue, while the audio component is making excursions into PCM, and in V8 alone for home use, but co-existent with linear head, analogue audio for the sake of compatibility.

Putting aside PCM, the rotary-head hyperscan FM analogue recording gives a dynamic range of 78-80 dB which compares well with a nominal 92 dB for a CD deck, without all the fuss and cost of digitising and undigitising: offending the 'golden ears'. It is better than the quoted FM broadcast dynamic range of 74 dB.

The Sony V8 format PCM hi-fi has been well covered in previous issues of AEM. Before it can be regarded as an acceptable long term format it will have to be endorsed by rising consumer sales and other major manufacturers offering hardware to the same format. It is still early days for this to happen.

I said the same thing about the VHS-C (VHS in a compact cassette format) when it was first released by JVC in 1982, and there was no support from other manufacturers for a long time. Consumers in Japan and the US were the most enthusiastic, but the constant talk of 8mm video being the next format lead to a 'wait-and-see' response. No one wanted to do a Beta.

VHS-C makes way

Now V8 has been on the US market for over two years, the portable camcorder market is coming alive. If the sighting survey I did in Europe and Canada as well as at Expo '86 is any indication of future trends, VHS-C is the next big format. JVC's GRC-1 and 2, VHS-C camcorders were a surprising 61% of my sightings: Betamovies 11%, VHS camcorders 9%, V8 camcorders 7%, various two-piece videcam and VCR, 12%.

In talking to VHS-C camcorder users I found many of them used two-piece portable video before and traded or sold them. They claimed they got hooked on video but hated the weight, cord and bulk. They said they only need them on very special occasions, but now they took their 2 kg camcorders on *all* outings. My sightings did not indicate ownership, but use of portable videos. They usually had either a VHS or Beta home VCR as well and edited their cine shots onto an album tape. This is the pattern of use emerging.

Nowhere has the battle of formats raged more fiercely than in consumer video. The half-inch tape cassette conflict may be over, the victory won by VHS for home use. But in the professional area of ENG (electronic news gathering), formerly the preserve of bulky 1" cassettes, there is now a new VHS M2 format in the US from National with a camcorder having three colour-filtered CCD chips, and a minimum light response down to 21 lux, but still well above the 10 lux of good home videcam. The battle is on again in pro NTSC: the PAL offensive will start here shortly.

This trend seems to confirm a broader consumer preference for a single standard supported by a number of manufacturers to choose from. There is no denying that those who bought VHS are mostly happy and loyal to their format and will give it preference in any future purchases.

These factors are mentioned as they will have a bearing on future format acceptance or rejection. The recent introduction of 8 mm video (V8) format was subscribed to by almost every significant video interest in the world, 127 in all. (AEM Nov. '85, Jan. '86). At the time it looked as though V8 would be the next undisputed video format for portable video and a faint chance of making timeshift and home movie video.

For two years in the US, Kodak has been marketing an earlier format of V8 made by Matsushita (National Panasonic). The latest V8 format is promoted by the Beta supporters who had difficulty in bringing themselves to make a VHS machine.

In the format battle, 8mm was a form of counterattack by the Beta camp. The new models included an across-the-board system, for timeshift and feature films, as well as portable video; the original objective of the miniaturisation of video. Compatibility with Kodak V8 was not a major consideration.They added a PCM sound system option within the rotary scan format as well as FM multiplex sound. The former, intended to make a new digital audio format, pre-empted the DAT system, yet the backers of the 8mm PCM were part of the consortium for the DAT just released.

Confusion

Is there any wonder there is confusion amongst consumers with this situation now unfolding. Mostly they do not know the difference between a bit, a Hertz, or a dB and rely on informed 'experts' to advise on what is best to buy and when. Although our Editor is doing a gallant job in trying to keep you informed whilst the drama unfolds, we are not without our moments of confusion, too. We can but keep you informed with what is happening from the dispatches we have intercepted; often from confidential sources. It is a secretive conflict.

Having run a lot of information on V8 video in the past we try to remain impartial by quoting the following from the VHS counter-counterattack; or the case for not going into V8. But first let us examine the forces involved.

JVC advises that, from their VHS family they will have riding with them into battle, each armed with their own VHS-C camcorders, Matsushita (National Panasonic), Sharp, Toshiba, NEC, Hitachi and Akai. They expect support or sympathy from the 100 million VHS owners that were estimated to be throughout the world last July, and growing.

With these friends in battle, the VHS-C format could become the accepted world standard for camcorders. Their battlecry is "No new formats! A little VHS will do you!" Their secret weapon is the new JVC, VHS-C GRC7, just released at CES in Chicago where it was the consumer product feature of attention. It has every feature of a full videcam and VCR combined in one unit: TV viewfinder, auto-focus, instant replay, low weight, (an amazing 1.7 kg) and it fits into the hand. No current V8 camcorder is close to this package.

The arguments for no new format and the adoption of semi-compatible VHS options instead, will have great consumer appeal. Here are the points made.

1) The race is usually won on "horses for courses". The V8 format was intended for portable video and is now pushed into general video use, such as unattended timeshift, prerecorded software, etc. A survey of 135 films released by CIV-Victor Video showed the greatest number fell within 90-120 mim. A significant number were 130-140 min, with some to 160 min. This would result in 25% of feature films running to two cassettes. The track width/pitch and thickness of V8 tape make it unsuited to film library use because of tracking and durability problems in this role. ▶

Video	System	Tape thickness (μ)	Mode	Track pitch (μ)	Max. recording time (min)	Pre-recorded tape
VHS	NTSC	Normal	SP	58	120	•
		20	×3	19	360	
		Thin	SP	58	160	•
		15.6	×3	19	480	
	PAL	Normal	SP	49	180	•
		19	×2	24	360	
		Thin	SP	49	240	•
		15.6	×2	24	480	
8 mm	NTSC	Normal	SP	20.5	90	•
		13	×2	10	180	
		Thin	SP	20.5	120	
		10	×2	10	240	
	PAL	Normal	SP	34.4	60	
		13	×2	17	120	•
		Thin	SP	34.4	90	
		10	×2	17	180	

Figure 5. VHS and 8 mm tape system characteristics.

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.

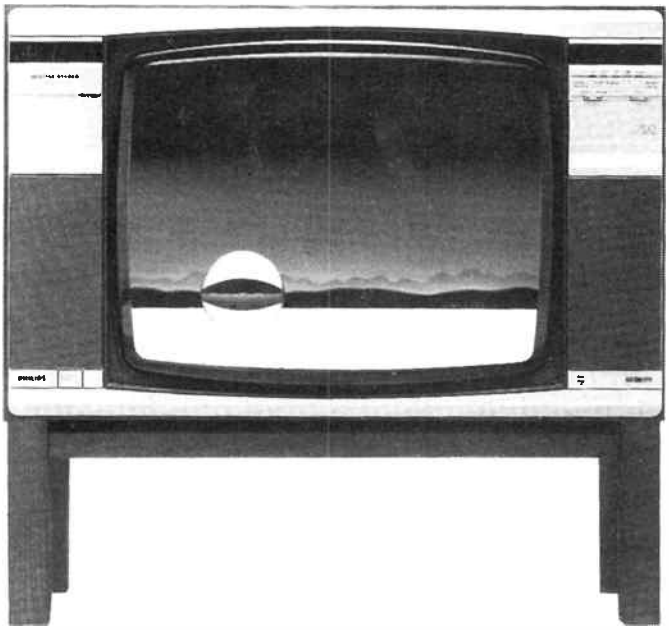
Winners will be notified by telegram the day the result is declared and the winner's name and contest results published in the next possible issue of the magazine.

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 woodgrain 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 ....

The compact audio cassette is arguably the most widely used audio imaging media. New growth in recent years has come from 'personal portable' audio products.

2) The contention is that in standard play, which is the pre-recorded standard for movies, on NTSC, VHS offers 120 min on normal tape 20μ thick, with a track pitch of 58μ; in PAL 19μ thick with 49μ track pitch. This compares with the NTSC, V8 120 min play normal tape 13μ thick with track pitch of 20.5μ, but PAL 13μ thick, requires double-play track pitch of 17μ to achieve 120 min for pre-recorded tapes. The suggestion is that these V8 light tapes and fine track pitch will be greatly inferior to the VHS with almost twice the tape thickness and about three times the track pitch. Having to use the double play option in PAL does not seem to make this an attractive outlook for video publishers, libraries or consumers.

For V8 to go to 240 min in NTSC, or 180 in PAL (the maximum times) the tape thickness and track pitch are the same; a mind boggling 10μ.

VHS-C says if you want to play this game we can go to triple-play and a slightly lighter 15.6μ thick tape with 19μ track pitch in NTSC and 24μ in PAL; still a lot better than V8, and this is just what they have done, in camcorders only.

This triangulation chart summaries Figure 5, comparing VHS and V8 in presenting typical films.

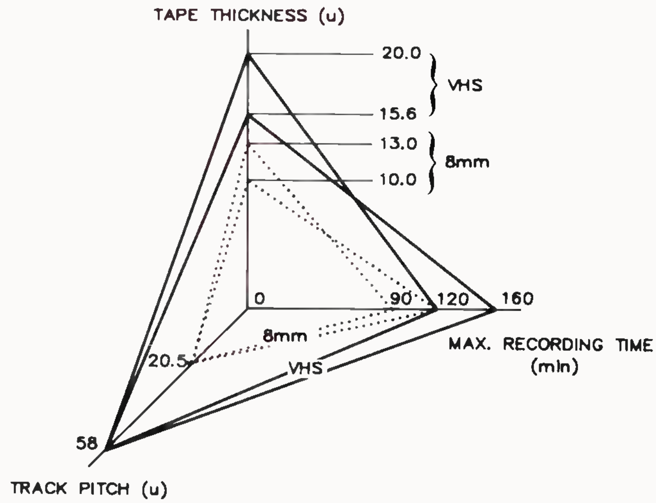


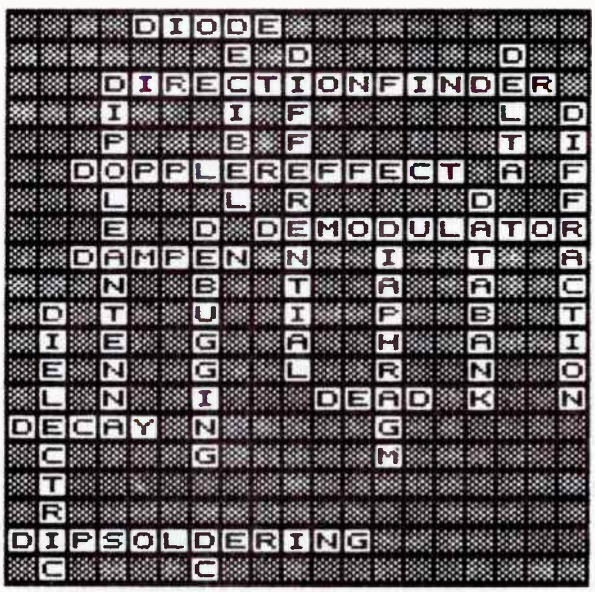
Figure 6. VHS and 8 mm tape, physical characteristics comparison.

3) VHS concedes that VHS-C is a short-run format and argues that it is not a disadvantage for home video to be short-run, 20 min in NTSC and 30 min PAL. The average shot is only a few seconds and seldom is there a requirement that cannot be broken every 20 min. Scenes are easier to find and edit on small tape runs.

The VHS 'camp' agrees that the 20 min. tape cost in VHS-C is much more than 120 min V8 format, per minute. VHS-C is 75¢/min NTSC, V8 25¢/min. in 120 min. video cassette and 63¢/min in a 30 min. cassette. (Converted to cents Aus. from Yen). Costs in PAL are lower VHS-C will soon release extended play option camcorders to drop these costs to 1/3, and run time to 60 min. NTSC, 90 min. PAL. This will be for portable video only, as VHS points out they will not use VHS-C for timeshift or film; horses for courses.

4) On the plus side of short run, they point to their motordriven, VHS-C to standard VHS converter which allows not only instant replay of VHS-C on any of the 100 million VHS VCRs around the world, but, with the VHS vidi-fi VCR, you can record audio alone on VHS-C using LP in full hi-fi for 60 min. NTSC and 90 min. on PAL. These handly little cassettes are already popular with audiophiles in Japan and it is claimed to be superior to V8 PCM hi-fi.

ANSWERS TO THE WELLER CROSSWORD COMPETITION No. 12



Winner of Crossword No. 11 was R. F. Noonan of Fairfield NSW.

COMPUTER LOGIC IMAGING

This part of imaging is presently a can of worms. Every computer or data processing organisation has its own format. Suffering computer users would dearly like to carry a pack of CDs with them and be able to pop one under the nearest tongue of a DOS, then see all their images up and running; just as you can with a compact audio cassette, on billions of players, or VHS video cassette on one of the 100 million about the world (woops, must be either NTSC or PAL.).

Jokes aside, AEM will try to rationalise progress that is expected in the computer end of the imaging spectrum, as it occurs, and keep you informed. Maybe the audio CD will emerge as the first computer imaging format, as we know it in audio and video.

letters

A committed fan

Dear Sir,

Please find enclosed my advertisement for inclusion in your AEM Admarket. Since the launch of your magazine I find it no longer necessary to purchase the magazines I now wish to sell. Thank you for a truly "complete" electronics magazine.

R. Gallimore
Newcastle, NSW.

Queries on the 6103 three-ways

Dear Mr Tilbrook,

Thank you for your article on the three-way loudspeaker system AEM6103 (Jan. '86 AEM). I notice in the construction details that the length of the pipe used for the vent is not specified. I may have missed it in the text, but a friend of mine has also commented that he is unable to find it mentioned either.

I notice in the section AA through the speaker enclosure, on page 53, that the vent is not shown as extending into the enclosure. If it does, then could you please let me know how far? If it doesn't, why not just cut a hole in the front baffle?

Also, in the design of the crossover network, you have used a number of resistors to compensate for the different efficiencies of the speakers used. How did you determine the values of the resistors used and why are some in parallel with the speakers and some in series?

Philip Rowland
Roma, Qld.

The correct length for the bass reflex port for the AEM6103 is 225 mm, as noted in Notes & Errata on p. 105 of the March '86 issue.

In order to decide on the correct amount of attenuation that should be applied to a particular driver, I generally consider three separate things. Firstly, the published sensitivity figures; secondly, the frequency response as measured either out of doors or in an anechoic chamber; and thirdly, its measured sensitivity using a pink noise source.

The sensitivity figures alone are not sufficient since no driver has a perfectly flat frequency response. The actual sensitivity figure quoted depends on the method used to measure it. The pink noise test is the next most valuable test and generally gives quite an accurate figure.

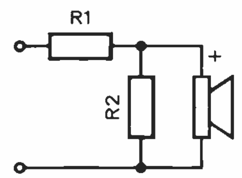
Finally, attention should be paid to the frequency response of the driver. If, for example, the driver exhibits some particular frequency response anomolies it is often advantageous to attenuate by perhaps a little more or little less so that the overall response conforms more closely to that desired.

Once the required attenuation has been determined, this can be obtained by the fitting of the series and parallel resistors you mentioned. The resistor in series is used to attenuate the overall signal level that is applied to the driver. The parallel resistor is used to reduce the overall load impedance so that it remains at around 8 ohms. This is necessary on some power amplifiers which can become upset by a highly non-linear load resistance.

I have outlined here a procedure to use if you wish to experiment with the values of these resistors.

1) Start by using the methods described above to decide on the required amount of attenuation in decibels.

2) The resistors are connected as per this circuit:



3) Calculate the value of a variable, d, using the equation:

$$d = \text{antilog} \frac{\text{signal drop in dB}}{20}$$

4) The value of R2 in the above circuit is given by:

$$R2 = \frac{8d}{1-d}$$

5) The value of R1 is then given by:

$$R1 = \frac{64}{8 + R2}$$

I trust this answers your questions satisfactorily.

David Tilbrook

Listening Post TRS-80 software?

Dear Sir,

I was wondering whether you could find someone who could convert the Listening Post software and hardware to suit a TRS-80 Model 1 with disk drives and an MX-80 printer. If so, could you send me the converted circuit fo the Listening Post and a listing of the converted software.

Andrew Avery,
Mosman, NSW

The Listening Post hardware needs no conversion for use on other computers, only the software. Unfortunately, we know of no one at present who could convert the software for you. Would any suitably equipped and experienced readers care to look into this?

Incidentally, The Listening Post may possibly be used with commercial RTTY/CW software for the Model 1, or any other computer, if the project's outputs are hooked up as required by such software.

Roger Harrison

IBM and the Listening Post

Dear sirs,

Congratulations on your first birthday AEM!

I must say, the content is vastly superior to the other two. For some reason, the quality of the others has slipped badly. Perhaps you now have all the best technical people!

I would be grateful if you could advise me where I could get a software listing for AEM Project 3500, the Listening Post, which will run on the IBM PC. Actually, I have an NEC APC III which runs at 8 MHz and runs all IBM software except some which has timing loops, i.e.: it is equivalent to the new 8 MHz 16-bit IBM clones such as the Olivetti and Cleveland. (The Cleveland is an Australian IBM clone!).

Hope you can assist.

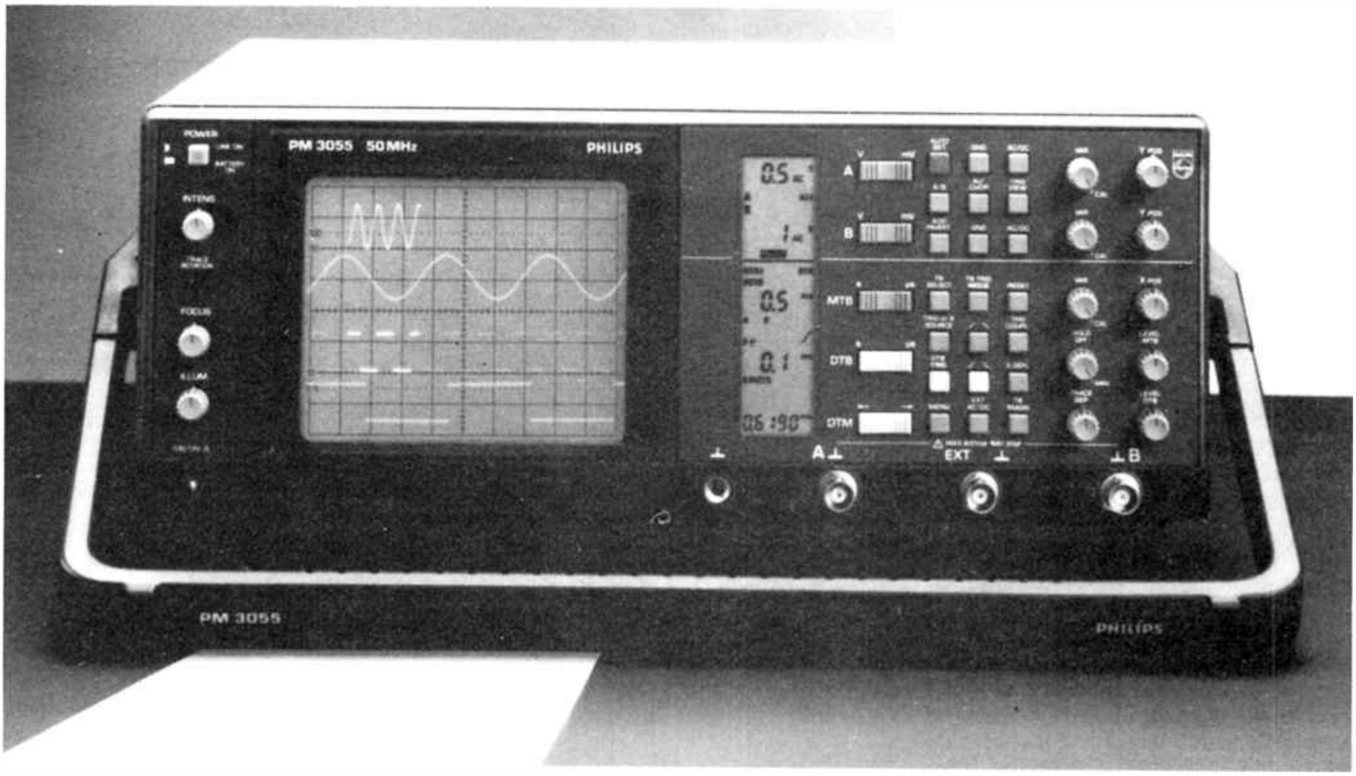
Bill Fraser
Winnellie, 5789.

Well, we have "put the problem" to a programmer or two and we all await with baited breath! Has any reader, unbeknown to us, written IBM-compatible Listening Post software, or software to decode Morse, RTTY and FAX transmissions? We'd like to hear from you.

Roger Harrison

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 14 of this issue.

Updating Compufi

In AEM September last year, we carried a story on page 33 about a possible wildcard in the hi-fi industry. A company called CompuSonics had, for the past few years, been doing a fingernail climb up a smooth wall with their belief that with the right black box, all computers could be hooked up to an amp. and produce their share of high quality Amadeus. They were back again at CES this year bigger and better than ever.

For new readers, we left them last year with everything up and running with a limit in time of about 15-20 min from 5.25" floppies. Compusonics were hoping to boost it to 40 min, just short of a compact audio cassette side.

This time they have CSX, CompuSonics' Video. This is what they claim.

"CSX digital signal processing can be applied to a wide variety of consumer, industrial, and professional digital video products. CSX dramatically reduces the amount of data required to record or broadcast the digital video/audio signal.

"Therefore the cost/performance ratio of digital video products may be improved substantially by incorporating CSX signal processing in the product design.

"The **home video editor** is a disk-based video recorder capable of recording from any standard video source such as the home VCR or video camera. Once the source material has been selected and recorded into disk, the editing functions allow th euser to select and rearrange specific video segments arbitrarily. The resulting edited video may be played directly from disk for viewing, or dubbed back to VCR tape. This gives consumers the capability to consolidate and arrange choice segments among their home video recordings for future enjoyment."

This sounds just what is needed to doctor up a footy tape with a bit of 'funny' stuff for the club's beer and prawn night!

Other CSX features are: using high capacity 12Mb discs for editing several minutes of audio/video or up to an hour and more on the new optical recordable disks now available with over 100Mb.

Video databases are also part of the offering. The mind of a young man about Big Blue with more girls than he can remember will boggle with the possibilities. Picture and voice identification for security is a good venue for CSX; so would be encyclopedias with video pics.

Buying digital music by phone or cable for the home is another aspect. The CSX has a data rate of one megabit per second! A home digital decoder/recorder using curently available 400 Mb write-once optical disks would capture and store about one hour of CSX format digital music material permanently.

This CompuSonics system is typical of the high-tech, maverick put-togethers that are appearing like mushrooms. Until they sort themselves out into a *format* which is widely used and rigidly complied with, purchasers of this type of gee-whiz hardware will be unable to obtain a proper return on their investment, because the people you want to deal with may have incompatible gear (like 'XCS' or 'SXC'). But it makes you think, doesn't it?

— **Malcolm Goldfinch**

Onkyo and Tannoy move over

Andrew Harrisson, former Director and General Manager, Audio with Rank Electronics, has resigned to establish his own company which will re-launch Onkyo and Tannoy.

Harrisson's new company, Lifner Pty Ltd, has been appointed Australian agent for the British-made Tannoy consumer loudspeakers and the Japanese-made Onkyo range of consumer audio products. Lifner will distribute the Onkyo range throughout Australia, Papua New Guinea and Fiji.

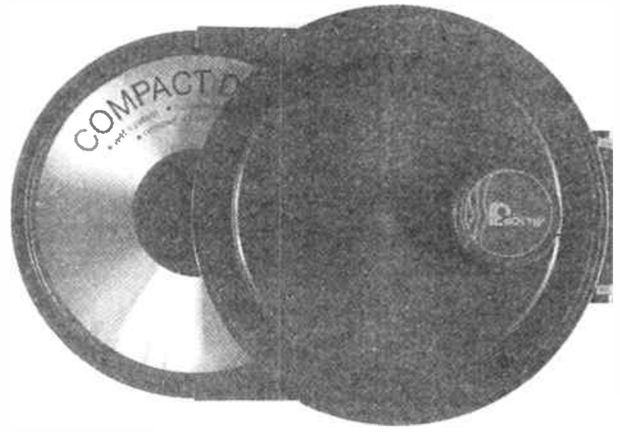
Full details from **Lifner Pty Ltd, 16 Suakin St, Pymble 2073 NSW. (02) 449 5666.**

COMPACT DISC CLEANER

Allsop, well-known for their innovative and effective cassette and vinyl disc cleaning products, has released a compact disc cleaner. Compact discs are not immune to the ravages of dust, lint and grime and need cleaning from time to time to give of their best in your player.

In keeping with Allsop's past performance, the product is innovative, ingenious in construction and simple to operate. Constructed rather like an oyster with an extended lower shell, you lift a circular top cover, which contains the cleaning mechanism, and place the disc, label downwards, on the lower part, or disc carrier. You than close the two parts and rotate the handle. This applies an annular cleaning cloth of soft, non-abrasive, lint-free material to the disc's 'active' surface, running it *radially* across the disc as the disc manufacturers recommended, while at the same time rotating the disc with a planetary gear mechanism housed in the disc carrier and driven by the handle.

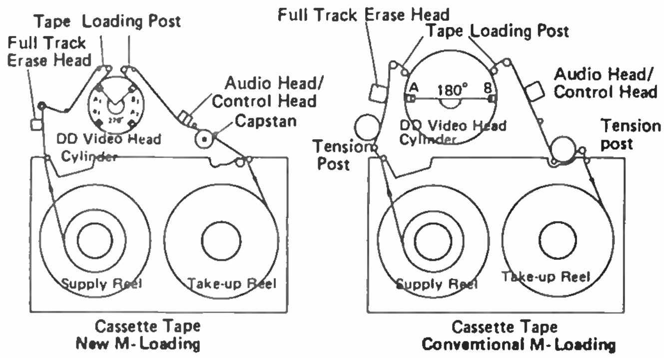
A specially formulated cleaning fluid is applied to the cleaning cloth, which Allsop says prevents damage to the disc surface. Further details from the Allsop distributor, **Communications Power Inc., PO Box 246, Double Bay 2082 NSW. (02) 357 2022.**



VHS plays its Joker at Chicago CES

Malcolm Goldfinch

VHS took up the cudgels against the advance of 8mm video at this year's Chicago Electronics show. JVC lead the battle against the 8mm leader, Sony, and they're soon to be joined by six other 'big names' from the VHS camp. It's war!



2. Head Switching System

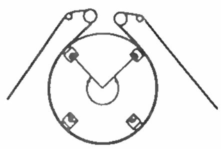


Figure 1. The new M-loading system developed for the VHS-C tape.

AT THE bi-annual Consumer Electronics Show held in Chicago in June, and in Las Vegas January, retailers gather to see what manufacturers are offering and what their customers are likely to buy. Mostly, in the huge exhibition areas, stands have people drifting in and out. Some few have hoards trying to get a look at a "hot box" and queueing for a hands-on demonstration. Mostly, the latest video releases have provided really hot products. Sony is perhaps the champion with its many firsts such as Walkman (portable audio), early 8 mm prototypes and Mavica still video camera, yet to arrived on the order books. At CES Las Vegas in January it was the Sony V8 format, with a tiny camcorder and a whole line of V8 home video including PCM hi-fi audio that packed them in.

At the June CES in Chicago it was JVC and Zenith's (the big US electronics company that will be marketing JVC products) turn to have the hot box. The dealers stormed their exhibits. The reason? JVC's GRC-7, a camcorder that was almost as small and light as the tiny Sony 8 mm camcorder, but with half inch VHS format and all the features of a big heavy camcorder that were missing from Sony's Handycam. The seemingly impossible had been made possible. It was compatible, by an adaptor, with every VHS machine ever produced. Crowds wanted to see and hold it to believe it really existed. So did I, and I managed to do this while visiting Expo in Canada.

The reason for the fever of dealer interest was their concern about portable video formats. After the VHS win in home VCR no one wants to be on the wrong horse. Now camcorders look like being the next boom box. VCR sales are saturating and camcorders are expected to take up the slack. I suspect AEM readers are just as anxious. This is the story of the Joker that has been thrown down by JVC when many thought the V8 format was bolting home.

Further dealer anxiety for those with V8 commitments resulted from the aggressive, saturation TV and press campaign that went with the JVC release, showing the mini camcorder in the palm of a hand, in the background a black snooker ball with a big "8" on it; a lens, mike and eyepiece reminiscent of Sony's V8 Handycam were on the ball. The caption asked, "Why Put Yourself Behind The Eightball — When You Can Have The World's Smallest VHS". Can anyone say now that there is not a video war raging?

On the folder given away by JVC at Chicago, the first of the items below "10 years of VHS" said, "*1. CONSISTENCY IN FORMAT COMPATIBILITY. The format specifications of VHS have remained unchanged since its inception; the first VHS recorder is fully compatible with the latest.*" This has tremendous consumer appeal.

With so many changes in video coming one on top of another it is a most rare achievement. It also reminds us of a little-known fact, the first VHS-C recorders appeared in 1982; we are behind NTSC with the PAL format and sometimes a reworking of NTSC to PAL is out of the question.

Before you lose interest, the camcorder should be in Australia in PAL format about the time you read this story, being released at Perth CE Show in late July. It will cause the same waves in Australia as it did in Japan and the US, I believe.

At the centre of excitement is the weight of the GRC-7; only a shade more (130 gm) than Sony's CCD-M8 Handycam, which is a miniature Betamovie in that it has no TV viewfinder or playback; you must buy or have a V8 VCR to see what you have taken.

CURRENT CAMCORDERS IN WEIGHT ORDER FROM SPEC. (BATTERY AND TAPE INC.)

MAKE & MODEL	TAPE	FORMAT	DIMENSION cubic cm	WEIGHT kg	SPEC. FEATURES
SONY Betamovie	½"	Beta	146 x 177 x 374 = 9665	3.1	With AF, no EVF Replay
NATIONAL M3	½"	VHS	155 x 192 x 324 = 9642	3.1	With Autofocus (AF)
SONY CCD-V8AS	8mm	V8	126 x 191 x 350 = 8423	2.63	With Autofocus
JVC GRC-1	½"	VHS-C	176 x 136 x 340 = 8138	2.5	Not Autofocus
JVC GRC-2	½"	VHS-C	123 x 142 x 317 = 5537	2.4	With Autofocus
JVC GRC-7 CCD	½"	VHS-C	121 x 165 x 223 = 4452	1.7	With Autofocus
SONY CCD-M8	8mm	V8	107 x 109 x 215 = 2507	1.37	Not AF, EVF, Reply

* "JOKER . . . an extra card in the pack . . . can rank above any other card." Dict.

JVC's GRC-7 camcorder appears slightly bigger than the Sony, but so many things stick out it's hard to get a fair bulk assessment between them. The autofocus lens and the TV viewfinder on top account for the extra bulk and weight but they are essential to real video. It also includes all those other features missing from the Sony that go to make a fully sophisticated camcorder, such as instant playback in the viewfinder or on any TV (NTSC or PAL, according to local standard). If a VCR of any format is available you can dub a copy instantly through a single aerial connector.

The weight listed in Sony's Handycam release is 1.37 kg with batteries and JVC's GRC-7 VideoMovie is given as 1.7 kg with batteries. To match the GRC-7 features in Sony's VB series, the model CCD-V8 is closest in weight at 2.63 kg including batteries, almost an extra kg.

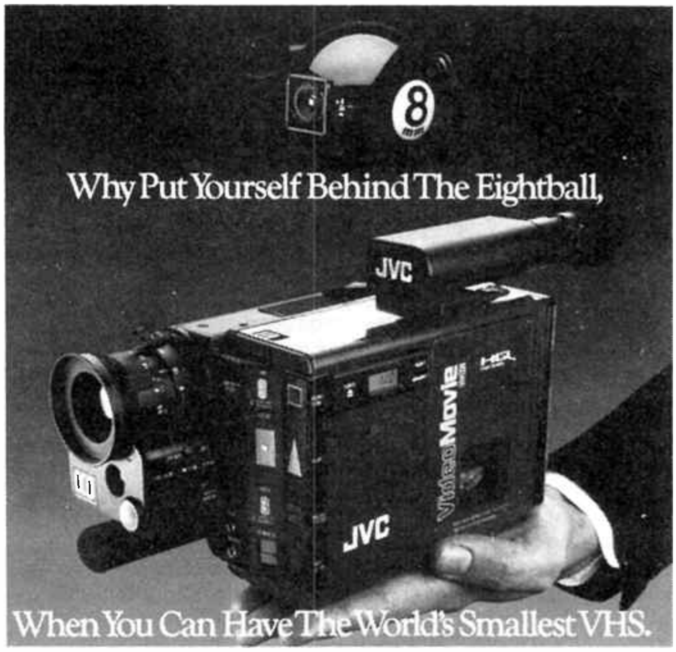
In the handbook on V8 format released last year, the first paragraph reads, "The 8 mm video format is designed to be the most compact of VCRs. The width of the tape is only 8 mm, almost the same size as an audio cassette." Compact it may be, but on a hike up Ayers Rock, the camera weight is what counts; VHS-C has got this part of the act together, with an existing half-inch format compatibility as a bonus. The VHS designers deserve congratulations. They have really achieved the apparently impossible.

Part of the explanation is in the diagrams here. A small scanning head drum with a tape wrap of 270°, instead of the normal VHS 180°, plus an extra pair of heads with alternative switching, to scan the essential standard VHS length of tape, each revolution. It has been used in both JVC and National camcorders for over a year now and has proved reliable.

The VHS engineers were also able to reduce the standard VHS half inch, 12.65 mm tape headscan drum of 62 mm down to 41.3 mm, within 1.3 mm of the 40 mm used in V8 format, this with the advantage of only an 8 mm tape to scan.

In looking at the GRC-7 you are first struck by the small size of the lens system. Not only have JVC designers used their CCD chip instead of a bulky current thumping Newvicon pickup tube, but they have used the small ½" sensing area on the chip to reduce the lens size and enclosed it in a fibreglass shell. (CCD, refer AEM Nov. '85, page 27). The CCD also eliminates the HT supply and deflection circuits for hot bottles, although the mini TV viewfinder needs this in a very small scale. Will plasma EVF be the next video plus?

The autofocus on the f/1.6, 6:1 power zoom lens is all you could expect from a larger videcam. Outdoor/tungsten options are available and backlight setting. A tiltable eyepiece on top allows a mini EVF focus check and instant replay/search, functions. These are vital components of full-scale video and to have them in such a small package is tremendous progress.



VHS versus 8 mm! JVC launched their first 'broadside' in the video format war with this advertisement at the Chicago CE Show.

At this point I always ask, "where's the catch?" Usually there is, but the more I looked and tested the more I became impressed. To start, there is the VHS-C drawback of 20 min NTSC or 30 min on PAL; not so. You have a x3 LP option which allows 60 min on NTSC and I expect 90 min in PAL when it arrives. Ah, but the loss in quality! On test it is hard to notice any loss of quality. But this is absurd? Well not if you consider the science of rotary scan in LP.

Audio tape recorder's extend playing time by slowing tape speed. VCRs first slowed tape and head scan for long play. This was not good, but heads were then a major cost. With cheaper heads, an extra set with narrower track width allows a constant headscan speed in long play and standard play. You just draw the tape over the drum at slower speeds for LP: in JVC's case, a third of SP speed (SP 33 mm/sec, LP 11 mm/sec). The NTSC VHS standard pitch in SP is 58μ and in LP 19μ, with some close tracking. Sounds crazy but it works well and if you upgrade the tape formulation (e.g: metal) LP is as good as the SP. Q.E.D.!

To further enhance LP, JVC recommend their SuperPro cassettes with a tape using Barium-ferrite coating, said to retain 50% more information than normal.

If you think this is close tracking, consider V8 format for maximum play of 240 min, which it can only manage on 2x LP; track pitch goes down to 10μ.

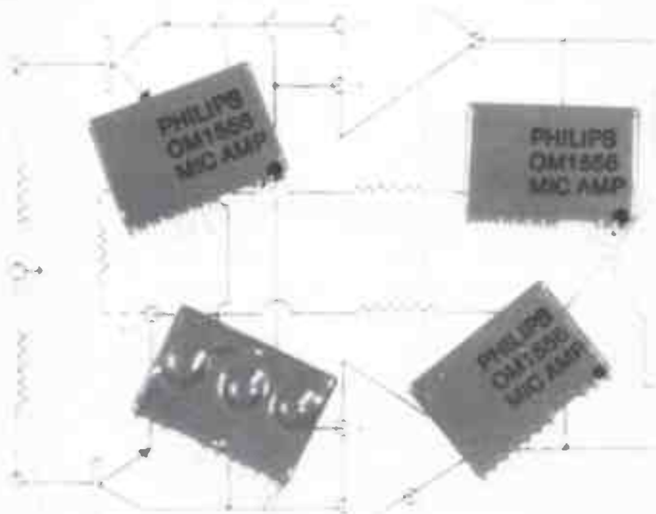
Another feature of the GRC-7 is the inclusion of the new HQ (high quality) white clip pre-emphasis and comb filter circuits, which were fully discussed in AEM April 1986, page 16. No wonder the LP looks like SP.

To hazard an Australian cost for the GRC-7 when it arrives is impossible, but the US prices may be of interest. Recently they were US$1500 including motorised adaptor to full VHS, a 1 hr battery, (2 hr optional extra) RF converter and cables, charging transformer and carrying case. It was rumoured that Zenith was shaving the price by nearly $200, but probably by charging for some of the JVC standard accessory package.

If you hold your breath long enough after the JVC GRC-7 arrives in Australia, you might find something very similar from National, Sharp, Toshiba, NEC, Hitachi and Akai; they have all run up the VHS-C battleflag. Look out V8!

Hybrid double-balanced mic. amp. released by Philips

A balanced microphone transformer and a low noise amplifier is normally used for studio microphones. A hybrid microcircuit has been developed by Philips to replace the transformer and the associated amplifier.



The hybrid incorporates the balanced and floating virtues of a transformer without the signal loss introduced ahead of a low noise amplifier. The gain and input stage current is adjustable. High common mode rejection is achieved with a good noise figure at all gain settings. The output is available as a single ended or balanced output and is capable of driving 600 ohm lines.

Transformers are commonly used on microphone preamplifier inputs for several reasons: Isolation, "Phantom" powering of the microphone, obtaining good common mode rejection of unwanted signals, and impedance step up to obtain a good noise performance.

Some disadvantages are frequency response limitations, size and cost requirement for magnetic shielding, and loss of dynamic range due to voltage step up. Transformers can exhibit relatively high distortion, particularly at low frequencies.

The hybrid, microphone amplifier designated as OM1556, replaces the transformer for most applications. Being direct-coupled on its input, the large, matched input coupling capacitors required for transformerless designs are not required.

The input stage has several unique features, Philips claim. It employs LM194 super-matched dual transistors physically cross-connected in parallel. Each transistor is connected in a feedback loop with half a NE5532 operational amplifier. The emitter current of each transistor goes into the output of each operational amplifier.

The transistor current is set by a bridge connection on the inputs of the op-amp and 300 ohm feedback resistors give the highest dynamic range, that is, maximum output level consistent with the best noise figure.

The external gain setting resistor can have a low value, particularly at high gain settings, whre it can be less than one ohm. This enhances the excellent noise performance of the input transistors.

Each output stage is connected in the classic four-equal-resistor instrumentation amplifier connection. The output stages sum the output from both input stages. A gain of two is therefore obtained between the two outputs of the output stage.

The output impedance of each output is 25 ohms and this terminates long lines when the hybrid is used in such applications.

The input stage transistor collectors have very little signal at any gain setting or level. This results in virtually no collector modulation of the transistor base region ('Early Effect'), that is common in many input stage designs. The Miller input capacitance variation is also reduced.

Both these effects, if present, can have an effect on the signal source, particularly if it is inductive, and could degrade the quality of the input signal.

Field tests in various studios have shown good results with no apparent problems that can be present with transformerless input stages.

When substituted in some of the better quality mixing consoles the only obvious difference was the better noise figure of the hybrid, Philips claim.

The input stage can have up to twelve volts applied as "phantom powering" for condenser or electret type microphone polarisation.

For further information, contact: **David Segal, Philips Elcoma, 11 Waltham Street, Artarmon 2064 NSW. (02) 439 3322.**

Eye spy, with my little eye . . . even plastic guns

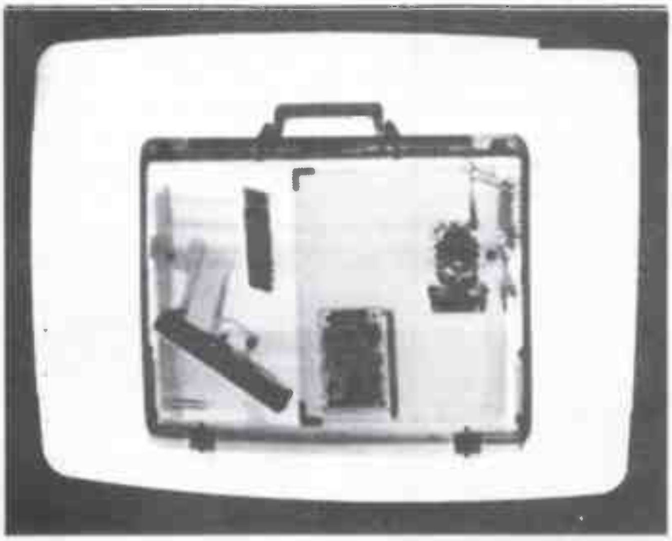
A security X-ray inspection system, now available to airport and other security surveillance authorities, is able to identify even plastic weapons concealed in baggage.

Developed by Philips and known as the Dynavision X-Ray Screening System, the unit was tested by law enforcement and security authorities in the USA because of their concern about the availability of modern handguns constructed mainly of plastic parts.

Weapons were placed in attache cases with routine items such as calculators and papers. The results were overwhelmingly positive with the full outlines of the weapons being easily detected, proving that handguns like the Glock 17 and VP702, or even toy guns, could be identified.

According to Philips, this confirms that the current Dynavision X-ray machines are fully capable of "imaging" threats from plastic handguns, without the need for other electronic devices which could distract from the operator's important function of rapid but thorough inspection.

Further details from **Philips Scientific and Industrial, 25-27 Paul St, North Ryde 2113 NSW. (02) 888 8222.**



More Audiosound for the ABC

The A750M MkIII from local manufacturers, Audiosound Laboratories, is supplied in quantity to the ABC. The unit is a 30 watt per channel integrated amplifier featuring a high capacity power supply with a toroidal transformer.

Balanced line inputs via Cannon sockets enable interfacing professional lines with domestic amplifier inputs. Also featured is a 20 dB/octave rumble filter/equaliser on the phono input.

A full domestic version, The A750D is also available. Further details can be had from **Audiosound Laboratories, 148 Pitt Rd, North Curl Curl 2099 NSW. (02) 938 2068.**

Eldorelt acquires cassette duplication business

On June 3rd 1986 the directors of Eldorelt Pty Ltd announced that they finalized negotiations with Regent Traders Pty Ltd for the purchase of Regency Recordings cassette duplicating business.

Regency Recordings has been providing a high quality cassette duplicating service for the last three years and currently boast a large list of customers including: Mattel toys, National Broadcasting Commission (N.B.C.) of Papua New Guinea, Bill Armstrong Organisation and EON-FM, just to name a few.

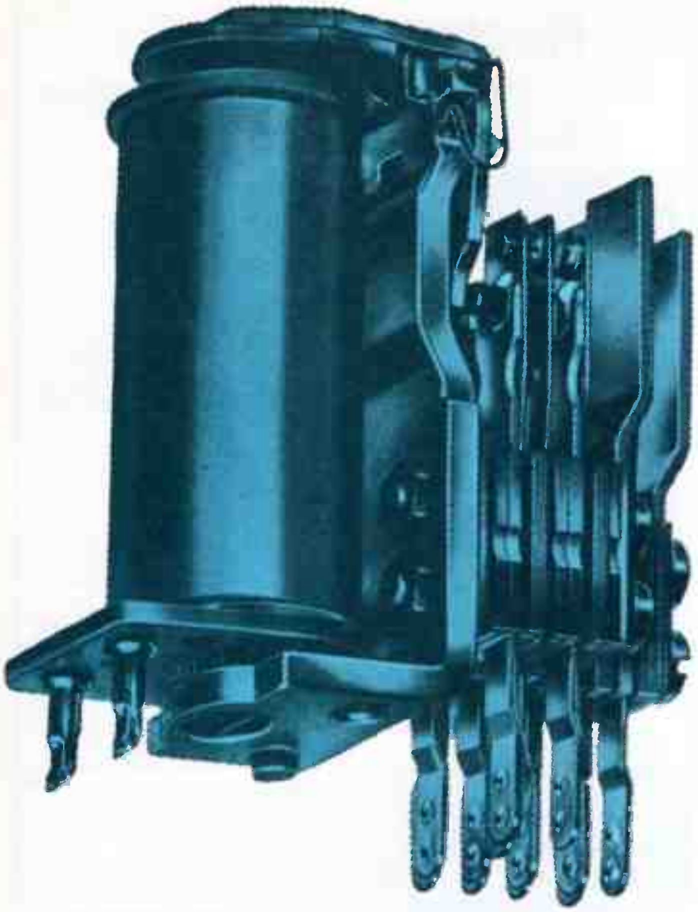
Regency will be offering a wide range of services from large quantity high speed Loop Bin, cassette-to-cassette and real time duplicating to the manufacture of special ength wound blank cassettes.

Eldorelt is owned by Fiona Horman, who has been managing Regency Recordings over the last two years, and Martin Pullan, who is a highly respected freelance studio engineer in Melbourne. Eldorelt has also appointed Brian Horman as Technical Director, whose experience spans many years in the duplicating business, being the first to introduce high speed cassette duplicating into Australia back in 1968.

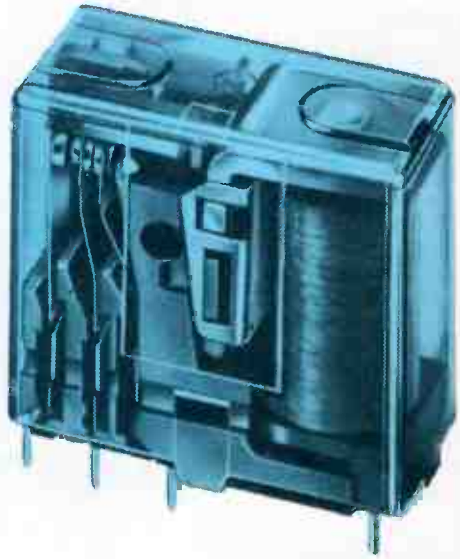
Fiona Horman, commenting on the acquisition, said: "Our idea was to combine the talents of highly technical people with state-of-the-art equipment in order that we provide our customers with the service and quality they deserve to expect."

For turther information, contact: **Fiona Horman, Regency Recordings, 129 Peel Street, North Melbourne, 3051 Vic. (03) 329 2059.**

From left to right Martin Pullan, Fiona Horman, Brian Horman of Regency Recordings.



Electromagnetic relays come in a host of styles — pc mount, cradle types (which plug into a special socket holder), bolt-down open types, DIL package miniatures, enclosed, encapsulated and sealed types. (Siemens relays, courtesy Promark).



RELAYS

— technology and application techniques

Roger Harrison

The humble relay has had a long and honoured history and modern technology has not only not supplanted it but provided enhancements!

"RELAYS? I thought it was all done by solid-state switches these days!", said a well-known industry identity when the subject came up for discussion during a business function. He could hardly be taken to task for the assumption though, given the rapid, far-reaching advances of electronics technology in recent years. However, the relay is in no danger of being usurped by 'new-fangled' solid-state devices, not for the forseeable future anyway.

The humble relay has had a long and honoured history in electro-technical technology. The earliest patent for a relay, by Cooke and Wheatstone (British Patent 7390), will be 150 years old next year. Their patent described an electromagnetic relay device for bringing a local battery at a distant telegraph station into action to sound an alarm bell. Edward Davy was granted a patent for a relay in 1838, although he worked on electric telegraphy from 1836 and opposed Cooke and Wheatstone's application. Davy probably coined the term for the device as his patent application says, in part ". . . making telegraph signals . . . from one distant place to another by employment of relays of metallic circuits brought into operation by electric currents."

Relays have a range of advantages not offered by other switch forms.

(a) An open-to-closed switching resistance variation that goes from infinite to a few milli-ohms.

(b) Total electrical isolation between the operating (input) circuit and the switched (output) circuit. This is achieved through a mechanical linkage that is wholly electrically isolated. Solid-state relays cannot provide this feature. (See Figure 1.)

(c) Multiple output circuits may be operated from a single input circuit.

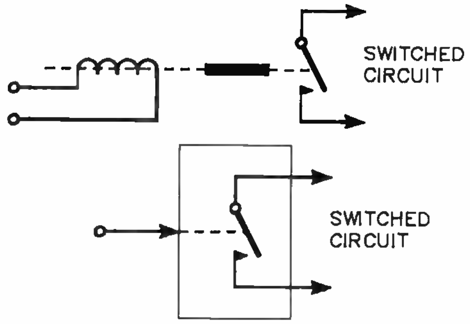


Figure 1. Top — an electromechanical relay provides physically isolated switching; no electrical connection exists between the activating signal and the switched circuit. Bottom — a solid-state switch does not provide total electrical isolation between the input and the switched circuit.

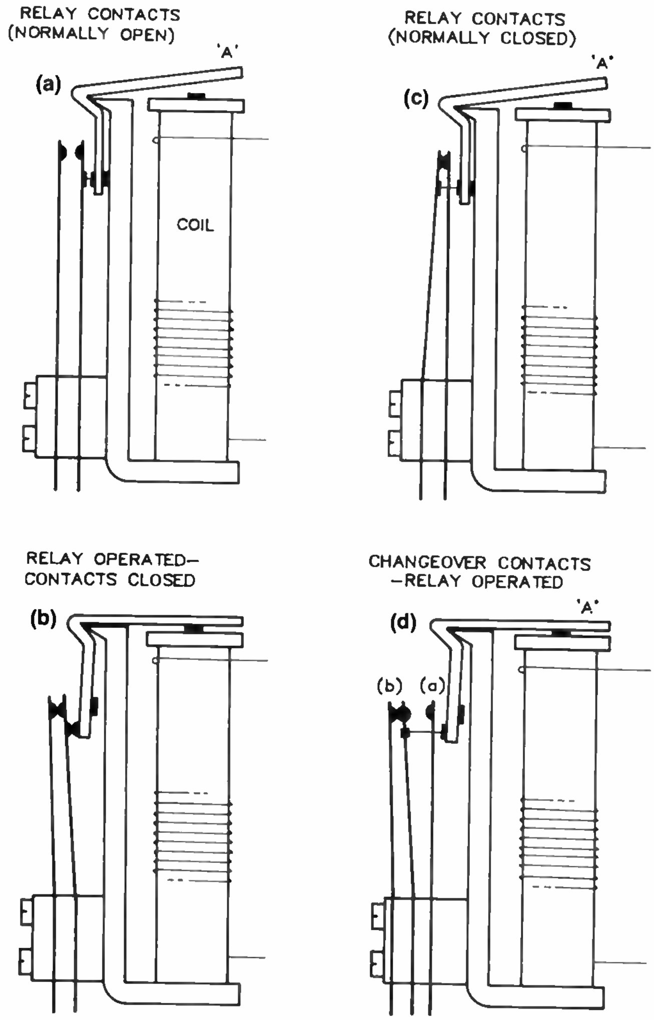


Figure 2. Fundamental arrangement of the electromagnetic relay, illustrating various contact assemblies and armature operation (see text).

Fundamentals

A relay is simply an electrically-operated switch. The most common types employ an electromagnet that operates a hinged lever, called the 'armature', when energised. The armature then mechanically opens or closes a set of contacts. A widely used 'special' type is the reed relay in which the coil's magnetic field acts directly on one contact. Another common type, principally used in vehicle turn indicator flashers, employs a resistance wire that heats up a bimetallic strip which deflects, operating a set of contacts. Some, admittedly rare, relay types are operated by an electrostatic field or by a piezo-electric or ferro-electric device. Major relay types employed in electronics are covered in a later section.

As the type of relay most widely used in electronics is the electromagnetic type, we'll concentrate on that here. Note that the electromagnet may be energised by an ac source or a dc source. Figure 2 (a — d) shows the basic relay construction. The coil is a solenoid wound on a soft iron core.

In 2(a), the set of contacts has one 'moveable' and one 'fixed' contact, each made of a 'spring' metal. Some relays employ contacts actually attached to a spring. In 2(a) here, the contact set is 'normally open'. The armature ('A') is attracted toward the coil when the coil is energised. This deflects the right hand contact, pushing it against the left hand contact, which also deflects slightly. Each 'arm' of the contact set deflects somewhat further than is necessary just to effect contact, as seen from 2(b). This is necessary because firstly, it assures firm mechanical contact. Secondly, the spring metal stores energy to ensure rapid breaking of the contacts when the coil is de-energised. Thirdly, the overtravel makes up for contact wear. In addition, the contacts slide across each other, effecting a self-cleaning action which maintains a low contact resistance.

The armature butts against a stop, as can be seen in 2(b), designed to limit the armature travel once required contact pressure is reached. Often the stop is the coil core, but in some designs a screw-adjustable stop is used.

Figure 2(c) shows a relay with 'normally closed' contacts. Here, the left hand contact is the moveable one and it is bent against the right hand contact while the coil is unenergised. A small (insulated) post connects the armature to the left hand contact. Both contacts are pre-stressed, effecting the wiping action and allowing the take-up of wear in this type of contact set.

Figure 2(d) shows a set of change-over contacts, shown here with the coil energised and the armature operated. Here, the middle contact is the move-able one, moving from contact (a) to contact (b) when the coil is energised. Thus, the normally closed contacts are the middle and right hand (a) set, the normally open contacts being the middle and left hand (b) set.

Characteristics

The electromagnet in a relay must generate a force on the armature to overcome all the mechanical forces that restrain it: inertia, a variety of friction forces, 'stiction', spring tension, etc. The force generated depends on a number of factors — the reluctance of the iron in the magnetic circuit (pole, armature, etc), the area of the pole face, the gap between the pole and armature (unoperated), the number of turns on the coil and the current passed through the coil. The latter is known as the 'ampere-turns', designated by N (turns) and I (current) — NI. This parameter is of prime importance because, for a relay electromagnet of given size, the force generated depends on the square of NI.

The amp-turns figure at which the contacts just make (in the case of a normally open contact set) determines the relay's 'amp-turns sensitivity'. However, a more useful parameter used to determine what it takes to operate a particular relay is the power required to close the contacts, known as the 'power sensitivity'. This is dependent on the ratio of the number of coil turns squared to the coil resistance, called the 'coil conductance'.

The power required to operate a relay depends directly on the coil's winding depth and inversely with its length. Hence, a relay with a long, thin coil requires the least energy to operate. Depending on the design operating current and voltage, a relay coil may be wound with many turns of fine gauge ▶

wire or few turns of heavy gauge wire.

Initial contact pressure, at the point of closure, depends on the mechanical design and the contact rating, more pressure being required for heavier, high current contacts as you would expect. Typically, initial contact pressures range from fractions of a gram for tiny pc-mount relays, up to 150 grams or more for relays having contacts rated at tens of amps.

For a given nominal operating voltage, a relay will have a specified 'pick-up' or 'pull-in' current. The pick-up voltage is typically around 70% of the nominal coil operating voltage. The coil voltage required to sustain the armature in the operated state ('hold-in') is considerably less than this level, however — as much as 60% lower, or more. At a level well below this, the force provided by the electromagnet will be insufficient to sustain the mechanical load of the armature, contact springs etc, and the armature will release, or 'drop out'.

A relay may be operated over a wide range covering its nominal operating voltage. For dc-operated types, this may be 70-220%, for ac-operated types it may be 80-110%.

The actual drop-out level of any particular relay will depend on a lot of variables, such as precise contact spring tension, mounting position, etc.

It takes a finite time for the contacts of a relay to close following the application of the coil operating voltage. This is known as 'closing time' or 'operating time'. For ac- and dc-operated types, this typically ranges from 5 to 50 milliseconds.

For dc-operated relays, closure time increases steeply when the applied coil voltage drops below the nominal voltage. It may increase by as much as 50% for a 20% drop in coil voltage. Conversely, operating time may be decreased by operating the coil above its nominal rating. Typically, it may decrease 20% for a 20-50% increase in coil voltage.

Closure time for ac-operated relays typically ranges across 5-20 milliseconds and is not so greatly affected by operating voltage as are dc types.

Drop-out times for dc-operated relays are quite a deal shorter than closure time, typically being a few milliseconds once the coil current drops below the hold-in level. With ac-operated relays, release times are typically similar to operating times, but may actually be longer by as much as 20-50%.

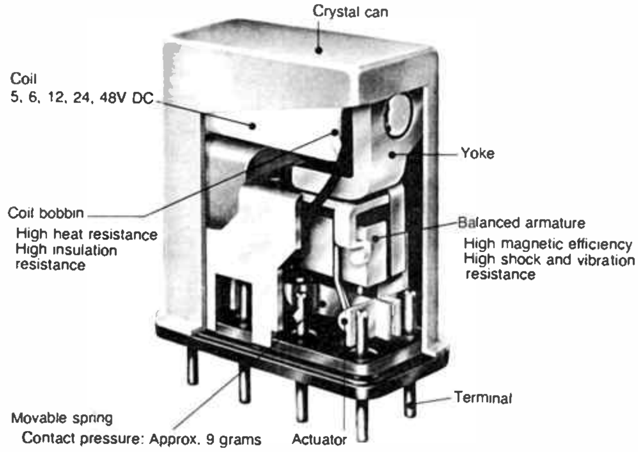
Major types employed in electronics

While over 120 distinct relay types may be identified, major relay types employed in electronics may be classified into five basic categories. All are manufactured in a wide variety of forms, shapes, sizes, contact sets and ratings for a wide variety of applications. They are described here in alphabetical order.

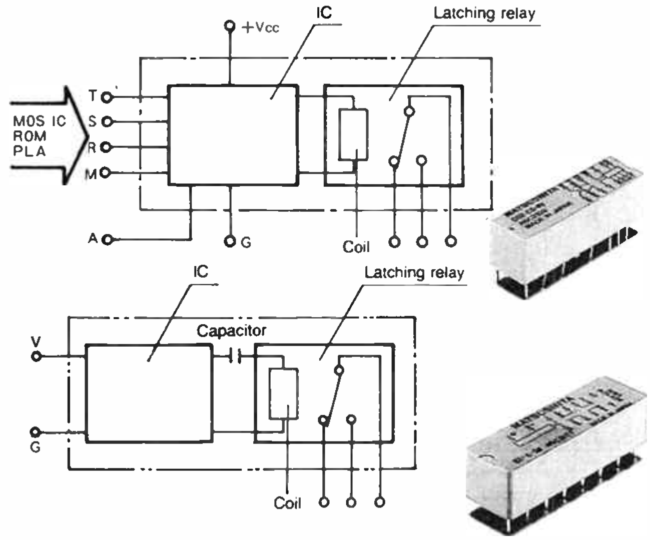
Electromagnetic. These are the coil-and-armature types as described earlier. They are available with single and multiple contact sets for operation in any orientation. Contact ratings vary from 100 micro-amps to 30 amps. Forms range from a variety of pc-mount types including in dual-in-line (DIL) packages rather like ICs, socket-mounting and bolt-down types.

The coil of an electromagnetic relay may be energised by ac or dc, depending on its construction. The familiar solenoid-type coil operates from dc. Now, alternating current passes through zero each half-cycle and thus the magnetic field generated by an ordinary solenoid-type coil will drop to zero each half cycle. Try applying ac to a normally dc-operated relay and see what happens!

When energising a relay with ac, you need to see that the relay armature remains closed as the magnetic field passes through zero each half-cycle. Several methods may be employed, but probably the most common involves placing a cylindrical copper 'slug' over part of the coil winding. The

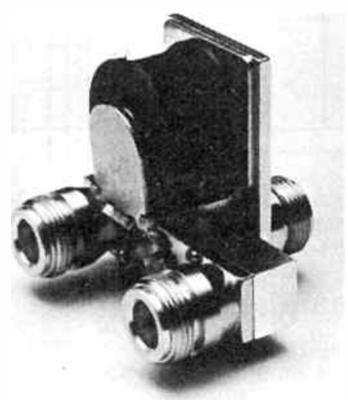


A vertical-mount balanced armature polarised relay. (National DN type, courtesy RVB).



Hybrid relays are available in various forms. Some feature an internal IC which permits logic drive (upper), others feature impulse drive and microamp current drain (lower). (National relays, courtesy RVB).

Reed relay (without enclosing coil). This one has a set of change-over contacts. (From Hermetic Switch Inc., courtesy Koloona Industries).



Coaxial RF relay, change-over type. The armature actuates a sprung portion of centre conductor inside the assembly, but maintaining constant impedance. (Toyo relay, courtesy Imark).

ac energising current in the coil induces a current in the slug that lags the coil current. Thus, the field generated by the coil and the slug never passes through zero and there is always a net magnetic force on the relay armature when the coil is energised.

Hybrid types. These take a variety of forms. Some widely used types comprise a sensitive electromagnetic relay incorporating a solid-state driving device such as a logic IC, op-amp or a transistor amplifier. The logic IC types may have a single input or multiple inputs to provide AND-NAND or OR-NOR operation.

Some hybrid types incorporate a triac in the output, giving the advantages of both the traditional relay and the solid-state switch. Such relays are used in ac switching applications because they provide substantially greater load switching capability than conventional contacts during opening and closing.

When the relay coil is energised, the triac is turned on by a set of low current primary contacts prior to the main contacts closing. The triac absorbs the load in-rush current, typically withstanding in-rush currents of 15 times the steady load current, whereas relay contacts will typically only withstand in-rush currents of three to five times the steady load current.

Likewise, when the relay coil is de-energised and the main contacts open, the primary contacts maintain the triac on briefly, allowing it to absorb the load's switch-off transient.

The main contacts carry the load current during operation, while the triac is only brought into play during switch-on and switch-off. This keeps heat dissipation low because the contacts have a very low on-resistance compared to the triac.

Polarised types. There are two basic forms of this type — the balanced armature and the differential type. In addition, they can be made with 'latching' contacts.

Balanced armature relays incorporate an armature which is balanced about its centre of mass. A coil set is arranged to pull the armature one way or the other according to the coil energisation.

Differential relays have two or more windings arranged such that the armature motion, and thus the contact operation, depends on the polarity of the coil voltage(s). Some are made with a 'centre off' feature.

'Latching' type contacts employ a permanent magnet mechanism which causes the armature, and thus the contact set, to remain in one position or another, depending on coil energisation. The advantage being that the coil only need be energised for a short period while the armature changes position. This has great application in circuitry requiring minimum quiescent power consumption.

Reed relays. These comprise a set of small, flat metal blades (or reeds) sealed within a glass tube. One blade is the moveable contact and it responds to a magnetic field that may be applied by moving a permanent magnet near the tube, or by a solenoid-type coil. They are made with normally-open, normally-closed and change-over contacts. Some have the contacts 'wetted' by mercury, drawn up the contacts through capilliary action, to improve the contact characteristics.

Reed relays exhibit very fast operating times, have high reliability and are relatively inexpensive. They are used in a wide variety of applications, although reed relays do not have the contact current ratings possible with other types.

RF relays. As the name implies, these are made for switching radio frequency circuits and are specially constructed to preserve circuit impedances and minimise loss across a given frequency range.

'Coaxial relays', having coaxial connectors for directly terminating cables, are a familiar item in radio communications. However, in recent years, printed circuit mounting types ▶

have appeared, intended for direct interfacing to printed circuit 'stripline' RF conductors.

RF relays can be obtained with ac- or dc-operated coils and with or without auxilliary contact sets for switching associated (non-RF) circuits.

Contact considerations

The contacts on a relay are primarily required to do two things: (a) carry the load current when closed, and (b) withstand the circuit voltage when open. That sounds pretty simple, but there are a whole host of considerations to take into account along the way.

When relay contacts close, small areas of the connecting metal faces deform, stopping when the total contact area is able to support the contact force. The load current flowing will very briefly heat the contacting metal areas, raising it to the metal's boiling point or even causing it to vapourise. The contacts will actually 'weld' over a microscopic area and depth. If the contacts are switching dc, a small amount of material will be transferred from one contact to the other when they next break. When switching ac, minute amounts of metal on the contact faces are vapourised causing some loss from the contact faces. Thus, relay contacts have a finite lifetime, principally limited by these mechanisms and wear caused by contact sliding.

When the relay contacts open, similar processes occur, with the addition of arcing, particularly when breaking dc circuits (a small amount of arcing occurs during contact closure, too). A controlled amount of arcing can be a good thing actually, burning off oxides and other contaminating material which may build up on the contacts. However, arcing is destructive if it continues for more than a few milliseconds because it causes rapid loss of contact material and transfer of material from one contact to the other. Thus, contact arc suppression is important in many applications. I'll get around to that in detail later in the article.

R-C CONTACT QUENCHING

Using this nomograph you can determine the resistor and capacitor values needed for simple series R-C quenching of relay contacts for dc and ac sources switching resistive or inductive loads.

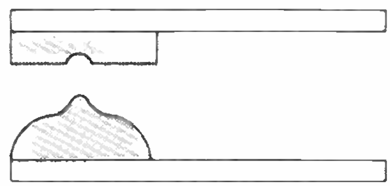
In dc applications with resistive loads, the source voltage, E, is the supply voltage and the current, I, is the current flowing in the load immediately before the relay contacts open.

In ac applications with resistive loads, for the source voltage, E, use the peak value of the supply and for the current, I, use the peak value of the load current.

With inductive loads, E is the overvoltage produced by the current interruption (you can measure this with a CRO). The current, I, has to be calculated from this voltage and the resistance of the load.

To use the nomogram, run a straightedge between the load current and the source voltage, right across to the resistance scale. The capacitance required is adjacent to the load current, the resistance required is read from the scale. The example shows a 300 mA load current being switched from a 12 V source. The capacitance indicated is 9 nF (use 10 nF) and the resistance about 550 ohms (use 560R).

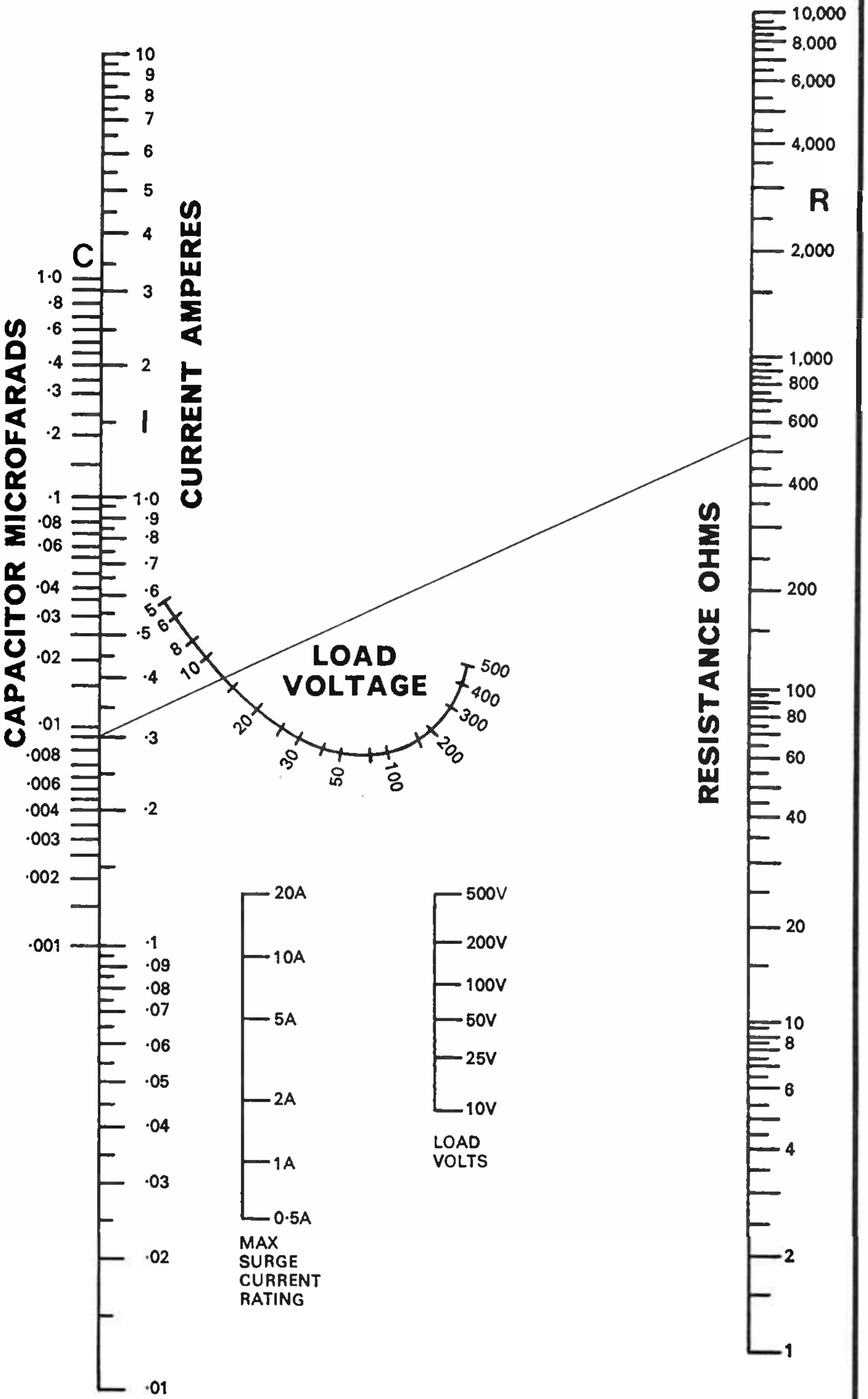
Minimum resistance to be used is half an ohm, minimum capacitance is 1 nF. For E less than 70 V, R may be three times the indicated value; for E between 70 and 100 V, R may be ±50% of the indicated value; for E between 100 and 150 V, R may be ±10% of the indicated value and for E greater than 150 V, R may be ±5% of the indicated value.



In relays which do not have the contacts sealed from the atmosphere, organic material condenses on the contact surfaces and will become adsorbed in time. Arcing carbonises contacts operated at their rated voltage and current levels, any carbonised material on the contact surfaces is breached when the contacts operate. However, when used to switch currents or voltages substantially below the contact ratings, or where currents are not present at the time of switching (known as 'dry switching'), organic deposits can and do cause problems.

This brings us to the subject of contact materials. Different metals or metal allows are employed to maintain a low contact-contact resistance over the life of the relay. The contact specification depends on the intended application and on the sort of load to be switched.

Loads are defined in four categories: 'dry loads' — where voltage levels are low and current is not present at the time of switching, or is in the microamp/milliamp region or below (e.g: low level AF or RF signals); 'light loads' — low voltages and currents in the milliamp region, up to 0.5-1 A; 'intermediate loads' — where voltage and current levels do not generate arcing sufficient to break down contact deposits; 'heavy loads' — generally refers to switching situations where the relay contacts are operated at or near their rating and contact arcing occurs at each opening and closure. ▶



$$C = \frac{I^2}{10}\ \mu F \text{ (dc; for ac, use the peak values)}$$

$$R = \frac{E}{101^x} \text{ where } x = (1 + \frac{50}{E})$$

If contact surge current rating is critical, determine the minimum permissible value of R from the lower nomograph. If higher than that previously determined, this resistance value must be used to limit surges due to the suppression circuit.

Nomograph and information compiled from material produced by AMF Inc. and Electrothermal Engineering Ltd. (The latter courtesy Koloona Industries.)

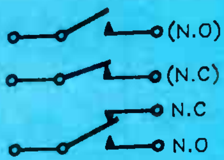
CONTACT FORMS

Relay manufacturers generally specify a particular relay's contact sets in one of three forms:

(i) Form A — normally-open;

(ii) Form B — normally-closed;

(iii) Form C — change-over.



The 'Form' will be prefixed by a number to indicate the nunber of contact sets. Thus, "1 Form A" is a single set of normally-open contacts, "3 Form B" stands for three sets of normally-closed contacts, and "6 Form C" represents six sets of change-over contacts.

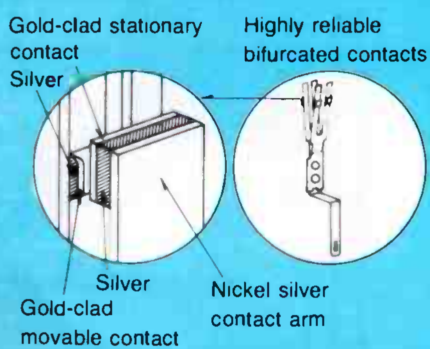
For dry load applications, special contact materials are necessary to avoid organic film and particle contamination and maintain low contact resistance. Contact contamination can be a very real problem. Gold-clad or gold-plated contacts are widely employed, often on nickel-silver or phosphor-bronze contact material. Gold-palladium alloy contacts are also seen.

With all relays, the contacts slide across one another when opening and closing. The friction generates heat which is enough to polymerize organic material condensed on or adsorbed by the contacts and a powder forms, creating high and variable contact-contact resistance. When switching light loads, this is disastrously unreliable. Sealed relays, where the contacts are enclosed in an environment of dry nitrogen, are often specified for light load applications or where severe environmental conditions are encountered. Contacts of gold-clad silver or gold-palladium alloy are employed, in both sealed and non-sealed relays, for they are virtually immune to contamination and polymer formation.

As explained above, intermediate loads do not generate sufficient arcing to reliably break down contact deposits. As a result contact-contact resistance increases, sometimes quite rapidly, depending on the particular conditions. Many applications will tolerate such conditions — but, sooner or later trouble will show up. Where the contacts are called upon to switch a wide range of voltage and current levels, contacts, or gold-overlayed palladium contacts are often specified in intermediate load applications. Palladium, one of the platinum family metals, is quite a useful meterial and relay contacts using it exhibit good low-noise characteristics, do not suffer from contamination by oxides or sulphides and have

SPECIAL CONTACTS

Where the highest reliability is required, whether it be for dry loads or heavy loads, gold-clad bifurcated contacts are employed. Bifurcated means 'split in two', as the accompanying illustration shows. The contact material may be silver on silver-nickel springs or silver-nickel on phosphor-bronze springs.



Birfurcated contact assemblies provide several chances to make a low resistance contact, reduce contact heating when switching current and provide increased contact surface area.

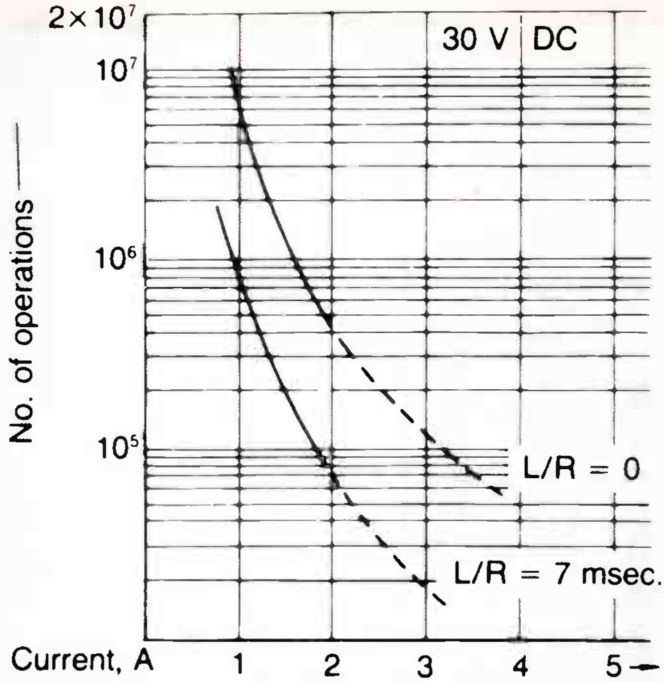


Figure 3. Typical electrical life expectancy curve for a relay contact set rated at 2 A maximum current, and maximum switching power of 50 W/100 VA.

ten times the life of plain silver contacts.

Silver-nickel and silver alloy contacts are probably the most widely used. Plain silver, while having the highest electrical conductivity, is subject to sulphide formation, arc erosion and relatively more rapid wear than silver-nickel. In addition, silver-nickel is less sensitive than silver to high switch-on peak ('in-rush') currents, often encountered when switching lamps or reactive loads. Silver-cadmium-oxide contact materials are specified where contact welding may prove a problem, is less liable to arc erosion than silver or silver-nickel and gives improved reliability where particularly high switch-on peaks are encountered. However, silver-cadmium-oxide contacts are not suitable for switching voltages below 12 V, light loads or dry switching.

Tungsten contacts are specified in applications with high switch-on and switch-off loads. e.g: inductive and capacitive circuits without spark suppression. It is employed for its hardness and high resistance to arc erosion. However, tungsten tends to oxidise and is not suitable for high humidity climates. Tungsten contacts are not suitable for switching dry loads or voltages below 24 V.

The life of a relay is limited by contact resistance, not its mechanical attributes. Typically, a particular relay's mechanical life is 10-100 times the contacts' electrical life. A relay's life expectancy is measured in "minimum operations". Mechanical life expectancies range from one million to 1000 million, while electrical life expectancies typically range from 100 000 to 100 million. Electrical life depends very much on contact loading, arcing characteristics and contact materials.

Switching inductive loads can be quite destructive of relay contacts, particularly in dc circuits, and materially shortens electrical life of the relay. As mentioned earlier, material is transferred from one contact to the other during switching. With high on-off cycle frequencies, concave-convex formations appear on the contacts. Contact resistance rises, increasing contact heating until eventually, the contacts 'weld'. Such an event will certainly mean destruction of the contacts, if not the circuit or device being switched!

Figure 3 shows the 'life curve' of a relay with gold-clad silver contacts rated at 2 A, switching a 30 Vdc load. When the load is resistive (L/R ratio zero), life expectancy when switching the rated current is greater than 400 000 operations.

to p.57 ▶

DSE PUTS VALUE BACK IN YOUR $

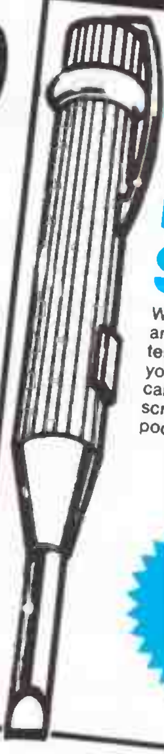
Become a gun handyman with turbo screw driver!

NEW!

Don't waste time and energy screwing and unscrewing by hand. Pistol-style Turbo Driver does the job quickly and easily, like a drill! Includes 4 different head types and sizes, plus reverse drive for screw removal. Cordless mobility and removable handle for hard to get at areas. The ideal addition to any tool box. 30kg/cm torque. Cat T-4740

$76.95

W • NEW • NEW • NEW



Flick blade Neon Screwdriver

What an improvement for handymen and technicians: combining a 240V neon tester in a compact screwdriver. Lets you test live wires in AC mains, then carry out repairs. Retractable screwdriver blade for convenient, safe pocket carrying. Cat T-4007

GREAT VALUE!

$6.55

We've got what it takes to make desoldering easy

Our affordable desoldering tool is a 'must' for anyone servicing or replacing components, PCBs, etc. Does a neat job, quickly! Completely self-contained for on-site use. 240V, 30W. Energy Authority approved. Cat T-1340

VALUE AT ONLY **$75.95**

Bloctronics

New, safe way to build projects

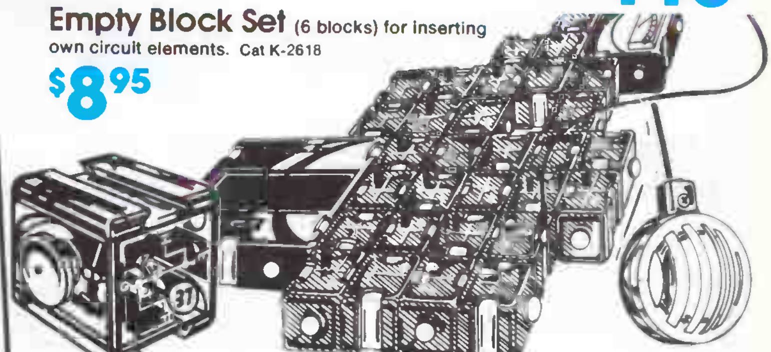
Kids can experience the fun and excitement of building electronic projects in complete safety with Bloctronics. Instead of soldering, Bloctronics uses interconnecting circuit blocks to create radios, flashers... all the popular projects. It's an invaluable grounding in electronics, and affordable; add-on sets offer better value as parents can buy each stage when required.

Set A Starter Pack Cat K-2612 **$43.45**

Build On Set 1 Cat K-2614 **$43.95**

Set D Up to 160 experiments with full instructions. Cat K-2616 **$115**

Empty Block Set (6 blocks) for inserting own circuit elements. Cat K-2618 **$8.95**



Handy Service Aids

Silicon Sealant
Versatile adhesive/sealant works on glass, wood, metal and most plastics. No mixing required! 75g tube. Cat N-1225 **$5.75**

Matte Black Spray Paint
Quick drying paint simply sprays on to give projects a professional touch. 175g. Cat N-1070 **$4.15**

Super Glue
Strong, no-fuss glue for virtually any application. No clamps or messy mixing needed. 3ml tube. Cat N-1220 **$4.35**

Heat Transfer Compound
Safe, non toxic! Superb thermal coupler to cool heatsinks. 10g tube. Cat N-1205 **$3.25**

CRC-2-26 Spray
Moisture removing, cleansing spray that leaves a protective film. Ideal for contacts and switches, for removing stubborn bolts and many more applications. 400g. Cat N-1060 **$13.75**

MORE SERVICE AIDS ON THE BACK PAGE!

DICK SMITH ELECTRONICS PTY LTD

SOLDERING ON AT DSE...

Mini Soldering Iron for precision work

Don't make a mess of it! Our ultra-slim iron is perfect for precision soldering on computers, PCBs and auto repairs (optional cigarette lighter plug available). Heats quickly. 6W output, 12V AC or DC operated. Cat T-1920

$16.95

Replacement Tips

Copper Wedge. $3.25
Cat T-1921

Copper Conical $3.25
Cat T-1922

Don't be a sucker!

A quality, metal solder sucker like this would cost twice as much anywhere else. And our low price isn't the only thing to please. The sucker features a Teflon tip with simple thumb release mechanism for easy solder removal. Cat T-2560

ONLY $12.65

Your third hand... a solder stand!

DUE LATE SEPTEMBER

$43.95

You always wish for another hand when soldering PCBs... Here it is! Just place board in rubber faced vice, adjust angle, and secure. Iron and solder spool holder means they're always close at hand.
Cat T-5700

The heat's on! varitemp iron for all your jobs.

At last an affordable variable temperature soldering iron to handle the heat of performing all those jobs requiring different temperatures. Temperature control is conveniently located in the handle for easy adjustment. Powerful 25W capa[illegible] and quick heating performance. 240V operated, Electricity Authority approved. Cat T-1350

$32.95

Spare Tips

Medium. Cat T-1351
Large. Cat T-1352
Conical. Cat T-1395

$4.35 each

Easy Desoldering!

Desoldering Bulb is simple, quick and very efficient. Hold Bulb to molten solder, squeeze and release: solder is sucked up instantly. Ideal for blow cooling too.
Cat T-2580

ONLY $9.85

Desoldering Braid

Famous 'Dick Wick' — treated copper braid that quickly and thoroughly removes solder by capillary action. On economy reel — use only what you need! Cat N-1682

$3.15

Economy Solder Packs: 'project' sized!

Just what the hobbyist ordered: a liberal amount of solder in very affordable packs. Available in two sizes:

1.25mm (18g). Cat N-1638
0.75mm (22g). Cat N-1636

Only $2.15 each

Soldering Stand/ Magnifier

The perfect accessory! Sturdy soldering stand features clips for holding PCBs, etc. Invaluable magnifying lens for delicate work too! A must for every bench. Cat T-5710

GREAT VALUE! $14.25

Bargain corner these items must go!

(UP TO 60% OFF!)

Metric Knobs
Red, plastic; 16mm Cat H-3800
Orange, plastic; 16mm Cat H-3802
WAS $1.55 75¢ ea

RCA Metal plug; red.
Cat P-1424
WAS 95¢ 50¢

OP-AMP Experimental PCB. Suits 741 type op-amps with provisions for circuit variations: input, feedback, etc.
Cat H-5618
WAS $4.95 $2

N connector; female line; silver plated. Cat P-2405
WAS $7.95 $4.95

BP (mains) connectors; 240V. Pk. of 10. Cat H-6710
WAS $2.75 $1

DPDT Mini toggle switch; right angled.
Cat S-1177
WAS $2.50 $1.50

Wire Stripper/ Wrapper

You don't have to spend a fortune for professional wire wrapping. Our simple, economic tool does a great job and strips wire too! Add it to your tool box today.
Cat T-3650

BARGAIN AT ONLY $15.35

Give flux removers the can!

The fast, efficient way to clean up messy solder jobs is with spray flux remover. It's perfect for service work and projects. 400g spray can. Cat N-1055

GREAT VALUE! $10.95

DICK SMITH ELECTRONICS
PTY LTD

TOOLS SAVINGS AT DSE

Rechargeable Soldering Iron/ Station

Versatile, quick heating cordless iron that's perfect for circuit and general purpose soldering... on the workbench or away. Build-in bulb for better viewing, safety cap for on-site jobs. Dual purpose soldering station is a stand and recharger. Complete with long-life tip, solder, sponge and AC adaptor. Cat T-2020

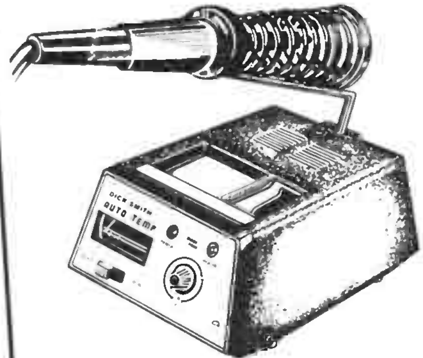
ONLY $54^{95}

Spare Tip & Sponge Kit

Very affordable stand-by to suit rechargeable soldering station above. Keep one handy — just in case! Cat T-2021

VALUE $8^{75}

The DSE Soldering Station



$99

If you're serious about good soldering, there is only one way to do it — with a temperatue 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 degres to over 500 degrees 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

Versatile 12V Soldering Iron

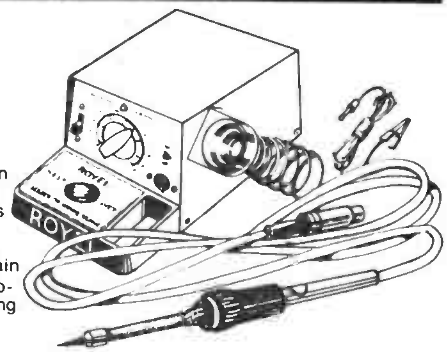
When you need more power for electrical work this heavy duty iron delivers a full 30W. Use it around the home, professional workbench or on the car (comes with cigarette lighter plug). Lightweight, balanced design is ideal for PCB work too! Operates from any 12V supply (AC/DC). Cat T-1910

ONLY $6^{50}

DICK SMITH ELECTRONICS

NEW! Royel Professional Vari- Temp Soldering Station

Precise Temperature Control!



Your passport to professional soldering. A state-of-the-art station that allows variable temperature control for a variety of applications — ideal for expensive circuits. Temperature sensor located right behind the tip to accurately maintain desired heat level. Features electro-static shields, zero voltage switching and much more. Cat T-2050

GREAT VALUE!

ONLY $169

Accessory Tips

Fine.
Cat T-2051
Medium (Standard)
Cat T-2053
Large Bevel
Cat T-2054

ONLY 5^{95} ea

ARLEC SUPER TOOL

The one tool you should own because it does so much! It polishes... cuts... engraves and erases... even mills. All parts are included, plus 240V plug pack adaptor. Hobbyists, handymen and tradesmen can use it for all those jobs that usually require buying two, three or more different tools: save $$$! Cat T-4754

ONLY! $62^{75}

Bonus: Super Tool Carry Case included! Arlec Accessories

Wire Brushes

Pack of three brushes for polishing PCBs, jewellery, brass ornaments, etc. Cat T-4768

ONLY $16^{45}

Erasers

Quickly and thoroughly erases ink from plans and diagrams. Perfect for the office and that professional touch at home. Cat T-4760

ONLY $4^{15}

LIMITED STOCKS... HUGE SAVINGS...

50% Off Book Sale! And what a choice...

Motorola RF Products Databook. Everything you've wanted to know about Motorola's RF devices: from small signal to power amps... and much more! Cat B-4035
WAS $24.50 $11.25

How to tune the Secret Shortwave Spectrum. Tune into the hush-hush frequencies that aren't printed. Hear military, Government and even espionage gossip. This book tells you how! Cat B-1649
WAS $16.65 $8.45

Australian Marine Radio Handbook. A 'must' for all boat owners! Tells you how to choose, install and use marine radio PLUS essential details for every Salt. Cat B-9604
WAS $4.95 $2.45

Philips General Catalogue: Considered the Bible of Electronics. 568 Pages of ICs, semiconductors, components... the lot. Everything a hobbyist needs. Cat B-4010
WAS $13.95 $6.25

Tricks & Experiments. Ideal book for all students of science, packed with 333 exciting experiments: gasses, chemistry, light and much more. Cat B-1730
WAS $19.95 $9.25

More Scientific Tricks. Builds on to the first edition (above) with a brilliant selection of experiments. An excellent publication that gives students the edge at school. Cat B-1735
WAS $19.95 $9.75

Digital ICs & LEDs. Superb source book that teaches important fundamental circuit concepts, how to build digital devices and handy troubleshooting hints. Cat B-1785
WAS $21.45 $10.70

Laser Technology. Brilliant source book that covers laser radiation, construction, design and more! All the principles and practical information hobbyists and technicians require. Cat B-1861
WAS $32.95 $14.95

Complete Guide to Satellite TV. Everything you've ever wanted to know about Satellite TV is in this book! Choosing equipment and setting up a station... orbit link-ups and down-link specs, etc. Cat B-1841
WAS $20.45 $9.95

Motorola Small Signal Products Databook. All the JEDEC types plus Motorola's house branded small signal transistors. Cat B-4036
WAS $27.95 $12.75

Value! Metric Screw Packs

Always handy around the workshop. Generous pack of 150 assorted self-tapping, counter sunk screws. Cat H-1505
WAS $3.50 $1.50

Assorted pan head machine screws in a beaut 320-pc. pack for all those jobs that always come up. Cat H-1510
WAS $5.95 $2.95

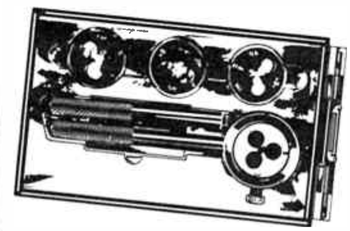
Secure cables easily!

Heavy-duty cable clamps for a variety of service and hobbyist uses. Bargain priced pack of 5. Cat H-1972
WAS $2.50 $1

Near ½ price! Metric Die Set

SAVE $14

Value! 6-pc. die and stock set. Contains: 2mm, 3mm, 4mm and 5mm dies PLUS a handled stock. All in a convenient case with full instructions. Cat T-4905
WAS $29.50 $15.50



More Metric Screws...

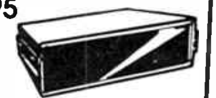
Value! Pack of 160 assorted pan head screws... handy to have around! Cat H-1500
Normally $3.50 per pack
Now $1.50

Die-Cast Aluminium

Versatile project box with all the benefits. Channelled walls for PCB mounting: ideal for RF circuits as lid forms a screen. Perfect for heat orientated circuits... aluminium makes a heatsink! Withstands high temeratures: up to 600° C. 150x50x80mm. Cat H-2206
Normally $10.50 $7.50

$10 Off! Plastic Case

Take all the features a hobbyist would want and this is it: The Case! PCB mounting slots and posts, transformer mounting posts, ventilation and speaker slots... the lot! Huge size: 250x190x80mm. Cat H-2507
Normally $19.95
$9.95



Hey! We're Crazy with Metric Screws...

Bargain pack of 270 assorted, counter sunk machine screws. Cat H-1515
Was $5.95 $2.50

...And Metric Nuts too!

Bolt in for this bargain! Pack of 150 assorted nuts in popular sizes. Cat H-1520
SAVE $4 $3.50

Metric Washers

You've got the nuts, the screws and the bolts... so now you've got the washers: pack of 680 assorted. Cat H-1525
WAS $7.50 $3.50

DICK SMITH ELECTRONICS

High Gain UHF CB Antenna

Get the most from your UHF base station with this excellent antenna. An impressive 4.5dB gain... for extra range that counts. Cat D-4012

HURRY... LIMITED STOCKS

$25

Satellite Experimenter's Handbook

½ Price!
WAS $26.50
Now Only
$13.25

We've come a long way since Sputnik — and now you can be part of the action! Whether you're interested in amateur radio, TV, etc. this superb book contains all the details about satellite communications. Cat B-2235

COMPONENT SAVINGS UP TO 80% OFF

DESCRIPTION	Cat No.	NOW	WAS
Ceramic Cap. 50V 12pF	R-2237	1c	15c
Electro Cap. RB 10V 33uF	R-4330	5c	65c
Electro Cap. RB 10V 470uF	R-4407	5c	65c
Resistor PW5 W/W 820 ohm	R-1672	15c	55c
Electro Cap. 16V 22000uF	R-4575	$2.50	$12.50
Electro Cap. 10V 100uF	R-4125	15c	45c
Green Cap. 100V 5PT 0.047uF	R-2080	10c	27c
Electro Cap. RB 25V 2.2uF	R-4300	10c	25c
Electro Cap. RB 25V 22uF	R-4319	10c	27c
Electro Cap. RB 25V 47uF	R-4350	10c	32c
Electro Cap. RT 16V 10uF	R-4055	10c	35c
Electro Cap. RP 80V 2500uF	R-4572	$1.80	$3.80
Electro Cap. RB 25V 4.7uF	R-4310	5c	25c
Cap 250V 6.5uF	R-2855	$2.50	$5.30
Cap Tant. 10V 33uF	R-4765	50c	$1.05
1K W/W Pot 6mm	R-6915	$3.00	$6.35
Green Cap. 100V 5. PCT .01uF	R-2055	5c	27c
Carbon Pot ¼" SG LIN 500K	R-1812	70c	$1.20
Carbon Pot ¼" SG LIN 10K	R-1806	50c	$1.20

TAKE ADVANTAGE OF OUR STOCK PROBLEMS!

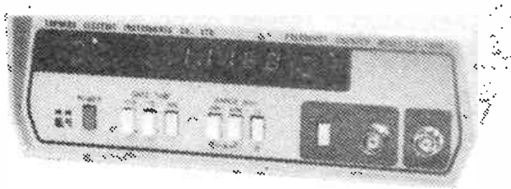
Save Over $600 Was $2120

Extend earthly 2m, 70cm and 6m to the exciting world of satellite communications with Yaesu's FT-726 VHF/UHF all mode transceiver. Just install optional IF unit for full duplex crossbanding with independent tuning and mode selection — it's out of this world! Comes complete with 2m band module: 70cm and 6m modules also available.

- **All modes on all three VHF/UHF bands — 6m, 2m, 70cm (with all modules installed)**
- **Full duplex crossbanding with satellite unit installed**
- **10W output on each band**
- **Repeater splits for all bands easily programmed into memory**
- **Dual synthesised VFO's tuning 20Hz/step**
- **Speech processor for SSB**
- **240V AC operated (12V DC with optional power cable)**

Cat D-2950

BARGAIN AT ONLY! $1500



1GHz Frequency Counter now $100 off!!

The affordable counter with a professional standard of performance for every workbench: in schools, labs, etc.! And with an impressive range — up to 1GHz — there's no limit to its applications. Check out these superb specs:

- **Large easy to read 8 digit display**
- **Streamlined, functional design**
- **3 gating time — 0.1, 1 & 10 seconds**
- **3 frequency ranges — 10MHz, 60MHz & 1GHz**
- **Sensitivity at 1GHz — 20mV**
- **Inbuilt 10:1 attenuator**
- **Inputs — 10Hz to 60Hz at 1M ohm 50mHz to 1 GHz at 50 ohms**

Cat Q-1315

Was $539 **$439**

The one tool all Hobbyists need... now nearly ½ price!

Only **$7.50**

Were $14.95

Every workbench and tool box needs one — in fact two or three! The long nose plier is a handy tool for any hobbyist, technician or home handyman. And now DSE's quality stainless steel mini plier is nearly half price... a good reason to add another to your tool box. Heavy-duty serrated jaws offer high gripping power. Fantastic value! Cat T-3565

KITS

Famous DSE Kits are amazing value! By building it yourself, you save $$$... have the satisfaction of saying you did it... enjoy the latest and the best in electronics for a fraction of the price.

Two-Up Game

An Aussie tradition goes electronic! Now play Two-Up without breaking the law by building this fun game. No coins required: it simulates the throw, spin and results. Great fun for the whole family. Cat K-2661

WAS $5.95 **$3.95**

Stereo TV Decoder

Enjoy TV even more, in sensational stereo, without the need to buy an expensive new set. Our easy to assemble Stereo Decoder can be built into your set or fed through Hi-Fi system — providing true channel separation. Includes UHF tuner too! As described in EA Cat K-6325

MARCH '85 WAS $199 **$149**

Binary Bingo

It's fun and educational! The perfect school project that demonstrates binary math... the basis of computers. More than a game, it's a challenge. Cat K-2668

$11.95

FunWay Gift Box

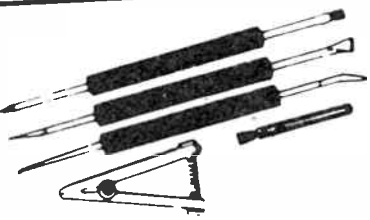
What value! Over $70 worth of electronics excitement for under $60 Includes two projects from each of the three popular FunWay kits PLUS all three FunWay books. Makes the ideal gift for kids of any age. Cat K-2680

$54.95

When the bean counters say "You're overstocked..." Who are we to argue?

DESCRIPTION	CAT NO.	WAS	NOW
Dynamic RAMS:			
4116 (16K x 1)	Z-9310	$3.95	$1.00
4164 (64K x 1)	Z-9312	$7.50	$3.50
2114 (1K x 4 static)	Z-9306	$3.95	$1.95
2732A EPROMS, too!	Z-9209	$7.95	$3.95
And 2513 Char. Gen!	Z-9206	$15.95	$8.95
WHAT! Not 4000 & 74 C Series CMOS too? Is nothing sacred?			
4001 (Quad 2 in NOR)	Z-5601	70¢	40¢
4044 (Quad NAND r/s latch)	Z-5644	$2.25	75¢
4518 (Dual BCD Up count)	Z-5740	$2.15	75¢
74HC85 (4 bit mag comp)	Z-5885	$2 50	75¢
74HC165 8 bit shift reg	Z-5930	$3.50	$1.00
74HC373 (Octal 'D' latch)	Z-5965	$4.50	$1.50
74C157 (Quad 2 in mux)	Z-5374	$4.50	$2.50
74C221 (Dual mono multivib)	Z-5378	$3.50	$2.00
74C946 (4.5 dig counter)	Z-6301	$24.50	$10.50
Low Power Schottky...			
74LS00 (Quad 2 in NAND)	Z-4900	75¢	40¢
74LS14 (Hex Schmitt)	Z-4914	75¢	30¢
74LS138 (1 of 8 dec/mux)	Z-5284	75¢	40¢
74LS241 (Oct buff/driv)	Z-5293	$2.50	$1.00
And TTL, too!			
7400 (quad 2 in NAND)	Z-5010	50¢	30¢
7401 (Q NAND, O/Coll)	Z-5011	50¢	25¢
7413 (Dual schmitt)	Z-5023	95¢	40¢
And other semi savings:			
LM3909 (Monostable Osc)	Z-6109	$2.25	$1.00
Get an optic on these optics:			
LT312 (Comm An 7 seg dis)	Z-4117	$2.25	$1.00
3mm Orange LEDs	Z-4031	15¢	5¢
3mm Red LEDs	Z-4010	15¢	5¢
3mm Green LEDs (premium qual)	Z-4079	35¢	15¢
Rectang. Red LEDs (2 x 5mm)	Z-4040	25¢	10¢
And even transistors...			
DS548 (yes, equiv to BC108)	Z-1308	19¢	10¢
DS558 (equiv to BC558 etc)	Z-1348	19¢	10¢
BC549C (top spec, hi gain)	Z-1329	40¢	10¢
MRF629 (RF silicon NPN)	Z-2509	$16.45	$5.00
MJE2955 (PNP Power silicon)	Z-2005	$2.25	50¢
FETs, too:			
MPF131 (N-channel g/p)	Z-1848	$1.80	$1.00
2SK134 (hi power mosfet)	Z-1815	$8.95	$4.95

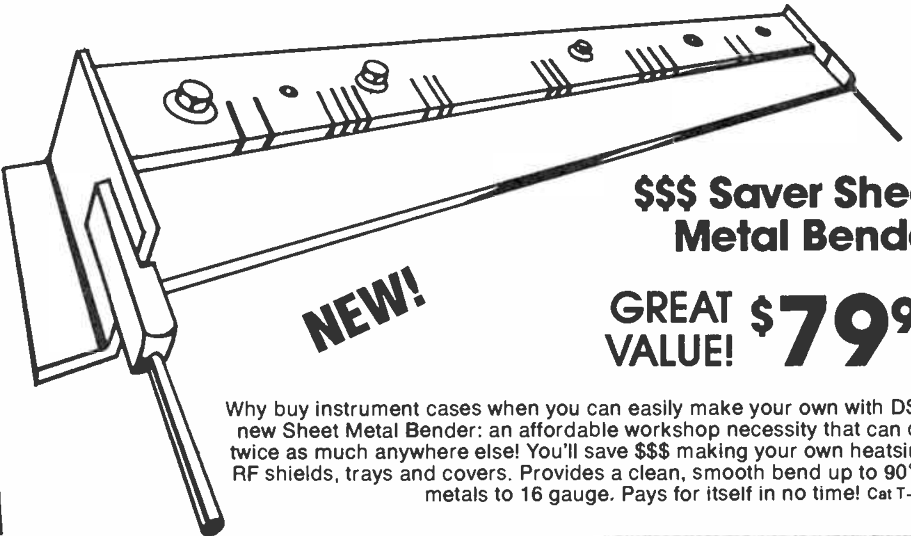
$TOCKTAKE $UPER $AVERS...



Soldering Aid Set

Inexpensive kit that's a 'must' for PCB soldering work. Includes everything you need for a professional job: guide fork tool, reamer point and knife tool, scriber, heatsink clip and stainless steel bristle brush. Great for restringing dials too! Cat T-2610

BARGAIN AT ONLY $17.55



NEW!

$$$ Saver Sheet Metal Bender

GREAT VALUE! $79.95

Why buy instrument cases when you can easily make your own with DSE's new Sheet Metal Bender: an affordable workshop necessity that can cost twice as much anywhere else! You'll save $$$ making your own heatsinks, RF shields, trays and covers. Provides a clean, smooth bend up to 90° on metals to 16 gauge. Pays for itself in no time! Cat T-5250

Premium Solder

Highest quality, non-corrosive solder for electrical work. 60% tin, 40% lead compound. Choice of two:
1.25mm, 200g. Cat N-1619
0.75mm, 200g. Cat N-1623

$8.25 each

Soldering Aluminium?

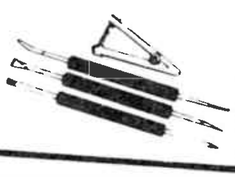
Our ALU-SOL solder is ideal... perfect for any dissimilar metal. 1.6mm, 100g roll. Cat N-1625

BARGAIN $11.95

Solder Kit

Handy kit makes expert soldering easy! Contains: brush & scraper tool, fine point probe, heatsink clip and slotted probe. Cat T-2605

$4.95



10-Pc. Driver Kit

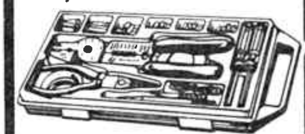
Handy kit with all the tools you'll need from time to time. Includes: four screwdrivers, hammer, magnifying glass, AWL, magnet, tweezers and wire prong holder. All contained in a convenient see-through carry case. Cat T-4380

Was $10.50 Save $3.50 ONLY $7

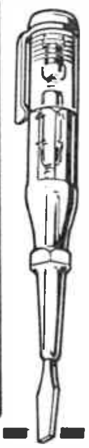
DICK SMITH ELECTRONICS

68- Pc. Repair Kit

Everything you could ever want for electric and auto repairs. In a handy plastic carry case. Cat T-4834



$21.95



Neon Tester Screw-driver

Invaluable two-in-one tool that's ideal for working on mains circuits. Handy mini screwdriver features an inbuilt neon tester for checking dangerous voltages. Operates from 90V (AC/DC). Cat T-4005

$3.85

Kits

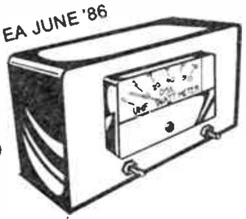
Enjoy the latest & the best at affordable prices!

VHF Wattmeter

Excellent 'build-yourself' meter for checking VHF transceiver's power output and antenna efficiency. Operates over full 2m band with +/- 10% accuracy. Max. power: 150W; 0-15W and 0-30W ranges. Cat K-6316

EA JUNE '86

BARGAIN AT ONLY! $49.95



Improve VCR Sound!

EA AUGUST '86

Reduced hiss is just the start with our new Dynamic Noise Reduction system! It also adds stereo-like sound for even greater enjoyment. Capable of improving signal-to-noise ratio up to 18dB. Cat K-3423

New $99

Give your car a head start!

Efficient transistor assisted ignition offers real performance! Dwell extension for longer, hotter sparks; radial fin heatsink with die-cast box to dissipate unwanted heat. Cat K-3301

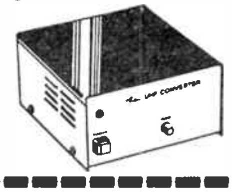
GREAT VALUE! $41.25

EA FEB '83

UHF/VHF TV Down Converter

Inexpensive, simple way to take advantage of UHF on your old VHF-only TV. Covers UHF bands 4 and 5 (Ch. 28-63). Pre-aligned for your convenience with a handy by-pass switch (disconnect the antenna lead for VHF viewing). As described in EA April '86 Cat K-3236

ONLY $76.50



MEASURE THE SAVINGS WITH THESE BEAUTIES...

Ultra Compact 3.5 Digit Meter

Small in size, big on features! Auto ranging for voltage and resistance and 2 current ranges: 20mA or 10A. Low power ohms limits open circuit voltage (suitable for in-circuit resistance measurement). **DC Voltage:** 200mV, 2, 20, 200, 1000V +/-(0.5% +1dgt). **AC Voltage:** 2V, 20, 200, 750V +/-(0.75% +5dgt). **Resistance:** 2 ranges: 200 ohm - 2M FSD. Cat Q-1515

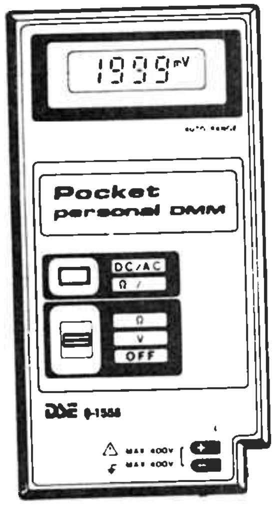
$99

LCD Meter Cap/ Transistor Checker — a 3-in-1

bargain for every bench and tool box. It's a 33 range multimeter with auto zero and over-range indication, exceptional high current measurement (10AC/DC) and much more. But that's not all! Check capacitance in five ranges from 2nF - 20uF... plus transistors (hFE 0-1000) and diodes (Vf) too. Sensational value that saves the cost of buying other instruments. Cat Q-1500

GREAT VALUE! $139

The Personal Pocket Meter



Calculator sized meter adds up to convenience: only 10mm thick! Boasts • super fast auto ranging • auto polarity indicator with minus sign • 2x/ second sampling • audible continuity (200 ohm +/- 10 ohm). Excellent frequency response allows it to be used as a millivolt meter — up to 20KHz. **DC Voltage:** 2000mV, 20, 200, 400V +/-(2.0%rdg +/-2dgt). **AC Voltage:** 200mV, 20, 200, 400V +/-3.0%rdg +/-5dgt). **Resistance:** 200 to 2Mohm in 5 auto ranges. Cat Q-1555

VALUE! $59.95

Economy Meter

For the price, you'll be amazed at the performance! 3.5 digit wide angled display for easy viewing. RF shielding and resistance range overload protection: handles 250V AC or 350V DC indefinitely. **DC Voltage:** 2000mV, 20, 200. 1000V +/-(0.5%rdg +/-2d). **AC Voltage:** 200V, 750V +/-(1.2%rdg +/-10d). **Resistance:** 2000, 20, 200, 2000 ohms +/-(0.75%rdg +/-1.2%rdg).

Cat Q-1520 **$64.95**

LCD Temperature/ Meter

What a combination! 3.5 LCD multimeter for current and voltage checking with over-ride indicator, buzzer continuity and 0.1%/0.25% accuracy. Also takes thermal readings (F and C) for scientific and hobbyist measurements: check heatsinks, etc. Covers -20 to 1370° C with +/-0.3% +/-1° C accuracy. Cat Q-1512

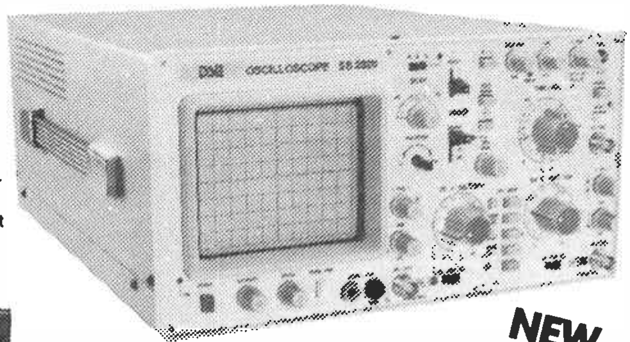
Measure the temperature of power transistors, heatsinks, etc.

NEW

BARGAIN AT ONLY $199

Complete with probes

Unbeatable value for dual trace 20MHz CRO!



NEW

- 1mV Sensitivity
- + and - Algebraic additions

Sensational value! An affordable, professional standard 20MHz oscilloscope that's got the lot: **Bandwidth:** DC to 20MHz (-3dB). **Input impedance:** 1m ohm to 25pF +-2%. **Algebraic addition:** CHI+CHII, -CHI+CHII. **Sweep time:** 0.1us/DIV - 0.2s/DIV +/-3% (10°C - 35°C) steps in 1-2-5 sequence. **Expansion:** x10 MAG sweep rate up to 50ns, additional error for magnifier +/-2%. Cat Q-1260

ONLY $949

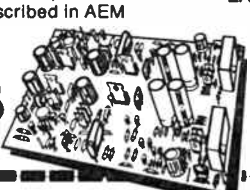
Equipping your service bench, lab or school...
SAVE! Two for $899 each.

SAVE! Build it yourself and save $$$... enjoy the latest and the best with DSE kits.

Improve Amp performance... SAVE $10

Your amp straining to live up to expectations? Our Ultra Fidelity Preamp gives a boost to dynamic range and frequency response, reduces noise and distortion. **Max. output:** > 2V rms. **Freq. response:** conforms to RIAA within +/-0.2dB typical with 1% components. **THD:** <0.001%/100mV, 100Hz-10Hz (MM cartridge); <0.004%/100mV, 100Hz-10kHz (MC cartridge). As described in AEM Cat K-3037

ONLY! $39.95

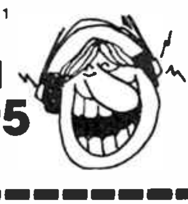


Double enjoyment: Stereo Simulator II

Get more from your old mono TV, video or AM tuner with our Stereo Simulator II. Produces artificial channel separation so good, it's hard to distinguish it from the real thing! **Signal-to-noise ratio:** 60dB (left), 56dB (right). **Distortion:** 0.1% (both channels). **Current drain:** 6.5mA without LED, 17mA with LED.

EA APRIL '83 Cat K-3421

BARGAIN $26.95



Troubleshooting from the hip (pocket)...

Neat! Handy pocket-sized signal injector with simple push button operation... Perfect for servicemen on the go. **Frequency range:** 700 - 1000Hz with harmonics to 30MHz. **Signal output:** 1.4V p-p. Impedance:10K ohm (capacitive). **DC voltage input:** 50V max. Suitable for in-circuit (live) testing where voltage range is -3 to +50VDC. Cat Q-1270

VALUE AT ONLY! $7.95 **WAS $12.25**

Everything the Hobbyist needs...

DSE the one stop supermarket of electronics offers the hobbyist an extensive range of service accessories... all at affordable prices.

Electronic Cleaning Solvent

Efficient, non-corrosive spray cleans tuners, switches, relays, etc. 300g pressure pack can with long tube. Cat N-1040

$6.90

Circuit Lacquer

Solder-through lacquer to protect PC board tracks while allowing easy service later. 350g pressure pack can. Cat N-1045

$8.25

Spray Freezer

Instantly freezes components to -50° Celsius. Ideal for cooling and servicing electronic/electrical components, shrinking shafts, bushes, etc. 350g spray can with nozzle. Cat N-1056

$6.55

DSE PVC Tape

Top quality PVC insulating tape for hundreds of uses. 18 metres long x 19mm wide x 0.2mm thick. Cat N-1362

$1.15

Spray Cleaner

Safe cleaning and degreasing spray for electronic components, jewellery, rubber and plastic. 250g pressure pack can with long nozzle. Cat N-1051

$4.15

Acrylic Spray

Clear, moisture-proof spray protects front panels, etched screens and even TV antenna terminations. 125g spray can. Cat N-1011

$6.55

Positive 20 Photo Resist Spray

The easy, economical way to make your own PCBs and prototypes! No negative required, exposes directly from positive and develops a perfect reproduction. Cat N-1000

$16.95

Electrolube Pen

Electro-mechanical lubricant in a handy pen style for easy carrying and use in hard-to-get-at areas. Cat N-1047

$7.65

STORE LOCATIONS

NSW

Swift & Young Sts.	**Albury**	(060) 21 8399
T55 Terrace Level	**Bankstown Sq**	(02) 707 4888
Shop 1, 65-75 Main St	**Blacktown**	(02) 871 7722
613 Princess Hwy	**Blakehurst**	(02) 548 7744
Oxford & Adelaide Sts	**Bondi Junction**	(02) 387 1444
Shop 2, 1B Cross Street	**Warringah Mall**	(02) 93 0441
Campbelltown Mall Queen St	**Campbelltown**	(046) 27 2199
Shop 235, Archer St Entrance	**Chatswood Chase**	(02) 411 1955
147 Hume Hwy	**Chullora**	(02) 642 8922
164 Pacific Hwy	**Gore Hill**	(02) 439 5311
315 Mann St	**Gosford**	(043) 25 0235
4 Florence St	**Hornsby**	(02) 477 6633
Elizabeth Dr & Bathurst St	**Liverpool**	(02) 600 9888
450 High Street	**Maitland**	(049) 33 7868
621-627 The Kingsway	**Miranda**	(02) 525 2722
173 Maitland Rd, Tighes Hill	**Newcastle**	(049) 61 1896
Lane Cove & Waterloo Rds	**North Ryde**	(02) 88 3855
George & Smith Sts	**Parramatta**	(02) 689 2188
The Gateway High & Henry Sts	**Penrith**	(047) 32 3400
818 George St	**Railway Square**	(02) 211 3777
125 York St	**Sydney City**	(02) 267 9111
Treloar's Bldg, Brisbane St	**Tamworth**	(067) 68 1711
263 Keira St	**Wollongong**	(042) 28 3800

ACT		
96 Gladstone St	**Fyshwick**	(062) 80 4944
VIC		
Creswick Rd & Webster St	**Ballarat**	(053) 31 5433
145 McCrae St	**Bendigo**	(054) 43 0388
Shop 46, Box Hill Central, Main St	**Box Hill**	(03) 890 0699
Hawthorn Rd & Nepean Hwy	**East Brighton**	(03) 592 2368
260 Sydney Rd	**Coburg**	(03) 383 4455
1150 Mt Alexander Rd	**Essendon**	(03) 379 7444
Nepean Hwy & Ross Smith Ave	**Frankston**	(03) 783 9144
Shop 9 110, High St	**Geelong**	(052) 43 8522
291-293 Elizabeth St	**Melbourne City**	(03) 87 9834
Bridge Rd & The Boulevarde	**Richmond**	(03) 428 1614
Springvale & Dandenong Rds	**Springvale**	(03) 547 0522
QLD		
157-159 Elizabeth St	**Brisbane City**	(07) 229 9377
166 Logan Rd	**Buranda**	(07) 391 6233
Gympie & Hamilton Rds	**Chermside**	(07) 359 8255
Queen Elizabeth Dr & Bernard St	**Rockhampton**	(079) 27 9644
2nd Level Western Entrance	**Redbank**	(07) 288 5599
Redbank Shopping Plaza		
Gold Coast Hwy & Welch St	**Southport**	(075) 32 9883
Bowen & Ruthven Sts	**Toowoomba**	(076) 38 4300
Kings Rd & Woolcock St	**Townsville**	(077) 72 5722

Cnr Pacific Hwy & Kingston Rd	**Underwood**	(07) 341 0844
SA		
77 Grenfell St	**Adelaide**	(08) 232 1200
Main South & Flagstaff Rds	**Darlington**	(08) 298 8977
Main North Rd & Darlington St	**Enfield**	(08) 280 6088
24 Park Terrace	**Salisbury**	(08) 281 1593
WA		
Wharf St & Albany Hwy	**Cannington**	(09) 451 8888
66 Adelaide St	**Fremantle**	(09) 335 9733
William St & Robinson Ave	**North Perth**	(09) 328 6944
Raine Square, 125 William St	**Perth City**	(09) 481 3261
TAS		
Shop 40A, Lower Level	**Hobart**	(002) 31 0800
Cat & Fiddle Arcade		
NT		
17 Stuart Hwy	**Stuart Park**	(089) 81 1977

Relocated store now open at
Shop 2, 1B Cross St Warringah Mall
Phone: 93 0441

Dear Customers,

Quite often, the products we advertise are so popular they run out within a few days, or unforseen circumstances might hold up shipments so that advertised lines are not in the stores by the time the advert appears. And very occasionally, an error might slip through our checks and appear in the advert (after all, we're human too!) Please don't blame the store manager or staff; they cannot solve a dock strike on the other side of the world, nor fix an error that's appeared in print. If you're about to drive across town to pick up an advertised line, why not play it safe and give them a call first ... just in case! Thanks. Dick Smith Electronics.

MAJOR DICK SMITH ELECTRONICS AUTHORISED RESELLERS

NSW: • **Ballina:** A. Cummings & Co. 91-93 River St 86 2284 • **Ulladulla:** Pauls Electronics, 10 Wason Street, 55 3989 • **Bowral:** F.R.H. Electrical, 28 Station St 61 1861 • **Broken Hill:** Hobbies & Electronics, 31 Oxide St 88 4098 • **Charlestown:** Newtronics 131 Pacific Hwy 43 9600 • **Coffs Harbour:** Coffs Harbour Electronics, 3 Coffs Plaza, Park Ave. 56 5684 • **Deniliquin:** Deni Electronics, 220 Cressy St, 81 3672 • **Dubbo:** Mavins Electronics, 35 Talbragar St, 82 8500 • **Gosford:** Tomorrows Electronics & HiFi, 68 William St, 24 7246 • **Lismore:** Decro 3A/6-18 Carrington St, 21 4137 • **Port Macquarie:** Hall of Electronics, Horton Centre, Horton St, 83 7440 • **Orange:** Fyfe Electronics 173 Summer St, 62 6491 • **Springwood:** Wellington's Electrical Discounts 115 Macquarie Rd, 51 4888 •**Taree:**Brad's Electronics Shop 6, Civic Cinema Centre, Pulteney St, 52 6603 •**Tumut:**Tumut Electronics Wynyard St, 47 1631 • **Tweed Heads:** Stuart Street Electronic Sales, Stuart St, 36 5744 • **Wagga:** Phillips Electronics 60 Forsyth St, 21 6558 • **Windsor:** M & E Electronics, Sh 7, Mc Ewans Arcarde, 206 George St, 77 5935 •**Young:** Keith Donges Electronics 186 Boorowa St 82 1279 **VIC:** • **Echuca:** Webster Electronics, 220 Packeham St 82 2956 • **Mildura:** McWilliams Electronics 110A Langtree Ave, 23 6410 • **Morwell:** Morwell Electronics, 95 George St, 34 6133 • **Shepparton:** GV Electronics Centre 100 High St, 21 8866 **QLD:** • **Bundaberg:** Bob Elkin Electronics, 81 Bourbong St, 72 1785 • **Cairns:** Electronic World Shop 27 K-mart Westcourt Plaza, 51 8555 • **Gladstone:** Supertronics, 9 Tank St, 72 4321 • **Mackay:** Stevens Electronics, 42 Victoria St, 51 1723 • **Maryborough:** Keller Electronics, 218 Adelaide St, 21 4559 • **Mt Isa:** Outback Electronics Shop 71 Barkley Hwy 43 3331 • **Nambour:** Nambour Electronics Shop 4, Lowan House, Ann St, 41 1604 • **Rockhampton:** Access Electronics, 15 East St, 21 058 **SA:** • **Mt Gambier:** Hutchessons Communications, 5 Elizabeth St, 25 0400 • **Whyalla:** Eyre Electronics Shop 2 Forsythe St, 45 4764 **WA:** • **Albany:** Micro Electronics 133 Lockyer Ave 41 3432 **TAS:** • **Launceston:** Wills Electronics 5A The Quadrant, 31 5688

DSX PRESS **ORDER SERVICE**

ORDERS OVER $75
FREE DELIVERY

Use your Bankcard, Mastercard or Visacard.
Just Phone **008 22 6610** (toll free) for, despatch of your orders.
Enquiries: By mail or phone (02) 888 2105 — Fax (02) 888 3631 — Telex AA10036

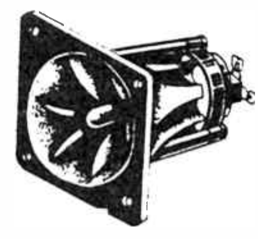
POST & PACKING CHARGES	Order Value	Charge	Order Value	Charge
	$5.00- $9.99	$2.00	$50.00-$75.00	$6.50
	$10.00-$24.99	$3.50	$75.00 or more	N.A.
	$25.00-$49.99	$4.50		

Terms available to approved applicants
SA Customers: Credit facilities available through AGC
Adelaide: 10 Pulteney St, Adelaide

VISA
MasterCard
bankcard welcome here

DICK SMITH ELECTRONICS PTY LTD
P.O. Box 321, North Ryde N.S.W. 2113. Tel: 888 3200

Piezo transducers and tweeters for our doorbell



A wide variety of piezo tweeters and transducers suitable for use with our AEM1501 Three-Chime Doorbell are available at many electronics retailers.

A variety of circular and rectangular piezo horn tweeters can be had for prices ranging from around $14 to $35 or so. The PH1005A from Jaycar, cat. no. CT-1900, and PH1038A (CT-1902) are circular types each costing around $15. Dick Smith stocks a circular one, similar to the PH1038A, DSE cat. no. CT-2005, also for around $15. Altronics stocks a circular piezo tweeter with higher efficiency — giving noticeably more sound output — than these, cat. no. C6100, for a tad under $20.

The rectangular types are generally more sensitive and give the best output, but cost more. Jaycar stocks two Motorola types, the KSN1016 and KSN1025A. Altronics also stocks the KSN1025A.

The Motorola KSN1071 shown in the article with our prototype is a sensitive unit with good sound output in this application, a good 'tone' and wide dispersion of the sound. The KSN1071 also has the distinct advantage of being simple to mount.

The KSN1071 is stocked by Jaycar, catalogue CT-1918, and at $12.95 it was the lowest cost piezo tweeter we could find. Jaycar has five stores in Sydney and one in Brisbane. In Adelaide, Eagle Electronics is a Jaycar stockist, so you could try them.

Melbourne readers should call in to All Electronic Components in Lonsdale Street to see what's currently in stock there. North side Melbourne residents should check out Preston Electronics, while out east, Ian Truscott's Electronics World could turn up a few transducers to suit.

PROJECT BUYERS GUIDE

The AEM6000 MOSFET Stereo Power Amp project will be stocked as a complete kit by Jaycar (five stores in Sydney, one in Brisbane), and Eagle Electronics in Adelaide. The front panel heatsink is of gravity cast aluminium and was designed in conjunction with Jaycar who is having them manufactured. It has been designed for several roles — as a front panel (as in the 6000 project), and as a side panel in a 19" four unit high rack box. Hence, it is not "specific" to the 6000 project and we understand it will become available as an off-the-shelf component.

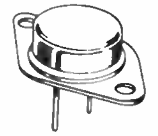
The 6000's power supply requires 10 000u/100 V electrolytic capacitors. These are available from several sources, in particular, Siemens and Elna. While the Siemens units are a "stock line" Siemens advise, at time of going to press (wouldn't you know it?) they were out of stock and awaiting an order. Elna electrolytics are imported by Soanar and stocked by various retailers, although the 10 000u/100 V ones are currently scarce at time of going to press.

Some retailers keep a variety of large value, high voltage electros in stock. You might try David Reid Electronics in York Street, Sydney and All Electronic Components in Lonsdale Street, Melbourne.

Printed circuit board sets for the AEM6000 Stereo Power Amp are available through our PC Board Service.

The AEM4605 Super Simple Modem is destined to be widely available as a kit, according to indications from kit suppliers. Components for it are widely available off the shelf for those who prefer to roll their own, and pc boards will be available through our PC Board Service. For kits, try Jaycar in Sydney and Brisbane, Eagle Electronics in Adelaide and All Electronic Components in Melbourne.

The AEM1501 Three-chime Doorbell is designed around the Telefunken U450B IC, distributed here by Promark. We don't know at this stage who'll be stocking the IC, but you might try Geoff Wood Electronics in Sydney and Protronics in Adelaide.



Hitachi 2SJ56 and 2SK176 MOSFETs

Looking for the new high voltage, high power Hitachi MOSFETs, 2SJ56 and 2SK176 — as featured in the output stage of the AEM6000 power amp module?

You'll find them stocked in Jaycar stores in Sydney (five locations) and Brisbane. Melbourne is well-served with outlets; try Active Electronics on the southside, Ritronics in A'Beckett Street city and High Street Northcote.

In Adelaide, try Eagle Electronics in Unley.

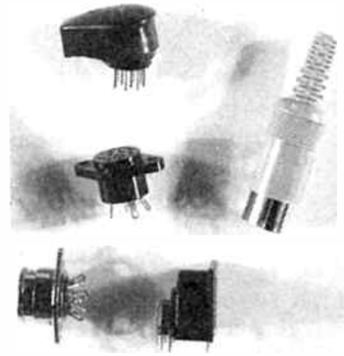
Data sheets for both MOSFETs were reproduced on pages 50 and 51 of our June issue.

Speech chips

Our two speech synthesiser projects, the '4504 (Feb. '86) and '4505 (June '86), have proved quite popular. We get many requests for information on the suppliers of the G.I. chips which these projects were designed around.

The '4504 uses the SP0256A-AL2 synthesiser chip alone, while the '4505 employs both that and the CTS256A-AL2 code-to-speech chip. Daneva in Melbourne imports and distributes them.

Geoff Wood Electronics in Lane Cove Sydney (02) 427 1676 stocks both ICs at keen prices. In Adelaide, try Eagle Electronics in Unley (08) 271 2885. Printed circuit boards are stocked by both firms and Eagle Electronics have kits available.



Ge' DIN to it!

DIN connectors of all varieties and descriptions are obtainable for keen prices from All Electronic Components in Melbourne. They have 5-pin and 8-pin plugs and sockets, in line and chassis-mount formats, with plastic and metal bodies as you may require.

DIN connectors are universally used on domestic audio and TV gear, as well as many popular makes of home/hobby computers (Commodores and Microbees, for starters). It's always a good idea to keep a few spares on the shelf.

You'll find DIN connectors very handy when building and experimenting, too. They're a convenient size and readily panel-mounted without the need for drilling special holes.

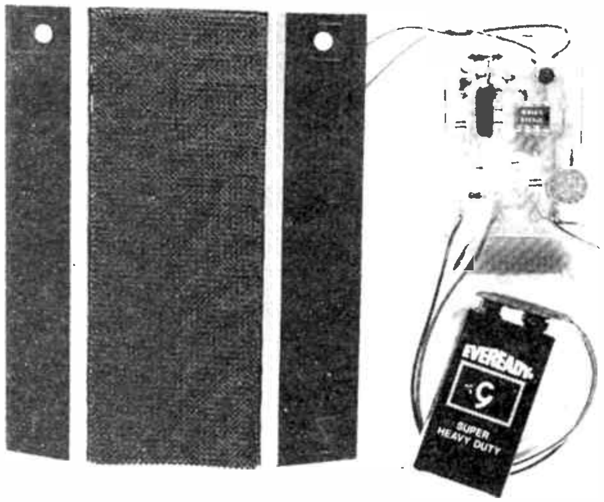
For your desires in DIN connectors, dawdle down to All **Electronic Components, 118-122 Lonsdale St, Melbourne 3000 Vic. (03) 662 3506.**

aem project 1501

Build this three-chime doorbell

David Currie
Roger Harrison

Why put up with boring buzzers, deathly ding-dongs or wretched warblers when for modest cost, an afternoon's work and considerable satisfaction, you could have this charming chime announce your visitors.



The doorbell is quite simple to construct. Our prototype is shown here with the Motorola KSN1071 piezo tweeter.

A RECENT READER'S LETTER bemoaned the lacklustre sound of low-cost electric 'doorbells' and the high cost of electronic ones. Prompted by the reader's question that, surely it was possible to construct an electronic doorbell with a suitable, or novel, sound for low cost, we embarked on a little research among suburban hardware stores. We found that almost invariably the low-cost electric 'doorbells' were simply buzzers of boring tone or solenoid operated two-bell ("ding-dong") chimes . . . and some were definitely out of the 'low-cost' class. Investigating the innards of some electronic doorbells showed them to be simple electronically, based on an either or unrecognised or un-numbered single IC.

Some half-remembered ICs, oft passed over in data books whilst seeking other data, were recalled as being suited to such applications as "chimes", "ringers", etc. A quick search of a few catalogues and data books turned up several likely devices. We rang around a few distributors to check prices and availability and get some samples. The Siemens SAB0600 "chime" IC was considered. Its greatest "selling point" is the fact that it electronically mimics the sound of "classic" doorbells with three chimes which sound and then decay in sequence. But, with a retail price tag close to $10, it seemed a poor start to our goal of developing a low-cost electronic doorbell. Secondly, it has been around for some time and is employed in a variety of commercially available doorbells, ruling out the chance of achieving a novel sound. The next IC that looked anywhere near suited to the task was the Telefunken U450B "three-tone ringer", imported and distributed here by Promark, who supplied a couple of samples and detailed data in short order.

In no time at all a prototype was assembled and, with a few component values adjusted 'to taste', we had the makings of a low-cost doorbell with a novel sound.

The U450B three-tone ringer

This device is a versatile 8-pin IC in a dual-in-line (DIL) package. Internally, it is a mixed analogue/digital circuit that generates a sequence of three tones — 800, 1067 and 1333 Hz. A master oscillator in the chip is divided-down by three dividers to generate the output tones. The master oscillator frequency can be varied to alter the output tones for an application. The rate at which the output tones sound can be set anywhere between two and a half per second to 25 times per second, or so, determined by a second, low frequency, oscillator. The oscillators only require resistors and capacitors to function. Thus, the U450B requires a minimum of external components, as our project circuit shows!

Two output stages provide for single- or double-ended (push-pull) output. An internal voltage stabiliser allows the IC to be used over a wide supply range. Pin 7 is a 'trigger' input with Schmitt switching action, which means it switches the circuitry on and off at two distinct levels, providing good immunity from false triggering caused by noise.

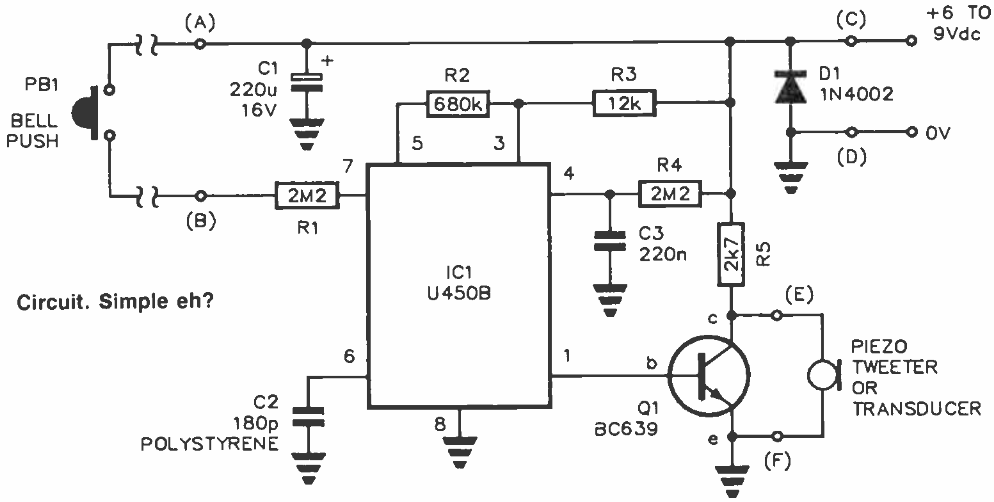
The U450B can be configured to draw less than half a milliamp quiescent current, making it ideal for economical battery operation. A data sheet is included elsewhere in this issue.

The circuit

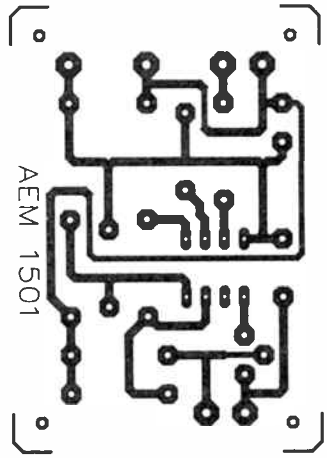
Because it could be designed to draw quite low quiescent current, we decided on battery operation as it offers versatility in installation arrangements — the electronics does not need to be located close to a power point. For convenience, a 9 V battery has been specified, but a 6 V battery may be used if you wish, with a minor change in some component values (see later). For safety's sake, a diode is connected across the battery input to the circuit, to avoid destroying the IC should the battery be accidentally reverse connected.

Using a 9 V battery, the quiescent current will be around half a milliamp, or less. This means that the unit could be permanently connected and the battery will last more or less its shelf life. In fact, we found the unit will still work, though its characteristics will be noticeably affected, when the battery has dropped to half its voltage.

For sound output, we elected to use a low-cost 'piezo' tweeter, a variety of which are readily available. The accompany-



Circuit. Simple eh?



CIRCUIT OPERATION

The unit centres on the Telefunken U450B three-tone ringer IC. This has two internal oscillators, three internal frequency dividers, a reference voltage section, a trigger, a current source, and a pair of output stages. A full data sheet is published elsewhere in this issue.

When the bellpush PB1 is actuated, IC1's internal circuitry operates, generating the three-tone sequence which is output on pins 1 and 2. Here the output drives a transistor, Q1. The collector voltage swing developed drives the piezo tweeter.

The IC's reference voltage source, pin 3, supplies the internal circuitry with a regulated voltage of about 3.73 V, ensuring freedom from the influence of power supply variations. Pin 3 requires an operating current lying between 200 μA and 1 mA, provided here by R3, from the supply. With the value chosen, and allowing for component tolerances, the battery can fall to just under 7 V before the pin 3 minimum current is reached.

The internal current source derives a reference current for the trigger and the oscillators. Pin 5 requires a current of about 4 mA, sourced here from the reference voltage on pin 3 via R2.

The trigger input, pin 7 requires a current of 3 μA or above. When the bellpush PB1 is actuated, R1 supplies the appropriate current to pin 7.

The three tones are derived from an oscillator called Oscillator 1. The frequency generated by Osc. 1 is determined by a capacitor (C6) between pin 6 and common (O V). This is nominally set at 16 kHz to provide the source frequency for the three output tones of 800, 1067 and 1333 Hz. Three internal dividers provide the three output tones which have a relationship of 3:4:5, these dividers driving the push-pull output stages.

A second oscillator, oscillator 2, provides a sawtooth waveform which is employed to switch the divider outputs in sequence, starting with the lowest frequency. This is set to operate at a low frequency, in the range 2.5 to 25 Hz or so, according to the requirements of the application. Here it operates at the bottom end of the range. The frequency of Osc. 2 is set by a resistor from supply to pin 4 (R4) and a capacitor from pin 4 to O V.

Output from pin 1 is amplified by Q1. R5 is its collector load and the collector voltage swing drives the piezo transducer.

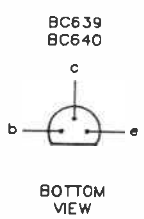
Diode D1 prevents possible damage to the unit should the power supply be inadvertently reverse connected. Capacitor C1 bypasses the supply rail.

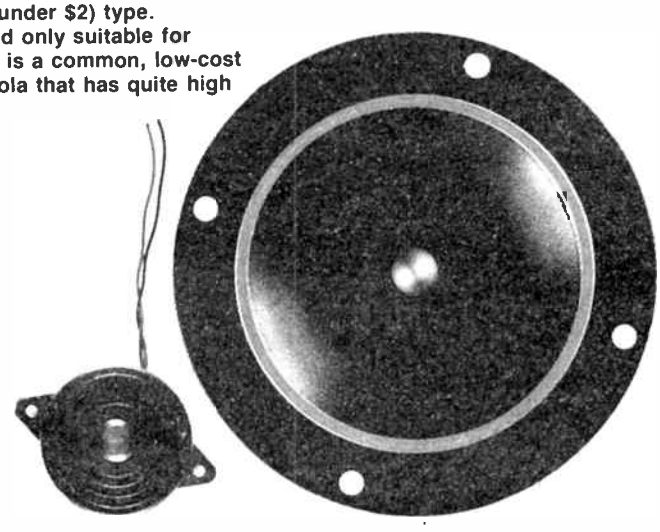
A mains operated dc supply, such as a dc plugback, could be used to supply the unit, but supply line ripple modulates the reference, giving a harsh 'edge' to the output. A three-terminal regulator in the supply line fixes the problem.

The output tone frequencies may be varied to suit yourself by altering the value of C2. Increasing C2 lowers the output tones' pitch, and vice versa. Varying R2 also influences it. Varying R4 or C3 will vary the rate at which the notes sequence through.

If operating the unit from a 6 V supply, reduce R3 to 10k and R1 to 1M8 for best results.

COMPONENT PINOUTS

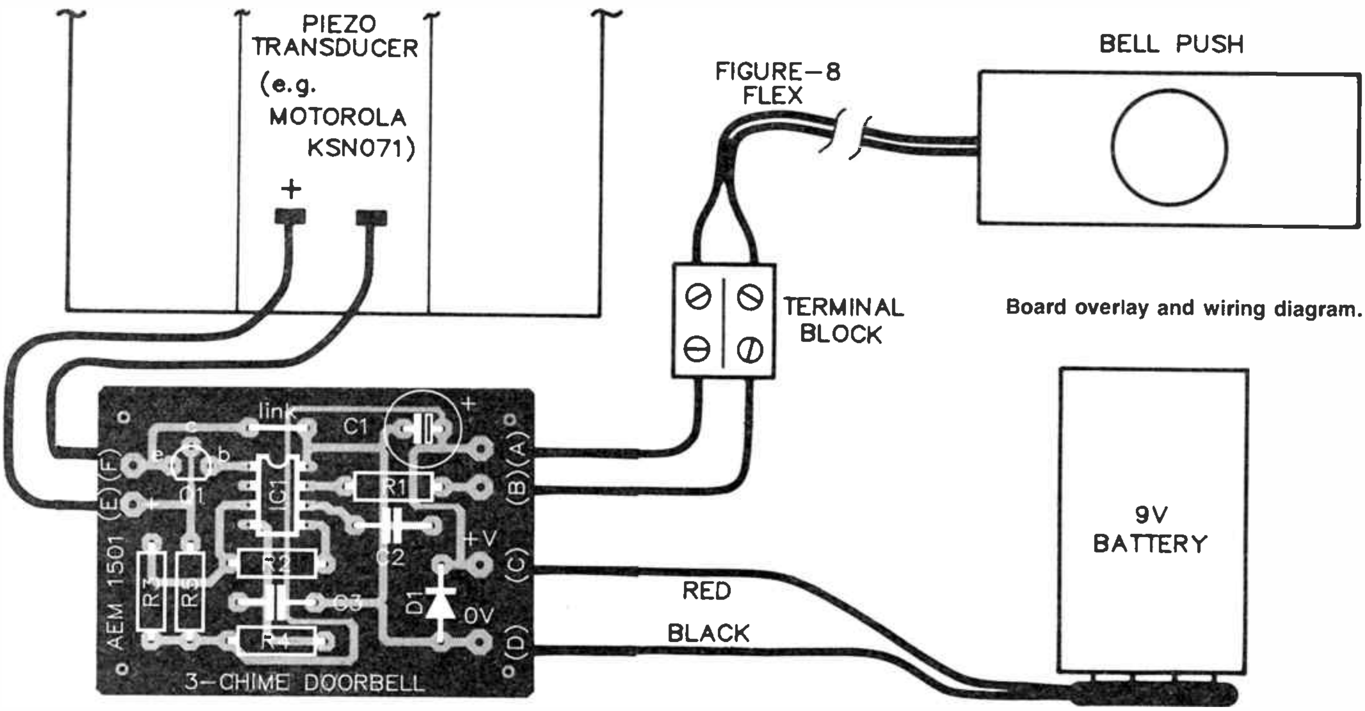




Many piezo transducers are suitable for use with this project. At left is a small, low-cost (under $2) type. However, its sound output is low and only suitable for applications requiring such. At right is a common, low-cost piezo (horn) tweeter made by Motorola that has quite high output.

ing photographs show a few types we tried. By far the most 'musical' was the Motorola KSN1071, sold by Jaycar for around $13. It was also the best in appearance we thought, as well as being mechanically simple to mount.

The Schmitt-switching operation of the input trigger, to which the bellpush is wired, proved to be entirely immune to false triggering, despite exposing long lengths of figure-8 cable running between the circuit and the bellpush to all sorts of induced interference.



Board overlay and wiring diagram.

Construction

We designed a small printed circuit board to hold the components. While they could be readily mounted on matrix board or Veroboard, the pc board reduces the possibility of wiring errors and provides a neat, convenient method of assembly. The accompanying board overlay and wiring diagram shows how the complete doorbell is assembled.

It's probably best to start by mounting the components to the pc board and soldering them in place. First, check your pc board, no matter whether you've made it yourself or purchased it ready-made. See that all the holes are drilled and are the correct size. Check that there are no small copper 'bridges' between closely-spaced pads, particularly around IC1 and the transistor Q1. Correct any problems before proceeding.

If, or when, all's well, you can mount the components. They may be mounted in any order. Take care when placing the electrolytic capacitor C1, diode D1, transistor Q1 and the IC. If you wish, an IC socket may be used. Note that capacitor C2 is a polystyrene type (also known as 'styroseals'). Note that Q1 has its collector connected to the middle 'leg'.

Check the board thoroughly when finished. See that all component leads have been soldered and that there are no dubious joints.

When you're satisfied the board's OK, you can make a temporary hookup as indicated in the wiring diagram to check the unit works properly. Upon depressing the bellpush, you should hear the 'dulcet' tones sound in a rising sequence which repeats as you hold it down. The sound output should be more than adequate in the majority of circumstances. If it proves too loud, reduce the value of R5 to, say, 1k.

If you don't get the expected result, check the voltage on C1. It it's under 1 V you have D1 back to front. Next check the voltage on pin 3 of IC1. It should lie between 3.54 and 3.92 V (a digital multimeter is handy here). If this is not right, disconnect the battery and check IC1 is correctly oriented. If so, then check the value of R3. Check the orientation of Q1. If you have a "crystal" earpiece, try connecting it between pin 1 of IC1 and terminal (D) or (F). Upon pressing the button, you should hear the tones sound. If you do and you still have no sound output, try another BC639 for Q1. Note that the project will work with a variety of transistors here — just watch the orientation.

AEM1501 PARTS LIST

Semiconductors
IC1 .... U450B Telefunken, 3-tone ringer
D1 .... 1N4002
Q1 .... BC639

Resistors all ¼ W, 5%
R1 .... 2M2
R2 .... 680k
R3 .... 12k
R4 .... 2M2
R5 .... 2k7

Capacitors
C1 ..... 220µ16 V RB electro.
C2 .... 180 pF polystyrene
C3 .... 220 nf (0.22 µF) greencap

Miscellaneous

PB1 .... Bell-push switch

AEM1501 pc board; piezo transducer or tweeter to suit requirements (see text); battery connector; battery; figure-8 'bell wire'; box to suit (if required); wire, solder, etc.

Expected cost: $20-$35
(depends on hardware)

Installation

The Motorola KSN1071 piezo tweeter was chosen because it's easy to mount on a flat surface, only requiring two small holes to be drilled to accommodate the connecting lugs. It is secured by four screws or bolts. Thus, it can be readily mounted on any flat surface, such as a wall, a small wooden box, etc. Whatever transducer you use, the pc board should be mounted in a convenient place nearby, out of sight or housed in a suitable box of its own, and wired to the piezo transducer. The pc board could actually be mounted to the piezo transducer by soldering short lengths of 18 or 20 gauge tinned copper wire between the tweeter terminals and the (E) and (F) pads on the pc board.

The battery should be housed with the pc board, or at least nearby. Take care that you wire the battery connector the right way round. The bellpush is wired in circuit with either 'bell wire' or light duty figure-8 flex. Terminate it at a two-way screw terminal block mounted conveniently near the pc board.

LOW COST MAINS POWER SUPPLY STABILISER

HAVE YOU CONSIDERED THE MATSUNAGA STABILISED AC POWER SUPPLY?

MODELS IN STOCK
FROM 350VA to 2KVA
INPUT VOLTAGE 180V
TO 260 VAC OUTPUT
VOLTAGE 240 V± 3%
(110V SIMULTANEOUS
OUTPUT ALSO
AVAILABLE)

Precision manufactured, accurate and efficient. Matsunaga automatic voltage regulators offer rapid voltage correction with zero waveform distortion. The units are of robust, but compact and lightweight construction and are ideal for applications where constant voltage is important.

ELECTROMARK PTY. LTD.
43 Anderson Road, (P.O. Box 184) Mortdale, NSW 2223
Ph: (02) 570 7287

AEM WANTS YOU!

– if you're egotistical or confident enough to believe you could edit a magazine like

AUSTRALIAN ELECTRONICS MONTHLY

– that's exactly what we want you to do!

AEM is looking for an enthusiastic, bright, technically-minded person to take on the day-to-day editorial responsibility of Australia's fastest-growing electronics publication, with the chance and the challenge to take it to market leader.

You'll be part of a keen, motivated, hard-working team dedicated to putting AEM in its rightful place – on top!

We need someone with an electronics and/or science background, but degrees and diplomas don't necessarily impress – we're more interested in being convinced you can do the job.

If you reckon you fit the bill, 'phone Val Harrison on 487 2700 or write to: Roger Harrison, Editorial Director, Australian Electronics Monthly, PO Box 289 WAHROONGA 2076.

Eagle ELECTRONICS Pty. Ltd.

(08) 271 2885

TILBROOK IS COMING!

FOR S.A.'s ULTIMATE HOBBYIST SUPPORT!

David Tilbrook from A.E.M. will be in Adelaide to present a Seminar on Amplifier Topologies, based on his enormously popular 5000 and 6000 Series. The Seminar will commence at 7.30 p.m., Friday, 3rd October in the John Kerr Theatre, S.A.I.T. North Terrace Campus. On Saturday, 4th October he will be conducting a workshop at Eagle Electronics, 54 Unley Road, Unley. We will be open until 4 p.m. that day.

EAGLE ELECTRONICS GREAT 3-WAY COMPETITION!!!

CHOICE OF THREE PRIZES:

1. ADC COMPACT DISC PLAYER
2. MICROBEE 32K COMPUTER
3. EAGLE ELECTRONICS VOUCHER to the value of $500.

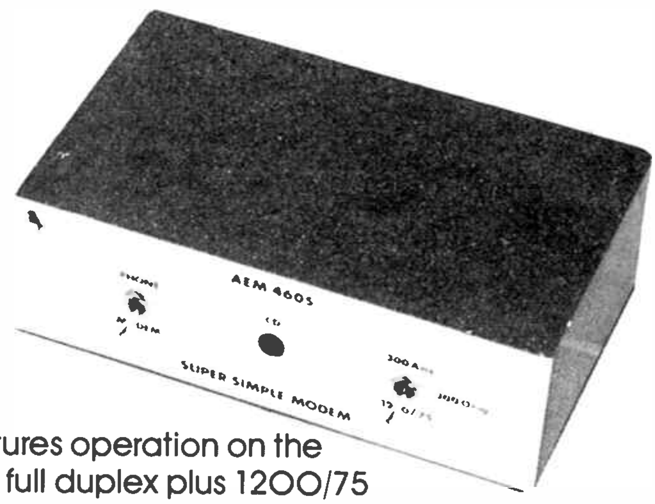
Simply Answer this Question:
The "long-tailed pair" circuit, now widely used in audio, was developed originally for video by an engineer associated with the development of stereo – who was he?
Write your name, address, and the answer to our question clearly on the back of an envelope and send it to Eagle Elecronics 3-Way Competition, 54 Unley Road, Unley, South Australia 5061 by the 30th September, 1986. The winner will be the first correct entry drawn from our barrel by David Tilbrook on Saturday, 4th October. The winner will be notified by mail. The winning prize will be freighted free of charge to the winning entry in Australia and New Zealand.

MAIL AND PHONE ORDERS WELCOME.
Eagle Electronics Pty. Ltd.
54 Unley Road, Unley, S.A. 5061
TELEPHONE:
(08) 271 2885 ALLOW $10 FREIGHT WITH ORDERS

MasterCard VISA

54 UNLEY ROAD, UNLEY

A super-simple modem to build



Anthony Tilbrook
David Tilbrook

Here's a low-cost, simple to build modem that features operation on the popular communications standards of 300/300 full duplex plus 1200/75 half-duplex, providing access to the many bulletin boards and public dial-up data systems, Viatel and other videotex services.

NOT ANOTHER MODEM?! That's the objection we were confronted with when deciding whether or not to publish this project. However, after considerable prompting from readers' letters, we decided to go ahead. This will be the third modem project published in AEM in the past year. The first was the AEM4600, a medium-priced unit which provided 300/300 and 1200/75 facilities and had the added feature of reverse 75/1200 mode. This was described in the December 1985 issue. The next was the AEM4610 Super Modem, a top-of-the line intelligent modem featuring a host of automatic functions. It was clear, however, that a demand existed for a really inexpensive, simple to construct, yet effective, modem which provided 300/300 and 1200/75 operation.

As the name implies, the AEM4605 is a simple modem. It is equipped with the minimum required functions to provide operation on the common 300/300 standard and the 1200/75 baud Viatel or videotex standard. The '4605 is probably best suited to those who wish to dabble in data communications for the first time, or simply those on limited budgets. This, as with our other modem projects, will cost the user a fraction of the cost of a comparable commercial unit.

A modem enables us to send digital data signals over long distances via the ordinary telephone network which was designed to carry speech. With the technology available, this has been brought down to a relatively simple matter. First, though, we have to consider how the computer 'communicates' with the modem.

For convenience and wide application with vastly differing computer equipment, most modems are arranged so that they interface with the computer via a standard serial communications interface, the most common one being "RS232". (See "The Ins and Outs of RS232", by Roger Harrison, AEM Nov. & Dec. '85). To do this you will need a serial interface connected to your computer. The RS232 serial interface on your computer operates by the use of positive and negative voltages to send information down a 'line' or cable meant to run over tens of metres, not kilometres. To send data over long lines, the modem converts these voltages into audio frequency tones in such a way that tones of different frequencies represents a digital 1 or 0. The CCITT standards for these signals is set out in table 1. It is important that the modem conforms closely to the standard so that it transmits and receives tones at the correct frequencies, necessary to decrease the possibility of data transmission errors.

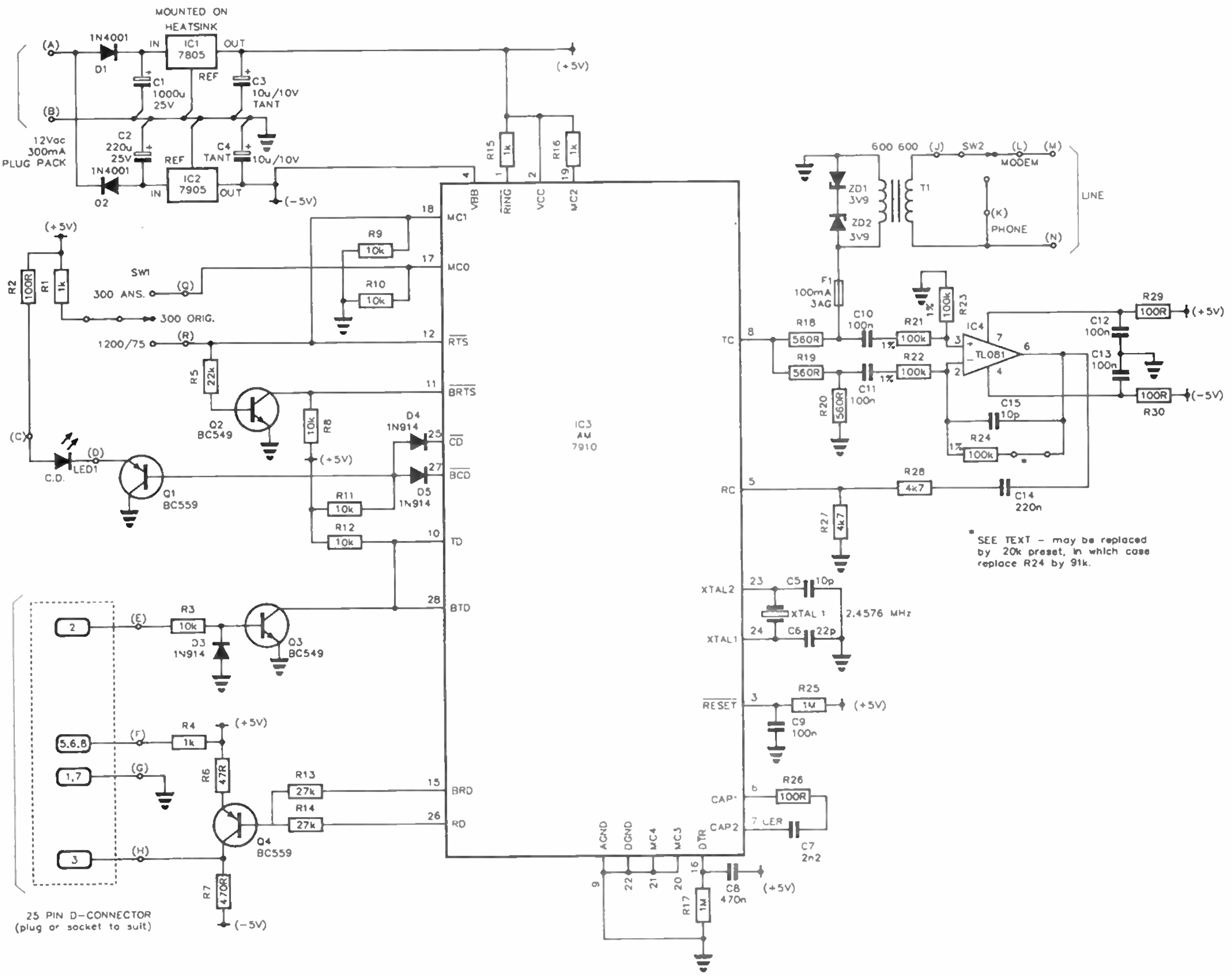
As mentioned above the AEM4605 operates in two different modes, 300/300 baud (answer and originate), full duplex and 1200/75 baud half duplex. These two are the most commonly used modes. Full duplex simply means that the data you are sending is placed onto your screen by means of an "echo" from the receiving computer. This has the advantage that transmit errors are easily seen. Half duplex, on the other hand, is a mode of operation whereby the data placed on your computer screen is placed there directly, and may not necessarily represent the data received at the other end. For many applications, particularly with text, this is not important since the requirement for absolute data accuracy is not essential.

The standard frequencies employed in this modem were set down by an international group known as the CCITT. The specification set down for 300 baud was documented in a paper known as V.21, hence 300/300 is referred to as "V.21." In the same way, 1200/75 is referred to as V.23. Table 1 sets out the relevant data.

The modem's job is to convert the digitally encoded ones and zeros into the required frequencies. The digital ones are referred to as 'marks', represented by a voltage between −3 and −25 V on the standard RS232 serial interface. The zeros are referred to as 'spaces', represented by a voltage between −3 and −25 V on the RS232 interface. ▶

TABLE 1: The standard tone pairs

Modem	Baud Rate	Duplex	Transmit Frequency Space Hz	Transmit Frequency Mark Hz	Receive Frequency Space Hz	Receive Frequency Mark Hz	Answer Tone Freq Hz
CCITT V.21 Orig	300	Full	1180	980	1850	1650	-
CCITT V.21 Ans	300	Full	1850	1650	1180	980	2100
CCITT V.23 (Mode 2)	1200	Half	2100	1300	2100	1300	2100
CCITT V.23 Back	75		450	390	450	390	-



CIRCUIT OPERATION

The project is designed around the '7910 World Modem chip. It does the majority of the work with the help of some external circuitry to set up the required functions and condition the interface signals between the computer and the modem and the modem and the line. It is the job of the '7910 to produce tones that represents the ones and zeros required for data communications.

The power supply for the circuit is a simple half-wave rectified supply providing positive and negative supply rails which are then regulated to 5 V by the three-terminal voltage regulator ICs, IC1 and IC2. Capacitors C3 and C4 are necessary to prevent oscillation of the voltage regulators.

The data from the computer to be transmitted appears on pin 2 of the RS232 connector. The 10k resistor R3 provides current limiting when the diode D3 is conducting. Remember that the signal on the RS232 interface goes both positive and negative. The inputs of the modem IC however, require that the data signal voltages lie between 0 V and +5 V. Diode D3 functions by shorting the negative-going signal to ground. Transistor Q3 acts as an inverter and, together with resistor R12, appropriately conditions the signal applied to IC3.

Data received by the modem is converted from the TTL-type signal from the modem IC to that which will drive an RS232 interface by transistor Q4 and its associated resistors, R6 and R7. This simple interface provides the necessary inversion and drives between plus and minus 4 V on the output line. This is within the RS232 standard and should successfully drive any standard RS232 interface. In addition, it will successfully operate with pseudo-RS232 interfaces that employ TTL-like input and output circuitry (e.g: the Microbee).

The toggle switch SW1 is a centre-off type and determines the operating mode of the modem by establishing the correct mode set-up required by the modem IC.

IC4 separates the transmit from the receive data so that the same line can be used for both transmit and receive data simultaneously. The IC is a TL081 operational amplifier which is configured here as a simple differential amplifier. The transmit carrier generated by the modem IC is applied to both of the inputs and is therefore reduced. The received carrier on the other hand is applied only to the non-inverting input and is therefore not subject to attenuation. The output of this amplifier is ac-coupled by capacitor C14 to ensure that pin 5 of the modem IC is not affected by dc-offset on the output of the op-amp.

The 100 mA fuse limits the maximum possible current that can be delivered to the primary of the isolation transformer T1. The two 3.9 V zener diodes limit the maximum possible drive voltage that can be applied to the load.

The project

This project, as with the other two modem projects we've published, is based around the AM7910 World Modem chip. This device does most of the work. External circuitry establishes the modes of operation and 'conditions ' the input and output signals so that they are compatible with the RS232 standard for serial data transmission. A detailed description of the operation of the modem is included in the Circuit Operation section of this article. The AM7910 is a standard 28-pin dual-in-line package using N-channel metal oxide silicon (MOS) technology. Thomson Semiconductors produce a second-source device known as the EF7910, fabricated using HMOS technology.

The baud rates at which the '7910 will operate are determined by pin selection and a wide variety of rates can be chosen. Here however, we have enabled only the two common standards discussed above. More information on the '7910 can be obtained from the data sheets published in AEM December '85 issue.

One aspect that is a notable change from earlier modem designs is the omission of the current limiting capacitor usually placed in series with the primary of the isolation transformer to prevent damaging or dangerous currents (in particular from the mains). In this modem a slightly different approach has been taken to solve this problem. Since the capacitor was used to ensure that the current in the circuit, and hence possibly in the line, was restricted to less than 100 mA, it is therefore equally acceptable to have this job done by a 100 mA fuse, thus reducing the cost of the unit. This is currently accepted practice for Telecom approval.

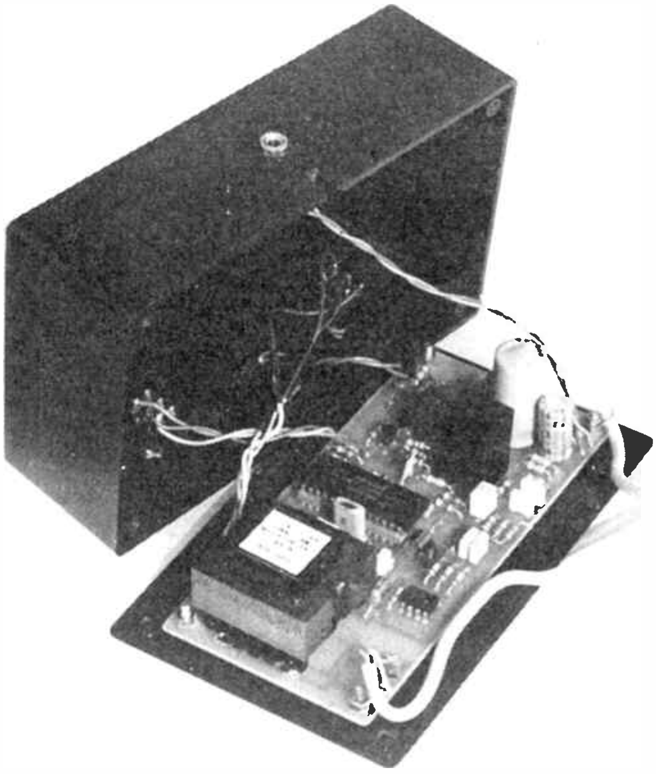
The unit is powered from a small, inexpensive ac plugpack so that the 240 V mains need not be brought into the modem chassis. Although the presence of the mains on the pc board is perfectly allowable, it increases construction difficulties slightly and is not really suitable for a project which we intend to be suitable for construction by novices.

Construction

In keeping with the low-cost criteria, a single-sided printed circuit board is used to mount the components. This, combined with the added task of enabling the project to be fitted into the smallest box practicable, made design of the printed circuit board quite a complex procedure. However, the prospect of the extra expense of a double-sided board made this essential.

Although this project is a relatively simple one the usual precautions should be carried out. Start by making a complete check of the printed circuit board for any sign of copper bridges or open-circuit tracks. Although the quality of printed circuit boards manufactured in Australia is generally high, there is the occasional problem, especially with boards such as this which employ tracks of less than 15 thou. in width.

Once the board has been checked construction can commence. Begin by positioning and soldering the links, resistors and the small capacitors. At this early stage it would be advisable to leave the power supply capacitors as their physical size will hamper the positioning of other components. When arranging the tantalum electrolytics be sure to orient them correctly so as to avoid smqall explosions that will result if the unit is powered up with these incorrectly oriented. There are several links to be soldered on the pc board. Two of these are essential. The third is only required if an optional 20k preset is not fitted. This preset can be used to optimise the rejection by the modem to its own transmit carrier, but is generally not required. If you decide to fit the preset, be



careful to replace R24 (100k, 1%) with a 91k resistor as discussed in the circuit operation.

The next step in the construction is to mount the transistors, 7905 voltage regulator, diodes and zener diodes. It is essential here to correctly orientate these components. Follow the component overlay exactly to be sure. Be especially careful not to mix the BC559s and the BC549s as these are PNP and NPN devices respectively and interchanging them would almost surely result in their destruction. The voltage regulator for the positive supply (the 7805) must be bolted to a pc board mounting heatsink. To do this you will need some thermal paste and the appropriate bolt. I would recommend the mounting of the 7805 voltage regulator to its heatsink be done before soldering to the pc board. If this is done in reverse the lining up of the components could exert unnecessary stress on the leads of the 7805.

You should now be ready to solder the power supply capacitors, IC3, IC4 and the crystal. The power supply capacitors are electrolytics and hence need to be oriented according to their polarity. I recommend the use of a DIL socket for IC3 and IC4. As IC3 is a 28-pin device, replacing it in the case of a fault becomes rather difficult without the socket. Also important is to ensure that the two devices are correctly oriented with respect to their pinout. Again, use the overlay to ensure this.

The final two components to be soldered to the board are the fuse and the 600:600 ohm isolation transformer. Telecom Australia's approval requirements call for this fuse to be hardwired onto the pc board so that it is not 'user replacable'. The fear is that, if the fuse is accessable from the outside of the modem it can be replaced with an incorrectly rated fuse in the event of failure at some time. It is important that this fuse is rated at no more than 100 mA. Simply solder a link to each end of the fuse to act as component leads which will enable you to position the fuse as you would any other component. Try not to overheat the ends of the fuse to avoid the ▶

AEM4605 PARTS LIST

Semiconductors

IC1	7805
IC2	7905
IC3	AM7910, EF7910
IC4	TL081
Q1	BC559
Q2, Q3	BC549
Q4	BC559
D1, D2	1N4001
D3-D5	1N914
ZD1, ZD2	3V9/1 W zener
LED1	T2462-52 red LED

Resistors All 1/4W, 5% unless noted

R1	1k
R2	100R
R3	10k
R4	1k
R5	22k
R6	47R
R7	470R
R8-R12	10k
R13, R14	27k
R15, R16	1k
R17	1M
R18-R20	560R
R21-R23	100k, 1%
R24	100k, 1%
R25	1M
R26	100R
R27, R28	4k7
R29, R30	100R
RV1	20k preset

Capacitors

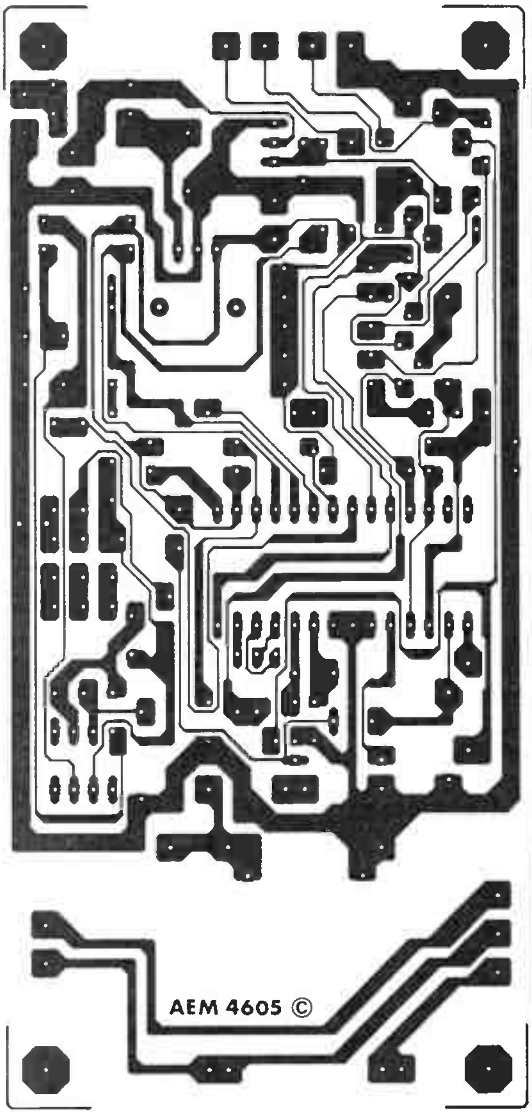
C1	1000μ/25 V RB electro.
C2	220μ/25 V RB electro.
C3, C4	10μ/10 V tant.
C5	10p ceramic
C6	22p ceramic
C7	2n2 ceramic
C8	470n poly. (MKT)
C9-C13	100n poly. (MKT)
C14	220n poly. (MKT)
C15	10p ceramic

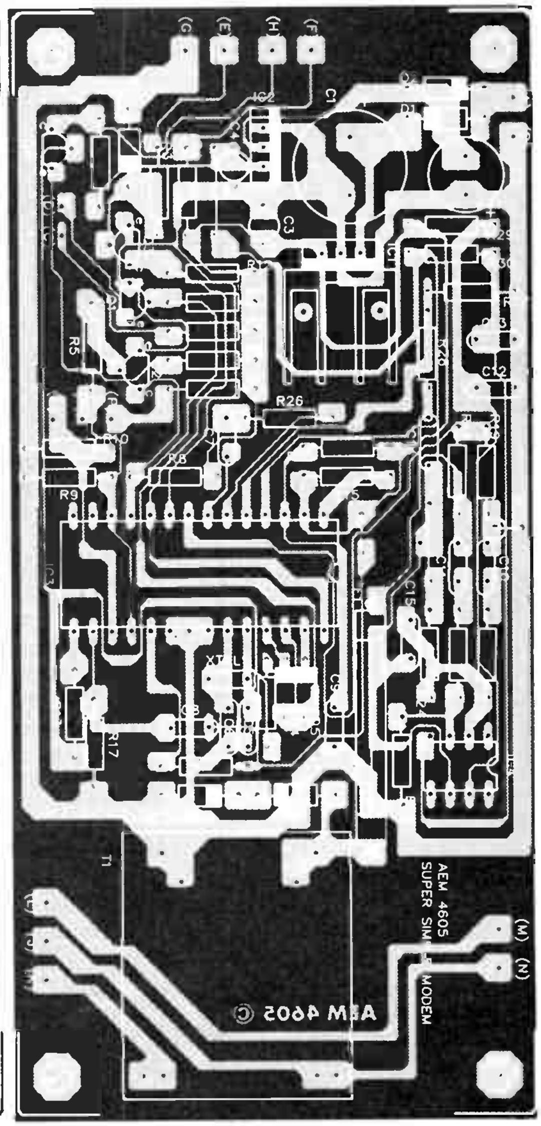
Miscellaneous

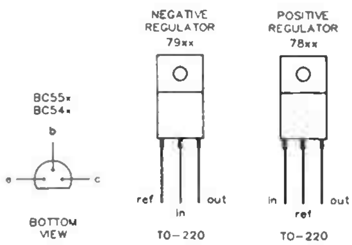
XTAL1 .... 2.4576 MHz

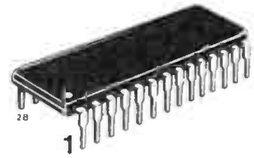
AEM4605 pc board; T1 600:600 ohm Telecom approved isolation transformer (see text); F1 — 100 mA 3AG or M205 fuse; SW1 — centre-off toggle switch; SW2 — SPDT toggle switch; RS232 plug or socket to suit; 12 V/500 mA ac plugpack; 3.5mm plug; hookup wire, etc.

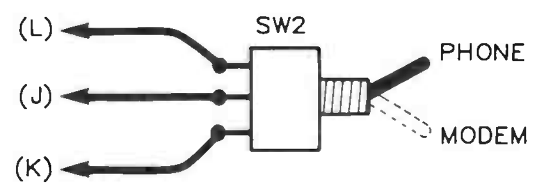
Expected cost: $85-$95

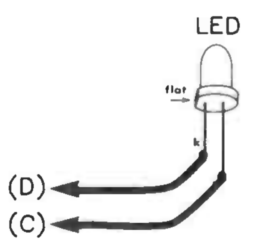


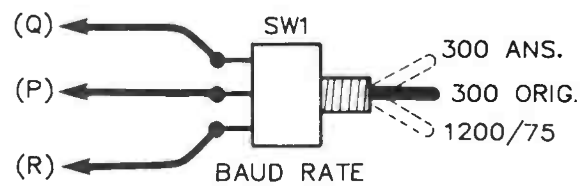












possibility of desoldering the fuse wire. In any event, check the fuse with a multimeter after soldering the leads to it. The pc board has been designed to suit the two most common types of Telecom-approved isolation transformers, i.e: the Arlec 45035 and Ferguson MT620.

Once all of the components have been soldered into their positions, do a thorough check of the board before mounting it in a box or applying power. Check the board for any solder bridges that may have snuck in and check that all of the components have been oriented correctly.

When mounting the board in a box, simply follow the wiring diagram included with this article. The board has been designed to fit in a relatively small and inexpensive box available from the major retailers. We dressed up the front panel with a Scotchcal lable, but this is not essential. However, if you require, it shoulld be available from a number of kit suppliers, such as All Electronic Components in Melbourne, Geoff Wood Electronics in Sydney or Eagle Electronics in Adelaide.

The final component to connect is the 25-pin D plug or socket. At first we were going to have the plug join directly to the modem with an extension joining the modem to the serial port of your computer. However, we decided against this when we realised the extra cost of the extension. I therefore recommend you check your computer's serial port to ascertain whether the lead from your modem will require a plug or a socket. A careful check of the wiring to the plug or socket is a good move before proceeding with powering up.

Powering-up and using your modem

You are now ready for powering the modem. Your computer should have a serial interface port. The project's interface has been designed to operate with standard RS232 interfaces as well as pseudo-RS232 interfaces which operate at TTL-level voltages (0 and +5 V); e.g: the Microbee. Some computers require a serial port attachment which plugs into a 'User Port'; e.g: the Commodore 64 and 128. A simple, low-cost Modem Coupler project for the Commodore 64 and 128 was described in our August '86 issue. You will require appropriate software to configure your computer as a terminal which will transmit and receive at the desired baud rates. For 1200/75 operation, you need a 'split baud rate' facility as you transmit at one rate and receive at the other. Some computers, or at least the software, do not provide for this, in particular the Commodore 64, and a peripheral known as a 'baud rate converter'is required.

A list of dial-up data services was included in an article by Jon McCormack published in AEM in May 1985, called "Dabbling in the dial-up data jungle".

When initiating a conversation with another computer you will need to have your modem set to ORIGINATE. Whereas, if you are on the receiving end, the modem will need to be set on ANSWER. When connection has been made with another computer you should notice the 'carrier detect' LED come on. This simply means that the modem is receiving a valid carrier (a single tone of a specified frequency) from the line.

LEVEL
We expect that constructors of an
INTERMEDIATE
level, between beginners and experienced persons, should be able to successfully complete this project.

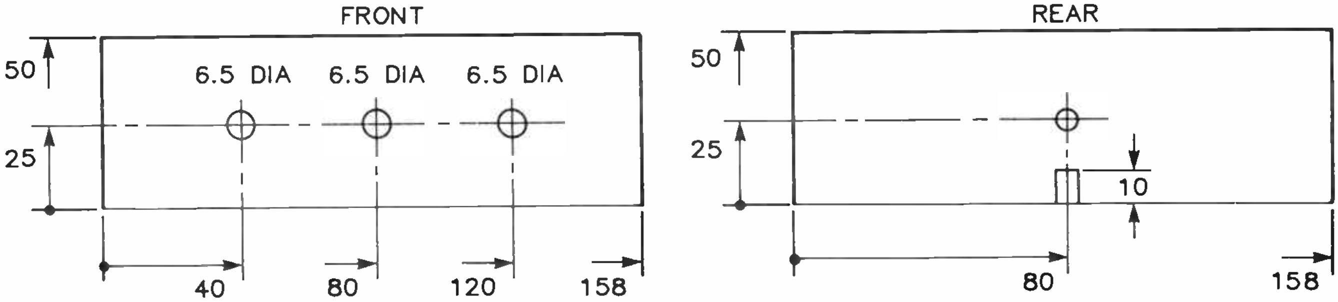
AEM 4605

PHONE — **CD** — **300 Ans.**

300 Orig.

MODEM — **1200/75**

SUPER SIMPLE MODEM



ALL DIMENSIONS IN mm

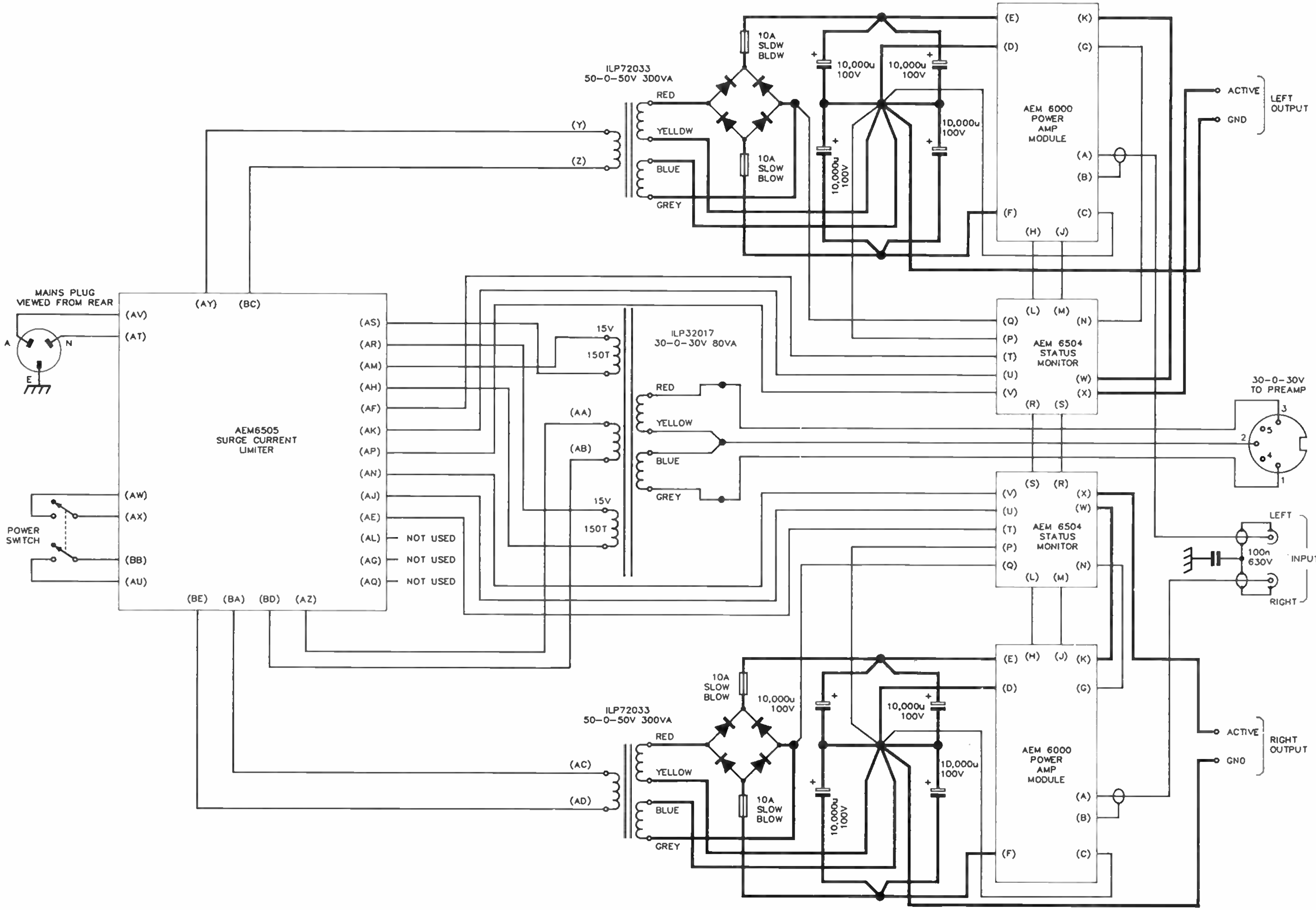
DIRECT-CONNECT MODEMS AND YOUR RESPONSIBILITIES

Any device which you intend to connect to a Telecom line must be 'type-approved' as an attachment. It is an offence under the Telecommunications Act 1975 to attach any apparatus to a telephone line which is part of the public switched telephone network other than an approved device or an appliance leased from Telecom.

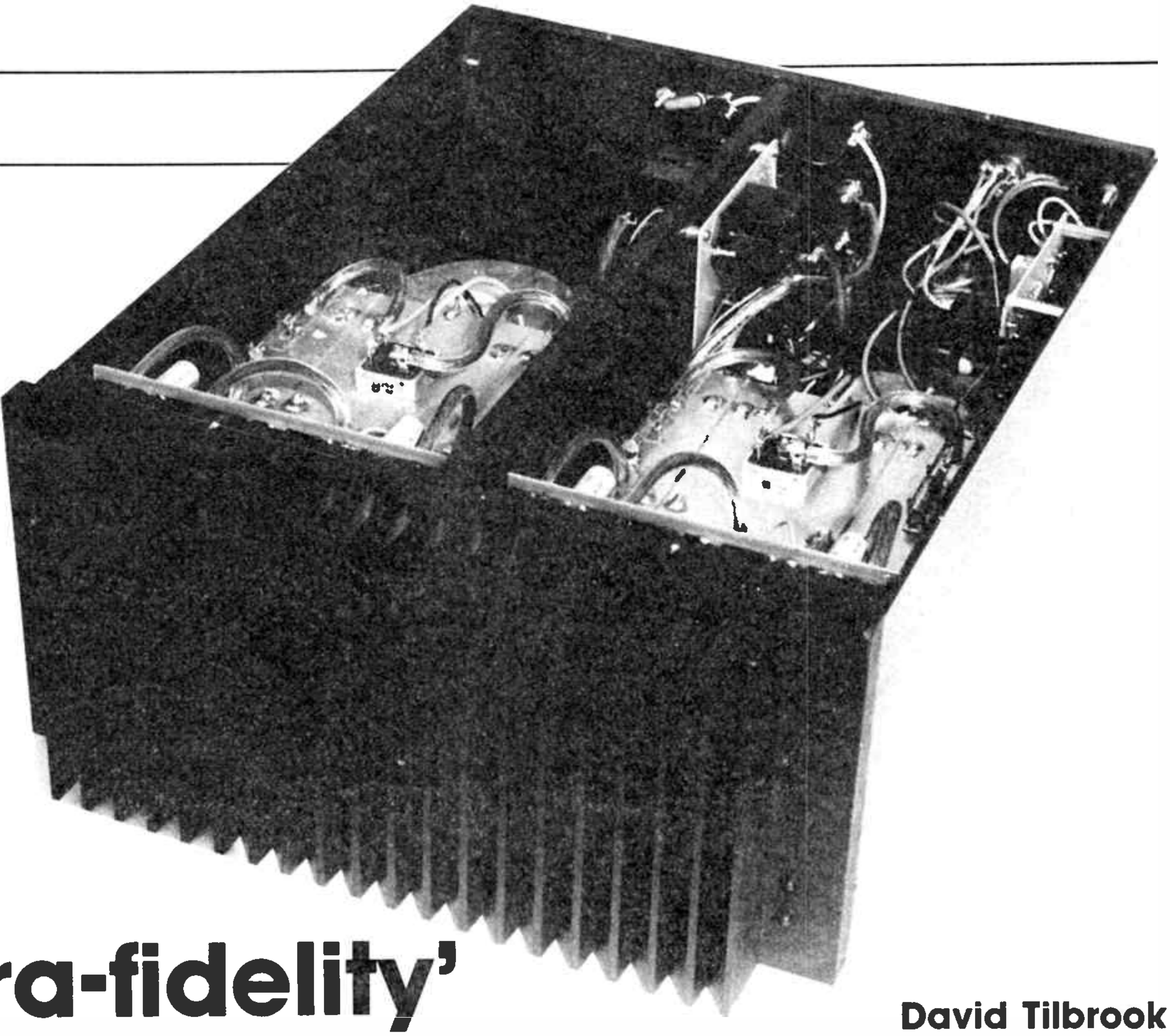
You are at perfect liberty to construct and use the modem described here over, for example, an internal building intercom line or other private 'twisted pair' line, or with a packet radio terminal node controller (TNC).

The electrical, electronic and physical design and layout of the project has been done to comply with relevant type-approval specifications and for electrical safety. In particular, the mains and line transformers both comply with Australian Standard AS3126, and Telecom typed-approved line transformers have been specified in the parts list.

The Telecom specifications relating to this sort of equipment include documents 1050, 1053, 1222, 1240, 1302 and 1364. Authorization for type approval must be made on Telecom's Form TS139 "Data and Non-Voice Equipment Directly Connected to the Telecom Network".



ILP72033
50–0–50V 300VA
RED
YELLOW
BLUE
GREY
(Y)
(Z)
10A SLOW BLOW
10,000u 100V
AEM 6000 POWER AMP MODULE
(E) (D) (F) (H) (J) (K) (G) (A) (B) (C)
ACTIVE
GND
LEFT OUTPUT
MAINS PLUG VIEWED FROM REAR
A
N
E
AEM6505 SURGE CURRENT LIMITER
(AV) (AT) (AW) (AX) (BB) (AU)
(AY) (BC)
(AS) (AR) (AM) (AH) (AF) (AK) (AP) (AN) (AJ) (AE) (AL) (AG) (AQ)
NOT USED
(BE) (BA) (BD) (AZ)
POWER SWITCH
ILP32017
30–0–30V 80VA
15V
150T
(AA)
(AB)
AEM 6504 STATUS MONITOR
(Q) (P) (T) (U) (V) (L) (M) (N) (W) (X) (R) (S)
30–0–30V TO PREAMP
LEFT
100n 630V
INPUT
RIGHT
ILP72033
50–0–50V 300VA
(AC)
(AD)
RIGHT OUTPUT



An 'ultra-fidelity' power amplifier

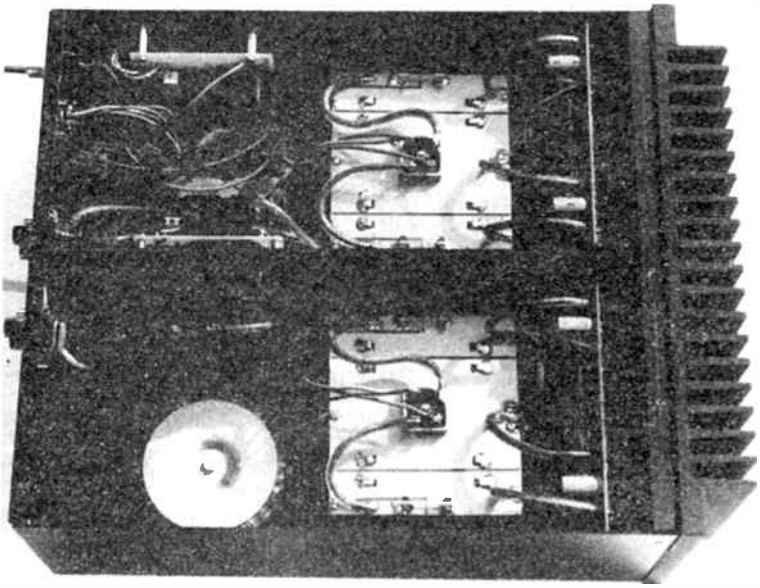
David Tilbrook

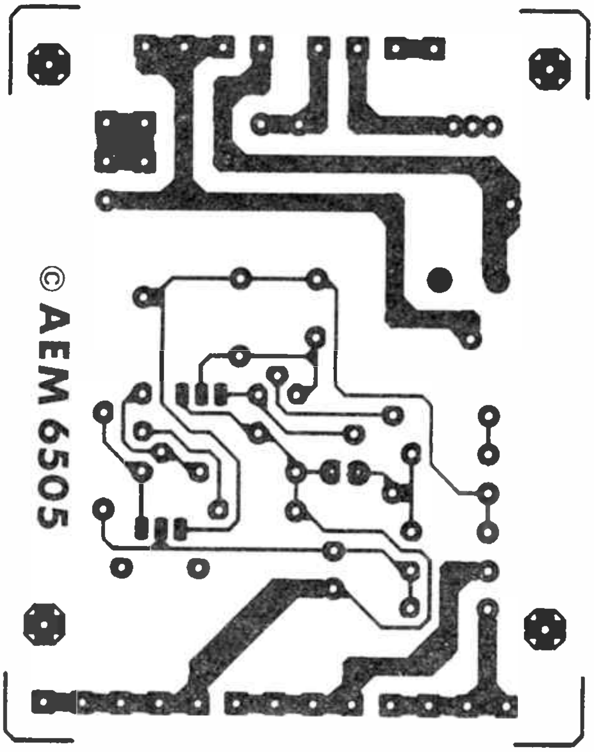
In Part 3 of this series I described the recommended power supply for incorporation with the AEM6000 power amplifier modules. In this article the surge current limiter and the remainder of the construction is described including the 240 Vac mains wiring.

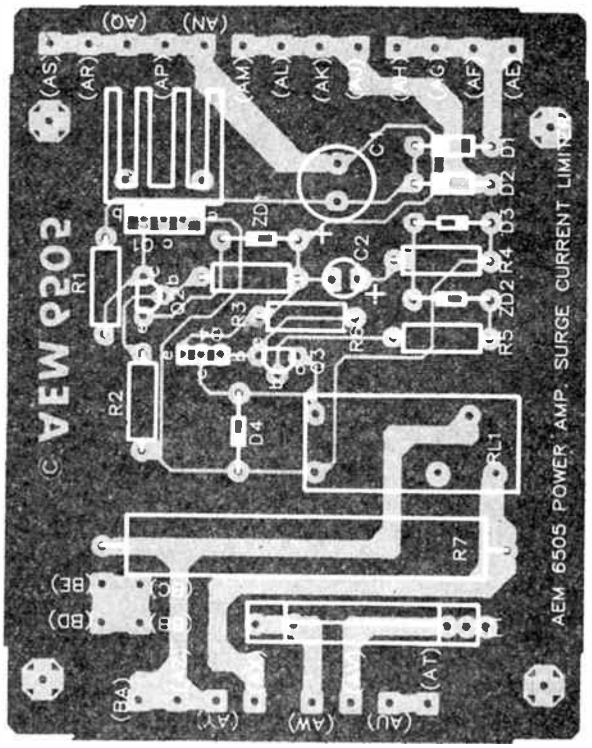
AS SHOWN in part 3, the power supply recommended for use with the AEM6000 power amp modules employs separate 300 VA toroidal power transformers for each channel, connected to high current capacity bridge rectifiers and 40 000 uF of capacitance for each channel. This provides each module with a very low-impedance power supply and helps ensure the best possible sound quality from the power amp modules. One problem associated with the low-impedance supply, however, is the in-rush current that can result at the moment of switch-on. When the supply is first turned on, the filter capacitors are fully discharged and represent a very low impedance (in fact nearly a short circuit) to the output of the power transformers. The resulting current is determined by impedances associated with the rest of the power supply wiring.

It is very important when using power MOSFETs in the output stage of a power amplifier such as this to ensure a very low impedance from each power amp module to the main power supply filter capacitors, and from the 0 V point at the capacitors back to the amp modules. If this current path has significant impedance, both the distortion and stability performance of the power amplifier can be severely affected. For this reason it is recommended that this wiring be done with a very low impedance cable such as Monster Cable (Monster Cable is a registered trade mark of Monster Cable Inc. It is distributed here by Convoy International and available through many hi-fi outlets and selected electronics retailers). Similarly, to ensure a very low impedance in this wiring it is necessary to remove power supply rail fuses from their usual location between the filter capacitors and the power module and to incorporate them instead between the ouput of the bridge rectifier and the filter capacitors. This still provides good fuse protection for the +ve and -ve supply rails in the event of a major power amp failure, but has the disadvantage that the fuses are exposed to the main turn-on in-rush current. Even if the appropriated slow-blow fuses are used in this application, the shock at each turn-on will significantly reduce the fuses' lifetimes.

In order to decrease the current in-rush at the moment of turn-on, a surge current limiter has been incorporated with the mains wiring. This places a resistor in series with the 240 Vac mains wiring leading to the primaries of the three toroidal power transformers. This resistor remains in series for a short time only, around 100 or 200 milliseconds, after ▶







which it is shorted out by relay contacts controlled by simple turn-on time delay circuitry. This simple technique is very effective and ensures that the power amp turns on with minimum trauma to the power supply components. A circuit diagram and component overlay have been included with this article, together with a wiring diagram which shows how it is connected to the power transformers.

In part 3, the wiring diagram shows the 80 VA toroidal transformer used to power the preamplifier connected to the Status Monitors as well. Although this is allowable on some preamplifier earthing configurations, it can create hum loop problems in some circumstances. It is therefore advisable that the Status Monitors and the surge current limiter be powered from a separate transformer secondary to that used for the preamp. This can easily be obtained by winding an additional 15-0-15 volt secondary winding on the 80 VA toroidal transformer.

Use two windings of 0.5 mm enamelled copper wire, each with 150 turns around the 80 VA transformer. The easiest way to do this is to wind the two 15 V windings simultaneously by winding with two lengths of wire. Start by winding two enamelled wires of different colour together onto a former with a small enough diameter to fit through the hole in the centre of the transformer. Make each winding by passing the former through the hole so that each pass completes one turn. When 150 turns have been wound, join the top of one of the windings to the bottom of the other. This task is greatly simplified if the two different coloured emanel wires have beem used.

It is very important to ensure that the correct wires have been joined together. If the start of a winding is joined to the finish of the same winding, this represents a short across the transformer and will cause it to draw excessive current and overheat.

Construction

The construction details for the Power Amp modules and Status Monitors have already been described. Start by constructing the power amp modules and status monitors as described in these earlier articles.

The construction of the AEM6505 surge current limiter can be tackled first. It should present few difficulties. This pc board is also used to carry the 240 V wiring to the transformers to minimise the number of external terminal strips required. Since the board has 240 Vac on it, it should be constructed based on the pc board pattern published with this article and only fibreglass board should be used. Assembly of the '6505 is relatively straightforward and only a few special precautions are necessary. Start by soldering the small passive components onto the pc board first and then move onto the semiconductors. The voltage regulator TIP31A transistor is mounted on a small pc-mounting heatsink. Mount the transistor to the heatsink first and, after positioning the transistor's leads through the pc board, solder the heatsink mounting pins before soldering the leads to the transistor itself.

AEM6505 PARTS LIST

Semiconductors

Q1	TIP31A
Q2, Q3	BC548
Q4	BD139
D1, D2	1N4004
D3, D4	1N914
ZD1, ZD2	5V1/1 W zener

Resistors All 1/4W, 5% unless noted

R1	10k
R2	1k
R3	820R
R4	22k
R5, R6	10K
R7	10R

Capacitors

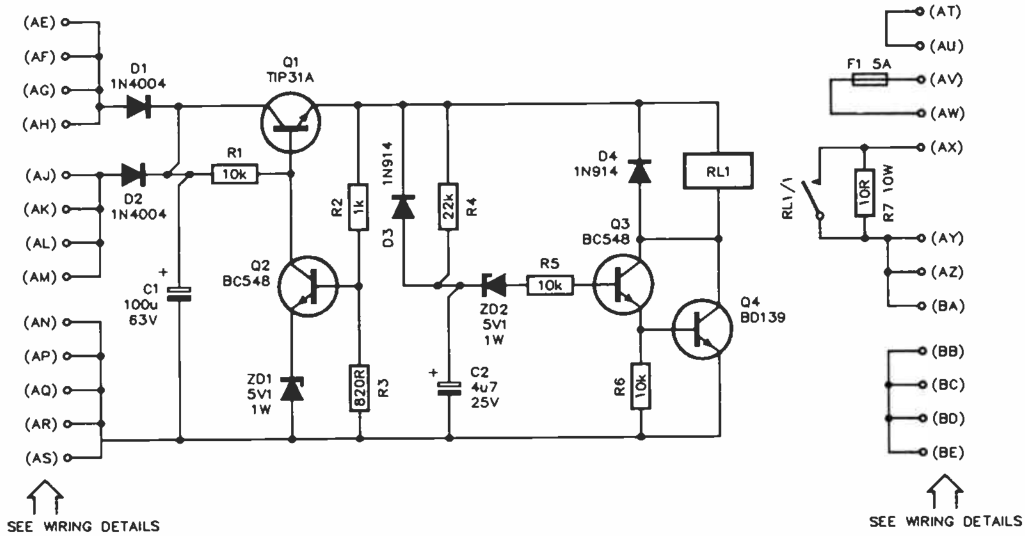
C1	100μ/63 V RB electro.
C2	4μ7/25 V RB electro.

Miscellaneous

RL1	SPDT 5 A contacts, 12 V coil
F1	5 A 3AG slow-blow fuse

AEM6505 pc board; heatsink, pc-mount type DSE H3490 or similar.

Expected cost: $22-$28



The final step of particular importance in the construction of the surge current limiter is the mounting of the large 10 W wirewound current limiting resistor. If a fault condition arises in the '6505 which prohibits the relay from operating correctly then the power dissipation produced within this resistor will become extremely high when the power amplifier is driven to even modest output levels. It is therefore essential that this resistor is mounted well off the pc board so that the board will not be affected by the heat and consequently destroyed. The best type of power resistor to use for this application is one which is thermally protected. These are fitted with a length of spring steel used to form a switch contact which has been soldered closed with special, very low temperature solder. This contact is in series with the resistor so that if it becomes excessively hot, the solder melts allowing the contact to spring open, disconnecting the resistor from the circuit. Unfortunately, these resistors do not seem to be commonly stocked by electronics retailers in Australia and may be difficult to obtain.

With all of the boards assembled, the remainer of the construction can be completed. The prototype power amplifier was constructed in a custom-made steel chassis with a gravity diecast front panel heatsink of aluminium. The chassis was supplied with a steel centre panel which serves to isolate the two channels and also provides a convienient mounting panel for the two AEM6504 Status Monitors. Drilling details for the panels have been included with this article.

Commence by winding the extra secondary around the 80 VA toroidal transformer as discussed above. Mount the transformers to the chassis using the special mounting kits provided with them. One of the rubber discs is placed between the chassis and the toroidal transformer. The other is placed between the top of the transformer and the circular steel mounting panel. Pass the mounting bolt through the chassis so that the nut is on the top of the transformer inside the chassis. Before tightening the mounting nuts, rotate the transformer so that the leads are positioned closest to the electrolytic capacitors. Mount the smaller 80 VA transformer to the rear panel of the chassis in a similar way.

Mount the two input RCA sockets and the output screw terminals to the rear panel. The input sockets must be insulated from the chassis, so use either the insulated RCA chassis-mount sockets or use 8 mm rubber grommets fitted to the mounting holes to provide the required insulation.

Next mount the 240 V mains switch and the 5-pin DIN socket to the rear of the chassis. There are also two chassis connections to be made to the rear panel. The first of these is located adjacent to the 240 V mains switch so that the mains cable earth can be secured to the chassis using an earth lug bolted to the rear panel. The second chassis earth lug is located adjacent to the left side RCA input socket. This is used to solder the 100n/630 V capacitor between chassis and the input shield. This capacitor ensures that the chassis acts as an effective shield for the power amp for RF, while providing sufficient impedance at 50 Hz to eliminate the potential hum loop that can result if the chassis is connected directly to the signal earth within the power amp.

After positioning the surge current limiter roughly in place the 240 V wiring can be carried out. Use a locking type 240 V mains cable grommet and mount the cable to the rear panel after first preparing the ends of the cable. The mains cable active and neutral wires are soldered directly to the '6505 pc board. The earth lead should be soldered to the chassis lug bolted to the rear panel. The four wires leading to the power switch all solder directly to the '6505 pc board as do the primaries of the three power transformers. The right channel power transformer and the 80 VA preamp transformer can solder directly to the pc board. The leads to the left channel power transformer must be extended by soldering lengths of cable and then passed through the bottom hole in the rear of the centre panel. This hole should be fitted with a grommet to ensure that the metal cannot cut through the plastic insulation surrounding the wires. In the prototype power amp the leads to the left channel power traqnsformer were extended by taking them to a two-way screw terminal block which had been mounted to the rear panel of the power amp. A small piece of surplus pc board was fitted between the metal rear and the terminal strip to help ensure sufficient isolation of the 240 V mains wiring from the chassis; 240 V rated cable was then taken from this terminal block to the '6505 pc board.

Finally, ensure that all 240 V wiring is adequately insulated to prevent the possibility of accidental contact. When doing this however, be careful not to allow flammable materials such as PVC insulation tape to come into contact with the ▶

AEM6000 POWER AMP PARTS LIST

2 x AEM6000 power amp modules
2 x AEM6504 power amp status monitors
1 x AEM6505 surge current limiter
AEM6000 Heatsink front panel and chassis
8 x 10 000u/100 V electrolytics
2 x 300 VA/50-0-50 V toroidal power transformers
1 x 80 VA/30-0-30 V toroidal power transformer
2 x 400 V/25 A bridge rectifiers
4 x 10 A slow-blow fuses, or 10 A quick-blow types if slow-blow unobtainable.
1 x DPDT toggle switch, 240 V/5 A
1 x 5-pin DIN socket
2 x RCA insulating sockets.
4 x screw terminals
1 x 100n/630 V capacitor
1 x 2-way terminal strip
3 x metres power cable
1 x mains plug
1 x mains cable grommet
2 x 12 mm grommets
2 x 8 mm grommets
8 x 6 mm spacers
4 x 25 mm spacers
4 x red LEDs
4 x LED mounting grommets
4 x metres Monster Cable, or similar 6BA and 4BA nuts and bolts
2 x solder lugs
2 x metres shielded cable
Assorted hookup wire

10 W current limiting resistor on the '6505 pc board because, as mentioned earlier, this resistor can become excessively hot under some fault conditions.

Before mounting the '6505 pc board to the side panel, complete the low-voltage ac wiring from the output of the 80 VA, transformer. The main 30-0-30 V secondary is wired directly to the DIN socket on the rear of the chassis. The extra 15-0-15 V winding connects to the '6505 pc board from where it is distributed to the two '6504 pc boards. The remaining wiring to the '6505 runs to the two '6504 power amp Status Monitors. Place each of the '6504 pc boards roughly in position on either side of the rear section of the centre panel. Measure lengths of hookup cable by running these around the chassis first and then solder them to the '6504 pc boards. The wiring to the left channal Status Monitor passes through the bottom hole at the rear of the centre panel. When all of the wiring has been soldered to the '6504 pc boards they can be mounted to the centre panel using 6 mm spacers and four 25 mm bolts which pass through both '6504 pc boards.

Finally, the wiring from the '6504 pc boards can be soldered to the '6505, which can then be bolted into its position on the right side wall of the chassis. In our prototype, 25 mm spacers were used to ensure good clearance between the side wall and the 240 V wiring on the rear of the '6505 pc board.

With the two AEM6504 Status Monitors mounted onto the centre panel and the '6505 mounted in its position, the main electrolytic filter capacitors, bridge rectifier and high current power supply wiring can be done. Start by bolting the capacitors to the chassis. Orient the capacitors so that their positive terminals are closest to the right side wall of the chassis (as viewed from the front). This minimises the power supply wiring to the power amp modules since their positive rail connection points are also closest to this side of the chassis.

In the prototype, the wiring between the filter capacitors and the fuses, and then to the bridge rectifiers, was achieved through the use of simple pc boards which were soldered directly to the tops of the filter capacitors. This has the advantage of simplifying this part of the construction but has the disadvantage that the pc boards are only useful on this particular type of capacitor. As it is not clear at this stage which electrolytics will be supplied by the retailers supporting this project we have not included the layout for these pc boards with the article. The wiring can be easily achieved without the use of pc boards by using conventional heavy duty tinned copper wire. In this case, use chassis-mounted 3AG fuse holders and bolt these, together with the bridge rectifier, to either side of the centre panel above the filter capacitors. The wiring should be carried out using very heavy duty cables (Monster Cable, for example) according to the power supply wiring diagram included with part 3.

The two power amp modules can now be bolted to the rear of the front panel heatsink. The rear of the heatsink is machined flat so that good thermal contact between the power amp brackets and the heatsink is achieved. Use thermal paste to improve the contact even further and bolt the module in place using six mounting bolts for each module. Position the heatsink roughly in place at the front of the chassis and wire the shielded cables between the inputs of the modules and the input RCA sockets on the rear of the chassis. Pass the cables between the centre panel and the '6504 pc boards since this helps to keep the input cables away from the power transformers. Wire the input earth between the modules and the 0 V point on the electrolytic capacitors, then wire the leads from the '6504 boards to the four LEDs which mount through the front panel. Make sure that these connections are well insulated from each other and from the front panel. Mount the LEDs to the front panel by passing them through the rear of the front panel. In the prototype unit we used conventional LED mounting grommets which were first glued to the front panel.

Once the LEDs are mounted and the input and output earths have been connected, the front panel assembly can be bolted into place on the front of the chassis.

The remaining wiring between the power supply and the power modules can now be completed, together with the wiring from the power amp module output to the Status Monitor relay and then to the output terminals. The earth for the output terminals is connected directly to the 0 V point on the power supply filter capacitors.

Finally, solder a length of insulated hookup wire between the two RCA input earths on the rear panel. This wire passes through the top hole in the centre panel which should be fitted with a grommet.

Powering up

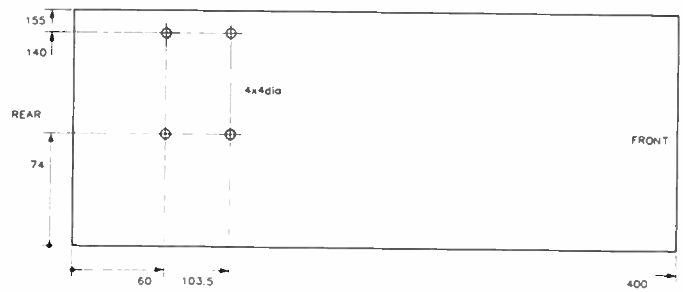
Before applying power, check all of the 240 V wiring. Check that the earth pin of the mains plug is connected to the chassis using a multimeter. Check all of the power supply wiring, being sure to check that the correct transformer leads are connected to the correct points on the power supply. If all is well, insert fuses into the fuse holders and switch on. Do not connect speaker leads at this stage. Instead, measure the output offset voltage on the output terminals at the rear of the chassis. If necessary, the output offset of each module can be adjusted using a small screwdriver, being careful not to short the preset to any other components on the power amp pc board. Preferably, a plastic 'trimming tool' should be used for this purpose.

Once this has been done, the speakers can be connected. The AEM6000 is a very quiet power amp, so very little noise should be heard in the speakers with the preamp disconnected. To avoid possible damage to the loudspeakers, turn the power amp off before connecting the preamp and be sure that the volume control on the preamp is turned fully down. Remember that the power amp will supply 240 W to each ▶

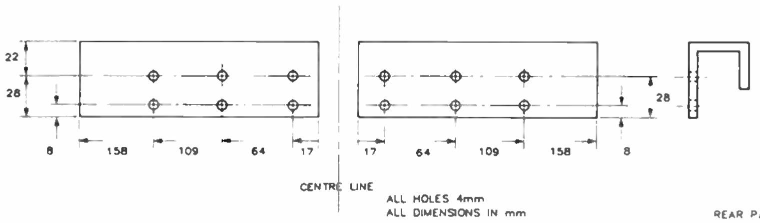
loudspeaker, if required, and this is more than enough to guarantee destruction of most loudspeakers if the power amp is used incorrectly.

Good listening!

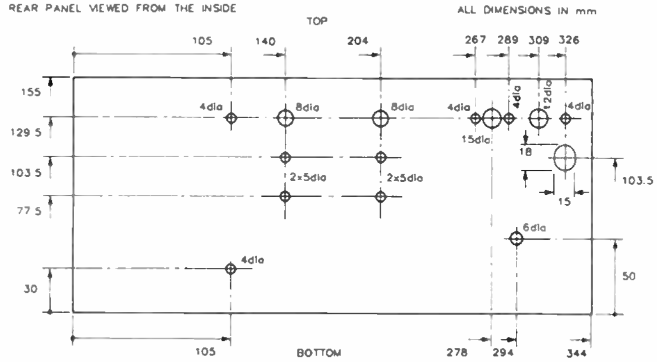
RH SIDE PANEL VIEWED FROM THE INSIDE ALL DIMENSIONS IN mm



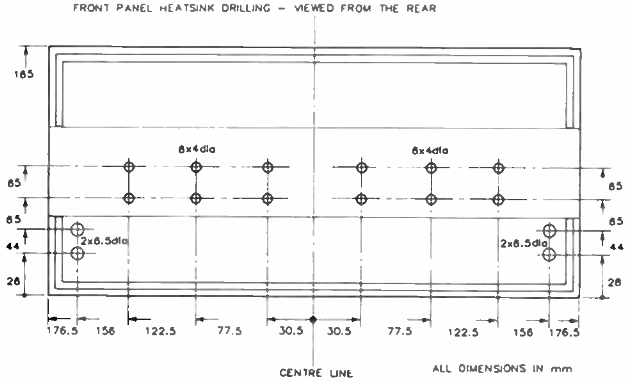
POWER MODULE HEATSINK BRACKET TO FRONT PANEL HEATSINK MOUNTING – BRACKET DRILLING



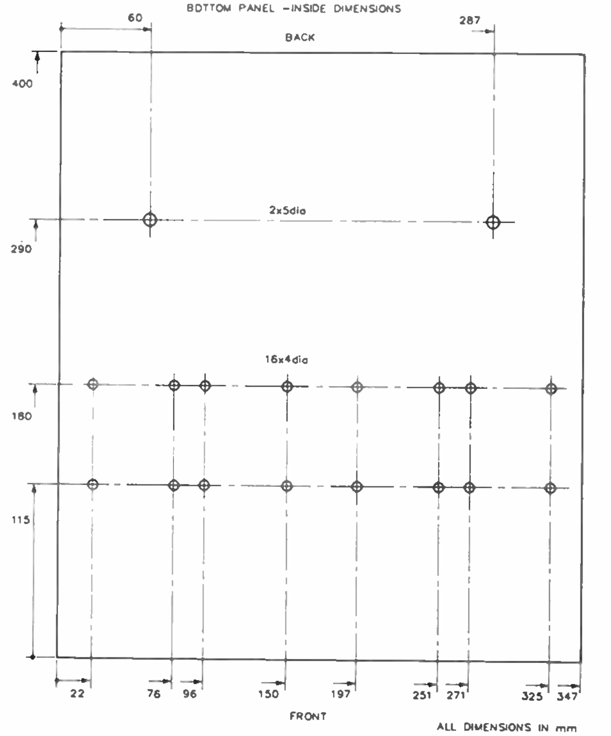
REAR PANEL VIEWED FROM THE INSIDE ALL DIMENSIONS IN mm



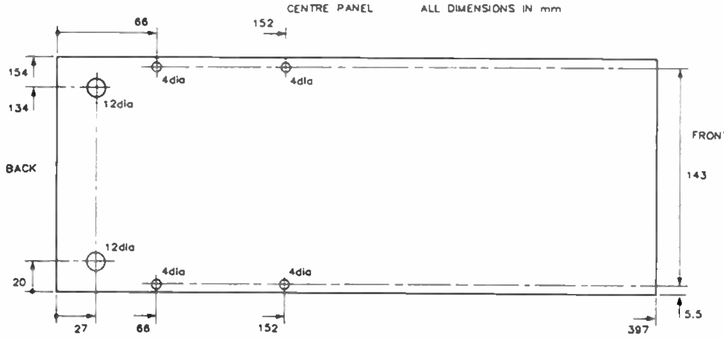
FRONT PANEL HEATSINK DRILLING – VIEWED FROM THE REAR



BOTTOM PANEL – INSIDE DIMENSIONS



CENTRE PANEL ALL DIMENSIONS IN mm



.... from p 0

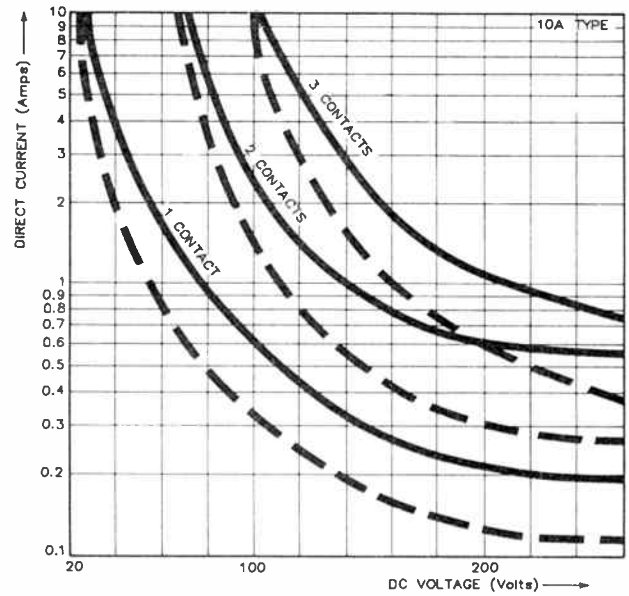


Figure 4. The contact current breaking capacity of a relay varies inversely with the voltage switched. This example is for a relay with contacts rated to switch 10 A at 24 Vdc. The solid lines are for resistive loads, broken lines for inductive loads with a time constant of 40 ms or less. Note that the maximum current breaking capacity cannot be exceeded but, by connecting contact sets in series, the voltage breaking capacity can be significantly increased. Note that this does not apply if you connect the contact sets of separate relays in series because their switching times will not be synchronised. (From an AMF data sheet).

When the load is inductive (L/R ratio has a time constant of 7 ms), life expectancy drops below 100 000. It is obvious that contact arc "quenching" has considerable benefits, although complete arc suppression is undesirable in many circumstances as explained earlier. What Figure 3 also shows is that contact life can be greatly increased by reducing the contact load. Note however, that this doesn't hold for light load or dry switching applications.

Apart from current carrying capacity, relay contacts are rated for voltage breaking capacity. This depends on the relay's construction — the greater the contact travel and the shorter the contact breaking time, the higher its voltage breaking capacity. As you would expect, inductive loads reduce voltage breaking capacity. Connecting contact sets in series can dramatically improve contact breaking capacity, particularly in dc switching applications.

Figure 4 illustrates the contact breaking capacity of a multi-contact set relay with each individual contact rated to break 10 A maximum at 24 Vdc. The solid lines show breaking capacity for resistive loads, while the dashed line shows breaking capacity for inductive loads (with L/R time constant of 40 ms or less). For a single contact, a four-fold increase in voltage reduces the current breaking capacity by a factor of ten! By just connecting two contact sets in series, the voltage breaking capacity at the maximum contact current rating of 10 A triples! Note that you can't extrapolate this graph above the maximum contact current rating. With three contacts in series, the voltage breaking capacity at 10 A increases fourfold or so. So you start to run into diminishing returns.

With an inductive load, a single contact set for this relay will only break 40 V at a 2 A load. But with two contacts in series, it will break 90 V or so at the same load.

Thus, you can extend a relay's breaking capacity at voltages well above its rated voltage. This leads to the question — can you increase a relay's current breaking capacity by parallelling contact sets? The answer is no, because the contacts will not open and close simultaneously and thus the rating of one contact alone will apply. However, much improved reliability is obtained by parallelling contact sets.

— continued next month

CALLING ALL interested Turbo Pascal uses! Plug yourself into the largest information base in Australia. Join with hundreds of other Turbo users and discover a new world of computing. Drop us a line now. TUG, Freepost No 6, PO Box 317, Sunshine 3030 Vic.

SELL: stereo step attenuator volume control, metal film resistors $40. P. Roberts, 1st Training Group, Wacol 4076 Qld. Call (07) 271 0281.

WANTED: Reasonably priced dot matrix or similar printer to suit Commodore VIC-20 for school student. Jason Turner, 5 Grey St, Auburn 2144 NSW.

BACK ISSUES OF: ETI, EA, Aust. Personal Computer, Your Computer, Micro-80 magazines from 1981 to 1985. Will sell the lot at a bargain price. Phone Randall Gallimore (049) 52 6261.

ADMARKET

Readers' free adverts.
READERS-CLUBS-ASSOCIATIONS

WE'LL PUBLISH your advertisement of up to 32 words (maximum), totally free of charge. Either fill out the coupon here, or write or type it out on a clean sheet of paper. But **please** make it legible, other wise it may not turn out as you intended! Copy **must** be with us **six weeks** prior to the month of issue. Every effort will be made to publish you advertisement, but no responsibility for so doing is accepted or implied.

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

WANTED, URGENT: Listening Post software for Sharp PC5000 on disk or bubble. Write with price to G. Pfister, 2B Francis St, Dee Why 2099 NSW for immediate reply. Sorry no 'phone. Cruising to Qld October.

SELL: Solenoid logic-controlled Realistic SCT-80 cassette deck. 11 months old. Still under warranty. Has auto-reverse, Dolby B&C NR, auto-bias selection. Only $260. Worth $360 new. 246 Pallas St, Maryborough 4650.

SELL: Valves 6GV8 — 78 pieces; 6BM8 — 100 pieces. $12 the lot. Ph. (03) 366 6872. Ask for Mark.

SELL: Tellurometer 2.3 GHz FM link, tripods, dishes, qty 3. $150. Video tapes, 0.5", 7" spool, new $5.00. Crystal set crystal holders, old open type $3.50 posted. VK2ZQC QTHR. (02) 81 2143.

ACTIVE X-OVERS: three-way, 4th-order Butterworth type with phase correction, high quality parts, pair, assembled. P. Roberts, 1st Training Group, Wacol 4076 Qld. (07) 271 0281.

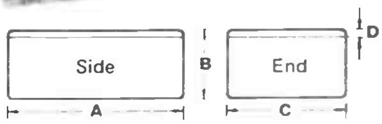
SINCLAIR REPAIRS: ZX Spectrum, Microdrive, Interface One. Cheap rates, excellent service. All Sinclair parts available (QL, ZX81, Spectrum etc.) Video conversions etc. Contact Chris Smith, PO Box 466, Epping 2121 NSW. (02) 86 5626

FOR SALE: "COPIERX" a machine language program that copies MC10 BASIC and machine language programs, tapes, name and all. Easy to use. $15 posted. Frank Rees 27 King St, Boort 3537 Vic.

NEW RANGE OF ABS PLASTIC BOXES

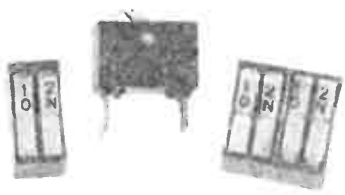
The 2000 series Bimboxes are ideal for projects. Lids are inherently dust, moisture and splash-proof and can be easily sealed for complete water-proofing.
Quality construction includes brass threaded inserts for lid screws (no self-tappers!) plus built-in PCB slots *PLUS* unique BIMADAPTORS which allow flat mounting either singly or sandwich fasion with 5mm spacing. The FREE adaptors fit in the corners and being plastic are easily trimmed and provide excellent insulation between boards.

FREE Adaptor allows boards to be mounted flat and stacked in box



Part No	A	B	C	D	Price
BIM2002/12	100	25	50	4	$4.75
BIM2003/13	112	31	62	4	$4.85
BIM2004/14	120	40	65	4	$5.10
BIM2005/15	150	50	80	4	$6.62
BIM2006/16	190	60	110	4	$11.75

MODULAR DIP-SWITCH SUPER SPECIAL 60c



What would you expect to pay for quality EECO rocker DIP switches? Would you believe 30cents per actuator? We've secured a quantity of two pole switches which can be stacked to get any even number of switches you like on the same PCB pitch - yes a 20SPST gang or more if you like.
They're rated at 1Amp, 28V non-switching or 125mA switching. Gold over copper alloy switch contacts and tin-lead over copper alloy terminals. Rugged sealed construction. Actuators can be locked against accidental actuation. 60 cents each (twin actuators blocks) but hurry.

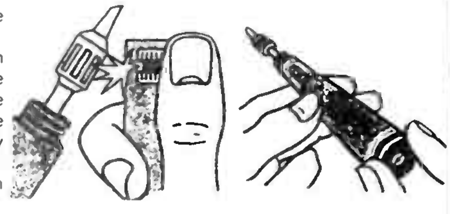
BOURNS TRIM-POT TOOL

Handy little tool for setting trim pots. It's always hard to find a screwdriver that fits so get one of these drivers. One end has a screwdriver for recessed slots, the other end fits over actuator screws and won't fall off - so you can leave the tool attached in awkard locations while you make other adjustments! At only $2.00 you'll soon recover the cost by saving time and frustration.

Fits your pocket

NEW CORDLESS BUTANE SOLDERING IRON

No cords and no gas bottles - this neat pen-like iron runs on standard butane gas lighter fuel. Up to 60 minutes continuous use and refills in seconds. Temperature is adjustable for the equivalent of 10 to 60 watts!! Tip temperature can be as high as 400C. Three tips are available - 4.8mm, 3.2mm or 2.4mm and are easily replaced. Ideal for the serviceman's tool box. Complete and ready to use - even has its own flint lighter!! $49.95

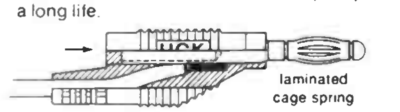


Built-in Flint Lighter — Adjustable from 10-60W

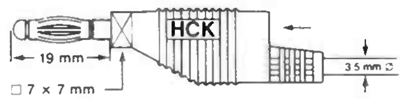
NEW RANGE OF HIGH QUALITY TEST LEADS

Sick of those stiff plastic test leads that come with most multimeters? You know the ones that kink and produce pungent smoke when you touch them with a soldering iron? Well we've done something about it and proudly introduce the HCK range of quality silicone leads.
It's impossible to describe how flexible they are. You wouldn't believe that a 1000V 16Amp rating cable could be so er, floppy (?). Cable has soldering-iron proof silicon rubber insulation with 512 strands of copper inside -100C to 300 C temperature range. Plugs are stackable, extremely hard-wearing. Choice of black, red, blue, yellow, green and violet.

We will also be stocking the cable cut to length. Not cheap but an investment in real quality and a long life.



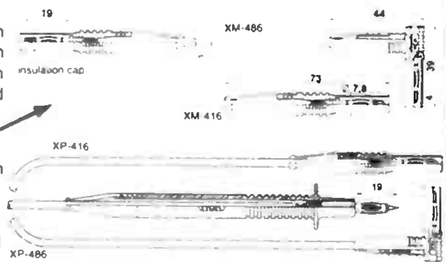
16 A Universal Test Lead with cracking protection grid



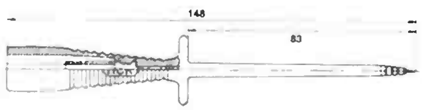
4mm Test Leads
Stackable with special cracking protection grid. Laminated cage spring contact with virtually no contact resistance. Available in three lengths - 500mm $5.66, 1.0m $7.21 and 1.5m $8.66 with exposed plug on each end.

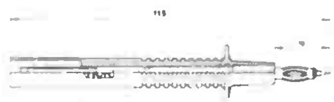
4mm Safety Shrouded Leads
Available with straight or 90 plugs. Available in 1 metre length only. Straight $9.43, 90 $9.99

4mm Safety Prod Leads
Available with straight or 90 plug. Available in 1 metre length only. Straight $10.15, 90 $10.60



4mm Plug-On Test Prods



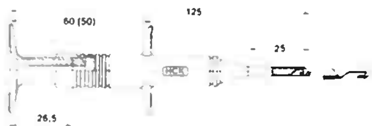


With 4mm plug tip $3.05

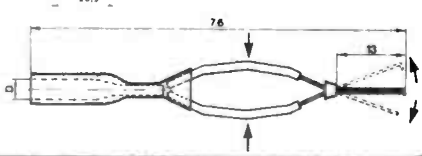
With quality steel tip $3.92

250V rated 130mm with steel tip $2.66

4mm Safety Hook Grip
Accepts 4mm plug and features quality steel hook $9.43



4mm Plug-On Clip Test Tweezers
No exposed parts. Fully epoxy-resin insulated. Grips down to 1mm and won't fall off $10.54.



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

GEOFF WOOD ELECTRONICS P/L

INC IN NSW
(02) 427 1676
229 BURNS BAY RD.
(CORNER BEATRICE ST.)
LANE COVE WEST N.S.W.
TWX 71996
P.O. BOX 671
LANE COVE N.S.W. 2066
OR CASH CHEERFULLY ACCEPTED

specialising in electronic components for the professional and hobbyist.

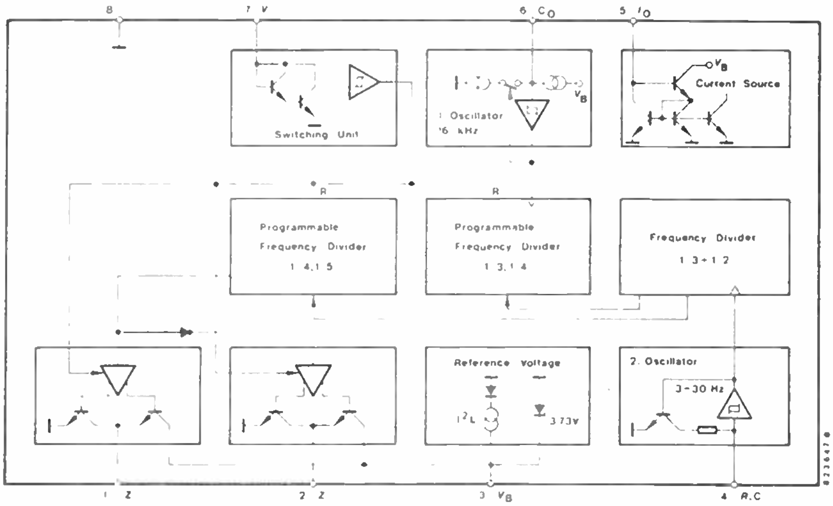
aem data sheet

Telefunken U450B THREE-TONE RINGER

The U450B is a mixed analogue/digital circuit for use in electronics "call-out" equipment, as well as an audible signal generator in cars, toys, household applications, electronic telephones, etc.

FEATURES

- Operates from the "call-up" AC voltage sent out from the office
- Has a sequence of three tones – 800, 1067, 1333 Hz, beginning with 800 Hz after triggering
- RC master oscillator
- Push-pull output stage
- The clock frequency can be adjusted in the range 2.5 ... 25 Hz using an external RC network
- Schmitt-trigger input
- Three tone sequence is adjustable independent of gating frequency
- Wide supply voltage range due to internal voltage stabilisation



Internal block diagram and pinout

DESCRIPTION

Current supply: The device is supplied with current via pin 3 and requires a minimum of 200 μA (e.g: via a series resistor from the supply rail). Pin 3 exhibits a zener diode characteristic with a typical zener voltage of 3.73 volts and an internal resistance of 50 ohms or less. The zener voltage is temperature compensated and serves as a reference source for the device and/or additional functions.

ABSOLUTE MAXIMUM RATINGS

Reference point — pin 8.

Supply current $I_{supply} = I_3$ 10 mA

Ambient temperature range: −10 to +60 degrees Celsius

ELECTRICAL CHARACTERISTICS

At I_{supply} = 200 μA, ambient temperature of 25 degrees C.

Reference Source	MIN.	TYP.	MAX.	
Operating voltage				
$V_B = V_{3-8}$	3.54	3.73	3.92	V
Operating current, I_3	200		1000	μA
Reference current				
$I_o = I_5$		4		mA
Switch-on Section				
Lower hysteresis point				
I_7/I_o	0.225	0.25	0.275	
Upper hysteresis point				
I_7/I_o	0.600	0.75	0.825	
Oscillator 1				
Charging current				
$-I_6/I_o$	3.56	3.75	3.94	
Discharging current				
$-I_6/I_o$	3.08	3.25	3.41	
Maximum frequency	16	20		kHz
Oscillator 2				
Static switching level				
Lower switching level		0.5		V
Upper switching level		1.8		V
Output stage				
Quiescent source current, I_1, I_2		I_3−120		μA

Reference current: The reference current is supplied to pin 5, usually via a resistor from pins 3 to 5. The oscillator current and the reference current for the Switch-on section are derived from the reference current on pin 5. Increasing the reference current increases the oscillator frequency and the thresholds of the Schmitt-trigger circuit in the Switch-on section.

Oscillator 1: This oscillator works with an external capacitor, Co, which is charged or discharged by the switched current source. The amplitude of oscillation is about 2.2 V. If the internal reference source is used with a resistance Ro between pin 3 and pin 5, then the frequency of oscillation is given approximately by:

$$f1 = 1.6 \frac{1}{Ro.Co}$$

Oscillator 2: The switching points for this oscillator are set at 0.5 V and 1.8 V. By connecting a resistor, R1, between pin 4 and pin 3, and a capacitor, C1, between pin 4 and common, a sawtooth waveform is obtained on pin 4 with a frequency approximately given by:

$$f2 = 1.6 \frac{1}{R1.C1}$$

Oscillator 2 only starts working when the current through pin 7 exceeds the upper hysteresis threshold.

Divider: Oscillator 2 drives a 6:1 divider which, in turn, drives the programmable 12:1, 15:1 or 20:1 dividers. In this way, a sequence of three frequencies is obtained with the ratio of 3:4:5. By setting f1 at 16 kHz, the three-tone sequence 800/1067/1333 Hz is available on the outputs, pin 1 and pin 2. After triggering, the sequence starts with the lowest frequency.

Switch-on Section: Pin 7 is a Schmitt trigger input, the current switching points of which depend on the reference current and are set to have a ratio of 1:3.

Output stages: The output stages supply currents which are approximately related to the supply current by the relation:

$$I_{1,2} \, . \, I_3 \sim 120\ \mu A$$

(The subscripts refer to the pin numbers)

The voltage ratio in standby is approximately V_3 - 0.5 V.

An experimenter's modular music synthesiser

Part 1 — the voltage-controlled oscillator

John East

This article kicks-off a series by the author showing practical techniques for experimenting with electronic music synthesis and the electronics of such instruments. He takes a modular approach and has built the system around a set of voltage-controlled 'building block' ICs produced by Curtis Electromusic of the UK. This is not a project series, so no pc boards are presented. Construction, however, is generally non-critical and experimenters can use any of a variety of assembly techniques.

DESPITE the musical successes of synthesists such as Wendy Carlos and Isao Tomita, which show the inherent power and flexibility of the modular voltage-controlled music synthesiser, the paths to obtaining such a system are few. The aspiring experimental musician is faced with the choice of buying a commercial system, or attempting to build or have built, a home-constructed system. Were it not for the current poor state of the art and relatively high cost with regard to the lower-priced commercial systems, building a modular synth. might not be so attractive. However, with this in mind and an eye on the state-of-the-electronic art, a home-constructed system is more feasible now than ever before.

Some may ask, why modular? If it were not for the fact that small, preset, keyboard-oriented stage synths use some voltage-controlled circuitry, they could hardly be called synthesisers. The modular voltage-controlled synthesiser was originally conceived to be an electronic musical instrument offering the ultimate musical control of all the parameters of a single musical voice, something previously unobtainable with acoustical instruments. Voltage-controlling the individual parameters of the modules allowed explicit, real-time control of the sound, by-passing the necessity to use tape at this stage of the musical realization. Tape may be used to combine the individually performed lines of music into a complete composition or arrangement.

Computers, interfaced by voltage and gate outputs to modular systems, may provide a nearly ideal controller for those keener on programming than learning some kind of traditional controller, such as a keyboard. The computer thus bypasses the need for a performer, putting the synthesist in the enviable position of having a virtual orchestra at his or her disposal, able to perfectly and repeatedly perform any conceivable musical statement.

This however, is not the perfect solution for many musicians, especially those desiring a more interactive, intuitive relationship with their instrument. Much work remains to be done in developing real-time controllers for the synthesiser that make best use of the degrees of freedom of the human body, especially the hands. Comparing for instance, the lack of control that a typical gate and voltage synth keyboard provides, with the subtlety and degree of nuance obtainable from a flute or violin, shows just how much remains to be done in this vital field of human engineering. The above points unfortunately seem to be actively ignored by some in their rush to use new technologies, to the detriment of traditional musicians who might benefit by some research in this area.

Whichever approach is adopted, it should be clear that the modular concept is the best for the experimental musician, as the flexibility obtained from the ability to utilise any conceivable patch and control setting for musical evaluation, far outweighs any disadvantage due to size, complexity or lack of portability. This series of articles will make available circuitry equal to the best obtainable commercially to build the major voltage-controlled functions normally associated with large, modular synths.

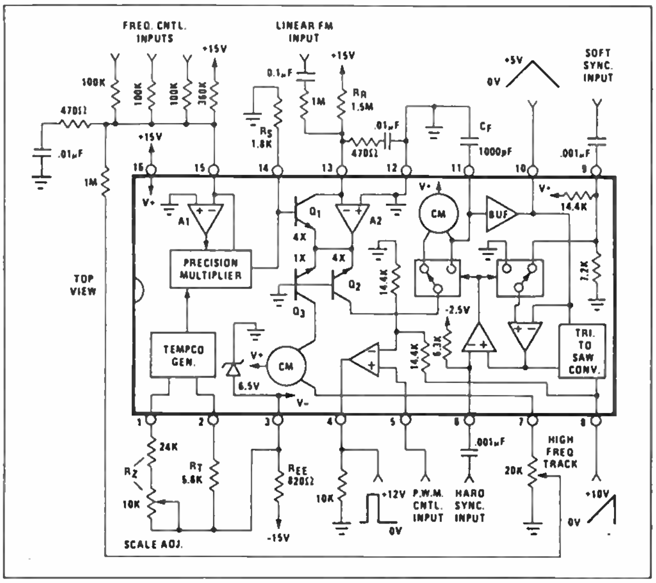
Design

Synthesisers consist of three different types of modules in general; *tone sources, tone modifiers* and *control modules*. These functions can overlap in any one module, depending how it is used in a patch. The principal functions have the main parameters voltage-controlled, and are usually the following: voltage-controlled oscillators, filters, amplifiers and envelope generators, abbreviated to VCOs, VCFs, VCAs and VCEGs.

Fortunately for the constructor, these functions are available on integrated circuits from several companies. Those made by Curtis Electromusic Specialties (CEM) I have used, as they are second generation chips and are likely to become some kind of standard in analogue synthesiser design. Compared to implementing the modules in discrete circuitry, the chips are more stable, easier to get going, cheaper and printed circuit boards are simplified. Although the modules are designed exclusively for musical use, enterprising constructors may find uses for them in other audio systems or suchlike. The author has even heard of wide-range VCFs being used as brain-wave filters!

This installment will describe the power supply and the VCO and sync options. Before embarking on a full description of these however, a few words about the system's electrical standards would not be out of place. A modular synthesiser should be able to be patched into any configura-

CEM 3340 Circuit Block and Connection Diagram



tion, as no patch should actually be "illegal", or damage the modules in any way. Input and output structures thus have to be designed to fulfill this condition, and also to ensure compatibility with external audio equipment.

To ensure a high signal-to-noise ratio and compatibility with control signal levels, audio signals are 10 volts peak-peak (at a VCO output), balanced about zero volts. That is, +/- 5 V. Figure 1 shows all VCO waveforms and also their phase relationships. Note that the sine is out of phase with the triangle from which it is derived. This allows the fundamental to be subtracted from the other waveforms by adding the sine to them in a mixer. Outputs in general are voltage sources with 1k series resistors mounted on the output sockets. This allows "output mixing" by the simple expedient of plugging outputs together into a multiple. The result is the arithmetic average of the outputs. Thus, the total level at the multiple does not overload the input of the following module. An exception is made for the occasional module whose function dictates that accurate control voltages are to be processed, in which case outputs do not have the series 1k resistor. Gate outputs (to provide timing information in the system), are voltage sources of 0 V for "off", and approximately + 14 V for the "on" state. A series diode and 1k resistor allow the logical "ORing" of gates by plugging them into a multiple, before a gate input.

Inputs are 100k impedance in general, high enough to make amplitude errors insignificant when driven from a 1k output impedance. The only exceptions are where an input is preceded by an attenuator (a 100k pot, bringing the input impedance down to 50k), or gain relative to a normal input is required, this being achieved by reducing the input resistor as most inputs are simply resistors to a summing node. This is an important point to bear in mind, as it means that control or signal mixers may be simply implemented by adding resistors to a summing node and preceding them by an attenuator if required.

Envelopes are kept to + 5 V maximum (see Figure 2), this being the same as the positive value of the oscillator waveforms. The VCEG module also provides an inverted output, also shown in Figure 2. If 10 V envelope levels are required, this can be simply provided by changing the gain on a control input of the module controlled by the envelope, as discussed above. This is usually only necessary on the filter module (VCF). Notice that no distinction is made between audio and control signals, any voltage in the system may be used to control another's voltage-controlled inputs, including gate signals. The only difference is what they are used for in any particular patch.

Control inputs obey the industry standard of 1 V/octave, except for linear control inputs which are generally 10 V/volt, giving full control of the parameter for a 10 V control voltage change. We now move on to a discussion of individual module design.

The power supply is very simple and needs no explanation. It produces + 15, 0 and –15 V lines to supply the mod- ▶

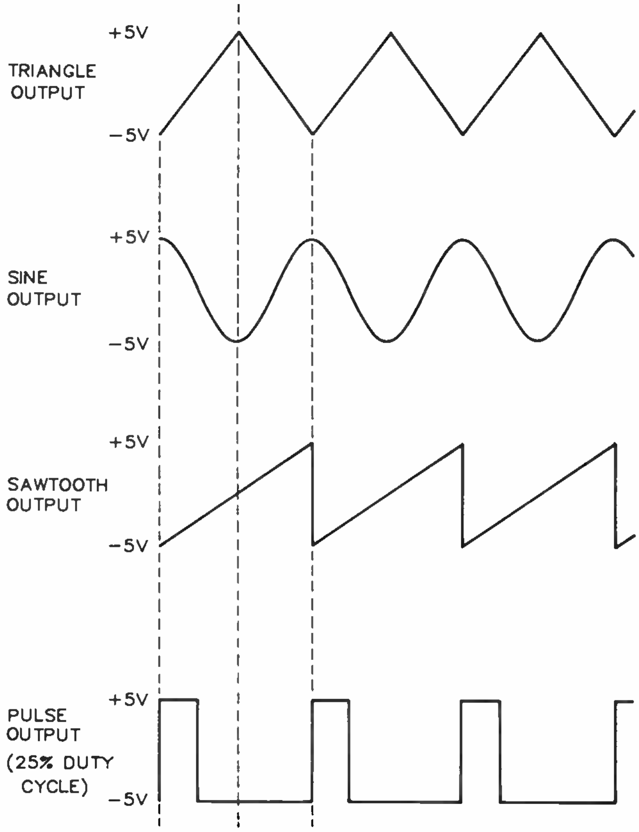


Figure 1. Waveform outputs from VCO.

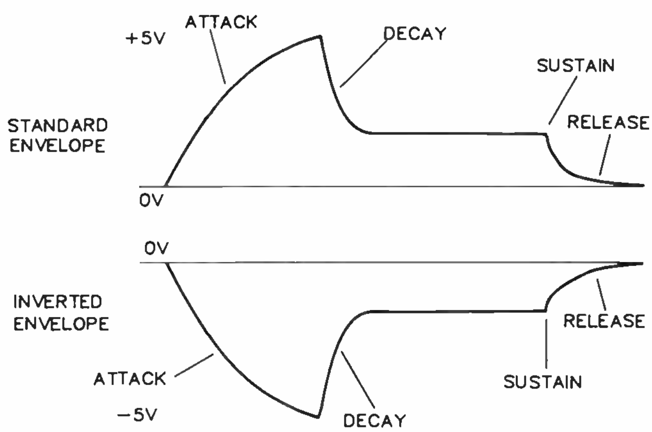


Figure 2. Envelopes.

In phase sync mode, the pulse from IC1 is switched to control the sample and hold formed by Q3, IC2 and associated components. The sample and hold is used as a phase comparator to generate a control voltage proportional to the phase error between the "master" and "slave" VCOs, by sampling the slave's sawtooth. Summing a voltage with the sawtooth (into IC2/A's summing node), allows the phase of the slave to be voltage-controlled with respect to the master. In this mode, the pulse is disconnected by SW1/C.

Construction considerations

Starting with the control voltage nodes, all resistors from R1 to R20, except for R12, R15 and R18, are metal types or similar for maximum temperature stability. RV6, 7 and 8 are 15-turn, cermet presets. Cf is a polystyrene type. All other components can be the standard type 5% carbon film resistors and 10% plastic capacitors, except for C5 and C6 (electros) and C8 and C9 (ceramics). IC2 and IC3 are biFET family devices, chosen primarily for their good slew-rate (13 V/µs), but also for the convenience of the dual and quad packages.

The Octave Selector is wired as in the circuit for convenience of tuning, and is used in conjunction with the Fine Tune control for most applications. The Tune control is only used when a wider range of initial pitches is desired, and takes the VCO up to it's maximum frequency of approximately 50 kHz. It can also double as the Phase control if the sync option is used. Likewise, the Exponential CV input doubles as a phase control voltage input for the sync. option. One CV input is wired as shown for a keyboard, and this input is the one calibrated to1 V/octave in the setting-up procedure. SW2 allows this input to be connected to a keyboard CV multiple for convenience, in lieu of using patchcords for this common connection. A linear FM CV input is provided to allow dynamic FM depth modulation patches, which would otherwise cause a pitch shift. Note that a waveform with an excessive dc component will also cause a pitch shift. This can be cured by ac-coupling the waveform before plugging it into the VCA input. This should not happen with VCO waveforms however.

The pulse shaper associated with pins 4 and 5 of the 3340 is not used as such, but reserved for use in the sync section. Instead, the pulse is derived from the sawtooth by IC3 and associated components, which also allow for external voltage control of pulse width. An attenuator (100k lin. pot), may also be fitted to this input if desired. The sine shaper consists of Q1, Q2, IC2/D and associated components, and is simply an over-driven differential pair, with adjustments to minimise odd-harmonic distortion and dc offset.

As sync facilities are not always necessary, it was decided to incorporate them all on a separate, optional "daughter" board. Two different types are provided, to give considerably more scope than is possible on commercial synths. The reset sync incorporates the "Hard" and "Soft" sync found on most VCO designs, and is also voltage controllable in a linear manner, from completely un-synced, through soft sync to hard sync. This is made possible by using IC3 as a control voltage summer to set the pulse-width at pin 4 of the 3340. This pulse is then used to give conditional reset sync.

If desired, IC3 can be left disconnected and the conditional reset pulse obtained from pin 7 to IC3 on the VCO board. This was done on the prototype, as it saves providing a Sync Strength control and Sync CV input socket where front panel space is a problem.

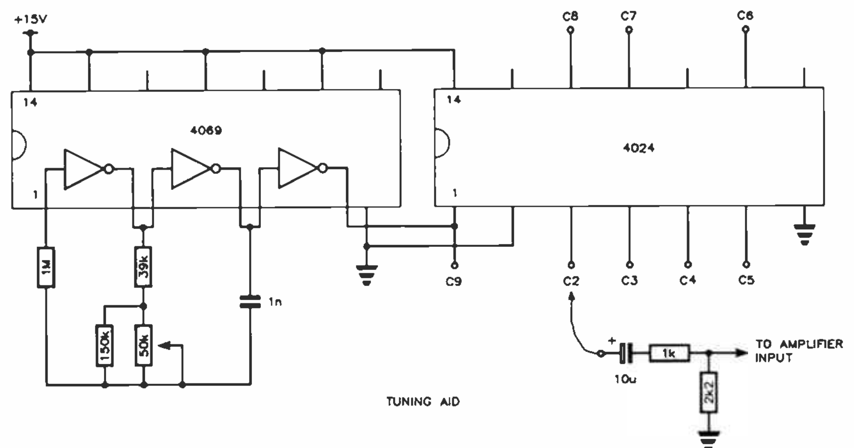
The pulse-width control section of the VCO exactly replaces the functions performed by IC3 on the sync board. The conditional reset pulse is only active in reset sync mode, so this is probably a worthwhile modification. The reset occurs on the rising transition of the input (master) sync pulse, so a gate pulse from the keyboard could be used to provide a "once-only" sync pulse, useful for percussion sounds or when the VCO is used as an LFO (low frequency oscillator), to begin vibrato at the same point with each new note.

Phase sync is most useful for locking slave VCOs to a master VCO in integral ratios to allow additive synthesis. When locked, the slave VCO's waveforms are 180 degrees out of phase with the master VCO. This means the slave's phase can be modulated plus and minus 180 degrees. A degree of control not normally associated with analogue systems is thus made possible. In this mode, the Tune control and Exp. CV In socket double-up as a Phase control and Phase CV In socket respectively. Also, as the phase sync system is a type of phase-locked loop, in which correction is done only by a control voltage, no waveform distortion occurs, thus making it suitable for sinewave additive synthesis.

Phase-locking is possible up to about the 20th harmonic, but tuning with the Octave Selector and Fine Tune control only allows locking up to the 11th harmonic. This matters little, as these harmonics and their envelopes are the most important to the ear, and would still require a very large system to make full use of the technique. Overall, the sync options provided make possible many sounds impossible to obtain in any other way, and would be a useful addition to all VCOs, except perhaps the master oscillator.

Hardware construction

As the principal aim of these articles is to make available circuitry, it is assumed the individual constructor will have his



OCTAVE	NOTE	FREQUENCY (Hz)
	C9	8,372
	C8	4,188
	C7	2,093
	C6	1,047
1'	C5	523.3
2'	C4	261.6
4'	C3	130.8
8'	C2	65.4

or her own ideas as to the physical layout and mechanical construction of a system. However, a list of front panel controls and input/output sockets that must be provided (assuming a fully-equipped module), will be given for each module. Here also follows the method of construction employed on the prototype, as it has been found to be very flexible and amenable to change, very necessary for an experimental (musically or technically) system.

The prototype modules were all built on the back of front panels cut from 2.5 mm sheet aluminium, mounted on 12 mm right-angle aluminium strips, top and bottom. These strips ran the full length of a wooden cabinet and were screwed to it, leaving one face for mounting the modules. 3/16" screws were used to bolt the front panel down, but ¼" holes were drilled in the mounting strips to allow a little slack for positioning and swapping of modules, which is more important than you think! The 0 V rail from the power supply board is run to mains earth, the metal case of transformer TR1 and to the aluminium mounting strips, providing a very solid ground.

The +/− 15 V rails were commoned along a row of two-pin McMurdo loudspeaker panel sockets, mounted in the base of the cabinet, as was the power board and transformer. The modules then had a two-wire flying lead, terminating in a two-pin polarized plug, to supply power to them.

No other wiring to modules is necessary, unless some pre-patching is done to obviate the need for patch cords for commonly used connections. Labels on the front panels have also been found to be very useful in avoiding the "Now what does that knob do?" syndrome. Rub-down lettering and paper labels have both been found to be serviceable, although the paper labels score on removal when designations have to be changed. Note also, that if using pc boards, they must be fibreglass for strength and also for its excellent electrical properties.

A word about plugs and sockets. Endless frustration at bargain prices can be yours by not investing in a reliable patching system. The author uses 6.5 mm metal plugs and sockets and light-weight coax cable, as used on many commercial systems. This is however, rather expensive and takes a lot of panel space.

A cheaper alternative would be to use 3.5 mm plugs and sockets. These are used on the ARP 2600, and the Aries and Roland 100M modular systems, and would allow smaller module panels. Another possibility is the use of banana plugs and unshielded wire, with the advantage that multiple connections are implemented by simply stacking plugs. The Buchla and Serge systems have them, and they are extremely reliable due to the large contact area, but have the disadvantage that no break contacts are used on sockets, thus ruling out that type of simply implemented pre-patching. In the end, it is the user who has to decide which system is most convenient.

The power supply is simple, and you can make a pc board by drawing in the copper pattern with a Dalo pen. In fact, the PCBs for all the modules were done this way in my prototype, obviating the necessity for photographic methods. The usual warnings about orientation of electrolytics and semiconductors apply when assembling boards, and care should also be taken when wiring the power and transformer to use the requisite mains cord clamp and terminal block. For convenience, the mains switch, mains fuse and "power on" LED can be mounted on a small module panel.

The VCO board must be finished cleanly, as stray control current will affect the accuracy at low frequencies. The 1k resistors in series with the saw, triangle and sine outputs, I soldered onto the panel sockets, and the panel switches are miniature toggles except for SW1, a single-pole rotary switch with at least seven positions.

Board mounting brackets can be cut from a large aluminium right-angle strip and held to the front panel by a couple of the pots. It is a good idea to use a socket for IC1, but the others can be soldered in.

The sync circuit should not be any problem, except perhaps for the number of wires! Also, some method of linking the earth pattern with that of the VCO, in close proximity to the VCO, must be adopted. It could be adjacent to an aluminium strip, or piggy-back on a couple of bolts.

PANEL CONTROLS

VCO

Knobs	Switches	Sockets
Tune	Octave Selector	Keyboard CV In
Fine Tune	(SW1)	Exp. CV In
Pulse Width	Keyboard VC Routing	Line. FM In
Exp. CV Attenuator	(SW2)	Pulse Width CV In
Lin. FM Attenuator		Saw Out
		Pulse Out
		Triangle Out
		Sine Out

SYNC BOARD

Knobs	Switches	Sockets
Sync Strength	Reset/Phase Synd	Sync Strength CV In
(Optional)	(SW1)	(Optional)
		Sync In

This list should remove all doubt about what goes on the front panel. Note that, in addition to the wiring shown for the sync "daughter" board, a wire must be soldered between the slider of the Exp. CV In pot (point C) and the "Reset" tag of SW1/B.

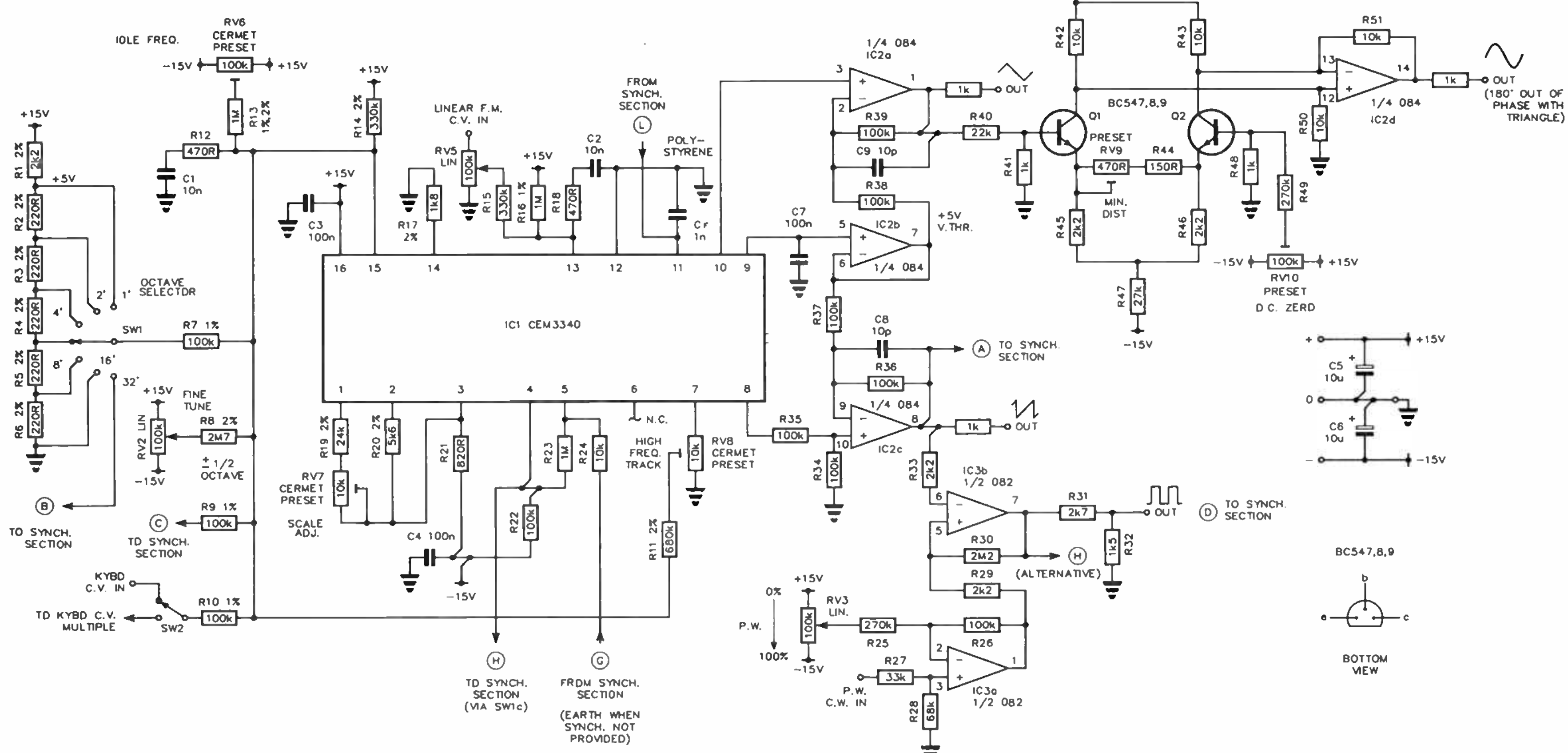
Setting up

There is little to do for the power board except to check that +/− 15 V is available upon switch-on and is extended to the power sockets.

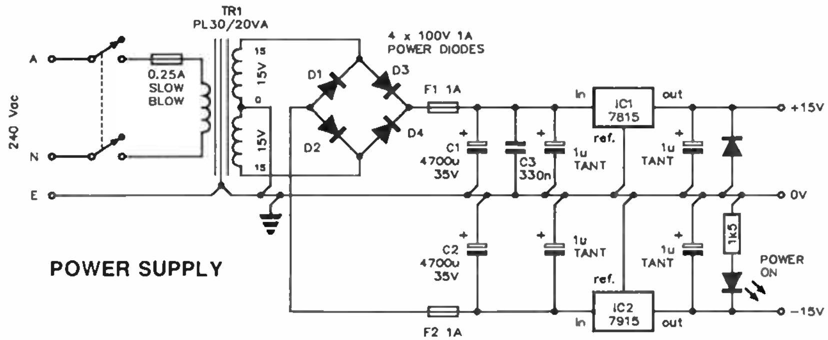
For setting up the VCO, you will need a meter with a low voltage dc range. A 0.25 volt range is sufficient, but even these only seem to come on meters with a sensitivity of 100k/volt, or FET-input types. The reason for requiring such a low range is to be able to set op-amp output offset voltages (which are in the millivolt range), as close as 0 V as possible. A 100k/V meter was used to set up the prototype. An oscilloscope is nice, but not really necessary. An "audible oscilliscope" can be implemented by simply running the VCO to be checked at about one or two Hertz, and plugging it's waveform into another VCO running at an audible rate. Even fairly subtle imperfections in waveforms can be heard this way. Keeping this technique in mind will save a lot of time and money trying to borrow or buy a CRO. (If the VCO cannot be made to run slow enough using the front panel controls, turn down the Exp. CV In attenuator, apply −15 V to that input, and turn up the pot slowly until the VCO is at about 1 Hz.)

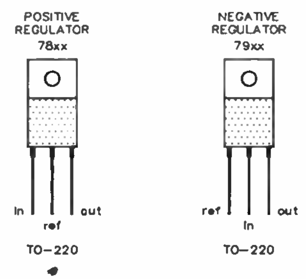
You will also have to build a simple "Tuning Aid", as in Figure 3. This is set up to give the frequencies shown in the table by tuning up against an organ, tuning fork or some other standard, unless you intend using the VCOs with a keyboard which has a lowest note that is not C. The VCO tuning procedure cannot really be done until the keyboard is built, but reasonable scale accuracy can be achieved by using the following method. ▶

VOLTAGE-CONTROLLED OSCILLATOR (VCO)



POWER SUPPLY





ules via a plug and socket system, with a current capability of about 600 mA with the PL30/20VA transformer specified. The use of this transformer is advised, as the regulator chips heat up for loads much greater than this. In a confined cabinet, this may cause trouble with the accuracy of some circuits, although a lot of effort has been invested to minimise temperature problems in the individual modules. For large systems, another transformer and power supply are recommended.

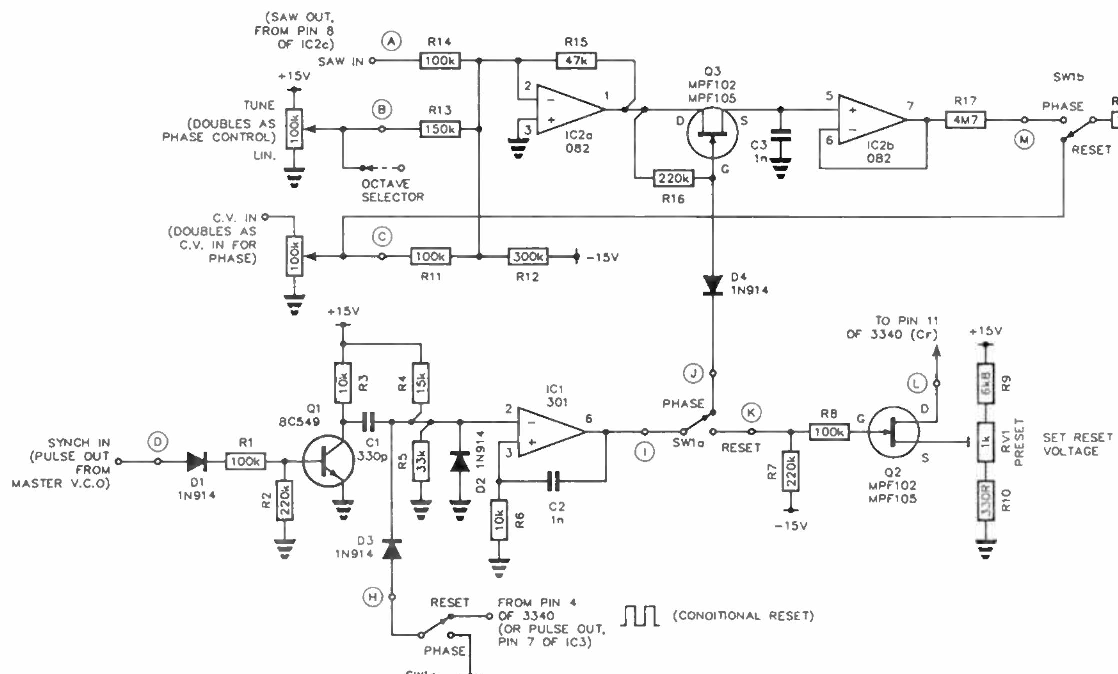
Because of the extreme pitch sensitivity of the ear, and the temperature dependence of the collector current of a transistor used as the exponential converter in an oscillator, designing a stable VCO is rather like making a silk purse from a sow's ear! All the problems traditionally associated with designing and building VCOs have been almost completely overcome in the Curtis chip however, and it is now possible to build high quality VCOs without breaking the bank buying hard to obtain, expensive, discrete temperature compensation components. Most required VCO functions are contained on the chip, except for a sine shaper and full synchronisation facilities.

The VCO functions are contained principally in IC1, the CEM 3340. Control voltages are summed at pin 15 and converted to a current into R17 at pin 14. This produces a voltage across R17 to drive the internal exponential converter. R17 is adjusted to produce a scale of exactly 1 V/octave. R15 sets the reference current into the exponential converter, which can be modulated by an external oscillator for linear FM. An internal arrangement of comparators, switches, a current mirror and a buffer, convert the exponential current into Cf into a triangular waveform at pin 10. An internal converter circuit also produces a sawtooth waveform at pin 8. Another internal comparator is provided to produce a voltage-controllable pulse width waveform at pin 4. An internal current mirror provides a means of adjusting the high-frequency tracking by sourcing a current into RV8 to produce a correcting voltage, which is then fed back by R11, to the pitch control voltage summing node.

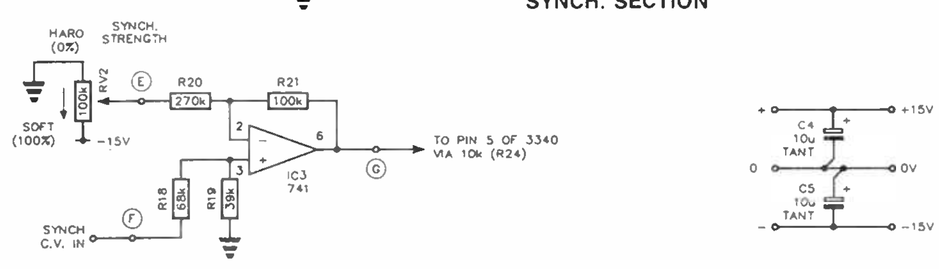
IC2/A, B and C perform waveform buffering and level-shifting functions, to give sawtooth and triangle waveshapes of 10 V peak-peak value and symmetrical about 0 volts. Q1, Q2, IC2/D and associated components, shape the triangle to give a sine output. IC3/A is a control voltage summer, used to provide a variable reference voltage to comparator IC3/B, thus giving a pulse output derived from the sawtooth.

The sync functions in two different modes reset sync and *phase* sync. Reset sync returns the VCO's waveforms to their lowest value upon receipt of a positive-going transition at (D). This turns Q1 on, generating a negative spike (with a time constant of C1 times R4//R5) to trigger monostable IC1. A 10 μs pulse (C2 times R6), is produced and used to turn on FET Q2, resetting the waveform to approximately + 1.6 volts, set by VR1. However, this reset is conditional upon the sawtooth wave being past a certain point in its upward ramp. To establish this point, we use the pulse fed in at (H) to allow reset only when the pulse waveform is low. Thus, "Hard Sync" (unconditional reset) occurs when the pulse wave is set to 0% duty cycle, and "Soft Sync" (conditional reset) when the pulse wave is set to around 90-95% duty cycle.

— to page 68 ▶



SYNCH. SECTION



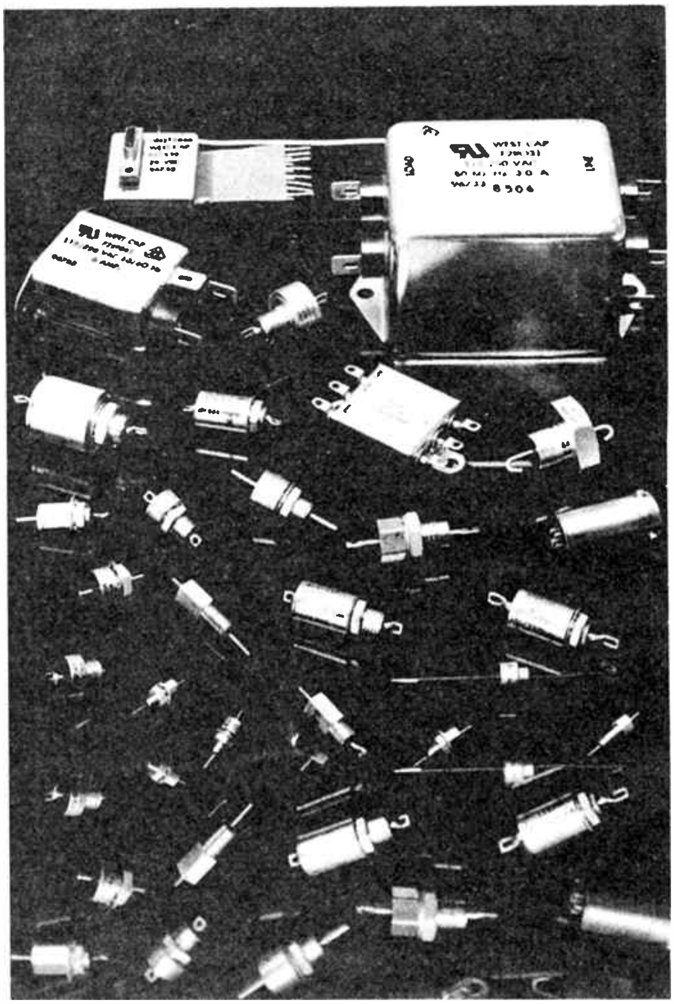
Modern fixed capacitors

— what the textbooks never told you

Part 3

Les Ferdinand

This article concludes the series, wrapping up the discussion on plastic and paper capacitors, then a rundown on ceramic types.



WHEN using MP or MK capacitors for pulse operation, or where very fast rise time signals or fast transients are encountered, the capacitor will be subjected to high current pulses. Depending on the capacitor type, the current must be limited. Non-sinusoidal pulses with fast rise or fall times will generate the highest current.

The problems will be dependent upon the following factors:

- amplitude and waveform
- rated voltage and capacitance value of the capacitor
- configuration of the capacitor windings
- ambient temperature

Pulse current limits are normally expressed in the form of maximum permitted change in voltage per microsecond. A simple way to limit the pulse current is to have a resistor in series with the capacitor.

Metalised plastic film capacitors — known as MK capacitors — are outstanding for their self-healing properties and low leakage characteristics. The dielectrics of these capacitors consists of plastic films, onto which the metal layers between 0.02 and 0.08 micrometers thick are vacuum-deposited. MK capacitors are wound construction in tubular or flattened form or stacked. A metal spray is used for making electrical contact to the edges of the winding, ensuring low inductance and losses. ESR is also very low in comparision to electrolytic capacitors.

The dielectric constant of MK capacitors is frequency dependent — the capacitance decreases with increasing frequency. As stated earlier, these capacitors have excellent self-healing characteristics; when the dielectric breaks down due to a voltage "spike" the arc evaporates the metalisation in the area of the breakdown without impairing the dielectric. This self-healing process takes about 6 microseconds. As only a small fraction of the energy stored in the capacitor is used, 1000 in a capacitor will effect the capacitance by less than one percent.

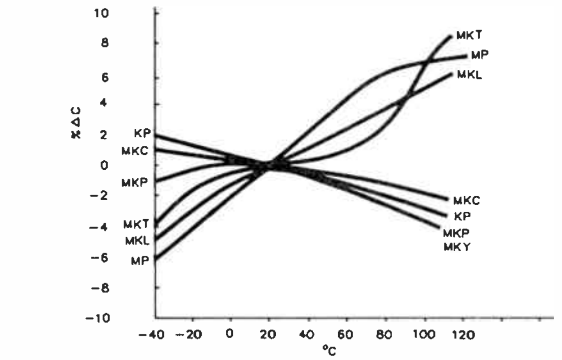
MKL and MKU capacitors are usually made in high reliability versions, have optimum self-healing capabilities and a very good capacitance to size ratio. Their capacitance range is from 33000 pF to 100 μF. Rated voltages range from 25 to 630 V.

MKL capacitors have a maximum capacitance drift of between +6 and -3%. Their dissipation factor at 1kHz is around 0.015 and at 10 kHz around 0.025. Their temperature coefficient is normally around +600 ppm per degree. These capacitors have a good pulse handling capability within their voltage ratings. MKL capacitors can be considered an "exotic" type as they are expensive and normally used in professional and military equipment. Quality assessed versions are available for military and aerospace applications — but they also make excellent coupling capacitors in very high quality audio equipment.

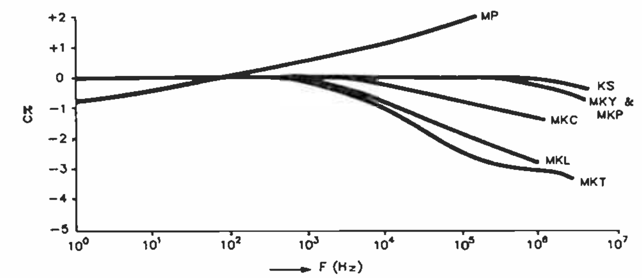
MKT capacitors are commonly known as polyester capacitors. They are the most widely used of all the metalised plastic film capacitors. They are available in capacitance values ranging from 560 pF to 22 μF, voltage ratings from 50 V to 12.5 kV. MKT capacitors have a maximum capacitance drift of +/- 3%. Dissipation factor at 1 kHz is 0.005, and at 10 kHz is 0.013 (average values). They have a temperature coefficient of around +250 ppm per degree.

Metalised polyester capacitors are used in applications from mains suppressors to coupling and bypass capacitors in mass-produced electronic equipment. They are available in a series wound construction for pulse applications. MKT capacitors are mainly used as coupling bypass and filtering at dc voltages and low frequency operation, they are very hard to beat in a performance versus price application.

MKC or polycarbonate capacitors are designed for circuits requiring stable performance characteristics over a wide temperature range. MKC capacitors are available in capacitance values ranging from 220 pF to 47 μF, and have a maximum capacitance drift of +/- 2%. Dissipation factor at 1 kHz is around 0.003, and at 10 kHz is around 0.005. Temperature coefficient is +/- 50 ppm per degree.



Temperature characteristics of the various plastic and paper dielectric capacitors.



Capacitance variation with frequency on various plastic and paper capacitors.

The excellent stability of this capacitor makes it the ideal choice for critical timing applications, filter networks, coupling, decoupling and in industrial and professional applications where severe environmental conditions are encountered.

MKT capacitors are also available with a full mil-spec rating. Capacitors with a double-sided metalised film are available for pulse applications.

MKP and MKY capacitors are based on metalised film polypropylene. They have the lowest losses of any plastic film capacitor, excellent high frequency, pulse and transient response characteristics. They are available in capacitance ranges from 100 pf to 100 μF, with voltage ratings from 100 V to 40 kV. Maximum capacitance drift is 2% and dissipation factor at 1kHz is 0.00025. Temperature coefficient is -230 ppm per degree.

The difference in the construction of MKP and MKY capacitors governs their applications. MKP capacitors are series wound for very high voltage applications — they are ideal for use in transmitter and radar applications. MKP capacitors will handle up to 40 kV dc or 21 kV ac peak to peak, and their pulse characteristics are staggering at 80,000,000 V/microsecond.

A similar polypropylene capacitor is manufactured with a mixed dielectric of paper and polyproplene. Pulse handling of these capacitors is excellent, combining the high frequency characteristics of polypropylene with the self-healing capability of paper.

KP capacitors are ideal for use in high frequency switch mode power supplies, high-current pulse applications, bypassing, coupling and decoupling. They are also being widely used in high power applications. KP capacitors are among the best available for high-quality audio applications. Current KP capacitors manufactured by Siemens and Rifa feature a total capacitance drift of 0.3% and a tolerance of 1% or 2%.

KS or polystyrene capacitors are extremely stable and accurate with extremely low losses. They also have excellent high frequency characteristics and a reproducable temperature coefficient. Maximum capacitance drift is 0.2%, dissipation factor at 10 kHz is 0.0003 and at 100 kHz is 0.0004. Temperature coefficient is -120 ppm per degree. They are available in capacitance values ranging from 5 pF to 1 μF.

KS capacitors are ideal for high stability LC Filters, RC filters, precision timing circuits, rf coupling, decoupling, telecommunications and measuring equipment. KS capacitors are also used in rf applications where a high 'Q' factor is of prime importance. KS capacitors are available in a standard 7.5 mm module, with capacitance values from 100 pF to 56000 pF. Voltage is 63 V.

Ceramics

In a ceramic capacitor, the basic capacitor element is called a 'chip' and consists of ceramic dielectric materials sandwiched between metal electrode layers. The entire structure is fired together at high temperatures. After this process conductive terminations are applied to the ends, making contact with the protruding electrode edges. The capacitor can then be terminated with materials suitable for hybrid circuit substrate assembly or surface mounting. Most capacitors are usually furnished with lead wires and protectively encapsulated. There are three principal types of multilayer ceramic capacitors: COG, X7R and Z5U.

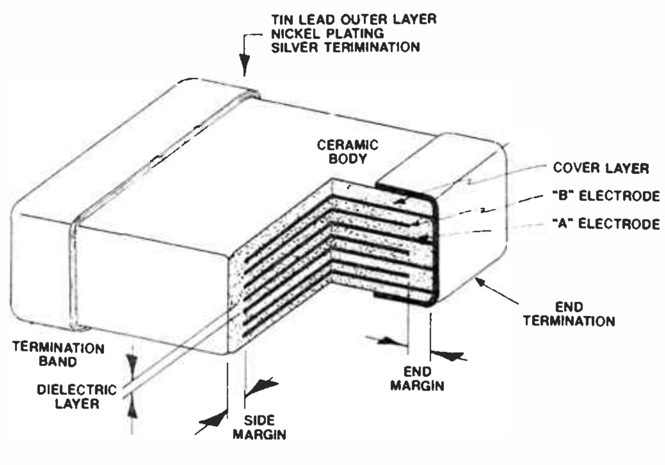
COG capacitors are made from materials which are non-ferroelectric; this gives superior stability, but a low packaging density.

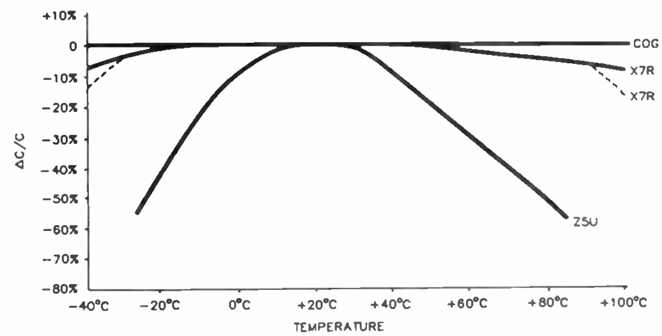
X7R and **Z5U** capacitors are made of ferroelectric materials, usually barium titanate. This material changes crystalline form at approximately 125 degrees C. This is known as its Curie point. This change in crystalline form causes a radical change in the dielectric constant of the material, which directly affects the capacitance. Other materials are added to the ceramic to modify this effect to different degrees in producing X7R and Z5U characteristics. This change in dielectric constant is reversible, but does not occur instantly. This phenomenon is known as ageing — the capacitance declines progressively with time.

Ferroelectric materials are also affected by both direct and alternating voltages. Low voltages produce a slight increase in capacitance. Higher voltages causes a decrease in capacitance. These effects are applicable to both X7R and Z5U capacitors. At full rated voltage X7R capacitors lose about 12% of their rated capacitance. At full rated voltage the Z5U capacitor can lose up to 60% of its rated capacitance.

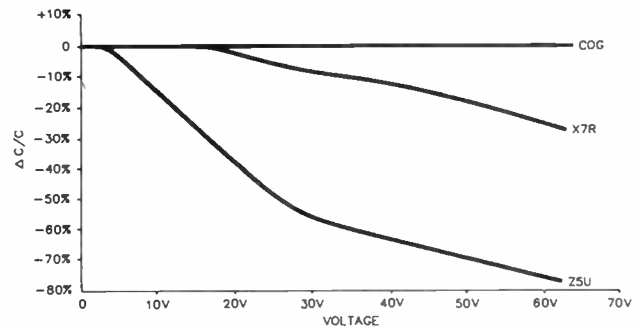
X7R capacitors have a maximum temperature drift of + 15% (+/- 2500 ppm per degree). The dissipation factor of X7R capacitors is 0.002 at 1 MHz. X7R capacitors are made in capacitance values ranging from 220 pF to 10 μF, and voltage rating is normally 50 and 100 V.

Construction of a ceramic multilayer chip capacitor. (From SFE, courtesy J.A. Severn).





Some ceramic capacitors have a marked dependence on voltage, the capacitance reducing with increasing applied voltage. Note the stability of the COG dielectric type.



Temperature dependence of various ceramic capacitor types. Once again, note the stability of the COG type.

Z5U capacitors have a maximum temperature drift of +22%, -60% (+/- 10000 ppm per degree). The dissipation factor of Z5U capacitors is 0.003 at 1 MHz. Z5U capacitors are made in capacitance values ranging from 220 pF to 10 μF, and their voltage rating is normally 50 or 100 V.

X7R and Z5U capacitors feature high capacitance values at small dimensions. Unfortunately they have a nonlinear dependence of capacitance on temperature and voltage. They have higher losses and higher capacitance tolerances than COG types. Typical applications include interference suppression at low voltages, blocking, coupling and decoupling (non critical applications) and hf bypass. Because of their characteristics they are unsuitable for audio applications.

COG capacitors display very stable voltage and temperature capacitance characteristics. They have very low losses and extremely good high frequency characteristics. Maximum capacitance drift is less than 0.3%. Dissipation factor at 1 MHz is 0.0015. Temperature coefficient is +/- 30 ppm per degree. COG capacitors are made in capacitance values ranging from 1 pF to 0.1 μF with a voltage rating of normally 50 or 100 V. Typical applications for COG capacitors include resonant circuits, coupling and decoupling in rf circuits, filter circuits and temperature compensation.

Glass, HIK glass, MICA and HIK tubular ceramic capacitors have not been covered in detail in this series, because their use is not as widespread as it was some years ago.

The theory of capacitors is much more complex than described and is beyond the scope of this series, but I hope this article sheds some light on a subject that is taken for granted by many people in electronics.

We would like to acknowledge the assistance of Crusader Electronics, Mayer Krieg, IRH and Philips Elcoma in the preparotion of this feature.

— from page 65

Set all presets to mid-point except RV8, which should be adjusted so it's wiper is at earth (0 V). The Pulse Width and Fine Tune controls are set to mid-point, and the Octave Selector set to Tune. Do not forget to earth the module if it is not bolted into the cabinet. At switch-on, the Tune control should vary the frequency over a wide range. The Pulse Width control should vary the pulse duty-cycle from 0% (anticlockwise), through a 50% square wave, to 100% (full clockwise); 0% and 100% are cut-off states in which the output stays at -5 V or +5 V respectively.

If you have another VCO, the various waveshapes and CV inputs can be checked, as previously explained. Adjust the Fine Tune to give exactly 0 V on the slider.

Now switch the Octave Selector to 8′ and adjust RV6 to the same pitch as the C3 output of the tuning aid.

Now switch back to 8′ and C2, and re-adjust RV6, then go to 4′ and C3 and do the RV7 adjustment again. Repeat these procedures until the 8′ and 4′ octaves are correct, then check the 2′ and 1′ octaves and tweak as necessary, in comparison with the C4 and C5 reference. This may not work perfectly due to the resistor tolerances in the R1-R6 divider chain. The adjustments can be completed when the keyboard is built. The RV8 preset adjustment for high-frequency tracking will be presented with the keyboard setting up instructions.

The distortion trimmer in the sine shaper, RV9, can be set for the smoothest sound by ear, and the dc zero trimmer, RV10, set to give the lowest possible dc offset at pin 14 of IC2/D. The most sensitive dc range on the meter is used for this adjustment. These two trims should be repeated, as they interact slightly. This completes the VCO setting up for the moment.

For the sync board, set VR1 initially to mid-point and SW1 to Reset. Set the Tune control to centre and the Sync Strength (or Pulse Width, whichever you are using), to 0% to give hard sync. Use the Octave Selector and Fine Tune controls for tuning. Patching the pulse output of the "Master" VCO into the Sync In jack of the "Slave" VCO will give very distinctive sounds of a "locked" nature from the sine, triangle and sawtooth outputs.

Listening to the pulse output, you may find that it has not gone quite to 0%, as previously set. Adjust VR1 until the pulse just, but definitely, disappears. This ensures that the waveforms are reset to the correct lower voltage (-5 V at the outputs, but approximately 1.6 volts on the capacitor Cf, due to offsets in the buffer in IC1.

Now switch SW1 to Phase, and you will be able to "lock up" the slave when it is close to an integral multiple of the master frequency. In this mode, the Tune now functions as a Phase control. Careful use of the Fine Tune allows the Phase control to be swept over it's entire range, without becoming "unstuck". The Exp. CV In socket is now the Phase CV input, and works in a linear manner. (36 degrees/volt.)

This completes the VCO and sync setting up for now. Exact calibration to 1 V/octave is better left until the keyboard is constructed. Meanwhile, do not be afraid to use and experiment with the VCO. The many possible patches between even two VCOs, and the fascinating and varied sounds that can result, shows the versatility of a modular approach to electronic sound generation in general, and music synthesis in particular. Have fun!

-continued next month.

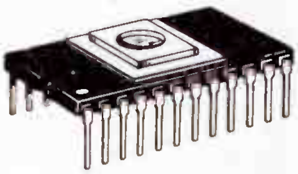
JAYCAR No. 1 for SILLY PRICES

BANANA REPUBLIC SPECIALS

Are you going Bananas over price increases? September is a slow month at Jaycar and we have slashed our prices to rock bottom. So don't "Monkey Around", at these prices we are only talking "Peanuts"!

2732A EPROM

Genuine Intel brand, 450nS
NORMALLY $10.00 each
ONLY
1 - 9 $3.50
10 - 24 $3.00
25 up $2.50 each

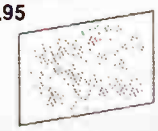


TWEETERS

PIONEER brand cone tweeters.
Cat. CT-2002
1975 PRICE. .
ONLY $2 each

BLANK FIBREGLASS BOARD

Single sided copper clad, for making your own PCB's.
300mm x 300mm
Cat. HP-9510
ONLY $5.00 each
NORMALLY $8.95
SAVE $3.95



GENUINE CANNON ISD RIGHT ANGLE SOCKET

NORMALLY $5.75 each
Cat. PS-0826
NOW ONLY $2 each

SILLY PRICES

UNBELIEVABLE SEMICONDUCTOR BARGAINS!!!

MOTOROLA 6800 SERIES

6809
8/16 bit microprocessor - Cat. ZZ-8055
NORMALLY $10.00 each
$5.00 each

6821
Peripheral interface adaptor
Cat. ZZ-8061
NORMALLY
$5.00 each
$2.00 each

SILLY PRICES

6845
CRT controller - Cat. ZZ-8063
NORMALLY $12.00 each
$5.00 each

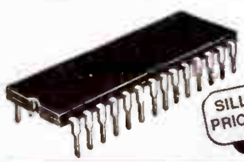
6850
Asynchronous communications interface adaptor
Cat. ZZ-8065
NORMALLY $7.00
$2.00 each

6818
Real time clock
Cat. ZZ-8057
NORMALLY $10.00
$3.00 each

MEMORY

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

2114 RAM
Cat. ZZ-8414
1 - 9 $2; 10 - 24 $1.50;



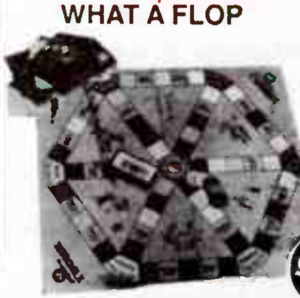
SILLY PRICES

DON'T HAVE A 1986 JAYCAR ENGINEERING CATALOGUE YET? SEND $1 AND WE WILL POST YOU ONE

"TUOHK" BOARD GAME

FOR COMMODORE VIC64 OWNERS

"University of the Hard Knocks". Basically the game works like this: You load a cassette into your VIC64 which contains 5000 "Trivia" type questions, community chest or chance type statements and other instructions.
Cat. XG-6000
WAS $49.95
NOW ONLY
$19.95
SAVE $30.00
WHAT A FLOP



TO-3 TRANSISTOR SOCKET

Phenolic type
ONLY 10 for $1
NORMALLY 25¢ each
SAVE $1.50

SILLY PRICES

MINI BURGLAR ALARM

WHAT A FLOP!

We thought it would sell, but alas it didn't.

As an alarm you can use it to protect a garage, tool shed, holiday house, boat and sheds, caravan, video recorders, etc. Far more information on the alarm in our 1986 Catalogue.
Or, you can pull it apart and use the parts.

YOU GET:-
1 x Horn speaker (Arista brand) - Value $13.00
1 x Jiffy box - Value $1.85
1 x p/on switch - Value 55¢
1 x 3.5mm chassis socket - Value 55¢
14m of speaker cable + mini plug - Value $3.92
1 x Alarm circuitry + 9v battery clip - Value $4 and instructions

TOTAL VALUE $23.87 in parts
ALL THIS FOR ONLY
$10.00
Less than the price of the horn alone

WERE SELLING FOR $39.50

SILLY PRICES

RCA SOCKETS

Single socket
Mounted on bakelite with plug.
Cat. PS-0262
NORMALLY 36¢ each
20 for $1
THAT'S 5¢ ea

Twin RCA Socket
Mounted on bakelite with plugs.
Cat. PS-0263
NORMALLY 75¢ each
10 for $1
THAT'S 10¢ea

SILLY PRICES

SPEAKER TERMINALS

Spring terminal for easy connection.
NORMALLY 75¢ each
ONLY $1 for 5!
Cat. PT-3001
THAT'S 20¢ea

PLUG & SOCKET

A 3 pin line plug and chassis socket suited for low voltage or speakers, etc.
NORMALLY 90¢ each
ONLY 5pr for $1
THAT'S 20¢ea
Cat. PS-2092

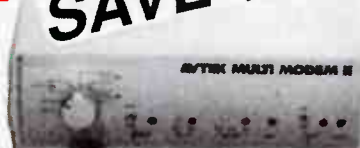
DB25 PLUGS & SOCKETS AT SILLY PRICES

(Solder cup, gold plated)
MALE Cat. PP-0840
$2.50 each
10 up $2.20 each
SAVE UP TO $1.75
FEMALE Cat. PS-0844
$3.00 each
10 up $2.75 each
SAVE UP TO $3.05
BACKSHELL Cat. PM-0848
$1.50 each
10 up $1.25 each
SAVE UP TO 95¢

AVTEK AUTOANSWER MODEM

Cat. XC-4822
$299

SAVE $50



4AA BATTERY HOLDER

Holds 4 penlight batteries. Suites many radios, etc.
Cat. PH-9200
NORMALLY 70¢ each
5 for ONLY $1
THAT'S 20¢ea

6AA BATTERY HOLDER

Holds 6 penlight batteries
NORMALLY $1 each
ONLY $1 for 4
THAT'S 25¢ea
Cat. PH-9206

SILLY PRICES

4½ DIGIT ACCURACY 3½ DIGIT PRICE!!

AND DIGITAL HOLD TO BOOT!

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!!

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

FEATURES:
• All ranges fully protected • Auto zero • 0.5" high LCD • Diode test (1mA fixed current) • LCD display feature • Functional annunciators • Extremely accurate • 20 page instruction manual included.
Cat. QM-1550

ONLY $159.00

ADD-ON ULTRASONIC DETECTOR FOR CAR ALARMS

Now you can really protect your car!
This unit is supplied with discrete looking ultrasonic transmitter and detector units in attractive moulded housing with mounting clip. The control box (which has a sensitivity adjust control) fits anywhere under the dashboard and runs from +12V. The output is either normally open or normally closed which will adapt to any existing car alarm with this facility. No soldering required. All screw connectors. Transmitters are tamper loop protected too!
About ½ the price of the 'name' brand ultrasonic detectors and JUST AS GOOD!
Cat. LA-5320

ONLY $49.95

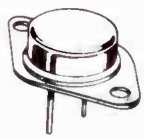
GORE HILL OPEN UNTIL 4pm SATURDAY

NEW MOSFETS

As used in the NEW AEM series 6000 poweramp.

2SJ56
Cat. ZT-2450
$13.95

2SK176
Cat. ZT-2455
$12.50



300 WATT INVERTER WITH AUTO START

This is the built version of the EA September 1985 project!
Just think how handy it would be to have 240 volts AC mains power when camping, or for your boat or caravan - well this brilliant new design is the answer.

COMPLETE KIT VERSION
Cat. KA-1610
ONLY $229

FULLY BUILT & TESTED
Cat. MI-5000
ONLY $289

BARGAIN BAGS

BACK AGAIN

Each bag contains heaps of goodies for your junk box. Average weight is 1kg. Personal shoppers only.

ONLY $9.95

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 attenuators in power supply wiring.
Cat. LF-1200

$1.00 EACH

BISHOP GRAPHICS

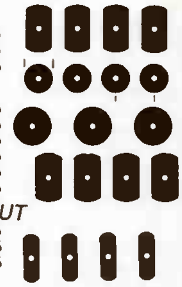
As demand for greater PCB density increases so does the need for a more professional approach to PCB design. To help in this regard, Jaycar stocks a comprehensive range of PCB artwork materials from *BISHOP GRAPHICS* of the USA. This material is both dimensionally stable and accurate, which enables you to produce complex layouts with greater accuracy (very necessary for LSI for example). Once your artwork has been produced, you can make your own board.

PRE-SPACED PADS

HG-9906	0.100" diameter 1.58mm 240 pads	$4.35
HG-9907	0.100" diameter 1.91mm 140 pads	$4.35
HG-9908	0.156" diameter 2.54mm 150 pads	$4.35

DIL PATTERNS

HG-9909	14 pin 32 symbols	$4.35
HG-9910	16 pin 32 symbols	$4.35
HG-9911	18 pin 28 symbols	$4.35
HG-9912	24 pin 12 symbols	$4.35
HG-9913	28 pin 12 symbols	$4.35
HG-9914	40 pin 8 symbols	$4.35



DIL PATTERNS - NARROW CUT

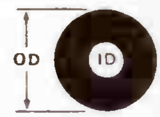
HG-9918	14 pin 32 symbols	$4.35
HG-9919	16 pin 32 symbols	$4.35
HG-9920	40 pin 8 symbols	$4.35

BLACK ARTWORK TAPE

HG-9930	0.026" wide x 20 yards	$3.15
HG-9931	0.031" wide x 20 yards	$3.35
HG-9932	0.040" wide x 20 yards	$3.35
HG-9933	0.050" wide x 20 yards	$3.35
HG-9934	0.062" wide x 20 yards	$3.50
HG-9935	0.080" wide x 20 yards	$3.50
HG-9936	0.093" wide x 20 yards	$3.50
HG-9937	0.100" wide x 20 yards	$3.50
HG-9938	0.125" wide x 20 yards	$3.50
HG-9939	0.200" wide x 20 yards	$3.50
HG-9940	0.250" wide x 20 yards	$4.75

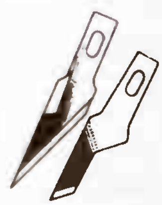
DONUT PADS

HG-9941	0.080" OD x 0.031" ID 96 symbols	$3.50
HG-9942	0.100" OD x 0.031" ID 96 symbols	$3.50
HG-9944	0.125" OD x 0.031" ID 96 symbols	$3.50
HG-9945	0.156" OD x 0.031" ID 96 symbols	$3.50
HG-9947	0.200" OD x 0.031" ID 108 symbols	$3.50
HG-9948	0.250" OD x 0.031" ID 128 symbols	$3.50



ARTWORK ACCESSORIES

HG-9955	X-ACTO KNIFE	$3.75
HG-9956	X-ACTO BLADES trim pk of 5	$3.50
HG-9957	X-ACTO BLADES art pk of 5	$3.50



RISTON PCB

HG-9970	127mm x 152mm	$5.50
HG-9972	152mm x 254mm	$10.50
HG-9974	254mm x 254mm	$21.50

SCOTCHCAL FILM

HG-9988	Black Aluminium 10" x 12"	$9.95
HG-9989	Red Aluminium 10" x 12"	$9.95
HG-9990	Red on white plastic 10" x 12"	$9.95
HG-9991	Black on white plastic 10" x 12"	$9.95
HG-9992	Blue on white plastic 10" x 12"	$9.95
HG-9962	Exposure film 10" x 12"	$7.95

DEVELOPERS

HG-9664	CCRD 30 developer 500ml	$4.25
HG-9968	Stripper CRS-40	$4.35
HG-9983	Negative photo resist CNR05	$6.10
HG-9981	Developer for positive	$3.50
HG-9984	Developer for negative	$8.90
HG-9966	8500 Scotchcal developer	$3.35

PC BOARD PRODUCTION ARTWORK

VIDEO SWITCHING BOX

With this video switch you'll never have to unplug video cables again.
It has inputs for a TV game, VCR, and also an auxiliary input/output which can be used for a computer, satellite receiver, video disc or 2nd VCR.
It employs RF switching and has common 75 ohm sockets, same as your TV.
Cat. AV-6505

ONLY $39.95
SAVE $10.00

CHARACTER GENERATOR ROM

Works with both 6845 & 6545. Saves the user having to design and program his own character generator, with a total of 128 characters. It contains the full ASCII character set plus more. Supplied in a standard 2716 EPROM for easy interfacing. Eleviates the need for an EPROM programmer when combined with an SCR controller they form the basis of a low cost video display capable of displaying up to 130 columns x 30 rows.
Cat. ZZ-8456

ONLY $19.95

PENLIGHT NiCads

Don't keep wasting money buying throw-away batteries - step up to rechargeable Ni-Cads.

SUPERB "ROCKET" BRAND
AA PENLIGHT 450mAh
Cat. SB-2452

$2.95 each
SPECIAL 4 for $10

IT'S HERE ULTRASONIC AIR HUMIDIFIER

CREATE YOUR OWN CLIMATE

This unit re-humidifies air automatically by an ultrasonic mist evaporator. You can adjust the humidity in your environment in the range 30-90% R.H.!! It has a large water container (4.15 litres) and switches off automatically when dry.
Cat. YH-5520

ONLY $149.00

10 AMP DIGITAL MULTIMETER

WITH TRANSISTOR TEST FACILITY

Superb features and specifications. Includes 0.5" high digits, single function range switch, long battery life etc. Size 170(h) x 90(w) x 35(d)mm. SEE THE JAYCAR 1986 CATALOGUE FOR MORE DETAILS.
Cat. QM-1530

ONLY $89.95

10 AMP DIGITAL MULTIMETER + TRANSISTOR TESTER & CAPACITANCE METER

The big daddy - this superb unit features 0.5" high digits, CMOS logic, auto polarity etc.
Cat. QM-1540

A BARGAIN AT $129.00

SEE NEXT PAGE FOR STORE DETAILS

JAYCAR No.1 for the LARGEST range of ex-stock kits

Kit	Issue	Mag	Cat. No.	Price
CD Compressor	May 86	EA	KA-1665	$69 50
Electric Fence	Dec 85	EA	KA-1660	$45.00
UHF Converter	Apr 86	EA	KA-1642	$59 50
CD Adaptor	Apr 86	EA	KA-1645	$32 00
Remote for AM/FM Tuner	July 86	EA	KA-1636	$89 50
Video Fader	Jan 86	EA	KA-1626	$19 95
CD Attenuator	Jan 86	EA	KA-1624	$7 95
100W rms Mosfet Module	Oct 85	EA	KA-1622	$89 50
Pest Off Pest Repeller	Nov 85	EA	KA-1620	$44 50
Dwell/Tachometer	Sept 85	EA	KA-1612	$36 95
Car Stereo Amp 50 watts	Aug 85	EA	KA-1600	$189 50
40 watt 12 - 240V Inverter	Aug 85	EA	KA-1598	$89 95
Digital Capacitance Meter	Aug 85	EA	KA-1595	$79 95
House Alarm	Jan/Feb 85	EA	KA-1582	$119 50
30 volt Power Supply 1 amp	Jan 85	EA	KA-1574	$74 50
Electronic Crossover	Nov 84	EA	KA-1571	$89 50
20 watt Low cost amp module	Nov 84	EA	KA-1567	$22 95
Railmaster train controller	Sept 84	EA	KA-1560	$99.95
Railmaster diesel sound simulator	Nov 84	EA	KA-1561	$22 50
Railmaster steam sound simulator	Dec 84	EA	KA-1562	$22 50
Railmaster walk around	Sept 84	EA	KA-1559	$11 95
CQAM stereo decoder	Oct 84	EA	KA-1555	$26 50
Deluxe car burglar alarm	May 84	EA	KA-1550	$79 50
Ignition killer	Feb 84	EA	KA-1535	$23 50
Motorcycle intercom	Feb 84	EA	KA-1533	$43 50
Video amp/buffer	Aug 83	EA	KA-1527	$18 50
Guitar effects BBD	June 83	EA	KA-1522	$99 00
Touch light dimmer	Apr 83	EA	KA-1508	$27 95
Transistor assisted ignition	Jan 83	EA	KA-1506	$39 95
TAI breakerless T.A.I.	Dec 83	EA	KA-1505	$43 50
Hall effects interface TAI	Dec 83	EA	KA-1504	$6 95
Siemens hall effects interface	Sept 84	EA	KA-1503	$6 95
Playmaster 200 watt amp	Feb 85	EA	KA-1500	$449 00
Fluoro starter	Oct 82	EA	KA-1480	$6 50
Subwoofer amp	July 82	EA	KA-1452	$119 95
Vocal canceller	Apr 82	EA	KA-1430	$23 50
Function generator	Apr 82	EA	KA-1428	$119 50
Dual tracking power supply	Mar 82	EA	KA-1410	$119 50
Metronome	Jan 82	EA	KA-1400	$19 50
50MHz Frequency counter	Dec 81	EA	KA-1390	$149 50
Prescaler to 500MHz	Dec 81	EA	KA-1392	$35 00
Transistor tester	Aug 83	EA	KA-1119	$19 95
300 watt amp module	June 80	EA	KA-1115	$99 95
Power supply for above	July 80	EA	KA-1116	$99 95
Speaker protector for above	July 80	EA	KA-1117	$15 95
Electric fence	Sept 82	EA	KA-1109	$19 95
Musicolor 4	Aug 81	EA	KA-1010	$99 90
Speech synthesiser	Feb 86	AEM	KM-3042	$39 95
Dual speed modem	Dec 85	AEM	KM-3040	$169 00
Ultra fidelity preamp	Oct 85	AEM	KM-3030	$289 00
8 channel relay interface	Oct 85	AEM	KM-3028	$44 50
Courtesy light extender	Nov 85	AEM	KM-3025	$11 50
Listening post	July 85	AEM	KM-3015	$37 50
120 watt Mosfet module	July 85	AEM	KM-3012	$69 50
60 watt Mosfet module	July 85	AEM	KM-3010	$55 00
FM transmitter - mini	Dec 85	ETI	KE-4711	$39 95
D.I. Box ETI 1401	Sept 85	ETI	KE-4708	$39 95
4 sector home alarm	May 85	ETI	KE-4698	$26 95
C.D.I. ETI 342	Feb 85	ETI	KE-4690	$79 50
Car alarm ETI 340	Apr 84	ETI	KE-4678	$75 00
RS232 to Centronic interface	Jan 84	ETI	KE-4666	$29 95
+/- 15 volt power supply	June 77	ETI	KE-4405	$25 50
150 watt Mosfet module	Mar 82	ETI	KE-4220	$98 50
100 watt Mosfet module	Jan 81	ETI	KE-4210	$75 00
ETI 5000 1/3 graphic equaliser	Nov 82	ETI	KE-4204	$209 00
ETI 5000 preamp	June 81	ETI	KE-4202	$339 00
ETI 5000 power amp	Jan 81	ETI	KE-4200	$399 00
ETI 480 100 watt module	Dec 76	ETI	KE-4052	$29 50
ETI 480 50 watt module	Dec 76	ETI	KE-4050	$25 00
ETI 480 power supply	Dec 76	ETI	KE-4048	$25 00
Temperature probe DVM	July 83	ETI	KE-4033	$25 50
NiCad charger	Mar 83	ETI	KE-4029	$14 95
Signal speaker protector	Oct 82	ETI	KE-4023	$19 95
Mixer preamp	July 80	ETI	KE-4014	$37 50
Microwave leak detector	July 79	ETI	KE-4013	$17 95
12 volt flasher	Dec 79	ETI	KE-4012	$8 95
2010 graphic equaliser		JC	KJ-6535	$159 00
2801 1/3 octave equaliser		JC	KJ-6531	$225 00
Negative ion generator		JC	KJ-6511	$49 50
Negative ion generator (shortform)		JC	KJ-6510	$27 50
8002 mixer - 8 channel		JC	KJ-6504	$560 00
Syntom drum synthesiser		JC	KJ-6502	$39 50
Robot - Alganon		JC	KJ-6500	$189 00
Red light flasher		JC	KJ-7000	$23 50

NEW KITS

VIFA SPEAKERS

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

ONLY $399
Cat. CS-2470

Complete speakers and cabinets

AEM 6000 POWER AMP

A JAYCAR STAR PROJECTS

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

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

ONLY $499.00

"Remember Jaycar Kits are Australian Made!"

TURBO TIMER

See EA Sept 1986

A simple sensor system to prevent the car ignition being turned off before the Turbo unit has cooled down (approx. 90 seconds). A must for those with turbo charged cars.

GREAT INSURANCE AGAINST A COSTLY TURBO FAILURE!

Cat. KA-1679
$39.95

SOLDERING IRON TEMPERATURE CONTROLLER

See ETI Sept. 1986

A variable control using diodes. No transformer required, soldering iron connects through this to power outlet. Simple to install.
Cat. KE-4725

ONLY $25.00

PLAYMASTER 60+60

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

ONLY $249.00
Cat. KA-1650

JAYCAR No.1 FOR NEW KITS

INTELLIGENT MODEM ETI 684

See ETI June, July, August 1986

The Ultimate Modem

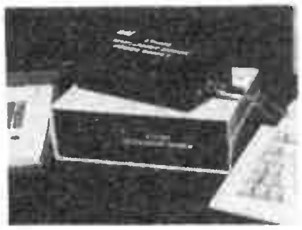
FROM $379.50

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

MODEM $379.50
Cat. KE-4716

POWER SUPPLY $49.95
Cat. KE-4715

INTRODUCTORY OFFER
BUY BOTH FOR **$419**



SCREAMER CAR ALARM

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

$29.95

NEW

DIGITAL SAMPLER ETI 142

Cat. KE-4720

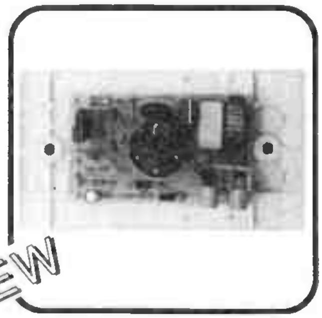
$119.00

AUSTRALIAN MADE

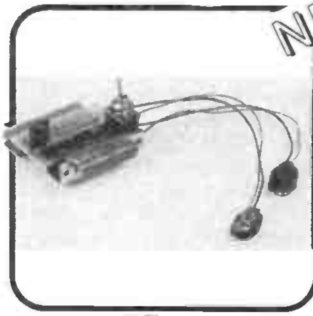
LIGHT SAVER

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

$14.99



NEW



RS232 TO COMMODORE

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

$14.95

FOOLPROOF SPEAKER PROTECTION

Ref: EA July 1986

You've read about them in July 1986 Electronics Australia and here they are:

RN3410
Is suitable for protection of tweeters in systems up to 100 watts. It's 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

AUSTRALIAN MANUFACTURERS

If you have any Australian made products which would fit into our product range, contact Gary Johnston or Bruce Routley with details

JAYCAR - SUPPORTING AUSTRALIAN MANUFACTURE MANUFACTURERS /WHOLESALERS!!

TURN YOUR SURPLUS STOCK INTO CASH!! Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.

CALL GARY JOHNSTON OR BRUCE ROUTLEY NOW
(02) 747 2022

PHONE CONTROLLER

Ref: EA June 1986
Cat. KA-1672

$55.00

AUSTRALIAN MADE

PLAYMASTER AM/FM TUNER

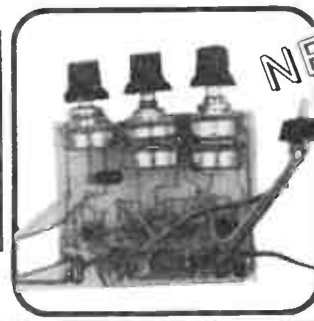
Our most popular kit in 1986. Extra high quality, with specs to impress all.
Cat. KA-1635

$499.00

REMOTE CONTROL
Cat. KA-1636

$89.50

NEW



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

$16.50

MAIL ORDERS

MAIL ORDER HOTLINE (02) 747 2022

ORDERS ONLY TOLL FREE 008 022 888

SHOWROOMS

SYDNEY	117 York St (02) 267 1614 Mon Fri 8 30 am 5 30 pm Thurs until 8 30 pm Sat 9 am 12 noon
CARLINGFORD	Cnr Carlingford & Pennant Hills Rd (02) 872 4444 Mon Fri 9 am 5 30 pm Thurs until 8 30 pm Sat 9 am 12 noon
CONCORD	115 Parramatta Rd (02) 745 3077 Mon Fri 8 30 am 5 30 pm only
HURSTVILLE	121 Forest Rd (02) 570 7000 Mon Fri 9 am 5 30 pm Thurs until 8 30 pm Sat 9 am 12 noon
GORE HILL	188 Pacific Hwy (Cnr Bellevue Ave) (02) 439 4799 Mon Fri 9 am 5 30 pm Sat 9 am 4 pm

Jaycar ELECTRONICS
INCORPORATING ELECTRONIC AGENCIES

QLD. BURANDA	144 Logan Rd (07) 393 0777 Mon Fri 9 am 5 30 pm Thurs until 8 30 pm Sat 9 am 12 noon
HEAD OFFICE	115 Parramatta Rd Concord 2137 (02) 747 2022 Telex 72293

ROAD FREIGHT ANYWHERE IN AUSTRALIA $13.50

VISA | bankcard | MasterCard | AMERICAN EXPRESS Cards Welcome

MAIL ORDER VIA YOUR PHONE

MAIL ORDERS
P.O. Box 185 Concord 2137
(02) 747 1888 HOTLINE
(008) 022 888 TOLLFREE
FOR ORDERS ONLY

POST & PACKING

$5 $9.99	$ 2.00
$10 $24.99	$ 3.75
$25 $49.99	$ 4.50
$50 $99.99	$ 6.50
OVER $100	$10.00

Datacraft supplies modems to Japan

When the Federal Government called for increased exports, Datacraft announced significant sales of its Australian designed and made Telelink modems to the Tokyo office of an international bank.

Datacraft Telelink modems are designed to provide a cost effective solution to internal networking requirements, since they allow for simultaneous voice and data transmission, using existing PABX equipment and cables within a one kilometre range.

"Our export team is now evaluting the potential of the Japanese market, since it would appear there is no comparable product available there," said Datacraft marketing manager, Robert Casson.

While Casson is cautious about claiming the Telelink modem is unique, he says it has proven to be extremely competitive in terms of price, performance and versatility and is being specified in preference to other network solutions.

"It is specifically designed to reduce in-house data communication costs by utilising the existing telephone network for both voice and data transmission," he said.

The Telelink modem consists of a remote desktop unit and a central rack-mount unit, linked through the existing twisted pair cable of the PABX network.

The desktop unit is capable of combining voice and data transmission at the telephone extension and transmits both signals over the telephone cable to the central site. The unit is contained in a slim-line case which is placed beneath the telephone.

Terminal equipment connects directly to the unit via a standard female DB25 connector and the modem itself to the telephone network through a standard telephone connection. The unit is equipped with data line status indicators and a test switch for local analogue loopback testing of the data line.

The modem delivers voice signals through passive low pass filters which prevent data transmission interfering with the voice signals. This means of transmission provides a failsafe method of maintaining voice communications in the unlikely event of faults developing in any part of the data communications link.

The data transmission component of the Telelink modem supports any synchronous or asynchronous RS-232C device operating up to 9600 bps (baud). The unit operates as a line driver device allowing data transmission over a one kilometre area.

Since most offices have telephone, the requirement for data terminals can be met without the need for additional cabling.

"We intend to actively pursue export sales of this excellent product," said Casson.

Further product details from **Datacraft Limited, PO Box 353 Croydon 3136 Vic. (03) 727 9111.**

IBM cabling system

Local electronics supplier, A. C. & E. Sales, is providing IBM-approved cablilng systems for computer interconnections and high speed data communications applications.

A cabling system is designed on a "wired once" concept, like an electrical power outlet system of a building, permanently installed for the interconnection of computers, terminals and workstations.

The IBM Cabling System uses cables with two twisted pairs of data conductors for high speed data communications and a specially developed four-way connector which can mate with another identical connector and will close two circuits when unmated.

The system can connect most of the available IBM data devices as well as many devices made by other manufacturers through various adaptor cabling assemblies and baluns. It has been widely adopted overseas and is currently being installed here. IBM publish two books on the system, available from their capital city offices.

A. C. & E. Sales offer a variety of components and assemblies of the IBM Cabling System from IBM-approved manufacturers. Products include: IBM Cables Types 1 and 6, IBM Data Connectors, adaptor cable assemblies, baluns, face plates, wall mounts, loop wiring concentrators and surge suppressors.

Further details on the full range of products is available from **A. C. & E. Sales Pty Ltd, PO Box 446, Leichhardt 2040 NSW. (02) 660 5077.**

CIS grab bigger share of disk market

With a sales growth from zero to 100 000 per month, CIS disks aimed at the IBM market (DSDD, 48 tpi) are grabbing an increased market share and have a big potential, according to the Managing Director of CIS Technology, Cyril Stevenson.

Quality control is the key, says Stevenson. CIS recently released a high density 96 tpi disk for the IBM AT computer. Stevenson says, ". . . the standard of diskette is high quality, certified and error free."

CIS Technology will shortly release a 3.5" disk, with 3.5" disk drives now becoming standard in a wide range of manufacturer's machines. Further details from **CIS Technology on (02) 449 3962.**

New generation Amstrad

Although still under wraps, rumours of the imminent arrival of the next generation Amstrad computer has everyone talking, according to the distributors, Mitsubishi Electric AWA.

Due for release here around September/October, AWA says it will make an even bigger impact than Amstrad's previous models, particularly in the highly competitive and cost-sensitive business user market.

While the new computer is based on the same successful Amstrad formula of quality and simplicity combined with a very reasonable price tag, it will also offer IBM compatibility, opening up a range of software and other peripherals to Amstrad users.

While not giving many details away at this early stage, Product Manager, John Chandler, is confident the new computer will be well worth the wait.

"Amstrad has a solid track record for producing value-for-money computer packages just when the market is ready," he said. "Amstrad's new model will not only match the capabilities of the comptetion, it will also offer considerable advantages in price and features."

Learning computers to speak proper

Dutch researchers have developed computer programs that break down human speech into pieces known as "diphones" which can be used to produce more lifelike electronic speech.

Currently, the most successful (non-stored speech) voice synthesisers employ phonemes — fundamental speech parts (see AEM, Feb. 1986) that represent the variety of different sounds of vowels and consonants. These phonemes are digitised and stored in memory, then retrieved and strung together in order by software to form words.

Because the phonemes do not flow into one another and only selected vowel or consonant variations are employed, the result is somewhat ponderous and to some extent (because the nuances of inflexion are missing) monotonic.

The diphone technique, developed by researchers at the Institute of Perception Research in Eindhoven, Holland, gets around the problem by a method that involves recording and reproducing the transitions, rather than the phonemes themselves.

Most languages can be represented by 2000 diphones, which up to now have had to be identified by researchers going through paper records of speech sounds. It could take up to six months to encode a language. The institute's computer can do the job in a few days.

Scientists at the institute, which is jointly run by Philips and Eindhoven University of Technology, have produced di-phone collections in Dutch and German. They are now working on English ones.

Gateway to Videotex

A new program developed to transform IBM and compatible PCs into Videotex terminals has been released by Visionhire Business Systems.

Called "Visionhire Gateway Plus", it was developed especially for Visionhire by Cybersoft Pty Ltd, and retails for $199.00. Aside from Videotex access, Visionhire Gateway Plus will also provide IBM and compatible machines with terminal-to-terminal communications facilities.

For further information, contact **Visionhire (Australia) Pty Ltd, 144 Pacific Highway, North Sydney 2060 NSW (02) 959 5600.**

Extended distance data cables

The Belden 9680 and 8102 families of paired overall shielded extended distance data cables are now available from Acme Electronics in Australia.

The 9680 Family is polypropylene insulated with a 100% 'Beldfoil' shield. They consist of nominal 100 ohm pairs with a velocity of propagation of 66%, a capacitance of 50.8 pF per metre and a 6 dB length limit of 640 metres. The family includes 3, 4, 6, 9 and 12.5 pair configurations.

The 8102 Family is Datalene insulated with 100% 'Beldfoil' plus 65% TC braid shields. They consist of nominal 100 ohm pairs with a velocity of propogation of 78%, a capacitance of 41 pF per metre and a 6 dB length limit of 640 metres. The family includes 2, 3, 4, 5, 6, 7, 8,1 0,12.5, 15, 18 and 25 pair configurations.

Both cables suit EIA RS232 and RS422 applications. Further information from **Hardie Technologies Components, Acme Electronics, 205 Middleborough Road, Box Hill 3128 Vic.**

Compact storage for computer disks

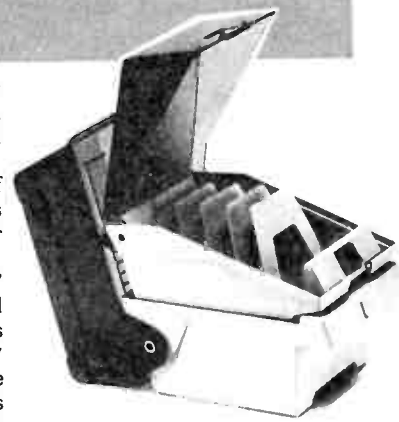
Well-known for their innovative audio accessory products, US-based manufacturer Allsop has entered the computer field with a range of disk storage boxes that offer something their competitors don't they claim.

Now, it seems to us that, if you're going to offer a new product in a well-established market that comes up against an entrenched range of existing products, your product has to offer more and do it better, regardless of price considerations.

That's the strategy Allsop has adopted quite successfully in the audio field and they're now applying it to the computer field with their just-released disk storage boxes.

Allsop claim their range of disk storage boxes take up less space (open or shut!) than other brands, yet hold more disks.

The Allsop "disk organizers" are available for both 5.25" and 3.5" disks. The 5.25" box holds up to 60 disks, while the 3.5" box holds up to 30 disks. Five dividers are included, and labels (supplied) can be attached to catalogue groups of disks to suit your requirements. The dividers seat in slots in the bottom of the box and swing back and forth to allow free access to your disks. The lid has a spring-loaded latch mechanism and requires no rear space when open — a boon with the usually overloaded computer desks most people work on!



For further details, contact the local distributor, **Allsop Computer Products Division of Communications Power Inc., PO Box 246, Double Bay 2082 NSW. (02) 357 2022.**

COMMODORE 64 OWNERS!

Here's a fantastic offer on a great new speech synthesiser from Mike Boorne Electronics.

THE VOTALKER C-64

This is the most sophisticated yet easy-to-use synthesiser ever introduced for the Commodore 64 computer. This powerful speech tool comes packed with advanced features unmatched by any other sythesiser.
Just look at these features:

UNLIMITED VOCABULARY
VOTALKER C-64 comes equipped with the popular Votrax SC01A speech chip that constructs speech using a set of 64 phonemes. VOTALKER C-64 comines these phonemes using a highly sophisticated algorithm. This method of speech synthesis allows VOTALKER C-64 to vocalise an unlimited English vocabulary with amazing accuracy. In addition to standard text, VOTALKER C-64 correctly pronounces symbols, numbers (from -999,999,999 to +999,999,999, including decimal places) and even BASIC commands, functions and screen messages.

VOTALKER C-64 adds 13 new BASIC commands!

POWERFUL NEW "SPEAK" COMMAND
VOTALKER C-64's text-to-speech algorithm is easily accessed through the powerful SPEAK command. SPEAK is used much like a PRINT statement except that is vocalises the expression instead of printing it to the screen. SPEAK an be used with numbers, phrases, and complex expressions. Pitch and volume control can also be included with a SPEAK statement to create even more natural-sounding speech. With the addition of speech, BASIC programs, take on an exciting new dimension.

SCREEN ECHO MODE
With the screen echo mode on, many programs can talk without any modification. All words, numbers and symbols are automatically spoken as they are printed to the screen. Listen to your program listings, disk directories, or use your communication software to create a talking terminal! VOTALKER C-64's screen echoing can also be an invaluable aid to the visually impaired.

COMPLETE THE COUPON NOW AND
SEND TO: "VOTALKER OFFER"
Australian Electronics Monthly
PO Box 289 WAHROONGA 2076 NSW

Offer closes 30th September 1986

PLEASE RUSH ME: . . . VOTALKER C-64(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.

VOTALKER C-64 PLUGS DIRECTLY INTO THE EXPANSION PORT

The VOTALKER C-64 normally retails for $264. But, through this Mike Boorne Electronics offer, exclusive to AEM readers, you need only pay

$229!

plus $10 packing & delivery

This offer is made by Mike Boorne Electronics and the magazine is acting a clearing house for orders.

SELF-CONTAINED "HELP" FUNCTION
Among VOTALKER C-64's new BASIC commands is the HELP feature. This handy command provides a quick screen summary of new commands.

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!

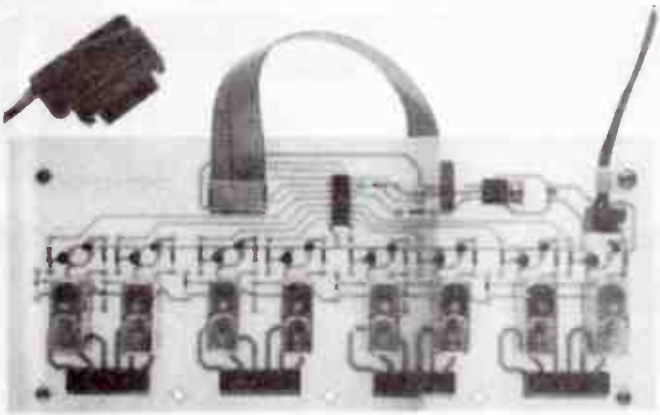
Codex: A wooden tablet; a system of secret writing; a set of signals for sending messages.

Adapting the AEM4501 8-channel relay interface for Commodore computers

Ron Koenig

This article presents both a demonstration program and a description of the hardware required to connect the AEM4501 8-Channel Relay Interface board to the Commodore C64 amd C128. The AEM4501 project, presented by Geoff Nicholls in AEM in October 1985, provides a low-cost method to connect the outside world to your computer. With suitable software, the project can meet a virtually unlimited range of computer control applications.

THE AEM4501 INTERFACE BOARD was designed with safety and reliability in mind by using eight high-voltage isolation relays as the controlling devices. Although relays are larger and consume more power than similar solid state devices, they are more robust and less likely to fail. The relays specified provide more than 3500 volts isolation and can switch loads up to 10 amps. Printed circuit board screw terminal strips are used to connect to the relay contacts. A 12 Vdc plugpack (or power supply) is used to power the eight relays and their associated LED indicators.



The Commodore User Port

Nearly every 'home' computer provides some form of general purpose interface port to which a range of peripheral items can be connected. On the Commodore range of computers this general purpose port is called the USER PORT, and it has remained unchanged from the earliest Commodore PET to the latest C128 computer. A large range of add-on accessory equipment is available from both Commodore and other manufacturers to connect to this port.

The success of the Commodore User Port lies in its flexibility through the use of a custom chip, the 6526 Complex Interface Adaptor (CIA). This device provides 16 input-output (I/O) lines, two 16-bit timers, an 8-bit shift register and a 24 hour alarm clock. Although eight of the I/O lines are used internally, the remaining eight are made available at the User Port. Under software, these lines can be configured as either input, output or mixture of input and output. Two handshaking lines are available for use in controlled data transfer from the port. The shift register operates in conjunction with one of the timers to provide a serial communication channel for connection to serial devices such as modems.

The hardware connection

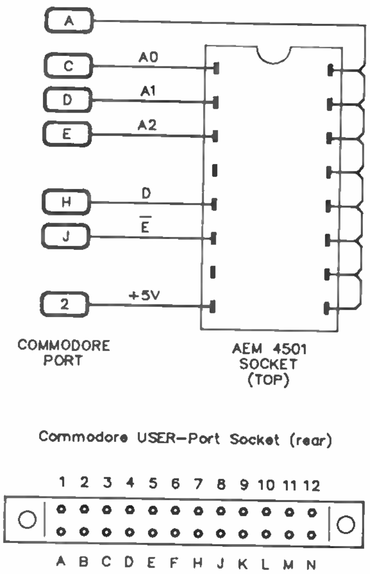
The AEM4501 requires three address lines, a data line and a negative-going strobe line to interface to the 74LS259 8-bit addressable latch located on the interface board. The operation or release of the eight relays is controlled by setting the address lines to select the required latch, setting the data line to the required logic state, and then pulsing the strobe line low to latch the data. In our application, each of these functions will be performed by one of the port's I/O lines. Five lines will be required and three will be spare.

The User Port appears as 12 printed circuit fingers on the back of the computer. A dual-row 12-pin connector (see the parts list) can be used to make a removable connection between the 16-wire cable from the interface board and the User Port. Polarizing tabs should be used to ensure that the connector cannot be installed upside down, and a 'hood' used to protect the wiring.

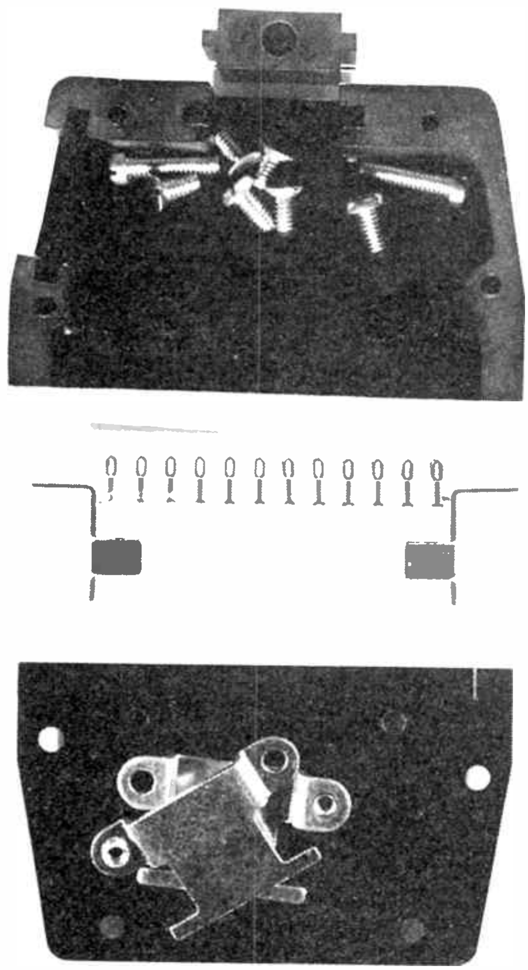
Only six wires need to be soldered to the connector, the 'spare' lines can be left unconnected. The connector pins and their associates port lines used are tabulated below: ▶

Port Bit	Pin #	Function	4501 DIL socket
GND	A	GND	16
PB0	C	A0	1
PB1	D	A1	2
PB2	E	A2	3
PB3	F	spare	4
PB4	H	Data	5
PB5	J	Strobe	6
PB6	K	spare	7
PB7	L	spare	8

In the original article, Geoff Nicholls used a 7805 5 V regulator on the interface board to power the 74LS259 latch from the 12 V plugpack relay supply. As the Commodore computer provides +5 V at pin 2 of the User Port, I have elected to use this to power the latch and the 7805 regulator is not fitted on the relay interface. I ran a wire from the output pin of the 7805 (the one going to pin 16 of the latch) to the spare pad adjacent to pin 8 of the 16-pin DIL socket. The associated wire in the flat ribbon cable was then terminated on pin 2 of the User Port connector. Now the latch will be reset and powered up each time the computer is turned on and the 12 V plugpack relay supply can be turned on or off at any time without affecting the User Port latch operation. The following circuit is the final interconnection circuit diagram.



Interface connections between the Commodore and the 4501 relay board. Note that the C64 and C128 have the same User Port arrangement.



I'd recommend you use a proper, shrouded User Port connector. This one (shown life size) is stocked by Geoff Wood Electronics in Sydney. (02)427 1676.

The program

The AEM 8-Channel Relay Interface program has been written in BASIC to simplify its entry and understanding. As some cursor control characters have been incorporated in the listing (the inverse characters) care should be exercised when typing in the program. The REM statements in lines 300 and 310 identify the characters involved. This program is only intended as a demonstration of the principles involved in interfacing the Relay Interface to the Commodore Computer and has not been developed for any particular application.

When the programme is RUN it initialises the User Port, sets up the Screen Display and then calls the Clear subroutine to program the latch to turn OFF all the eight relays. The Screen Display presents the status of the relays to the operator in two columns. The first column identifies the relays as number 1 to 8. The second column displays the status of each relay as either OFF or ON. A sub-menu line is displayed at the bottom of the screen indicating the acceptable Keyboard commands.

The four commands available are **Set, Reset, Clear** and **Test** and only the first letter of each command is required to select the function. The Set and Reset commands also require the entry of the required relay number (1 to 8) following the S or R Key. As each relay is set (ON) or reset (OFF), the screen display is updated to show the correct relay status. When C is entered the latch is programmed to turn OFF all eight relays. The Test function cycles through all eight relays first turning each ON in sequence and then turning them OFF.

The software connection

The 8-bit User Port is being used to supply the latch the three address bits, a data bit and a negative-going strobe. Data is passed through the User Port by way of two memory addresses in the computer. These addresses are the Data Direction Register (DDR-56577) and the Data Register (DR-56579). Each bit in the DDR identifies the direction of data flow from the associated DR bit. As all eight bits of the DR are output for this programme the DDR is POKE'd with the value of 255. The five DR bits are defined as follows:

```
Data bit........     ........ Latch
Strobe bit.... :     : ......Address
               : :   : : ....  bits
               : :   : : :
DR bit    7 6 5 4 3 2 1 0
               : :   : : :
weighting    32 16   4 2 1
```

```
100 REM " ┌─────────────────────────────────┐
110 REM " | AEM 8 CHANNEL RELAY INTERFACE   |
120 REM " | FOR THE COMMODORE 64 AND 128.   |
130 REM " |                                 |
140 REM " |          BY RON KOENIG          |
150 REM " └─────────────────────────────────┘
160 :
170 REM " ┌─────────────────────────┐
180 REM " | INITIALISE THE USER PORT |
190 REM " └─────────────────────────┘
200 DP =56577     :REM DATA PORT ADDRESS
210 DDR=56579     :REM DATA DIRECTION REG
220 POKE DDR,255  :REM ALL LINES O/P
230 POKE DP,32    :REM SET STROBE HIGH
240 FORN=1TO8:F=0:GOSUB1080:NEXT N      :REM RESET RELAYS
250 :
260 C$="■■■■■■■■■■■■■■■■■■■■■■■■■"      :REM 25 X CRSR RT.
270 S$="                            "    :REM 28 SPACES
280 H$="■"          :REM HOME CURSOR
290 PRINT"■"        :REM YELLOW CHARACTER COLOUR
300 REM "■" =RVS ON,"■" =RVS OFF,"■" =CLR
310 REM "■" = CRSR LEFT, "■" = CRSR DOWN
320 :
330 REM " ┌─────────────────────┐
340 REM " | SETUP SCREEN DISPLAY |
350 REM " └─────────────────────┘
360 PRINT"■           ■ AEM 8 CHANNEL INTERFACE "
370 PRINT"■             ■ RELAY        STATUS "
380 FOR K=1TO8
390 PRINT:PRINTTAB(12)K"......... OFF"
400 NEXT K
410 PRINT"■■■■■    ■ S#-SET  R#-RESET  C-CLEAR  T-TEST ■";
420 PRINT H$;
430 FORX=0TO 20:PRINT"■";:NEXT
440 PRINTTAB(13)"SELECTION ..?■";
450 :
460 REM " ┌──────────────┐
470 REM " | WAIT FOR A KEY |
480 REM " └──────────────┘
490 GETA$:IFA$=""THEN490
500 PRINT A$;
510 IFA$="C"THEN 240
520 IFA$="S"THEN GOSUB 630
530 IFA$="R"THEN GOSUB 790
540 IFA$="T"THEN GOSUB 950
550 PRINT H$;
560 FORX=0TO 20:PRINT"■";:NEXT
570 PRINT C$;
580 GOTO420
590 :
600 REM " ┌─────────────────────────┐
610 REM " | SUBROUTINE TO SET RELAY |
620 REM " └─────────────────────────┘
630 GETN$:IFN$=""THEN630 :REM GET RELAY #
640 IFASC(N$)<49ORASC(N$)>56THENPRINT"■ ":RETURN
650 N=ASC(N$)-48          :REM RANGE 1-8
660 PRINT N;
670 PRINT H$;
680 FORX=0TON:PRINT"■":NEXT
690 PRINT C$"ON ";
700 PRINT H$;
710 FORX=0TO 20:PRINT"■";:NEXT
720 PRINT S$;
730 F=16:GOSUB1080        :REM SET RELAY
740 RETURN
750 :
760 REM " ┌───────────────────────────┐
770 REM " | SUBROUTINE TO RESET RELAY |
780 REM " └───────────────────────────┘
790 GETN$:IFN$=""THEN790 :REM GET RELAY #
800 IFASC(N$)<49ORASC(N$)>56THENPRINT"■ ":RETURN
810 N=ASC(N$)-48          :REM RANGE 1-8
820 PRINTN;
830 PRINT H$;
840 FORX=0TON:PRINT"■":NEXT
850 PRINT C$"OFF";
860 PRINT H$;
870 FORX=0TO 20:PRINT"■";:NEXT
880 PRINTS$;
890 F=0:GOSUB1080         :REM RESET RELAY
900 RETURN
910 :
920 REM " ┌─────────────────────────────────┐
930 REM " | SUBROUTINE TO TEST CYCLE RELAYS |
940 REM " └─────────────────────────────────┘
950 FORN=1TO8:GOSUB670 :REM SET RELAYS
960 FORD=1TO200:NEXTD  :REM DELAY
970 NEXTN
980 FORN=1TO8:GOSUB830 :REM RESET RELAYS
990 FORD=1TO200:NEXTD  :REM DELAY
1000 NEXTN
1010 RETURN
1020 :
1030 REM" ┌───────────────────────────┐
1040 REM" | SUB TO WRITE TO RELAY BOARD |
1050 REM" └───────────────────────────┘
1060 REM N=RELAY NUMBER, F=16 FOR ON AND 0 FOR OFF.
1070 REM V=VALUE TO WRITE TO USER PORT
1080 N=N-1           :REM ADJUST RANGE FOR 0<N<7
1090 V=N+F           :REM ADD DATA BIT
1100 POKE DP,V       :REM WRITE TO USER PORT
1110 POKE DP,V+32    :REM RESET STROBE HIGH
1120 N=N+1           :REM RESTORE N VALUE
1130 RETURN
```

A selected relay is controlled by forming the required relay address in the range 1 to 8, adding in the data bit value of 16 (if the relay is to be set) and then pulsing the strobe line low. The Set Relay and Reset Relay subroutines generate the required address word (N) by taking the ASCII value of the relay number entered and subtracting 48 to convert it to a decimal value in the 1 to 8 range. The data bit variable F is set to 16 or 0 as required.

The Write Subroutine adjusts the address to the range 0 to 7 required by the latch and then adds the data value F. To generate the negative strobe the routine first writes to the Data Register the value calculated above and then adds the strobe value (32) and outputs the result to return the strobe line to the ON and idle condition.

Program additions

No program can ever be seen as complete. There always seems something that can be improved, removed or added. I have left the program in this form to limit the data entry task but several additions have come to mind. Perhaps you might like to add them after you have the basic program operating correctly.

The first improvement involves the addition of a tone when data is keyed in. A beep could be generated for an acceptable key entry and a buss for incorrect entries. Secondly, the ON and OFF words displayed on the screen could be coloured RED and BLUE respectively to enhance their readability.

Practical applications

While this program only demonstrates the principals of interfacing the AEM 8-Channel Relay Interface board to the Commodore computer it can be used as the basis of more dedicated programmes.

- **Moving Light Display.** With suitable software the relay board could be driven to provide a Moving Light or Coloured Light Display. The Sound Input Channel of the Commodore could be used to input the Audio signal for the coloured light application.
- **Stage Lighting Control.** A preprogrammed sequence stored on disk (or tape) could be used to control the stage lighting of a production. The computer's sophisticated Timer, Clock and Alarm facilities would be used both during the programming and the replay to provide the timing clock.
- **Domestic Lighting and Heating Controller.** Timing using the computer's Clock and Alarm facilities.
- **Instrumentation Controller.**
- **Model Train or Slot Car Controller.**
- **Robotics.** The computer's joystick ports can be used for eight bits of digital and four analogue-to-digital inputs.

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 14 of this issue.

Figure 1. The new model Multitech-K7S keyboard

An add-on keyboard for the Apple II+

Roy Hill

Here's a simple, low-cost way to extend the life and versatility of your old Apple II+ with the addition of a locally available keyboard.

FOR MANY YEARS NOW I have been the proud owner of an Apple II + computer, which has performed faultlessly during its life. However, I have been nearly tempted to trade it in on a IIe, simply because of the additional features that the IIe keyboard has to offer.

Any thoughts of actually going through with the trade-in have now been completely eradicated, due to my recent acquaintance with an add-on keyboard specifically designed to work with the Apple II +. The unit is known as a Multitech-K7S and is available from Emona Enterprises (1st Floor, 720 George Street, Sydney 2000) for the grand sum of $141 (tax included). It is an IBM-style keyboard, both in terms of layout and the presence of function keys (see Figure 1).

The keyboard itself has the standard QUERTY layout, with response being quite reasonable for a keyboard in this price bracket. The numeric keypad serves a dual function — in the *unlocked* mode, four of the keys (see Figure 1) act as direction control keys for use under Wordstar and similar programs. This is an extremely valuable feature for use with Wordstar (I used it to prepare this article). Several other valuable Wordstar keys are the "PaGe Up", PaGe DowN, 'HOME' and 'END' keys. The standard Wordstar 'INSert' toggle (CTRL/V) and the 'DELete' function (CTRL/G) are both also available as single key commands.

In the *locked* mode, the keyboard functions as a normal numeric keypad, with the addition of several strategically placed keys (e.g: ENTER — equivalent to RETURN, the '+' sign and several others). The numeric keypad is locked in the numeric mode by pressing the NUM LOCK key located in the top right-hand corner. A LED lights to indicate that the keyboard is locked in the numeric mode and similar LED also indicates the locking of the keyboard in the upper-case mode (NOTE: This is NOT the same as the shift-lock key on a typewriter).

All the functional keys (e.g. RETURN, CTRL, ESC, SHIFT and the two cursor direction keys) are in a different colour to the QWERTY keys. All these features are quite well documented inthe User's Guide supplied with the unit.

The keyboard is sculpted to allow the user's hands to rest comfortably on the desk and touch-typing is made far easier because of this feature. One addition that I really like is the adoption of index keys (the F and J keys on the main keyboard and the 5 key on the numeric keypad) to enable blind persons to use this type of keyboard. A very small raised 'bump' on each of these keys enables tactile recognition of these 'home' positions. There are two 'tilt' angles > available. The standard angle is 6°, adjustable to 12° by means of fold-away legs.

The function keys are located in a row along the left-hand side of the keyboard. They are labelled F1 through F10 and have a range of pre-programmed functions already available. These are typical Apple commands such as CATALOG, LOAD, LIST, RUN, MONITOR, PR#6 and HOME to mention a few. Functions are invoked simply by pushing the appropriate key.

Under the Hood

The heart of the unit is an Intel/AMD 8049 single chip microcomputer. This chip contains on-board clock oscillator circuits, an 8-bit timer/counter and 128 bytes of RAM (used for user-definable function keys) as well as all the address and data lines necessary to interface with external ROM/EPROM. The chip operates from a single + 5 volt supply, which it derives from the interface connector and the serial output is derived from pin 34 (one of the I/O ports of the chip).

I was once asked to modify an earlier version of this keyboard. The model that I was asked to modify was called the MAK-II, which was also distributed under the name of BOSS as an OEM (original equipment manufacturer) version. The MAK-II had several disadvantages (and one advantage) over the new version. Several of the keys present on the new model (\, :, ', ~, {, and } plus additional Wordstar keys) were not present onthe MAK-II. The advantage that the old version had had over the K7S model was that instead of using an 8049 chip (with its own ROM), the MAK-II used an 8039 chip, which required an external EPROM, rather than the internal ROM. However, this also made modifications to the software far easier and this is what I had been asked to do.

It is not possible to modify the software in the new model, without also performing extensive (for that read *expensive*) hardware modifications, which rather defeats the purpose of a good, low-cost keyboard. Additionally, there really isn't much point in modifying the new version. It works quite well without any need for modifications.

For those persons that have either of the older models, I will now describe the process I used to modify the character set and explain how easily it can be accomplished. The first thing I did was to whip out the EPROM and read it using my EPROM programmer card. I then scanned through the contents of the EPROM using a HEX/ASCII dump program that I wrote in FORTH. My reason for doing this was to see if I could find the storage locations of the Wordstar cursor control keys and also the locations of the numeric keypad keys. I had a good reason for doing this. If these were only simple ACSII locations, then I could alter them, save them to a disk, and then program a new EPROM with these new characters. The search proved easy. The four Wordstar control keys were at locations 33B, 33C, 33E and 33F (NOTE: All numbers are in hexadecimal, unless stated otherwise). For details of these locations see Figure 3. The numeric keypad has two positions in the EPROM — the *unlocked* mode at locations 3d38 through 349 and the *locked* at locations 39A through 3AB. Because we have to lock the keypad in numeric mode to use the numbers anyway, we could use any of the *unlocked* keys for other purposes.

Let's examine these other purposes first. Although the MAK-II version has 90 keys (including the function keys), it lacks four of the characters that are normally found on the Apple (and the new version K7S) — the grave ('), the tilde (~), the vertical bar (:) and the squiggly braces ({ and }). As can be seen from Figure 4, two of these symbols now replace the '7' and the '9' key respectively in the *unlocked* mode, and the other three occupy their standard positions above the '\', '[' and ']' keys respectively (I was able to scrounge some keycaps from an old keyboard — the colour difference between the different sets doesn't really show on a B & W photo).

Whilst I was modifying things, I decided to replace the '1' key with the colon and the '3' key with an asterisk. This means that my friend no longer has to use the shift key to access these frequently used keys (see Figure 4).

Having changed these keys, let us now turn our attention

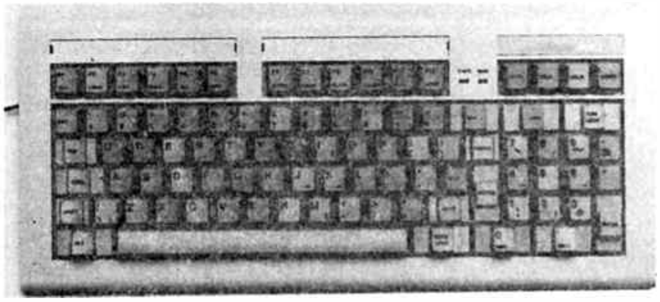


Figure 2. The old MAK-II version — Note the additional (handwritten) characters on the numeric keys. Also, note the switch on the left-hand side.

```
330 - 27 5B 2D 13 5D 3D  3  8  '[-S]=CH
338 -  D 13 90 18  4 35 13  5  MS.XD5SE
340 - 90 9C 33 31 2B 18 39 37  ..31+X97
348 - 2E 37 3C 41 46 4D 13 13  .7<AFMSS
350 - 13 51 5B 60 13 15 13 13  SQ['SUSS
358 - 21 40 23 24 25 5E 26 2A  !@#$%^&*
```

Figure 3. Contents of standard (supplied) EPROM.

```
330 - 27 5B 2D 13 5D 3D  3  8  '[-S]=CH
338 -  D 13 90 18  4 35 13  5  MS.XD5SE
340 - 90 9C 2A 3A 2B 18 7E 60  ..*:+X~`
348 - 2E 37 3C 41 46 4D 13 13  .7<AFMSS
350 - 13 51 5B 60 13 15 13 13  SQ['SUSS
358 - 21 40 23 24 25 5E 26 2A  !@#$%^&*
```

Figure 4. Contents of EPROM modified to contain new characters and Apple control keys.

```
330 - 27 5B 2D 13 5D 3D  3  8  '[-S]=CH
338 -  D 13 90  A 15 35  8  B  MS.JU5HK
340 - 90 9C 2A 3A 2B 18 7E 60  ..*:+X~`
348 - 2E 37 3C 41 46 4D 13 13  .7<AFMSS
350 - 13 51 5B 60 13 15 13 13  SQ['SUSS
358 - 21 40 23 24 25 5E 26 2A  !@#$%^&*
```

Figure 5. Contents of EPROM modified to contain new characters and existing Wordstar control keys.

to the arrow keys. My friend wanted to know if it was possible to modify these keys to work like the arrow keys on a IIe. All that was necessary to do here was to determine the correct cursor control codes used by Apple software. These are CTRL/K (0B), CTRL/U (15), CTRL/J (0A) and CTRL/H (08), going clockwise from the top. This poses a slight problem, in that we now require two EPROMs to handle the two different sets of cursor control characters.

This problem is easily overcome (without having to open the back of the keyboard each time we want to change EPROMs), simple by piggy-backing the two EPROMs. To do this, bend pin 20 of each EPROM upwards, and place one EPROM on top of the other. EPROMs with integral windows (rather than raised — suitable units are available from Energy Control, PO Box 6502, Goodna, 4300, Qld), are best used for this purpose, as there isn't a lot of height inside these keyboards. Solder the top set of pins to the bottom set, ensuring that solder does not run down the legs of the pins, preventing the EPROM from seating correctly in the socket. Now solder pin 20 of each EPROM to the centre pin of the DPDT switch (a Dick Smith type S-1174, I found ideal) and cross-connect the outher pins to + 5 V and pin 20 access (see Figure 6). A small hole for the switch can be drilled in the side of ▶

the plastic case — make sure it's in the right position to clear the circuit board. The completed modifications (including the piggy-backed EPROMs) are shown in Figure 6.

For those persons who wish to make these modifications, but do not have access to an EPROM programmer, Emona have a set of the modified EPROMs for sale to interested users. Contact Mr Alfred Bresnick. Another alternative (to avoid the need for semi-permanent modifications to the circuit), is to replace the existing EPROM with only one of the new ones, if most of your computing involves one system or the other. The modified keys (see Figure 2) have been labelled using a permanent pen, which tends to stand up to the repeated use of sweaty little fingers better than other types.

Two final notes for those persons attempting their own conversions:

(a) The locations for the ':', '{' and '}' are 382, 389 and 38C respectively, and

(b) the complete character set is echoed in the top 2K of the EPROM, so that each of the above mods must be performed in the indentical top half of the EPROM. Just add $800 to each of the above locations.

In conclusion, I would like to make two recommendations:

1. If you have an old MAK-II or BOSS keyboard, make these easy modifications and have a really versatile keyboard, or,
2. buy the new model K7S and you won't need to do any mods — particularly if you work a lot with Wordstar and similar programs.

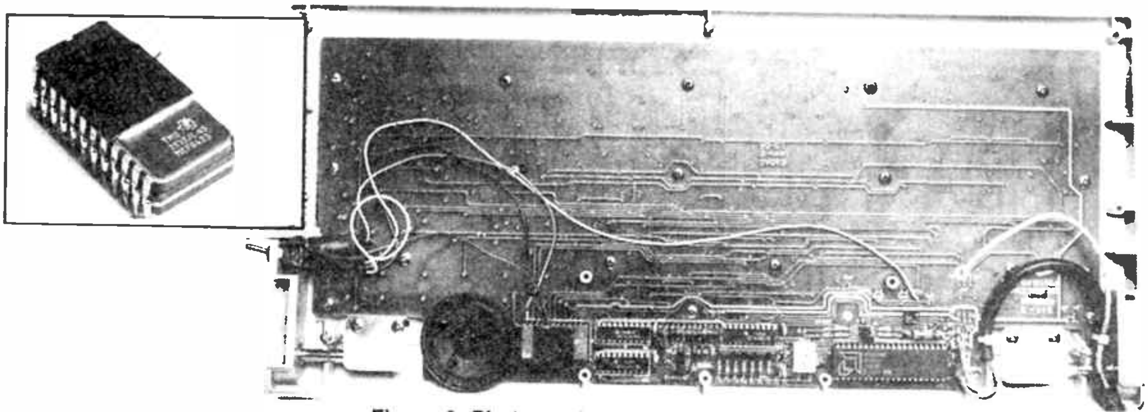


Figure 6. Photograph of internal modifications to the keyboard. Note the DPDT switch, the 'piggy-backed' EPROMs and the wires running to +5 V and pin 20 chip select (marked NUM on the overlay).

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 ....

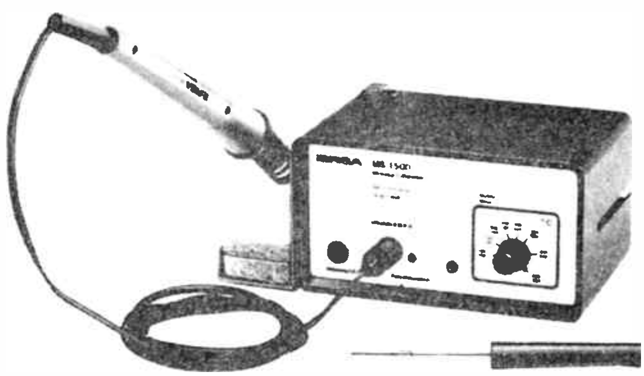
Address ....

.... 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 14 of this issue.



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

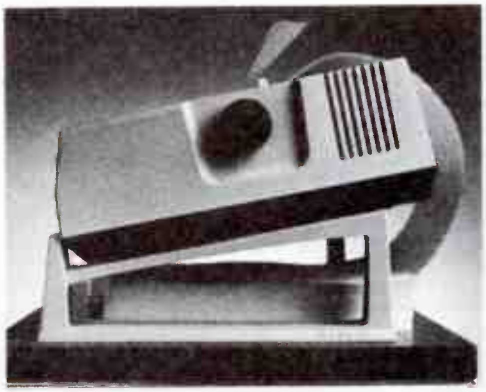
The Ersa MS1500 miniature soldering station is ideal for precision electronic soldering on today's high density pc boards. It comes with a 'Minor soldering needle' rated at 5 W, for very fine work, and the 8 W Multitip for general use. Fully variable temperature control setting is featured, providing 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.

'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



$49.95

plus $5.60 post and handling

Woops, there goes the dollar, but we've organised a saving on post and handling.

This offer is made through AEM by arrangement with Communications Power Inc., the Australian Allsop distributors.

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.

A brace of modems

Alan Ford

Inter-computer communications is the latest rage among 'computerists', professional and hobby types alike, it seems. If you're on the lookout for a modem right now, have a look at these two from Rosser Communications.

THE NAME Rosser will be familiar to a great many users of computer communications. Alex Rosser, who looks and sounds very Scottish but is in fact a naturalised Aussie and describes himself as very pro-Australian, has been running Rosser Communications in the Pymble area in Sydney for some years now. He recently moved to bigger premises on the 1051 Pacific Highway, although he tells us that it won't be long before he has to move again!

Alex specialises in modems and communications matters and has recently, with his move, updated his image with a new logo showing a cantering horse.

Two of the latest products Rosser Communications is handling are at opposite ends of the market. Firstly, we are told he has taken over from Rank Electronics the entire stock of the Xyllyx Videotex packs. These contain a Sendata 75/1200/300 baud modem, software and connecting cables to allow a variety of personal computers to connect into the Viatel or any other Videotex service. Computers catered for include the IBM PC, Apricot, Sirius, Apple II/IIe, BBC and Tandy Model III. The Xyllyx pacakge is attractively packed and would make an impressive gift.

With a few hiccups and adventures (my IBM clone has a twist in its genes somewhere and refused to acknowledge the intruder), we managed to get it going on AEM's IBM PC XT and a Data System/1. It performed faultlessly. One thing though, it doesn't seem to do 'reverse Viatel' (1200 send, 75 receive). The software, we discovered, is far more sophisticated than the modem hardware, being an "all bells & whistles" auto-damn-near-everything package. So, when you eventually upgrade to an auto-damn-near-whatall modem, you'll be fixed for software. At $399, the Xyllyx (isn't that a magic word from the classic computer game, Adventure?) package gives one pause to think.

At the other end of the scale, Rosser's latest offering is the DPX224 four-speed modem. This is a high performance multi-function modem with auto-dial, auto-answer, full Hayes command set, built-in error correction, and a host of other goodies.

What is particularly attractive about this modem is its automatic speed sensing. Just set up the communications program to 2400 baud and leave it on that setting. The model automatically tries speeds on the telephone line, from the highest down until it finds a match.

A brace of modems! On top is the Sendata, which comes with quite a sophisticated software package and costs $399. (A 'Mini Cooper S' machine). Beneath is the four-speed auto-dial DPX224 Hayes-compatible modem. It costs $1872, tax paid. (A 'BMW').

I was pleased to note that this modem includes the provision for tone dialling, as your scribe's office is on one of the new Telecom AXE exchanges with tone dialling rather than pulse. This is so much faster and easier it is almost painful to go back to the ordinary dial. Another advantage of tone dialling is that it does not produce bell tinkle on extensions on the same line.

Using the Procomm communications (a wonderful public domain program!) program with automatic redial we were able to enjoy a few glasses of orange juice while the computer and modem got on with all the hard work queueing up to get into Dick Smith's bulletin board. (Please fellas, can we have some more lines?). When the connection was successfully made our computer announced the same with a tone signal and communications began.

The transition from our old 300 baud accoustic coupler to a modem of this sophistication was reminiscent of our transition from cassette tape to floppy disk . . . those were the days!

If you're energetically pursuing a modem at present, Alex occassionally runs with that elite band, the "Hash House Harriers", who are well known for their energetic runs followed by stabilisation of the metabolism with suitable refreshment.

But if you're more inclined to sedentary pursuits, contact Rosser Communications at **Suite 4, The Pymble Professional Centre, 1051-1055 Pacific Highway, Pymble 2073 NSW. (02) 449 8233.**

AUTHOR!
AUTHOR!
AUTHOR!

So you've written this *great* article.

Tell us all about it then!

Maybe you've developed a project you think others might be interested in?

We'd like to hear from you!

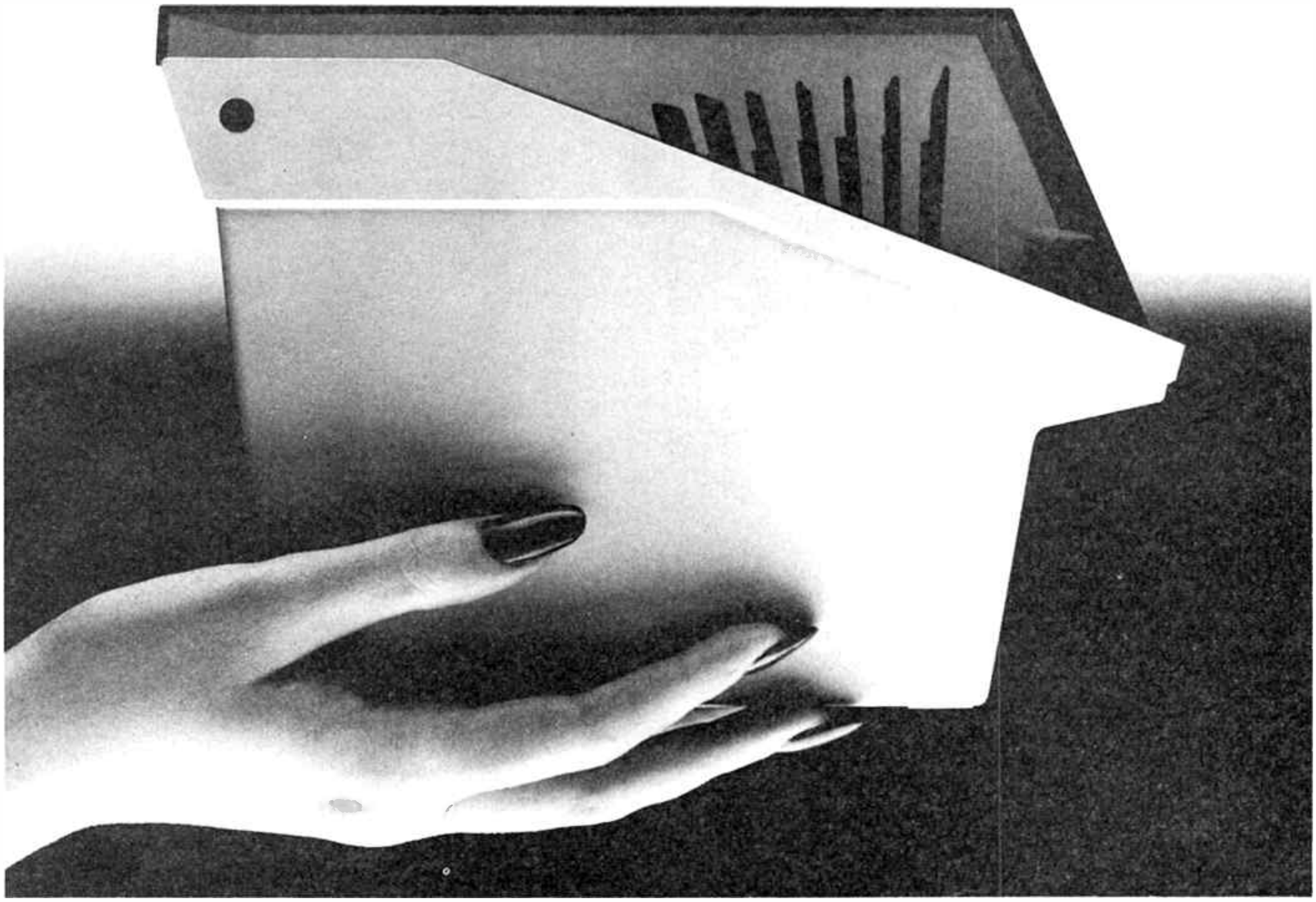
Perhaps you'd just like to write in and comment on the magazine, tell us what you think of it and what you'd like to see us doing.

We're only too happy to hear from you! (All bouquets gratefully accepted, brickbats next door, please!)

Write to:

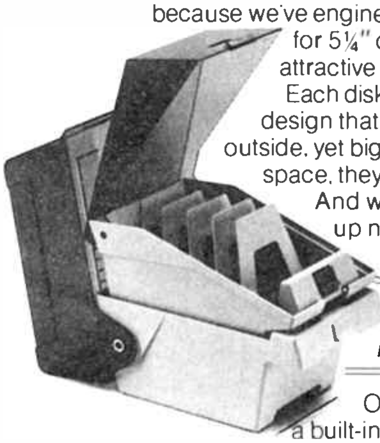
Roger Harrison
Australian Electronics Monthly
PO Box 289
WAHROONGA 2076 NSW

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.

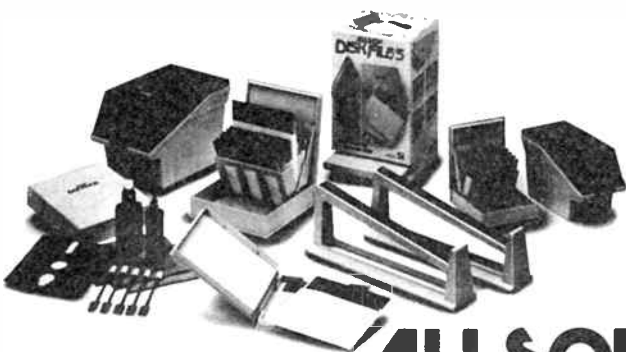
Our disk organizers also feature a built-in handle and spring-loaded latch, and are available with a unique locking system that's discreetly hidden within the latch. So you get the security you need. At a cost you can afford.

That's Allsop engineering.

Attractively priced to meet your needs, our disk organizers are a beautiful addition to your computer system.

For more information on our disk organizers, as well as our complete family of computer accessories, call us today on (02) 357 2022. Or write: Allsop Computer Products Division of Communications Power Inc. (Aust.) Pty Ltd, PO Box 246, Double Bay NSW 2082. Telex: 23381 "COMPOW".

Trade inquiries welcome.



ALLSOP®

Project modems, update 1

Our 4600 and 4610 modems, published Dec. '85 and April-July '86 respectively, have been very popular. This article commences a series of follow-ups giving hints, tips, improvements, modifications, notes and errata to assist owner/builders in getting the best from the projects.

THE AEM4600 MODEM has proved quite popular, being a relatively simple, low-cost way to acquire a modem to operate on the popular 300/300 and 1200/75 baud standards. Some readers reported difficulties with the project in various areas. Some problems were individual to the particular unit, mostly traceable to assembly or soldering difficulties, while some reported problems were common to a number of constructors. The tips and modifications given here have been largely extracted from correspondence sent by Adrian E. Tobin SMIREE Aust, who kindly provided detailed suggestions.

By the way, for those who missed it, the correct circuitry for the mode switching was given on page 76 of the February issue.

Line interface

Tobin points out that the line interface amplifier, IC2 (an LM301), has no provision for the input bias current at both the inverting and non-inverting inputs. Depending on the particular device used, the output is unlikely to have zero (or near zero) offset. If the LM301's dc output drifts, the maximum input offset of the 7910's input (pin 5) may be exceeded, shutting down the 7910. In addition, the line interface amplifier cannot be 'nulled' to minimise feedback of the transmit signal into the 7910's receive input.

Tobin's circuit modification, shown here, overcomes both these problems. With a transmit signal of 1.5 V peak-peak, feedback to the 7910's Rx input is less than 100 mV. Offset is reduced to +/- 5 mV.

Resistor R14a and trimmer R14b can be replaced by two fixed resistors, says Tobin (he used 27k and 15k in series, inserted into the space for R14). The track from C13 to pin 3 of the LM301 needs to be cut and a link made to the junction of R11 and C7. The remaining two 47k resistors and 100n capacitor may be mounted on the components side of the pc board by drilling appropriate holes and making connections to the copper side of the board.

Another, quick and simple, way to obviate the offset problem is to solder a 150k resistor from the junction of R12 and R13 to ground (OV).

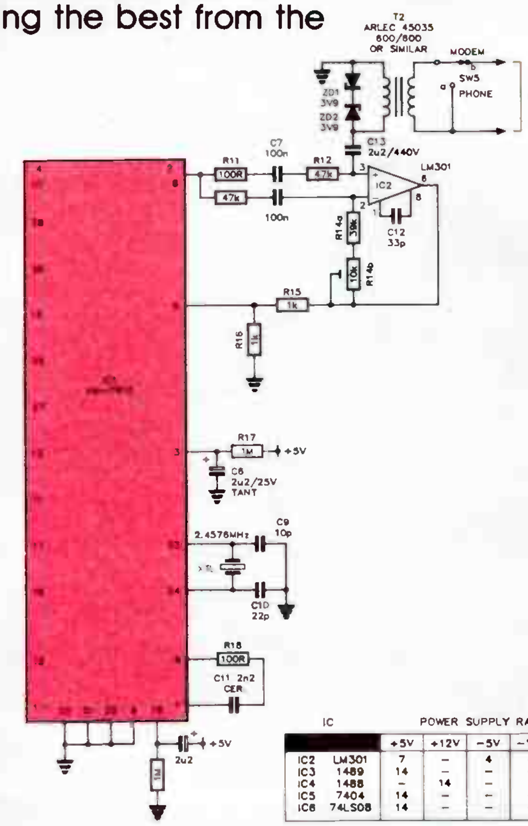
As the 4610 Super Modem employs the same line interface circuit (IC20), page 48 May '86 Although no users have reported problems here, you might like to try one of the above modifications.

The DTR pin

A further problem concerns the operation of the 7910's DTR control line. Mr Tobin says that, in some cases it will be necessary to de-activate this pin until after the power-up reset. However, some 7910's are not affected, but adding the 1M resistor and 2u2 capcitor to pin 16, as shown in the circuit here, will cover such an eventuality.

The 1488 RS232 driver

Mr Tobin, and many other readers, discovered that the 1488 RS232 line driver has its supply pins connected to the +12 V and -12 V supply rails (not shown in the circuit, page 83, Dec. '85 issue). Now these supply rail voltages are nominal only and will depend on the transformer used and its regulation. As the modem's current drain is relatively 'light', these



IC		POWER SUPPLY RAILS				
		+5V	+12V	-5V	-12V	0V
IC2	LM301	7	–	4	–	–
IC3	1489	14	–	–	–	7
IC4	1488	–	14	–	1	7
IC5	7404	14	–	–	–	7
IC6	74LS08	14	–	–	–	7

Modified portion of the AEM4600 modem circuit. Compare this to the circuit on P.83, Dec '85 issue.

rails may typically be around 14.5 V, perhaps too close for comfort to the 15 V maximum rating. Now, to "correct" this situation, Mr Tobin and many others thought it would be beter to connect the 1488 to the +/- 5 V rails. While this may work, it is not a good idea as the device really requires 7 V rails to adequately drive the line beyond the 3 V lower threshold of the RS232 spec. If you're worried about the high supply to the 1488, add some extra load to the transformer — like a suitable resistor across the supply rails, to 'load them down' somewhat (install a 100mA bezel lamp!).

The original circuit included a table of IC supply voltages and pin numbers. It contained an error, showing the 1488 as being powered from the +/- 5 V supply. The correct pin numbers and voltages are shown in the table here.

Crystal oscillator

The crystal oscillator came in for comment by a few readers, including Mr Tobin, as some had trouble getting it to work properly. To some extent, success — or lack of it, here depends on the particular crystal manufacturer. If you experience trouble, try reducing C9 to 10 pF. This ensures more reliable 'starting' of the crystal upon turn-on.

NEXT MONTH: We'll have notes and errata on the AEM4610 Super Modem project, plus a few hints and tips, and — space permitting, the circuit for a baud rate converter for the AEM4600, for those whose system can only communicate with the modem at one speed.

Hardware and software aspects of screen handling on the VZ-200/300 Part 1

Bob Kitch

This article describes the hardware aspects of the Motorola MC6847 Video Display Generator chip which is used in a number of microcomputers. Although this is an older device and lacks some of the features of newer chips, it is nevertheless a well-used device and is quite easy to interface and comprehend. To illustrate the MC6847, its use in the VZ-200 and VZ-300 computers is detailed. Additionally, some software implementations are explained and some simple hardware modifications to the VZ are given to improve screen resolution and display appearance.

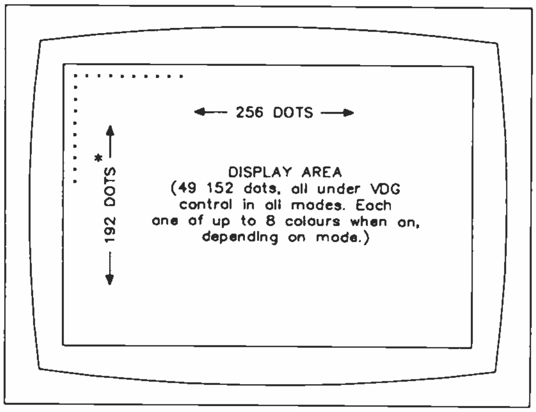
THE MOTOROLA MC6847 Video Display Generator (VDG) chip (sometimes referred to as a Cathode Ray Tube Controller — CRTC) is used to interface data read from the video RAM section of memory and to produce a modulated RF video signal or monitor output. The MC6847 is capable of operating in 14 different display modes. However, only a few of these are usually implemented in a particular installation. The MC6847 was conceived as one of the family of devices to interface with the Motorola M6800 and M68000 microprocessor families, but it can easily be adapted to other microprocessors. The VDG can be found in video games, home computers, process control displays, communications and graphics applications.

The VDG has the complex task of converting data from the screen memory into the form necessary for the raster scan display used in television and monitors. On these devices, the image is 'drawn' on the screen one horizontal scan line at a time. The 'spot' moves across the screen from right to left and its brightness or colour (chroma) is varied to produce the required display. In practice, the whole screen is built up in two passes, the first on even-numbered lines and the second on odd-numbered lines, by a process called 'interlacing' which helps to avoid flicker. The process occurs every 20 ms, or 50 half-frames are drawn every second.

Two types of VDG chip are produced by Motorola — the MC6847 for non-interlaced displays and the MC6847Y which interlaces the video display. the suffix 'P' after the device number identifies a plastic package. An enhanced version — the MC6847T1 — is also available but it is not strictly compatible with the MC6847 as it requires less external circuitry and has some additional features.

A timing or clock pulse is required to tie the scan rate and memory access cycles of the VDG in with that of the microprocessor (MPU) — otherwise chaos would reign on the bus systems! An external (to the VDG) clock is used to synchronise both the VDG and the MPU. A clock frequency of 3.58 MHz is usually selected to give the correct scan rates. If a common clock is used then often the speed of the MPU is restricted by the video display.

The format of the display area under the control of the VDG is actually 256 'dots' across by 192 'dots' down giving a total of 49 152 fundamental picture elements (pixels) under the 'control' of the VDG. Each pixel may be one of up to eight colours, depending upon the mode selected (see Figure 1.).



* One on each non-interlaced line. For interlace, the lines of the odd field are copied into the even field thus doubling the number of displayed dots.

Figure 1. Typical Format of the Monitor Screen. The border is black in Alphanumeric and Semigraphic modes and green or buff in Graphic modes.

As you will have observed, the MC6847 does not utilise the entire video screen. The standard video screen consists of 262 scan lines extending across the screen, but the usable display window is offset from the top by 25 lines and extends 192 lines down the screen with a further 25 lines at the bottom being offset. Across the screen, the timing pulses are blanked-off to reduce the useable horizontal width. The linearity of images is better in the central portion of a screen and this is used by the VDG.

The screen is 'memory mapped' with each pixel on the screen being represented by a byte (or a number of bits thereof) in the video RAM. There is a one-to-one correspondence between the X-Y location of the pixel on the screen and the address of its control information in memory. The sequence of memory addresses, which are accessed to extract data to be converted to a video signal, is controlled by the VDG. The VDG also keeps track of the position of the moving spot and produces the necessary timing signals to synchronise the display to the computer. It produces, for instance, the horizon- ▶

tal sync pulse to indicate when the end of the video line has been reached so that the spot can 'flyback' to the beginning of the next scan line. This pulse also permits the MPU to access video memory during the blanking period, thereby avoiding flicker.

The decoding of the data input to the VDG is usually done by a character generator. This may be a pre-programmed, on-chip ROM in the MC6847 or an external, perhaps programmable, character generator.

The display modes that the MC6847 may operate in are set out in Table 1. this tabulation summarises much of the information about the VDG chip. The way in which these features are selected is in-line with most digital devices. The pin assignment diagram for the MC6847 is shown on Figure 2. The chip is an N-channel, silicon gate device with most signals being TTL compatible. The device is housed in a 40-pin DIL package. The amount of memory required by the various display modes is a trade-off against element size or resolution of the display in pixels. This feature will become more apparent later.

The lines into, or out of, the VDG can be grouped into six classes but classes i) to iv) are the most important to this discussion.

i) **Address Lines.** (DAO — DA12) These permit up to 8K of video memory to be directly addressed, although only 6K is ever required. The absolute location of the video memory in the computer system will depend upon the address decoding used. The starting address is located at the upper left-hand corner of the screen. The activity of the address lines is regulated by the *MS pin and the display mode selected.

ii) **Date Lines.** (DDO — DD7) These are used to input values in RAM memory to be mapped onto the screen. The values are decoded within the chip with repsect to shape, luminance and chroma (see later).

iii) **Mode control Lines.** There are eight important lines into the VDG which control the 14 display modes. These are detailed in Table 1. Three major types of display may be selected: **(a)** Alphanumerics, **(b)** Semigraphics and, **(c)** Graphics.

The implementation of these displays within the VDG is quite different in each case.

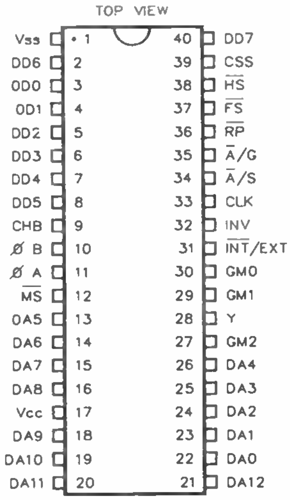


Figure 2. Pin-out for Motorola MC6847 Video Display Generator chip as used in the VZ computers.

Switching the screen to Alphanumerics or Graphics mode is determined by the (*A/G) line.

Switching the screen between Alphanumerics or Semigraphics mode is set by the (*A/S) line.

Selection of the internal (on-chip) or external character sets held in ROM is set by the (*INT/EXT) line. In Semigraphics mode this line determines whether SG4 or SG6 mode is selected.

Normal or inverse Alphanumeric displays are set by the (INV) line. Three lines (GMO, GM1, GM2) are used to select one-of-eight Graphics modes to be used.

An eighth control line (CSS) selects the colour set to be used in the particular mode selected. Most modes have two colour sets available.

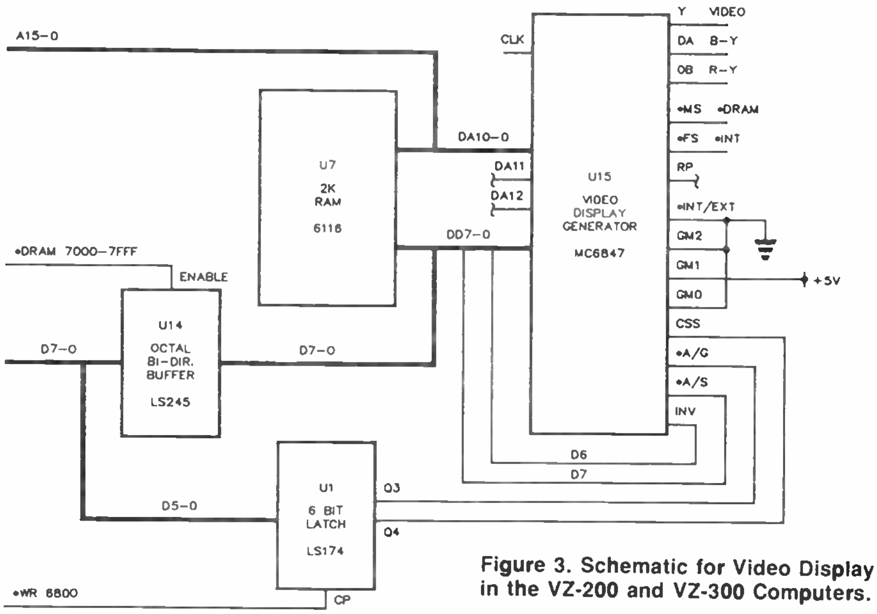
In Alphanumeric and Semigraphics 4 modes, one-of-two background colours is selected and in Semigraphics 6 and Full Graphics modes one-of-two colour sets is selected.

The operating mode of *A/S, *INT/EXT, CSS and INV may be changed on a character by character basis in Alphanumerics and Semigraphics mode.

TABLE 1:
SUMMARY OF DISPLAY MODES FOR MC6847 VDG

	colours available	bytes video RAM	memory mapping	element size	Control Lines *A/G	*A/S	*INT/EXT	INV	GMO	GM1	GM2
Four ALPHANUMERIC Display Modes											
i) Internal ROM Alphanumerics	2	512	byte	BX12	0	0	0	0	x	x	x
ii) Internal ROM Alphanumerics — Inverted	2	512	byte	BX12	0	0	0	1	x	x	x
iii) External ROM Alphanumerics	2	512	byte	BX12	0	0	1	0	x	x	x
iv) External ROM Alphanumerics — Inverted	2	512	byte	BX12	0	0	1	1	x	x	x
Two SEMI-GRAPHIC Display Modes											
v) 32 by 16 Semigraphics 4 (SG4)	8	512	byte	BX12	0	1	0	x	x	x	x
vi) 32 By 16 Semigraphics 6 (SG6)	4	512	byte	BX12	0	1	1	x	x	x	x
Eight GRAPHIC Display Modes											
vii) 64 by 64 Colour Graphics One (CG1)	4	1024	2 bit	3x4	1	x	x	x	0	0	0
iix) 128 by 64 Resolution Graphics One (RG1)	2	1024	1 bit	2x3	1	x	x	x	0	0	1
ix) 128 by 64 Colour Graphics Two (CG2)	4	2048	2 bit	2x3	1	x	x	x	0	1	0
x) 128 by 96 Resolution Graphics Two (RG2)	2	1536	1 bit	2x2	1	x	x	x	0	1	1
xi) 128 by 96 Colour Graphics Three (CG3)	4	3072	2 bit	2x2	1	x	x	x	1	0	0
xii) 128 by 192 Resolution Graphics Three (RG3)	2	3072	1 bit	sx1	1	x	x	x	1	0	1
xiii) 128 by 192 Colour Graphics Six (CG6)	4	6144	2 bit	2x1	1	x	x	x	1	1	0
xiv) 256 by 192 Resolution Graphics Six (RG6)	2	6144	1 bit	1x1	1	x	x	x	1	1	1

The IEEE standard for electrical state relationships uses the suffix '' instead of the overbar '‾' to designate when an electrical signal is active low.*



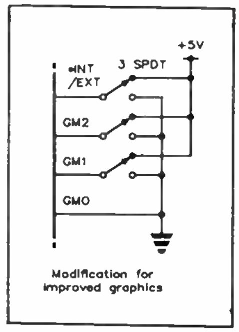


Figure 3. Schematic for Video Display in the VZ-200 and VZ-300 Computers.

iv) Power Supply.

Vss: 0 V supply — normally ground.
Vcc: +5 supply.

v) Video Lines.

These are four analogue signals:

OA	B-Y chroma	— a three-level signal used in combination with OB and Y to specify one-of-eight colours.
OB	R-Y chroma	— a four-level signal; the fourth is used as colour burst timing reference.
Y	luminance	— a six-level signal containing composite sync, blanking and four levels of luminance.

CHB chroma bias or a test point — not used in applications.

vi) Device Synchronising Controls.

*MS memory select, three-state control to allow the MPU to address the video RAM.

CLK 3.579 MHz clock.

*FS field sync to indicate the end of the active display area during which time the MPU may have access to the video RAM without causing undesirable flicker on the screen.

*HS horizontal sync to the TV receiver.

*RP row preset — important when an external character generator ROM is used.

From this brief description, a grasp of how the VDG operates may be gleaned. We will now examine how this particular VDG chip is used in a home computer application — the VZ computer.

The MC6847 in the VZ-200/300 computer

In the VZ computer a number of display modes using the MC6847 are available. Specifically, modes (i), (ii), (v) and (ix) on Table 1 are implemented as standard on the VZ. These modes are 'soft switched' or software selectable from the ROM-resident BASIC and will be described in detail later in this article.

The video display system in the VZ consists of a number of components or 'blocks' — but the heart of the display system is the VDG just described. This device interfaces with 2K of dynamic video RAM which occupies 7000H to 77FFH of the memory map for the Z8OA MPU used in the VZs. Additionally, a hex write-only latch mapped at 6800H (but extending to 6FFFH due to simplified address decoding) controls, via software, the display modes implemented on the VZ.

The analogue outputs from the BDG are processed by further video circuitry which need not concern us here. All of these blocks are synchronised by a 3.58 MHz clock. This is an instance where the full speed of the Z80A (4 MHz) is not realised due to impositions by the video display.

More significantly however, the architecture of the VZ has only allowed 2K of RAM for the video display. This effectively prohibits the implementation of some of the hi-res graphics modes. [Specifically, modes (xi) to (xiv) in Table 1]. The VZ does not contain an external character generator ROM and relies entirely upon the VDG on-chip character ROM. Clearly, the VZ is manufactured to a price (and a very attractive one at that!) and was designed to interface with Microsoft's BASIC Level II ROM routines. Despite these comments, there are opportunities to make a few slight and simple changes to the hardware around the VDG to implement additional display modes with improved resolution. It is also possible to add an external character generator — but more of these later.

Figure 3 is a diagrammatic representation of the way in which the MC6847 VDG is interconnected in the VZ computers. The address lines DAO-DA10 (11 lines) are connected to U7 — a 6116 2K RAM chip — which is mapped as the video RAM section of memory. Lines DA11 and DA12 are not connected, thereby limiting the addressable video memory to 2K. Data lines DDO-DD7 (eight lines) are connected into the data bus from the MPU of which the 2K video RAM memory of course forms a part. The way in which the eight control lines are connected is of interest as these determine the type of displays available on the VZ.

Reference to Table 1 will indicate how the control lines are configured. The Graphics display group consist of GMO, GM1 and GM2. As can be seen from Figure 3, both GM0 and GM2 are tied low (to ground) whilst GM1 is tied high, to the +5 V Supply. Similarly, *INT/EXT is permanently tied low, thereby enabling the on-chip character generator ROM. The configuration of GM0-GM2 to 010B means that only Colour Graphics Two (CG2) is implemented when Graphics mode is selected. ▶

The remaining four control lines are interesting as they are not 'hard-wired' but are set up to be 'soft switched' — although two quite different techniques are used.

The INV line is connected to bit 6, or DD6, of the data bus. Thus, whilst in Alphanumeric mode, the second most significant bit of a byte contained in video RAM controls whether a normal or inverse character is displayed. The line that selects between Alphanumeric and Semigraphic modes — *A/S — is similarly connected to the most significant bit or DD7. thus this bit determines whether the VDG should interpret a particular byte as an ASCII character or a graphics shape.

The remaining two lines are connected into the Output Latch mapped into 6800H. As mentioned before, this is a 6-bit write-only latch. It permits certain software commands to set or reset a particular bit of the latch and hence switch or control specific hardware interfaces. Figure 4 is a schematic of the portions of the latch which is of interest to us here. A copy of the latch is held in RAM at location 783BH. The *A/G line, which selects between hi- or lo-res screens, is connected to bit 3 of the Output Latch. If this bit is low or 0, then the screen is in lo-res mode which corresponds to Alphanumeric and Semigraphic modes. If the bit is high or 1, then hi-res or Graphics (CG2) mode is selected. It is quite simple to see that the MODE (X) command in BASIC directly sets this bit of the latch — where X maybe 1 or 0. Note that bit 3 of the latch corresponds to a value of 0BH on the latch.

The Colour Select line (CSS) is connected to bit 4 on the latch which maps as a value of 0FH. The effect of this line differs according to the mode selected. The CSS pin selects the background colour of the display and in so doing determines the colour set which may be displayed. When CSS is low or 0 the background colour is green, but if set high or 1, then in lo-res the background colour is orange, but if in hi-res then the background is buff. Sounds a little confusing — but actually it isn't, given a little thought and reflection on Table 1 and Figure 1. Furthermore, in hi-res mode this pin selects which of the two colour sets (each containing four colours) will be selected. Colour set 0 consists of green, yellow, blue and red, whilst colour set 1 consists of buff, cyan, magenta and orange. Clearly, this pin is set by the COLOR F, B command where B determines the background colour and F determines foreground colour.

An understanding of the operation of the mode control lines gives a good insight into how the BASIC interpreter interfaces with the hardware and the real world via the screen display.

For the hardware enthusiasts, and others closely following this article, the penny should have dropped as to how other screen modes can be made selectable on the VZ by some simple hardware alterations.

Improved graphics on the VZ computer

One of the disappointing features of the graphics capability of the VZ is that the Semigraphics (SG4) and Graphics (CG2) modes have rectangular characters and elements which considerably detract from the appearance of the displays. This feature can be remedied.

The following simple hardware modifications are outlined for those who feel they are competent tackle it. They involve the installation of three switches on the VZ. Figure 3 provides an indication of what is required.

If *INT/EXT can be switched high, then Semigraphic mode SG6 becomes available on the computer. This has the advantage of giving higher screen resolution and, although the characters are still rectangular, their elements are square rather than rectangular as in the standard implementation of SG4 mode.

In Graphics mode, only CG2 is available in the VZ. By switching GM1 and GM2 it is possible with the 2K of video

Figure 4. Schematic of Output Latch mapped at 6800H (26624D) in VZ computers. (Other latches are used to control piezo-speaker and cassette output)

BIT		
5		
4	Q4 → CSS	VDG background colour. 0 green (hi- and lo-res) 1 orange (lo-res) buff (hi-res)
3	Q3 → $\bar{A}$/G	VDG display mode. 0 lo-res 1 hi-res
2		
1		

memory to implement a further three modes (CG1, RG1 and RG2). There is little point in switching GM0 as there is insufficient memory to cover modes (xi) to (xiv). The element size in SG6 and CG1 is the same (3x4 pixels) and so there is little to choose between them — although their usage of memory is different and the characters in SG6 mode can be 'specified' through the keyboard as is done in SG4 mode on the VZ.

RG1 has the same resolution as the standard MODE (1) display but is only two-colour and consequently uses only half the memory space. the real benefit of adding the switches is in obtaining RG2 mode on the VZ. Although this only two colour, the element size is 2x2 pixels and is square. This is a great mode for plotting graphs for instance, where the screen resolution is 128 elements across by 96 elements down the screen.

To achieve this modification, use three SPDT toggle switches. Wire one side of each switch to +5 V, or pin 17 on the VDG, and wire the other side of each switch to ground or pin 1 of the chip. Cut the tracks leading from pins 27, 29 and 31 (GM2, GM1 and *INT/EXT) and wire the chip side to the centre terminal of a switch. This enables the three control lines to be switched high or low. (See inset on Figure 3.)

There you have it! It remains now to develop suitable software to drive these additional modes. The possibilities opened by the 'square' modes of SG6 and RG2 are exciting. (Who is going to submit some drivers for this conversion?)

As an afterthought, whilst you have got the VZ on the bench, why not add a RESET switch? A normally closed push-button switch inserted into the 'reset on power-up' line overcomes the annoying business of powering-down the VZ for resetting.

— continued next month.

New line of handheld scanners

Captain Communications, Sydney's self-styled "leading communications specialist", has recently landed the latest range of handheld scanners from Uniden-Bearcat. The Bearcat scanners have always pioneered the field, but this new handheld range is "something else again", according to David Gill, of Captain.

Not only are the prices "too hot to print" but, according to David, these scanners incorporate features that were not available on even expensive base station units a couple of years ago.

The scanners are extremely compact and rugged — "you could take them onto a battlefield", according to David. Sensitivity, is said to be extremely high, helped by the Bearcat's exclusive 'track tuning' circuitry.

The new Bearcat range include: Model 50 XL (pictured), low-cost handheld scanner with more features than many large (and very expensive) base station units. Its features include: *Direct Channel Access* — enter any channel for instant access or step through each channel individually; *10-band coverage* — includes low and high UHF, and UHF "T" public service bands, the 2, 6 10 m and 70 cm amateurs bands, specifically designed to cover the Australian bands; *Auto lockout* — program the scanner to skip any number of channels not of current interest; *Scan delay* — adds a three-second delay to all channels scanned so you won't miss any of the action; *Track tuning* — works right across the band providing automatic alignment for each frequency monitored.

The Model *100XL* is Bearcat's top of the handheld. Sixteen channels cover nine bands, including the aircraft bands. Your priority frequency is checked automatically every two seconds. The keyboard can be locked to prevent accidental programming. The LCD display is lighted for better night viewing.

For further information, contact **David Gill, Captain Communications, 28 Parkes Street, Parramatta NSW. (02) 633 4333.**

Bearcat's new scanner, the Model 50XL, features 10-band coverage, a backlit LCD display and 'track tuning'.

New solid state RF switch

Benmar International has announced the recently introduced new Model OS-1022, 10-2000 MHz, SPDT solid state RF switch, produced by Alpha Industries' Microelectronics Division.

This unit features 40 ohm termination (non-reflective), 2.0 dB insertion loss, TTL compatibility, excellent stability over temperature range, hermetic enclosure and a 25 nsec switching speed, Alpha claim.

Other specifications include 1.5:1 VSWR, 40 dB isolation, and 50 mA typical current draw at +5 Vdc.

Alpha Industries is a major manufacturer of materials, devices, components and subsystems used in microwave applications for the defense electronics, commercial telecommunications and other commercial markets; represented in Australia by **Benmar International Pty Ltd, GPO Box 4048, Sydney 2001 NSW. (02) 233 7939.**

Microwave directional couplers

Flann Microwave Instruments are a new series of broadband multihole directional couplers now with a directivity of more than 50 dB for most microwave bands between 2.6 and 50 GHz.

When used in high quality measurement systems, for example those associated with reflectometer or network analyser techniques, the new couplers will directly contribute to a far higher overall accuracy of measurement, Flann claims.

The couplers are the conventional three-port design with an extremely low return loss integral termination. The standard coupling values are 10 and 20 dB.

Further information is available, upon request, from **Flann Microwave Instruments Limited, Dunmere Road, Bodmin, Cornwall U.K. P131 2QL.**

Hornsby hamateurs hammer hon

Hornsby and District Amateur Radio Club, one of Sydney's most active clubs, shuffled their committees at their AGM earlier this year, to get on with the club's business in 1986/87.

The '86-'87 President is Tony Lamacchia VK2BTL, Vice-President is David Ramsay VK2KLX, Secretary is David Priday VK2CDZ, Publicity Officer Colin Christie VK2PLV and the Club's Treasurer and Newsletter ('QUA') Editor is Trevor Smith VK2ECD.

HADARC holds meetings on the fourth Tuesday of each month at the Asquith Sports Club Hall, Old Berowra Rd, Hornsby (adjacent to Storey Park). Club net nights are on MOnday from 2000 hrs EAST under VK2APF on 28.370 MHz and sometimes 3.615 MHz and 147.25 MHz.

HADARC can be contacted by post through **PO Box 362, Hornsby 2077 NSW.**

Coaxial relay

The Toyo Tsusho CX-520D coaxial relay, released here through Imark Pty Ltd, is a high quality, high specification switch, for use with antenna feedline systems up to frequencies of 2.5 GHz.

The CX-520D will handle 1kW up to 30 MHz, and 300 watts up to 1000 MHz, Toyo claim. The magnetic switch is operated by low voltage dc (12 V nominal) and draws only 160 mA @ 12 Vdc. Switching time is less than 20 milliseconds, according to the specification.

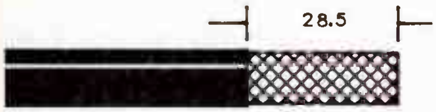
The CX-520-D features low insertion loss, better than 50 dB isolation @ 1000 MHz, low standing wave ratio and has a circuit impedance of 50 ohms. N-type connectors are used. Dimensions are only 53(W) × 53(D) × 50(H) mm and the weight is approx. 200 grams.

Further details can be obtained from the importers, **Imark Pty Ltd, 167 Roden Street, West Melbourne 3003 Vic. (03) 329 5433.**

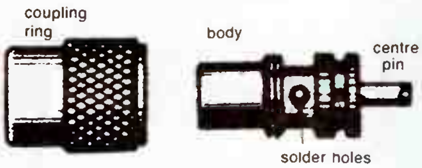
HOW TO TERMINATE COMMON

PL259 ('UHF' TYPE)

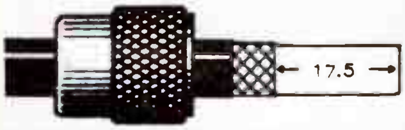
For large diameter 50 or 75 ohm cables.



1: Cut the end of the cable square. Carefully cut through and remove the outer sheath 28.5 mm from the end, taking care not to nick the braid beneath.

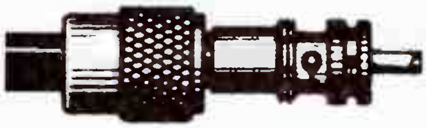


2: Disassemble the connector.



3: Slide the coupling ring onto the cable. 17.5 mm back from the cable end, carefully cut through the braid and remove the end bit. Using a hot iron, lightly tin the remaining exposed braid.

4: Remove 16 mm of dielectric, taking care not to nick the centre conductor. Using a hot iron, lightly tin the centre conductor.



5: Fit the plug body onto the prepared cable. Solder the plug body to the braid through the solder holes. You'll need a high heat capacity iron for this.

6: Screw the coupling ring down over the plug assembly.

PL259 ('UHF' TYPE)

(with adaptor)

For small diameter (4.95, 6.15 mm o.d.) 50 or 75 ohm cables.

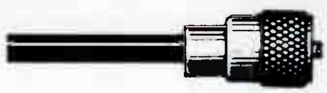
1: Cut the end of the cable square. Carefully cut through and remove the outer sheath 19 mm from the end, taking care not to nick the braid beneath.

2: Disassemble the connector.

3: Slide the coupling ring and adaptor onto the cable sheath. Fan back the braid over the sheath. Slide the adaptor down to it and compress the braid over it. Trim off excess braid.

4: Remove 16 mm of dielectric, taking care not to nick the centre conductor. Using a hot iron and working quickly, lightly tin the centre conductor.

5: Screw the plug body onto the adaptor. If you wish, you may now solder the braid to the body through the solder holes. You'll need a high heat capacity iron for this.



6: Screw the coupling ring down over the plug assembly.

BELLING-LEE ('PAL') PLUG

For 75 ohm 6.15 mm o.d. coax cable (e.g: RG59A/U)

1: Cut the coax cable end square. Carefully cut through and remove the outer sheath 22 mm back from the end, taking care not to nick the braid beneath.

2: 16 mm back from the cable end, cut through the braid and dielectric, right through to the centre conductor, taking care not to nick the latter. Using a hot soldering iron, quickly and lightly tin the centre conductor.

3: Disassemble the connector.

4: Slide the cap and collet clamp over the cable. Seat the end of the collet clamp just at the end of the outer sheath and lightly squeeze the collet fingers to hold it in position. Comb out the braid and fan it back over the collet clamp.

5: Slip the centre pin sub-assembly on the cable, seating it well back on the braid and collet. Quickly solder the centre conductor to the plug's centre pin. Take care to not overheat it or else you'll melt the insulator.

6: Push the plug body onto the sub-assembly, ensuring it seats properly with the centre pin more or less flush with the end of the plug body. Screw the cap onto the body, forcing the collet clamp fingers onto the coax sheath.

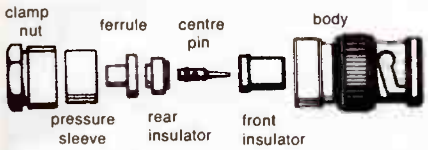
Tools: you will need a sharp 'hobby' knife or penknife; sharp, small-bladed sidecutters; small adjustable spanner; long-nosed pliers; soldering iron.

RF CONNECTORS

BNC MALE

For 50 ohm, 4.95 mm o.d. coax cable (e.g: RG58C/U)

1: Cut the end of the cable square. Carefully cut through and remove the outer sheath 8 mm from the end, taking care not to nick the braid beneath.



2: Disassemble the connector.

3: Slide the clamp nut and rubber pressure sleeve over the cable. Carefully comb out the braid with a scriber point or small screwdriver blade.

4: Fold back the braid and insert the ferrule between the cable's braid and dielectric so that the ferrule's flange seats firmly against the braid and sheath. Trim off the excess braid with sharp sidecutters.

5: Remove 5 mm of dielectric, taking care not to nick the centre conductor. Using a hot iron and working quickly, lightly tin the protruding centre conductor.

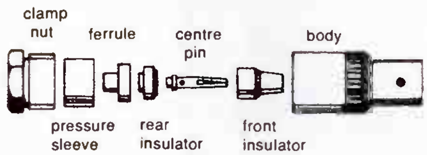
6: Slide the rear insulator over the cable centre conductor, pushing it hard against the ferrule. Then slide the centre pin on the centre conductor. Apply the hot iron tip to the body of the centre pin to preheat it, leaving the small hole in it upturned. After a few seconds heating, apply solder to the area of the hole in the centre pin and see that the solder flows freely. Don't apply too much solder.

7: Fit the front insulator into the connector body and push it carefully onto the sub-assembly. Slide the pressure sleeve into the body and screw in the clamp nut to secure the cable.

BNC FEMALE

For 50 ohm, 4.95 mm o.d. coax cable (e.g: RG58C/U)

1: Cut the end of the cable square. Carefully cut through and remove the outer sheath 8 mm from the end, taking care not to nick the braid beneath.



2: Disassemble the connector.

3: Slide the clamp nut and rubber pressure sleeve over the cable. Carefully comb out the braid with a scriber point or small screwdriver blade.

4: Fold back the braid and insert the ferrule between the cable's braid and dielectric so that the ferrule's flange seats firmly against the braid and sheath. Trim off the excess braid with sharp sidecutters.

5: Remove 5 mm of dielectric, taking care not to nick the centre conductor. Using a hot iron and working quickly, lightly tin the protruding centre conductor.

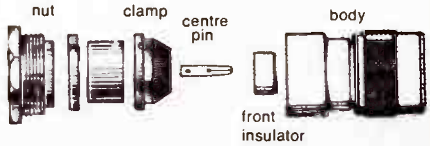
6: Slide the rear insulator over the cable centre conductor, pushing it hard against the ferrule. Then slide the centre pin on the centre conductor. Apply the hot iron tip to the body of the centre pin to preheat it, leaving the small hole in it upturned. After a few seconds heating, apply solder to the area of the hole in the centre pin and see that the solder flows freely. Don't apply too much solder.

7: Fit the front insulator into the connector body and push it carefully onto the sub-assembly. Slide the pressure sleeve into the body and screw in the clamp nut to secure the cable.

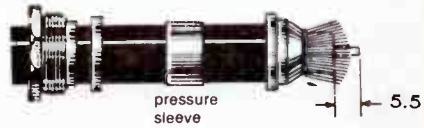
N TYPE

For 50 ohm, 10.3 mm o.d. cables (e.g: RG8A/U, RG213/U)

1: Cut the end of the cable square. Carefully cut through and remove the outer sheath 9 mm from the end, taking care not to nick the braid beneath.



2: Disassemble the connector.



3: Slide the nut, etc and rubber pressure sleeve over the cable. Carefully comb out the braid with a scriber point or small screwdriver blade. Fold back the braid and seat the clamp against it. Trim off the excess braid with sharp sidecutters.

4: Remove 5.5 mm of dielectric, taking care not to nick the centre conductor. Using a hot iron, lightly tin the protruding centre conductor.

5: Then slide the centre pin over the centre conductor. Apply the hot iron tip to the body of the centre pin to preheat it, leaving the small hole in it upturned. After a few seconds heating, apply solder to the area of the hole in the centre pin and see that the solder flows freely. Don't apply too much solder.

6: Fit the front insulator into the connector body and push it carefully onto the sub-assembly. Slide the pressure sleeve into the body and screw in the clamp nut to secure the cable.

1ST BIRTHDAY CONTEST No. 5.

Win this Regency HX1000 VHF/UHF handheld scanner from Emtronics.

The Regency HX1000 handheld scanner covers six bands: 30-50 MHz, 144-148 MHz, 148-174 MHz, 440-450 MHz, 450-470 MHz and 470-512 MHz. It features keyboard programming and you can store up to 30 channel frequencies to scan your favourite channels at 16 channels per second, or scan the VHF bands at 17 seconds per MHz and the UHF bands at eight seconds per MHz. Sensitivity for 12 dB SINAD on the VHF bands is given as 0.5 μV on UHF. It is powered from 9.6 Vdc, battery source or mains power supply. The HX1000 measures just 70 × 48 × 197 mm.

Wouldn't you like to win this great little scanner? It's simple — just answer correctly the questions here and write us a little essay on what you could do with the HX1000 scanner.

1ST BIRTHDAY CONTEST No. 5.

Q1: What are the frequency limits of the UHF CRS band?

....

Q2: What are the search frequency increments of the HX1000 on VHF and UHF?

....

Q3: What does the term "SINAD" stand for?

....

Now write for us, on a separate sheet of paper, using 30 words or less, on what you would like to do with a HX1000 scanner.

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 14 of this issue.

SOFTWARE FOR THE

SATELLITE FAX DECODER

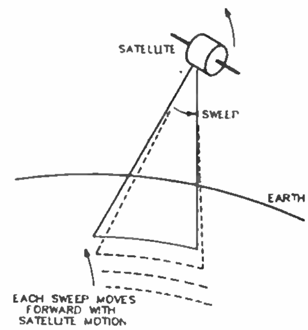
July 1986

Daunted at the prospect of keying-in that machine code?

By arrangement with the author, Tom Moffat, we are able to offer you software on cassette tape or diskette for just:

$17.00

plus $2.50 post & handling



All you have to do is:

- send us a blank C10 cassette or a blank diskette (3.5" or 5.25").
- fill out the return-address label below and **firmly** attach it to your tape or diskette.
- fill out the COUPON and send it to us, together with your labelled tape or diskette, enclosing payment by cheque or Money Order or your Credit Card details.

Enclose your blank tape or diskette in a jiffy bag for protection. Put 5.25" diskettes between stiff cardboard.

All mail orders will be despatched by certified mail.

Please allow for normal turnaround post delays prevailing at time of sending order.

We will gladly re-record any software that does not run.

Fill in and cut out this coupon, cut off and attach the return-address label to your tape or diskette and send it to:

Australian Electronics Monthly
PO Box 289, WAHROONGA 2076 NSW

COUPON

Yes please! Rush me software for the Microbee

SATELLITE FAX DECODER

Cost: $17.00 plus $2.50 post & handling

TOTAL: $19.50

I enclose payment by:

Credit Card No.:

Expiry Date: . . ./. . ./. . .

Signed: ....
(Unsigned orders cannot be accepted)

Cheque or Money Order No. ....*
(Please make cheques or Money Orders payable to 'Australian Electronics Monthly')*

RETURN-ADDRESS LABEL

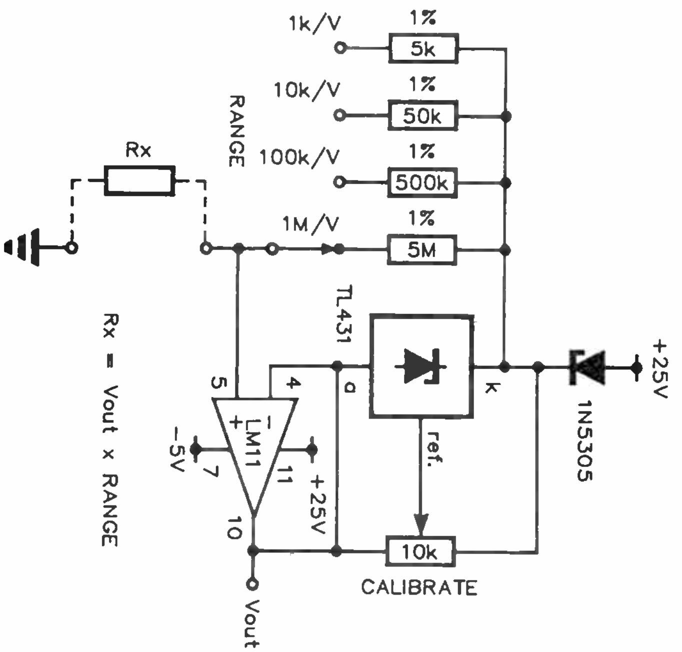
....

RUSH ME TO: .... **(name)**

Address ....

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

BenchBook



Linear ohmmeter

A linear-reading ohmmeter permits using a standard-scale meter, apart from the convenience of eliminating the crowding that occurs at the end of the scale of conventional ohmmeters.

This circuit employs Motorola's programmable precision reference zener IC, the TL431. The National LM11 op-amp acts as an output buffer/meter driver.

The reference maintains a constant voltage across the series combination of the unknown resistor (Rx) and the range resistor selected by the switch. The voltage dropped across Rx is then a direct linear measure of its resistance.

The unit could be used to drive a moving coil voltmeter for linear readout, or a digital panel meter. Only 2 mA is drawn from the positive supply rail. Note the use of 1% resistors in the range selection. Note that most common panel meters of good quality only have a full-scale accuracy of 2% (Class 2) or 2.5% (Class 2.5). If accuracy no better than 5% is needed, then the range resistor values may be made up from common 5% resistors — 5k0 can be made up from a 4k7 and a 270R in series.

L. Brown
Eastlakes, NSW.

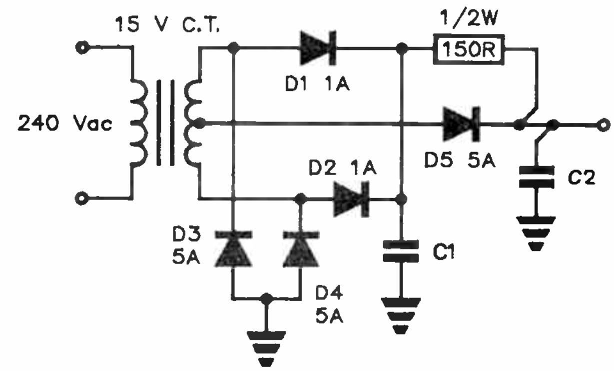
Cheap & cheerful boxes

A cheap, easy way to house electronic projects is an empty music cassette case.

Remove the cardboard sleeve from inside the case and replace it with blank paper, then snap off the spool holders from inside the opaque (dark) plastic half of the case.

Although large value electrolytics and D cells are too big, smaller projects using AA cells will fit, to make a neat, cheap alternative to a jiffy box.

Paul Henningsen
Seacombe Gardens, S.A.



Solenoid "kick start" supply

Solenoids (and large relays for that matter) require large initial voltage/current to pull in and reduced voltage and current to "hold in". This supply circuit will provide the required increased voltage and current "kick start" which then falls to hold the solenoid or relay operated.

Diodes D1 to D4 form a bridge rectifier, charging C1 and C2 to about 21 V from the 15 V transformer secondary. When the solenoid/relay is connected, D5 shunts D1, D2 and the 150 ohm resistor, diodes D3 and D4 providing the return circuit. the voltage across C2 then falls to about 8 V. The transformer only need be rated to provide the solenoid/relay hold-in current.

I used this circuit to energise an auto compressor solenoid (air conditioning type) at minimum cost, employing a standard small "2155" transformer.

John Hewson
Lindisfarne, Tas.

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.

We'll pay from $10 to $100 for each item published. Send your gems to **'Benchbook', Australian Electronics Monthly, PO Box 289, Wahroonga NSW 2076.** Please include your postal address for publication with your item(s).

As far as reasonably possible, material published in Benchbook has been checked for accuracy and feasibility etc, but has not necessarily been built and tested in our laboratory. We cannot provide constructional details or conduct correspondence or technical enquiries.

The Last Laugh

GEORG OHM was not a lawyer, though he has a famous law named after him. He was Professor of Mathematics and Physics at the Polytechnic Institute of Cologne (Germany) in the 1820s when he became interested in matters electrical.

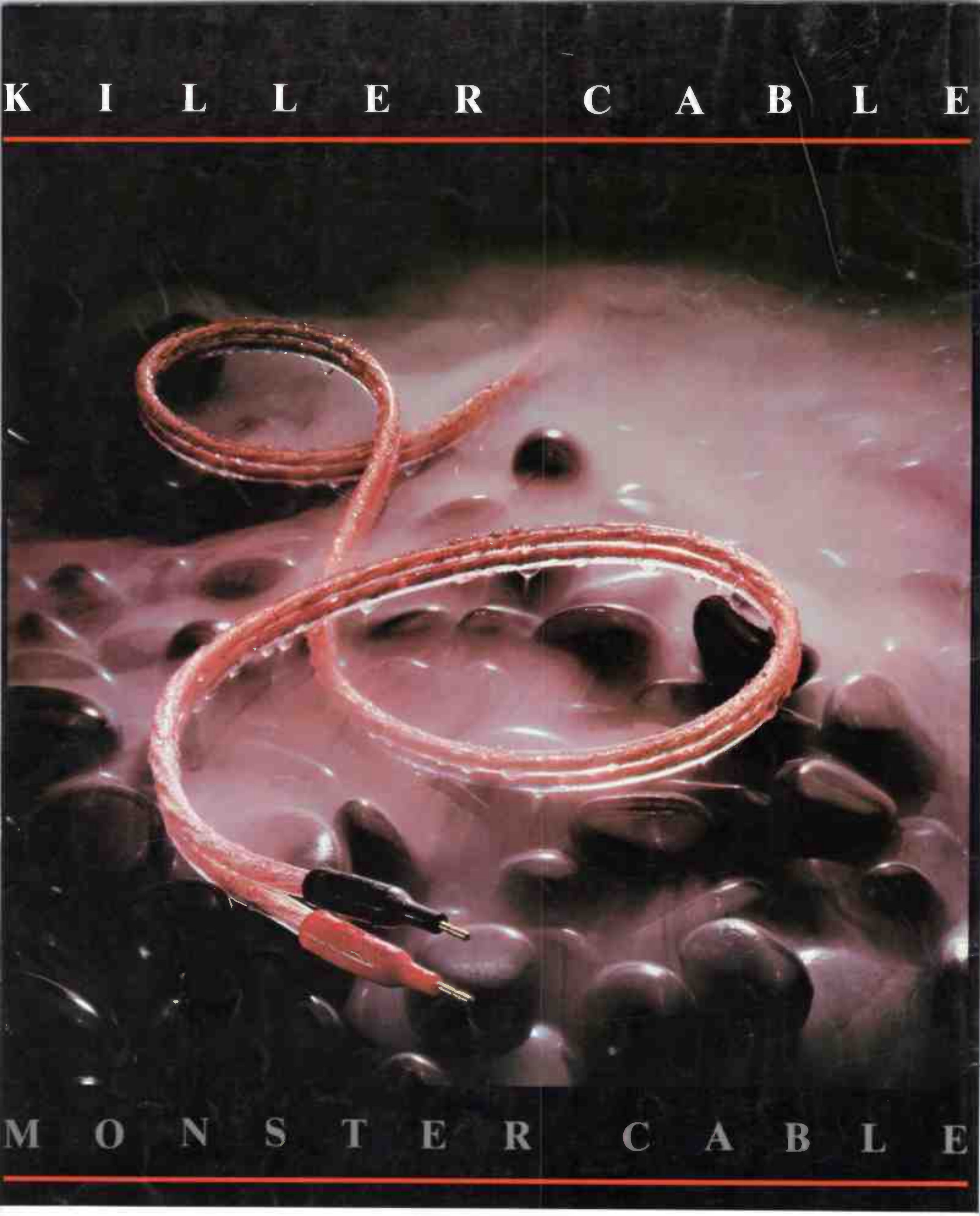
The 1820s were highly charged times, socially and politically (when haven't they been?), as the industrial revolution had by then gained a considerable head of steam.

Prof. Ohm, from his vantage point at the forefront of technology, saw the conflict between the post-Luddite conservatives and the nouveau technological revolutionaries. As the post-Luddites had the numbers, Ohm saw that there was danger of the industrial revolution being swallowed by a conservative backlash.

Thus, Ohm came to set up his resistance group. They held meetings at coffee shop called The Junction, where current philisophy was discussed. The group had a lot of potential but many differences arose. Nevertheless, more and more joined the group, raising the resistance significantly. But when some formed parallel alliances, the resistance dropped, and temperatures rose.

As electrical technology advanced more joined the group, but older members, being unlike the newcomers, left in repulsion because they failed to appreciate current philosophy.

Despite variations in the resistance and constant fluctuations at The Junction, the group survived 20 highly charged years until Kirchoff came along and dissipated itby declaring that those entering The Junction must equal those leaving The Junction, dropping potential at The Junction to zero.


KILLER CABLE
MONSTER CABLE