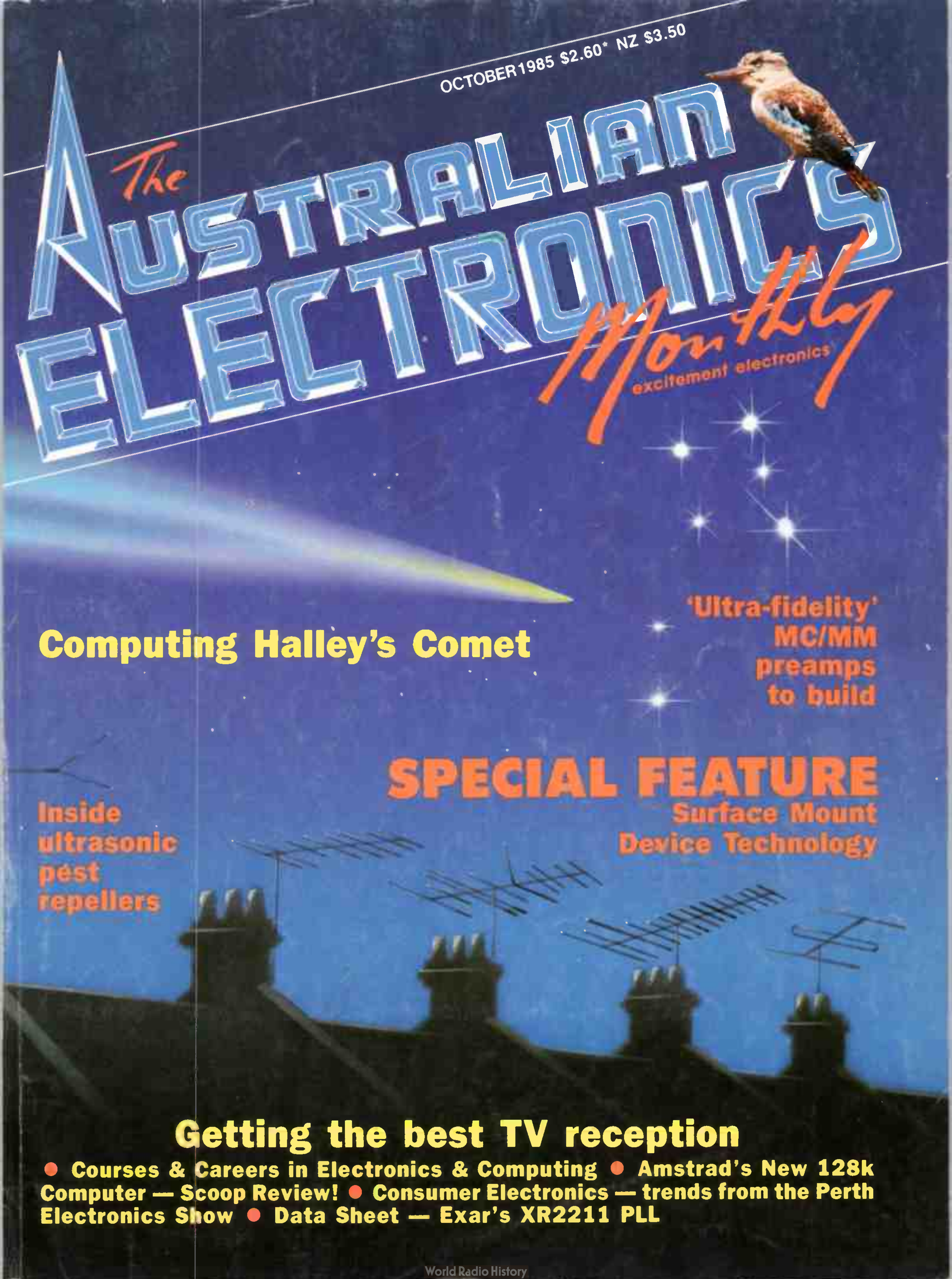
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The Australian Electronics Monthly

WITH THE GOVERNMENT'S recently introduced incentives for young people to undertake tertiary study, now is the time to tackle that course you were considering in electronics or computing. One of our major features this month is thus very timely. "Courses and Careers in Electronics & Computing" will run in this issue and the next. It covers the career levels and required courses for those of you contemplating a career in the industry, and includes considerable detail on the courses offered and the various tertiary institutes conducting them. Educational qualifications are of vital importance in this era of rapid technological development and change. Now is the time for action to gain the educational background you'll need for the future.

This month we commence three new 'features' in the magazine. The first is a 'Letters' page. We're very encouraged by your responses to date. We'd like to see some intelligent letters commenting on current issues or affairs in electronics, and we're only too happy to answer technical questions via this page. In fact, we received several letters along these lines and answers from sources outside the staff are currently being sought. However, before sitting down to dash off a missive, consider your thoughts carefully. Long, rambling diatribes that don't get to the point are boring to others and will likely be severely edited. The letters page is your forum — go to it! See page 129.

The second feature introduced this issue is 'Admarket' — free advertisements for readers, clubs or associations wishing to announce announcements, arrange arrangements, or to sell, swap or otherwise dispose of personal items no longer required. See page 128.

The third feature introduced this month is the first in a 'collection' of practical articles for the not-too-technical hobbyist/handyman — "Getting the Best TV Reception". We trust it reaches the desired audience. If you're way past this level, no doubt you run across those who aren't. It will repay you to pass on the articles(s) on appropriate occasions. You might just win a convert to the hobby!

Roger

Roger Harrison
Editor

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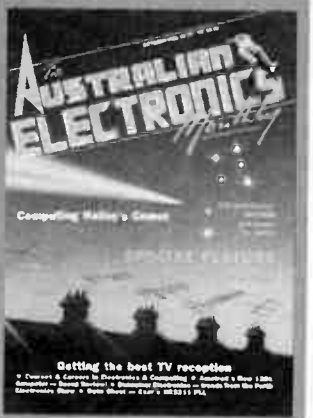

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Artist's impression of Halley's comet in the southern skies. Artwork commissioned from Patrice Guilbert, cover design by Marni Raprager.

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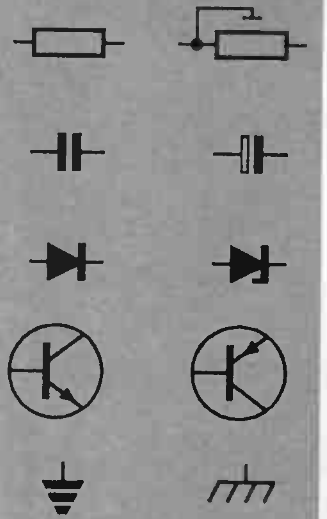

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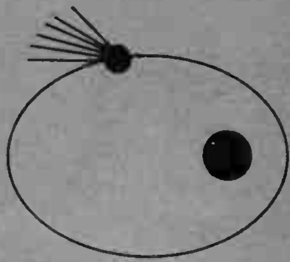

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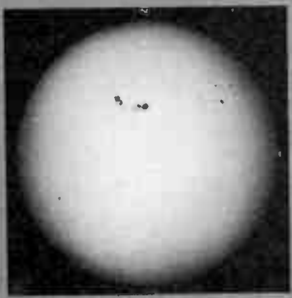

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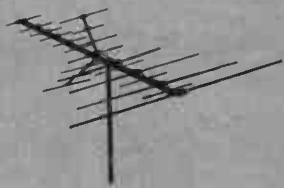

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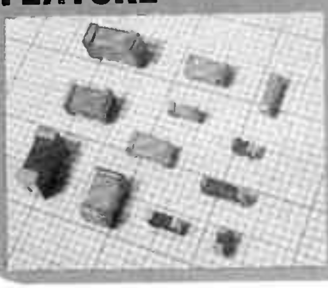
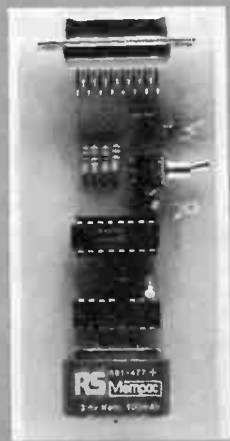


NEWS & GENERAL

NEXT MONTH!

THE INS & OUTS OF RS232
A practical guide through the RS232 maze. Sort yourself out about 'standard' and non-standard interfaces, etc.

THE ULTRA-FIDELITY PREAMP
The stringent demands imposed by the coming of the 'digital era' has placed demands on the electronics in audio systems unheard of a few short years ago. David Tilbrook's design meets those demands head-on.



BUILD A REAL TIME CLOCK FOR YOUR MICROBEE
Ever wanted a 'real time' clock for your Microbee? this simple, low cost add-on for the 'Bee is just the thing. It plugs into the 'Bee's parallel port and is battery-backed to keep the time once you've set it, so that it does not have to stay plugged-in.

A KEYBOARD IN THE HAM SHACK
Neil Duncan discusses the pros and cons, trials and tribulations of incorporating a computer into the typical radio amateur installation (the 'shack'), and offers some practical advice.

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

The new Amstrad 6128.

A comparable 128K computer could easily cost you twice as much.

The popular Amstrad personal computers have quickly become top sellers in Europe and Australia, and have established an enviable "value for money" reputation. Now comes the remarkable Amstrad 6128 computer.

The Amstrad 6128 offers a powerful 128K memory, high definition green screen monitor, inbuilt disc drive and sophisticated CP/M PLUS* operating system from around $800 all up. (Colour monitor package from around $1000.) Other computers with similar capabilities can cost hundreds or even thousands of dollars more.

$800 package offers real value for home or business.

- Powerful 128K computer
- High definition green screen monitor
- Inbuilt floppy disc drive
- CP/M PLUS* and AMSDOS operating systems
- GSX Graphics Enhancement
- Comprehensive User Manual
- Introductory program and exercises

Rapid loading, instant cataloguing.

The availability of such a low cost, disc based 128K system is a real breakthrough for both businesses and home computer enthusiasts. Programs are loaded rapidly and cataloguing is instantaneous. The CP/M PLUS* operating system is acknowledged as one of the best and most practical in the world.

Other key features of the Amstrad 6128 system include a highly functional alpha-numerical keypad with programmable function keys and broad sound and graphics capabilities. Thus, the system offers considerable scope not only for educational and entertainment uses but also for many serious business requirements.

Wide range of programs available now.

Most of the programs developed for the Amstrad 464 and 664 computers can be used on the 6128. These cover a broad range of subjects including Business, Education, Games, Brain Power, Programming and Electronic Home.

In addition, there is an excellent range of custom CP/M PLUS* disc -based programs available.

In all, there are hundreds of titles to choose from covering all aspects of personal and business computing. Programs include Wordprocessing, Spreadsheets, Graphics, Accounting and many popular games. The Amstrad 6128 computer offers a wealth of applications for home and business.

Amstrad. Distributed and guaranteed by AWA-Thorn.

Amstrad computers are distributed and guaranteed by AWA-Thorn, one of Australia's most trusted names in home products. The new 6128 system is available at leading retailers and computer stores throughout Australia. Ask for a demonstration and you'll agree – no other system adds up to Amstrad.

For the location of your nearest Amstrad dealer, please telephone: Sydney, 638 8444; Newcastle, 52 7088; Melbourne, 459 1688; Brisbane, 44 7211; Townsville, 72 7755; Canberra, 80 5314; Adelaide, 269 1966; Perth, 277 7788; Hobart, 72 4366; Darwin, 84 3243

*CP/M PLUS is a registered trademark of Digital Research

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Wait for it, wait for it — AUSSAT's away!

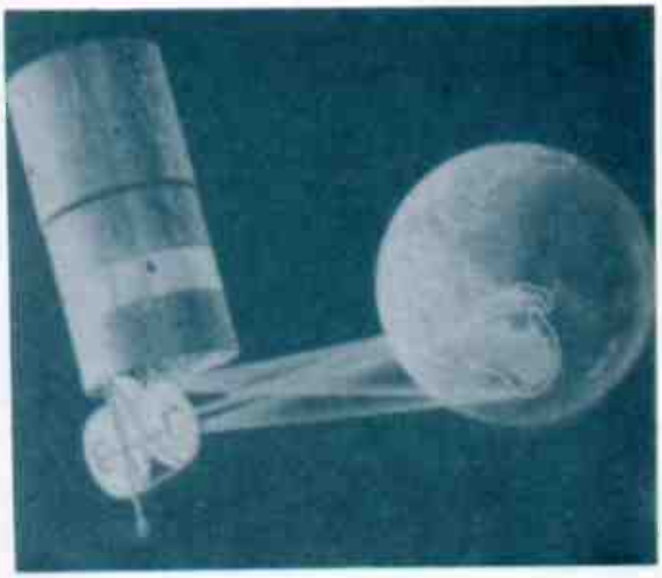
Following a delay of several days due to bad weather at the Cape Kennedy launch site, the space shuttle Discovery carried AUSSAT aloft in the last week of August, well and truly launching Australia into the space communications era.

The 528 kg satellite, built by Hughes Communications of the US, was first placed in a 'holding' orbit and then accelerated into geostationary orbit by an on-board 'kick' motor, taking it to its parking spot 36 000 km above 156 E. All control of the satellite following its launch from the shuttle was done from AUSSAT's ground control facility located at Belrose in Sydney.

The satellite is due to become operational in December and will provide direct television and sound broadcasting to remote communities, plus telephone and television relay facilities.

The Australian electronics industry has been involved with the construction of the satellite and the major earth stations. Standard Telephones and Cables (STC) provided wiring harness aboard the satellite, while J. N. Almgren Data Communications Engineers provided voice communications systems for in-house communications at the Sydney and Perth major earth stations.

AWA provided two subsystems for the AUSSAT tracking, telemetry, command and monitoring (TTC&M) system which forms part of the Australian satellite system under a $5.5 million contract. In addition, AWA supplied the Broadcast Performance Monitoring Sub-systems for all the AUSSAT major city earth stations under a $1.6 million contract to Mitsubishi.



This satellite is the first of three which are expected to open the way for the introduction of many more communications and bradcasting services for Australians, no matter where they may be situated.

Congratulations are in order to all concerned.

— **Roger Harrison**

United States policeman partly saves face with computer

Read any good books lately? How about any written by computers? Yes — the inevitable has happened — a computer has finally written a book.

In the United States (where else?) an IMS International computer has created a book of poetry and prose called "The Policeman's Beard is Half Constructed". It featured at a night of poetry reading in California (where else?) recently, but at least it wasn't read by the computer as well as written by it.

The book was composed completely by a BASIC program named Racter (a six-letter file name for Raconteur) on an IMS computer. Racter, co-authored over a five-year period by William Chamberlain (listed as author of the book) and Thomas Etter, is claimed to be the most highly developed artificial writing system in the field of prose synthesis today.

Fundamentally different from artificial intelligence, which tries to replicate human thinking, Racter can write an original work without promptings from a human operator.

This feat is so unusual that Racter and The Policeman's Beard have been discussed in magazines such as Omni and Forbes. The book will also be featured at a conference on artificial intelligence to be held later this year in the United States.

Chamberlain doesn't claim Racter represents artificial intelligence, however, or even inspiration. Part of Racter's program does what he calls the "bookkeeping" of English — conjugating regular and irregular verbs, for example, and assigning number and gender to nouns.

The system also chooses words from a dictionary file and rules from a syntax file to make sure the words are properly connected. "Identifiers" relate every entry to every other entry; for example, "cow" is related to "bovine" and "hoofed animals". This cross-indexing also helps Racter avoid such mistakes in logic as making pigs fly (Racter will choose a more appropriate verb, such as "eat").

"There is no reasoning here at all," says Chamberlain. "Rather, the program creates by following the geography of a sentence. It's a closed system, simply repeating variations of identifiers. In theory it's not much different than Pascal's number generating machine."

While The Policeman's Beard is said to be neither E. E. Cummings nor Rod McKuen, Shakespeare nor Robert Frost, some people apparently enjoy reading it enough to buy the book. The next question obviously is — how long before the movie? And could the Australian computer industry produce the same feat?

Note: *The Policeman's Beard is Half Constructed* is published in the USA by Warner Books. It has been reviewed in numerous magazines, including Scientific American (Jan. '85).

From circuit diagram to completed assembly

As WA seems now to be well and truly in Bondage, as it currently headquarters Australia's 8th largest corporation headed by Alan Bond (— you know — he won that cup), one might be tempted to assume other western corporate pioneers might be outshone.

Not so! Well, not according to Malcolm Sells of the Perth-based Jemal Products. Malcolm heads up what he claims is one of Australia's most expedient producers of high quality printed circuit boards, panels, chassis and racks. Not only is Jemal 'into the hardware,' but they offer an electronic assembly service, too.

Jemal can knock out single and double-sided printed circuit boards to order and offers what must be a unique "while-you-sleep" prototype service for eastern states customers. Get your artwork to them by air express one day and Jemal will expedite your prototypes by interstate overnight air freight the same day.

Jemal recently expanded their 'mainline' services of pc board manufacture, close limit metalwork and production assembly. In-house services now include artwork production and photog- ▶

raphy, roller-tinning and solder mask application on pc boards, plus silk-screening of annotation on boards.

Just to add that 'touch' to their range of services, Jemal can print on just about any surface, including powder-coat, for which they have developed specialised inks. Jemal can engrave acrylic panels and do reverse prints, plus process photo-etched panels in aluminium, brass and stainless steel.

Want your invention assembled? Jemal can do it, including chasing components orders as well as component sourcing. Jemal can perform component preforming, top-load boards and wave solder production runs. In addition, they offer hand soldering expertise and ATU facilities. You can start with a circuit diagram and end with the finished product!

Contact Jemal Products Pty Ltd, PO Box 166, Victoria Park 6100 WA. (09)350 5555.

Fancy a call from a robot?

A computerised telephone calling system has added new dimension to a repetitive task everyone likes to groan about *(and may well induce a few groans from recipients of its product! — Ed)*.

Manufactured by the Autocomm Corporation of Santa Monica, California, and based on the Texas Instruments Professional Computer and TI's Speech Command System, the Autocomm Messenger automatically calls a list of telephone numbers, plays a recorded message and records a response.

It combines flexible, high quality computerised calling with the functionality of a complete business computer system at a price lower than typical dedicated robotic callers.

The Messenger is said to provide a timely cost-effective way to get information to a targeted group of people. It can complete up to 40 calls per hour, more than twice the number that can typically be completed manually.

"Because it uses TI-Speech Synthesis, the quality of the recorded message remains high even with continual use, compared to the tape systems that can lose quality over time," said Dennis Vlasich, Executive Vice President of Autocomm Corporation. "For example, banks could use it to notify accounts that are overdrawn. Insurance agents could call for policy renewals, or stockbrokers could send buy/sell messages to clients."

Autocomm claims that The Messenger provides flexibility for designing specific calling sessions. The user can record a number of messages, file them, and select up to nine messages to be played during each call. The messenger can call the list at a pre-established time, delivering messages to each name on the calling list, recording responses, and recalling busy or unanswered numbers.

All information is stored in the computer, at the end of the calling session, the system can detail the number of completed calls, busy signals (very useful in Sydney), and hang-ups *(mind reading too? — Ed)*, as well as specific information about each call.

Included with The Messenger is special software; a 256K TI Professional or portable Professional Computer with a 10 megabyte Winchester disk; Speech Command hardware and software; and a TI Model 850 dot-matrix printer. The TI-Speech software allows the computer to be used as a telephone answering machine as well as a calling system.

Acesat place order for AUSSAT equipment

Acesat Satellite Receiver Corp. Pty Ltd, the Sydney-based national distributor of satellite receiver equipment, has placed the first 'substantial' order with Plessey (Aust) for supply of B-MAC indoor units required for the Australian remote area satellite TV and radio service from the AUSSAT satellites.

Mr Ivan Trayling, marketing executive for Plessey, confirmed the order would secure delivery of the first production of B-MAC equipment to Acesat.

The Acesat complete system will be available in late October in readiness for the first satellite transmission, expected on 1st November.

For further details, contact **Douglas Sawtell, (02) 521 5994.**

Getting the Best TV Reception

#1 The antenna system

J. Wilkinson

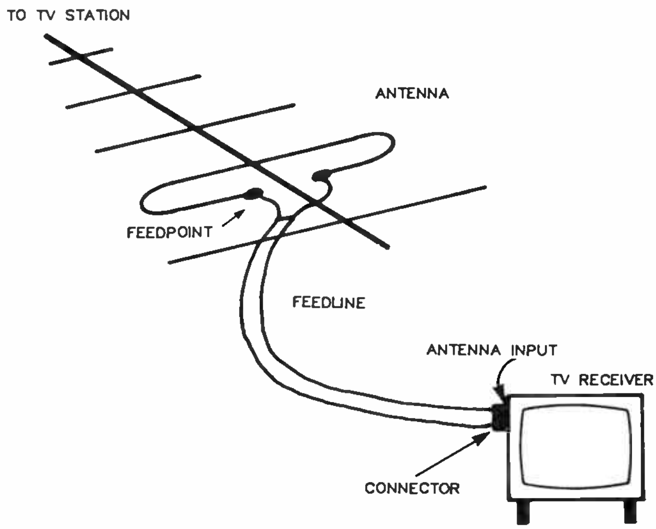


Figure 1. The TV antenna system and its important components.

NO MATTER HOW GOOD the quality of your TV receiver, it just won't give of its best if you don't collect the signal effectively and feed it to your set as efficiently as possible.

The place to start is at the antenna itself. Figure 1 shows the general TV receiver antenna system. I might be pointing out the obvious, but the diagram shows the important elements in the system. Let's examine each element of the system in turn and the factors one needs to consider in achieving the best TV reception.

The antenna

The function of the antenna is to gather the signal radiated by the television transmitter or transmitters you wish to receive. Television channels are allocated on a regional basis by the Department of Communications and the antenna must be designed to cover the channel frequencies allocated to your area. As you can appreciate by looking at Table 1, this may mean it has to cover an extremely wide frequency range.

There are five 'bands' allocated for television broadcasting. Bands I, II and III are in the very high frequency (VHF) range, while bands IV and V are in the ultra-high frequency (UHF) range. Band II stations are being 'moved' to other channels where they are allocated to particular regions, as channels 3, 4 and 5 are on frequencies which lie in the FM (stereo) broadcasting band.

The UHF channels are not widely used at present, but the Special Broadcasting Service (SBS), which currently broadcasts on channel 0 in the VHF band and channel 28 in the UHF band, will be using UHF exclusively from 1986. A number of VHF stations have their programmes re-broadcast on the UHF band to 'fill in' areas which may be unable to receive their primary VHF signal. Thus, in some areas there is a requirement to be able to pick up stations on *both* VHF and UHF. Antennas are available to cover just the VHF or UHF bands, while some special models are made to provide reception of both VHF and UHF bands with the one antenna. We won't cover choice of the antenna here — that's a separate subject all on its own!

If you don't know the TV channels covering your area, the Department of Communications publishes a book, through the Australian Government Publishing Service, which lists full details on TV stations and translators Australia-wide. See the accompanying panel.

Figure 2 shows some common types of TV antenna. Note the similar component parts. Every antenna has a 'feedpoint' ▶

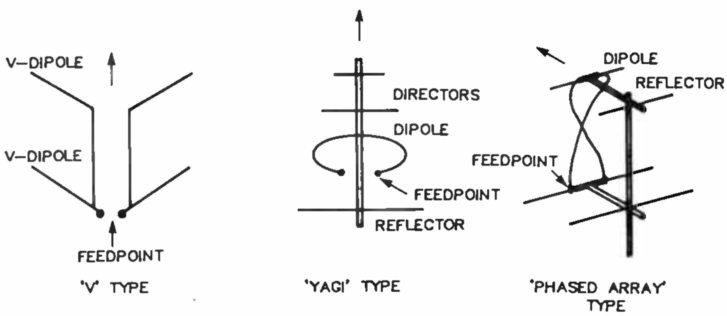


Figure 2. Common TV antenna types.

TABLE 1

DESIGNATION AND FREQUENCY LIMITS OF AUSTRALIAN TELEVISION CHANNELS

BAND I					
Channel 0	45 52 MHz	Channel 1	56-63 MHz	Channel 2	63-70 MHz
BAND II					
Channel 3	85 92 MHz	Channel 4	94-101 MHz	Channel 5	101-108 MHz
BAND III					
Channel 5A	137 144 MHz	Channel 6	174-181 MHz	Channel 7	181-188 MHz
Channel 8	188-195 MHz	Channel 9	195-202 MHz	Channel 10	208-215 MHz
Channel 11	215-222 MHz				
BAND IV					
Channel 28	526-533 MHz	Channel 29	533-340 MHz	Channel 30	540-547 MHz
Channel 31	547-554 MHz	Channel 32	554-561 MHz	Channel 33	561-568 MHz
Channel 34	568-575 MHz	Channel 35	575-582 MHz		
BAND V					
Channel 39	603-610 MHz	Channel 40	610-617 MHz	Channel 41	617-624 MHz
Channel 42	624-631 MHz	Channel 43	631-638 MHz	Channel 44	638-645 MHz
Channel 45	645-652 MHz	Channel 46	652-659 MHz	Channel 47	659-666 MHz
Channel 48	666-673 MHz	Channel 49	673-680 MHz	Channel 50	680-687 MHz
Channel 51	687-694 MHz	Channel 52	694-701 MHz	Channel 53	701-708 MHz
Channel 54	708-715 MHz	Channel 55	715-722 MHz	Channel 56	722-729 MHz
Channel 57	729-736 MHz	Channel 58	736-743 MHz	Channel 59	743-750 MHz
Channel 60	750-757 MHz	Channel 61	757-764 MHz	Channel 62	764-771 MHz
Channel 63	771-778 MHz	Channel 64	778-785 MHz	Channel 65	785-792 MHz
Channel 66	792-799 MHz	Channel 67	799-806 MHz	Channel 68	806-813 MHz
Channel 69	813-820 MHz				

Note:
The dial markings on some older 'knob type' UHF tuners show only approximate channel number.

and is intended to receive best from a particular direction (indicated by the arrows in Figure 2). The antenna feedpoint is where the received signal is collected for transmission to your TV receiver. The feedpoint of the antenna will have a 'characteristic impedance' which must be matched to the characteristics of the particular feedline employed, but more on that shortly. This characteristic impedance cannot be measured with a multimeter, but it is generally expressed in 'ohms' — usually either 75 ohms or 300 ohms, which are standard values settled upon many years ago for reasons of simplicity and uniformity in manufacturing TV components.

A transmitting or receiving antenna, as a result of its construction and mounting, will be polarised in a particular plane — either vertical or horizontal. The TV stations in different areas will transmit using a particular polarisation and your antenna must be polarised the same way. In the capital cities, with the exception of Canberra, horizontal polarisation is used. Some country areas use vertical polarisation, to reduce possible interference from other areas using horizontal polarisation.

When the elements of your TV antenna are horizontal, it will be horizontally polarised; likewise, it will be vertically polarised when the elements are vertical.

A TV station will have a primary service area, designed to cover, in general, the audience in the region the broadcaster chooses to serve. In the capital cities, for example, the TV stations' primary service area corresponds to the greater metropolitan area. The further away from the transmitter you are, the weaker the signal. You may, of course, receive a TV station though you live well outside its primary service area, and this is termed 'fringe' area reception.

Generally speaking, VHF and UHF signals travel in straight lines so that reception depends on your being within 'line of sight' of the TV transmitter. Where local terrain may 'shadow' the TV signal within the primary service area, reception may be poor due to the lower signal strength.

In general, TV antennas are designed to operate best in a particular area as TV channels are allocated on a regional basis. Those antennas designed to operate well in the capital cities may perform poorly in country regions, and vice versa. An antenna designed to give good fringe area reception may cause problems with your receiver when used in a primary service area, rather than give the "fantastic" reception you might expect.

The feedline

The function of the feedline is to convey the signal from the antenna to the receiver input with a minimum of loss and without picking up extraneous noise or other signals which may degrade the TV signal.

A feedline consists of a pair of conductors separated by insulation which maintains the two conductors a constant distance apart. There are two fundamental types of feedline — 'balanced' and 'unbalanced'. It's unnecessary to go into the technical background to these terms, but '300 ohm TV ribbon' is a balanced line (see Figure 3), while '75 ohm TV coax' is an unbalanced line (also see Figure 3).

A feedline has a 'characteristic impedance' and, like the antenna feedpoint, it is also specified in 'ohms'. The available feedlines have standard characteristic impedances of either 300 ohms (for balanced lines) or 75 ohms (for coaxial cable). Coaxial cable is so-called because the two conductors have the same axis — through the centre line of the centre conductor.

The most commonly available TV coaxial cable is known as '3C-2V'. It is about 5 mm diameter and the type intended for installation outdoors has a black outer sheath.

An important characteristic of all feedlines is loss. That is, a feedline will degrade the signal strength of any signal

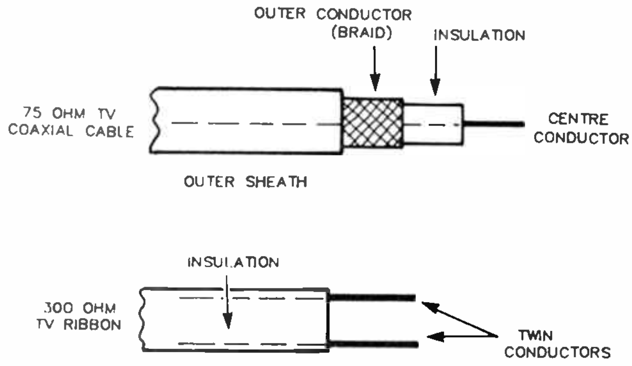


Figure 3. TV feedlines.

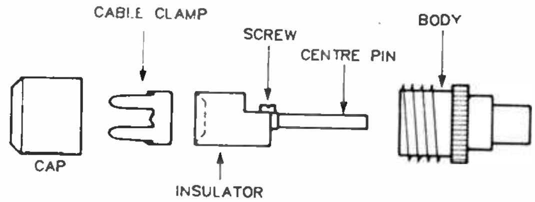


Figure 4. The 'PAL' or 'Belling-Lee' coax plug.

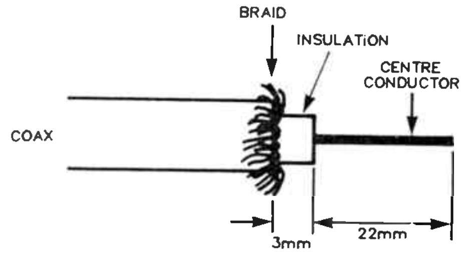


Figure 5. Preparing coax cable for a PAL plug.

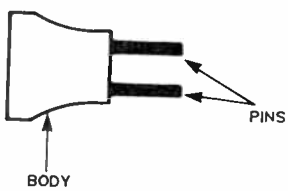


Figure 6. Ribbon cable plug.

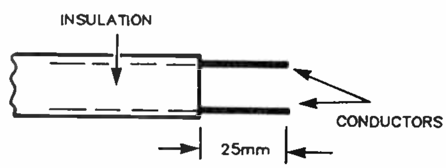


Figure 7. Preparing 300 ohm ribbon cable for attaching a plug. The conductors are soldered to the pins. Cut off any excess lead after soldering.

conducted along it. The amount of loss depends on its construction and on the length of feedline employed between the antenna feedpoint and the TV receiver's antenna input. No matter what type is used, the longer the feedline, the greater the loss.

All else being equal, 300 ohm line has less loss than 75 ohm coax. However, ribbon feedline is much more susceptible to being affected by weather than coax, and it deteriorates much more rapidly. Its loss tends to increase substantially when wet. 'Low loss' balanced feedline is available. This may be like ribbon with lengths of insulation removed at regular intervals, or simply consist of two conductors supported by insulators every so often along the length.

In addition, balanced feedline is susceptible to being affected by nearby objects, which can increase the loss or cause it to pick up extraneous signals. Thus, a great deal more care is necessary with TV ribbon during installation, compared to what you can do with coax.

Matching the antenna and feedline

It is important that the antenna feedpoint and the feedline have matching impedances to ensure the maximum amount of signal is conducted to your TV receiver. Most TV antennas are built with a balanced feedpoint having an impedance of 300 ohms. If you're using balanced ribbon feedline, it can be connected directly to the antenna.

If you're using coaxial cable, then some means of *transforming* the impedance from 300 ohms to 75 ohms is necessary, and at the same time changing from balanced to unbalanced feed. Such a device is generally referred to as a 'balun transformer' or just balun (derived from the term "balanced-to-unbalanced"). A balun may be used to convert 300 ohm systems to 75 ohms or 75 ohm systems to 300 ohms. In other words, they work 'either way'.

Connectors

The 'PAL' or Belling-Lee' connector is almost universally employed with 3C-2V coaxial TV cable. The component parts of a PAL plug are shown in the exploded drawing of Figure 4. It may have a metal body and cap, or plastic body and cap with metal rim at the end for making contact with the socket. The cable clamp serves to mechanically secure the cable and plug, as well as provide connection between the plug's metal body and the coax cable's braid outer conductor. Figure 4 illustrates the common, modern type where the coax cable's centre conductor is secured by a screw to the plug's centre pin. Older models require the coax's centre conductor to be soldered to the plug's centre pin.

Figure 5 shows how to correctly prepare TV coax when assembling a PAL plug to it. The cap and clamp from the plug should be slipped on the cable before cutting the end and exposing the conductors as shown. Use a sharp-bladed instrument such as a penknife or 'hobby' scalpel and take care not to nick the centre conductor or it may break later with disastrous results. Fan out the braid wires and cut them to a length of about 5 mm.

Firmly seat the insulator/centre pin assembly, making sure that no stray braid wires are shorting to the centre conductor. Tighten the securing screw, but not so tight as to sever the cable centre conductor. Cut off excess centre conductor protruding beyond the end of the centre pin. You can solder it too, if you feel it's necessary. However, use an iron with a small tip radius and complete the joint quickly or the plug's insulator may melt. Seat the cable clamp against the insulator and lay the braid down before screwing the cap and body together.

Ribbon cable is generally terminated with a two-pin plug, as illustrated in Figure 6. The plastic body may be solid or split, so that it clamps the ribbon when closed. Ribbon cable is prepared as shown in Figure 7 when attaching a plug. The insulation should be cut back with a sharp-bladed instrument such as a penknife or 'hobby' scalpel. Take care not to nick the conductors else they may break later.

Antenna siting and aiming

Indoor 'set-top' antennas are fine where a really strong signal direct from the stations is available, but best results are almost always obtainable with an outdoor antenna.

Remembering that we're dealing with 'line-of-sight' signals, the antenna should be sited so that it has more or less an unobstructed 'view' in the direction of the transmitter. Large obstructions in the path near the antenna will almost certainly affect the signal strength to some extent. If your antenna is sited so that it's 'looking' through a large tree — or worse, a block of flats — you may not be getting the best signal you can. You needn't cut down the tree, and there's little hope of doing anything about a block of flats, but re-siting your antenna can have a remarkable effect on results.

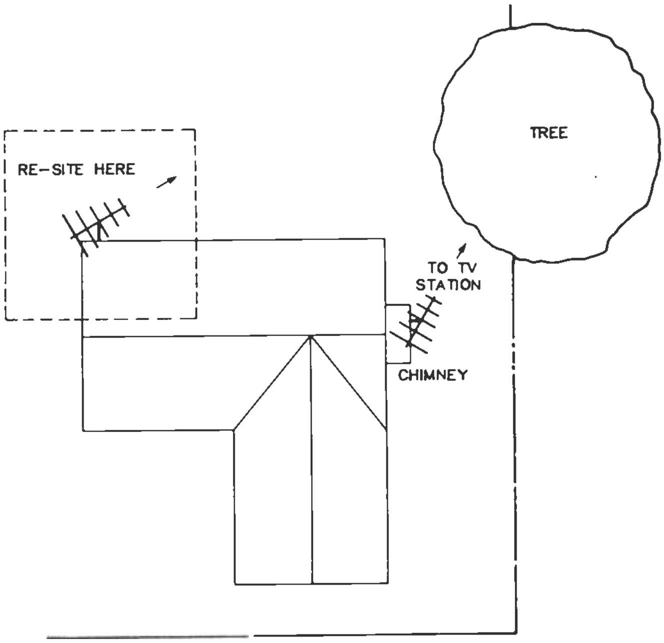


Figure 8. Re-siting the antenna to clear its 'view' toward the TV stations.

Figure 8 illustrates a situation where re-siting the antenna puts the obstructing tree out of the antenna's line of view to the TV station. Another way of improving the antenna's view, if available, would be to raise it, so that the tree (or whatever obstruction) is substantially below the height of the antenna. This particularly applies with UHF reception.

Some experimentation with temporary siting of the antenna may pay good dividends, especially if terrain obstructs your direct view of the TV transmitters.

Most TV antennas have a relatively broad directional response, so that aiming accuracy is not really stringent. An accuracy of ± 10-15 degrees is generally fine. If in doubt, and you cannot actually sight the transmitters, a local area map and a compass can greatly assist. However, make sure your map shows the magnetic deviation from true north so that you can correctly align it. ▶

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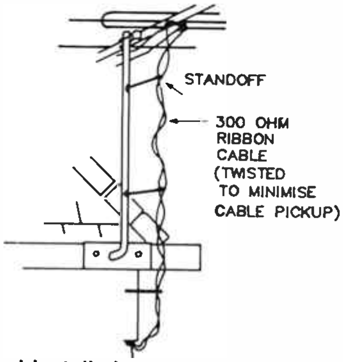

Figure 9. Typical installation of balanced TV feedline.

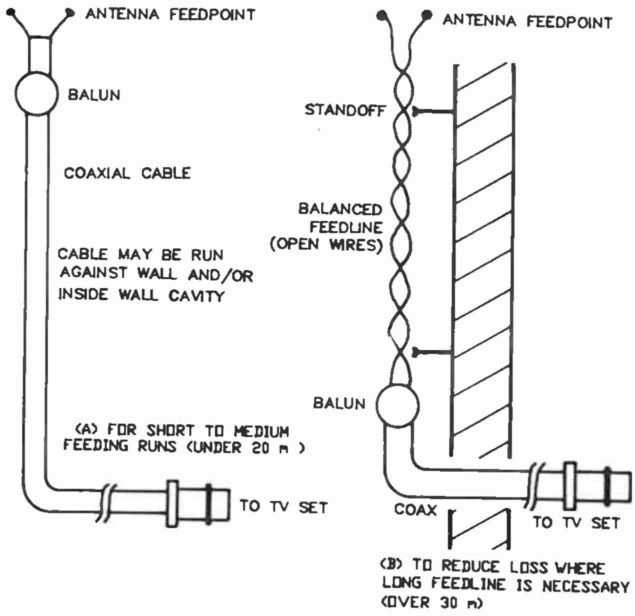

Figure 10. Typical variations for installing coax TV feedline. A balun must be used at the TV set end where the set only makes provision for 300 ohm blanced line connection.

Feedline installation pointers

If you're not currently installing a new antenna, examine your existing feedline. If it's ribbon, check that the insulation is not cracked or split and that all joints are mechanically sound. Replace your feedline if it's showing such signs of ageing. Joints showing signs of corrosion should be disassembled, carefully cleaned to expose bright metal, and reassembled. You can weatherproof joints by smearing a sealing compound such as 'Silastic' over them.

If replacing ribbon feedline, take a look at how it's installed. It must be conducted down the mast and external walls using 'standoff' insulator clips. It should not be tucked flat against the wall, or casually dropped down inside a wall cavity. It should be held away from the wall where it runs for any length by at least 50 mm, preferably more. The ribbon should be twisted, with about one twist per 100 mm. This maintains the 'balance' of the feedline and reduces pickup of extraneous noise, etc. Figure 9 illustrates a typical installation.

If your current installation has a coax feedline, give it a good going over, especially any external joints or connectors. If the coax is damaged at all, it's likely water either has got inside, or will do so. Nothing makes the feedline loss soar more quickly than the ingress of water. Replace the affected section, or the lot.

Where a balun is installed outside, check all joints carefully. If there's any substantial corrosion, disassemble the joints, clean them back to bright metal and re-assemble. It's always good insurance to weatherproof them. (Silastic is suggested as before).

Whatever feedline is used, go over the antenna connection, cleaning this up and weatherproofing it, if necessary.

If you're replacing ribbon feedline, seriously consider installing coax. Note that coax is used almost exclusively on UHF antenna installations. Generally speaking, while TV ribbon is lower in cost than coax, the latter gives better results in the long run. Coax can be run against the antenna mast, walls etc, without any affect on its operation. However, if the length of line necessary turns out to be 50-100 metres and you live on the outher reaches of the service area, then consider using low-loss balanced feedline for part of the run and coax where the cable has to run along and/or through walls, installing a balun where they join. This will minimise feedline loss. The other alternative is to add an 'amplifier' at the antenna (generally called 'masthead amplifiers') and use coax all the way. However, that's a subject all its own.

If you're using coax and your TV set only has 300 ohm balanced input, then you'll need a balun at the set. Figure 10 shows typical installation variations with coaxial cable feedline.

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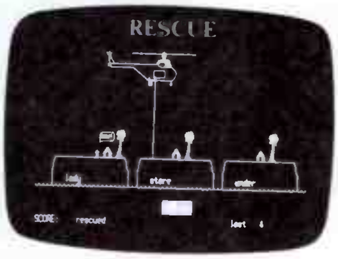

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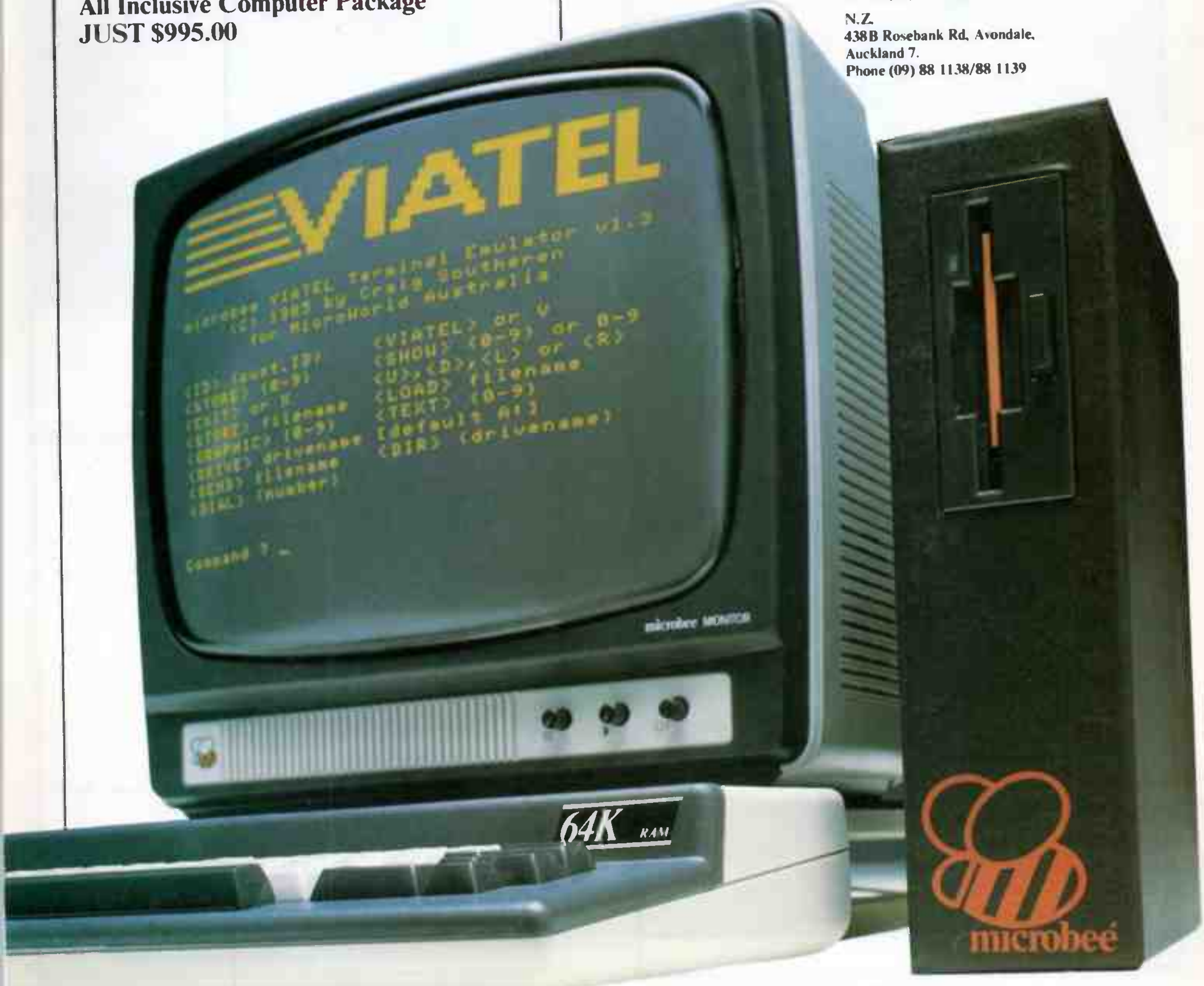

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Courses and careers in electronics and computing

If you're contemplating a career in electronics or computing you should read this article. The first of a two-part series, this article is a guide to the various courses available and the employment levels within these industries. Information on the subjects available and the different tertiary institutions is also included.

Kerry Upjohn

Part 1

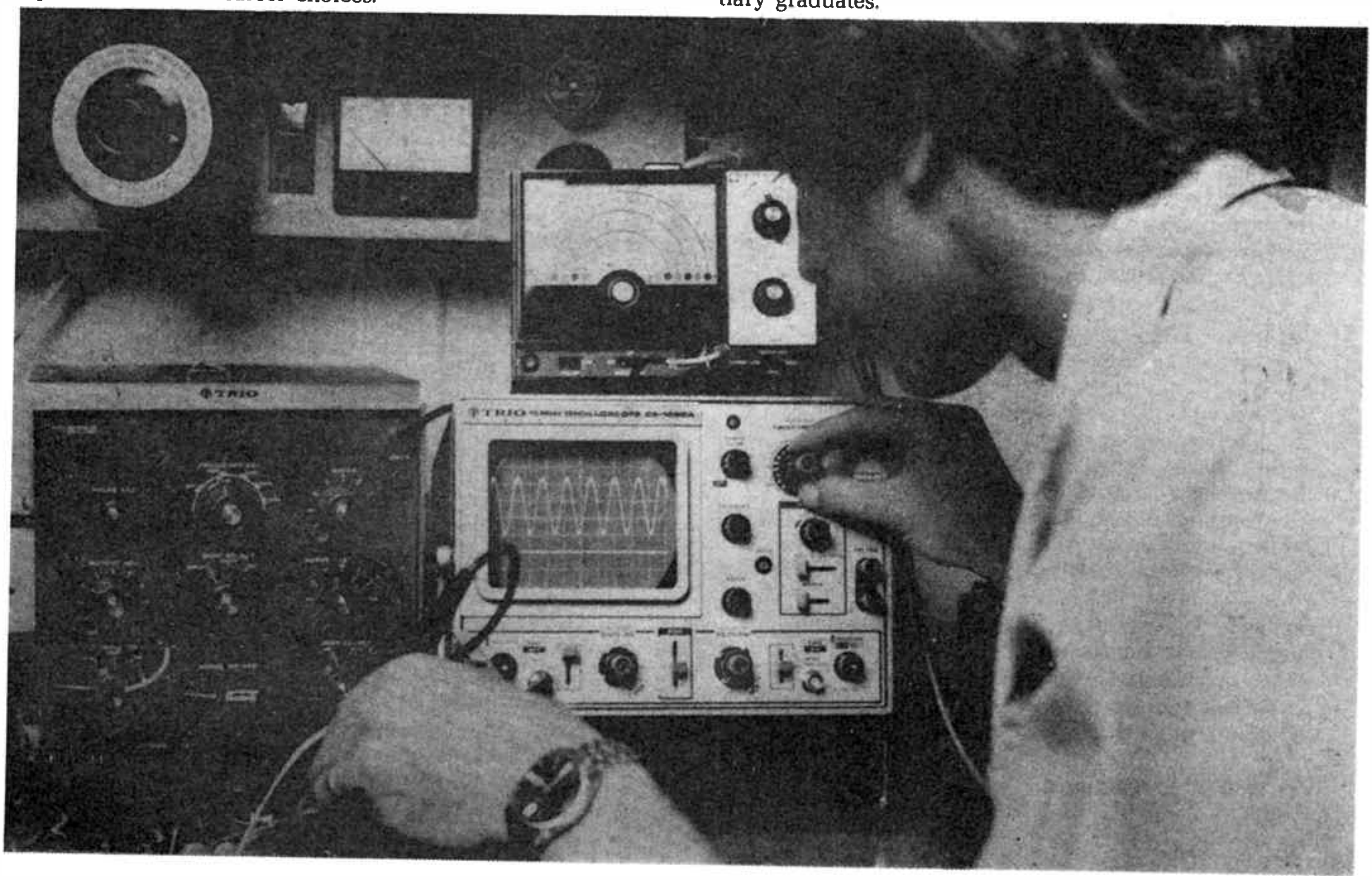
OVER THE LAST TWENTY YEARS there has been a rapid expansion in the electronics and computing industries. Electronics permeates everyday life to a very large extent and has revolutionised technology, communications, medicine, industry, business and many other areas. With developments in VLSI circuitry and surface-mounted componentry, it is now possible to design and build electronic products which only two decades ago would have seemed unthinkable. Due to this rapid growth, electronics is becoming increasingly complex and there is a great demand for skilled tradespeople and professionals in this field.

In response to this demand many educational institutions have introduced a large range of courses catering for people wishing to become tradespeople, technical officers and professionals in these areas. These courses proliferate at a remarkable rate as new courses are introduced and old ones are revised and altered to meet the changing needs of the industry. Increasingly, computer courses are being offered by engineering faculties and across a wide range of disciplines e.g. Business Administration, Computer Science. As a result of this rapid rate of change the prospective student faces a bewildering range of subjects and options as well as career choices.

This article is an attempt to illustrate the range of courses and career options available. Because of the large number of tertiary institutions offering courses it is only possible to discuss a brief sample of the courses offered rather than include all the available information.

According to the various professional bodies such as The Institution of Engineers, Australia, there is a critical shortage of trained technical officers and engineers and this shortfall should continue throughout the eighties until the supply catches up with the demand. Rapid technological change in the Australian manufacturing industry has resulted in the need for skilled rather than unskilled labor. With new advances in robotics for example, this trend will become even more pronounced.

The increasing complexity of the electronics and computing industries has resulted in more specialisation and this is already evident in the computing field where an interest in programming is no longer sufficient to become a computer programmer and a degree in computer science or its equivalent is necessary. The continued demand for trained people is evident in the high salaries and greater range of career opportunities offered to tertiary graduates.



Employment in the Electronics Industry

If you are considering a career in electronics it is necessary to be familiar with the various levels of employment offered within the industry. The electronics industry generally recognises three categories. The first category consists of "tradespeople" who are usually apprenticed to an employer and study for three years part time at a College of Technical and Further Education (TAFE). On gaining a certificate of proficiency the tradesperson is qualified to assist the engineer or technical officer in the installation, servicing and maintenance of electronic equipment.

The second category is the "middle level" or para-professional group and these people are usually referred to as "technical officers." In NSW the term technical officer has replaced technician as it is thought to reflect the greater specialisation and complexity within the industry. The technical officer usually does a Certificate Course at TAFE over three years. The Certificate courses offer more of a background in the theory of electronics and includes a greater range of subject areas. It is possible to upgrade trade qualifications to certificate level and tradespeople are accepted by TAFE Colleges and Institutes of Technology to further their career prospects.

The final category is the professional engineer, who has obtained an engineering degree at a University, Institute of Technology or College of Advanced Education. Most engineering degree courses are of four years duration and a prospective student needs to obtain good passes in Maths, Physics and Chemistry at Higher School Certificate level. Computer Programmers, Systems Analysts and Computer Scientists also require either a degree in Electronics/Electrical Engineering specialising in Computing or a specific degree in Computer Science.

TRADESPEOPLE

The term "electrical trades" covers electrical fitters, armature winders and electrical mechanics (more commonly known as electricians). These people are involved in the manufacture, installation, servicing and maintenance of a wide range of electrical and electronic equipment. They are employed in either government agencies eg. Electricity Commission, State and Commonwealth Public Service or in private industry, or they operate their own businesses.

If you decide to become a tradesperson you need to obtain an apprenticeship with an employer and undertake three years of part-time study at a technical college. Electrical and electronics trade courses provide the theoretical and practical skills necessary for employment in the electrical, electronics and communications industries. This training is a mixture of "on the job" training provided by the employer and attendance at a TAFE college.

Competition for apprenticeships is very keen and most employers advertise for apprenticeships from December to February. Entry into TAFE trade courses is dependent on securing an apprenticeship, although it is possible to do a pre-apprenticeship course for a year and then try to obtain an apprenticeship.

Attendance at TAFE is usually on a "day release" system where the apprentice spends one day per week at tech. and the remainder of the week with the employer. There is sometimes provision for "block release" with semesters spent on the job and then at college on an alternating basis. Correspondence courses are also available through TAFE's College of External Studies for students unable to attend because of distance, lack of facilities etc.

Educational requirements for apprenticeships vary with each employer but the minimum standard is the School Certificate with reasonable passes in English, Maths and Science. As competition for places is high some employers are taking people with year 11 standards.

Pre-apprenticeship Courses

Pre-apprenticeship courses are offered at selected metropolitan and country TAFE Colleges. These courses are offered on a yearly basis and successful completion of them often results in an apprenticeship, although this does not guarantee you one. When an apprenticeship is gained the student can then proceed to stage three of the relevant trade course. These pre-apprenticeship courses are restricted to people under twenty who have their School Certificate and only a limited number of students are guaranteed places. Courses include: Electronics, Electrical Fitting and Applied Electricity.

Trade courses

Entrance requirements

There are no specific educational requirements, however, the School Certificate is advisable. Priority for admission is given to apprentices, then displaced apprentices and finally those in relevant employment.

Electronics Trade Course.

This course has replaced the Radio Trades Course and is designed to provide instruction in basic electronics principles, circuit operation and the manual skills required to supplement the apprentices' industrial experience. The basic electronics knowledge is offered in the first two stages (which are the same as the Telecommunications Course) and in the third stage the student specialises in electives in such areas as digital systems, television servicing principles, sound systems, principles of elec- ▶

tronic control theory, introduction to microprocessors etc. The course is offered by day release and alternative attendance depending on numbers. People over twenty can take the course at night.

Successful completion of the course enables graduates to work under the supervision of engineers/technical officers on the installation, operation, maintenance and servicing of electronic equipment.

Telecommmunications Trade Course
The Telecommunications Trade Course replaces the Telegraph Mechanics Trade Course and provides instruction in electronics, telecommunications and alarm systems. The first two stages are common to the Electronics course and the third provides more specialised electives in telephone line communications and domestic and commercial security systems. Attendance is available on a day release basis.

Post-trade courses

These courses are available to tradespeople who want re-training or need increased specialization in the industrial applications of electronics. Entry is normally restricted to those who have completed the relevant trade courses. Courses include Semiconductor Electronics, Industrial Electronics and Industrial Instruments Conversion.

Electronics (PTC)
At present this course is under review, however, it is available to tradespeople who have completed at least one stage of an appropriate electrical trade course. Students undertake 216 hours of study and the choice of units includes basic instrument applications, digital principles and applications, electronic equipment servicing, power control, industrial controls, industrial TV and microprocessors.

Industrial Electronics (PTC)
This course is designed to give a deeper understanding of electronic devices commonly used in industrial electronics. The emphasis is on operating semiconductor circuits and understanding electrical circuitry. It is recommended that students study the appropriate units from the Electronics (PTC) to further their study. After successfully completing the required 216 hours of instruction students can qualify for the Electronics post-trade certificate.

Radio Transmission (PTC)
Designed to give students a thorough grounding in the principles of radio transmission, this course provides students with experience in handling high power equipment.

Special Courses Offered by TAFE

Basic Electronics
This is not a certificate course but comes under the category of special courses. It is the most widely available of all the TAFE electronics courses, being designed to provide the basic electronic and electrical principles for tradespeople in the industry. It is often used to familiarise salespeople with basic electronic fundamentals. Attendance is three hours per week for a year. At present this course is under review.

Other special Courses
These include Closed Circuit Television Production, Electrical Contracting and Estimating, Film and TV Production Techniques, Electrical Salesmen, Technical Principles of Two-Way Radio and several others.

Microprocessor Circuits and Applications
This a technically oriented course restricted to qualified tradespeople in the electronics industry. It is designed to provide training in microprocessor principles and equipment and basic skills in programming at machine language level. The course requires four hours attendance weekly and is only available at Newcastle TAFE (NSW).

Microprocessor Evaluation
Unlike the previously described course, the Microprocessor Evaluation course is designed for non-technical people. Students learn how to interpret the terminology of microprocessors and people with a technical background can move on to more specialised courses. The course is offered over eighteen weeks for two hours per week.

For further enquiries
Contact the TAFE Information Centre, Railway Square, Broadway, NSW 2007 (02) 212 4400 or your nearest TAFE college.

"MIDDLE LEVEL" POSITIONS IN ELECTRONICS & COMPUTING

The term "middle level" or para-professional applies to people seeking positions as technical officers, design draftspeople, technical supervisors, technical salespeople or service engineers in the electronics and computing industries. Technical officers, engineers assistants and design draftspeople work as immediate support staff to professional engineers. They work either with or without direct supervision in the development, installation and servicing of electronic equipment.

They should possess a combination of practical skills and theoretical knowledge so they can communicate effectively with both tradespeople and engineers. Often the technical officer supervises the work of tradespeople and may share in the design work with the engineers as well as the maintenance and installation of various electronic equipment etc. Technical officers need to possess reasonable communication skills as they are required to write reports and interpret and draw technical diagrams.

A wide range of career opportunities exist within the Commonwealth and State public services as well as positions in private industry either in research and development, laboratory work and design. There are also many positions available as sales

.... To page 124 ▶

Introduction to Surface Mounting Technology

Surface Mounted Assembly (SMA) is a totally new kind of automated electronic assembly technology that uses a totally new kind of electronic device called a surface mounted device (SMD), since it is mounted *on* the surface of the substrate, as opposed to being inserted *through* the surface.

SMDs can be mounted on substrates using conventional materials and these substrates may be single-sided, multi-layer, plated-trough-hole, etc. SMDs can also be assembled on ceramic and flexible substrates, which can be combined with conventional mother boards using leaded components or a mixture of SMDs and leaded components.

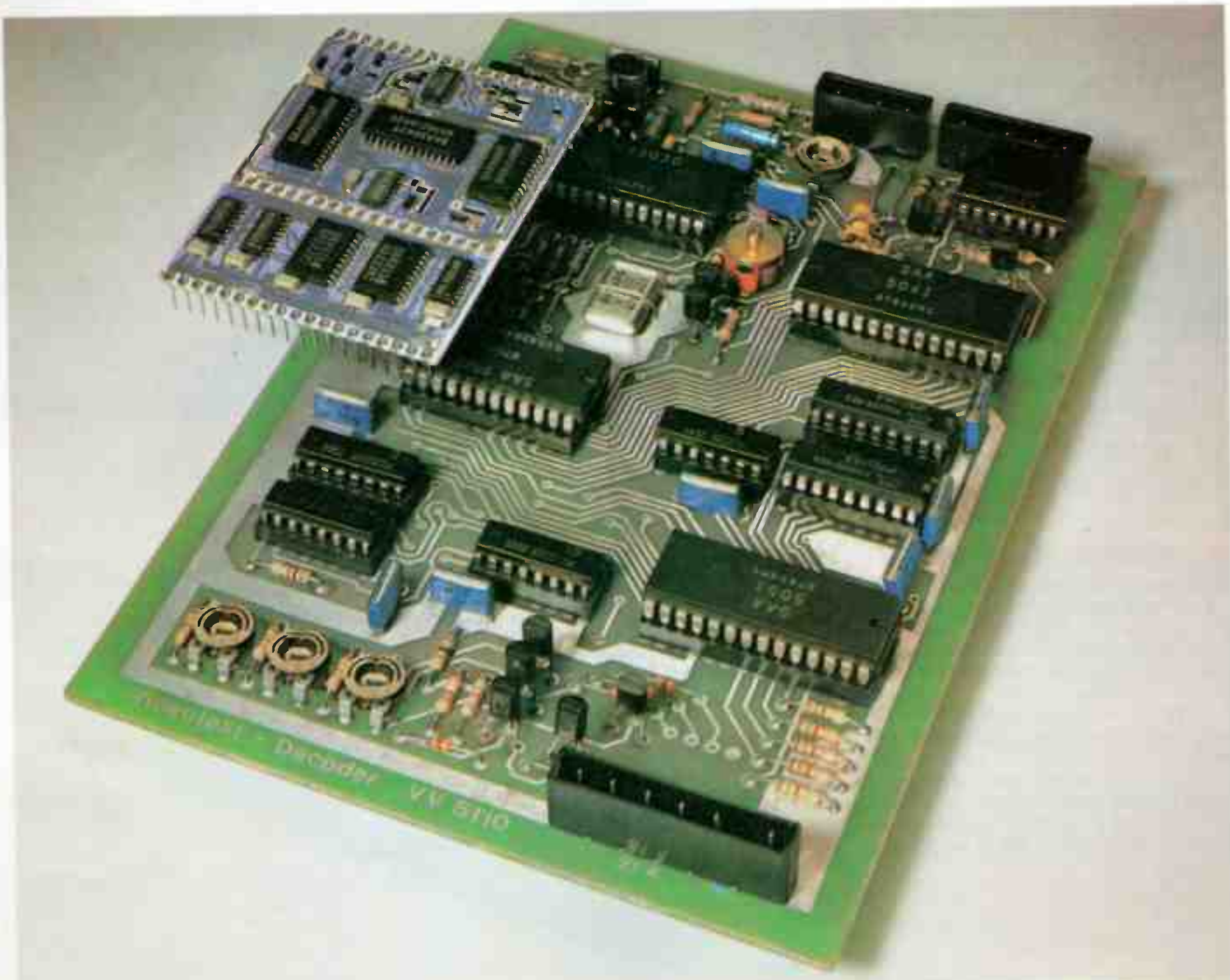
Electronically, SMDs perform the same functions as their conventional, leaded cousins, but mechanically they are very different.

SMDs are designed for handling by automatic placement machines, and for soldering by any modern technique such as immersion soldering, or reflow soldering. They offer four well-defined advantages:

— reduced size of final equipment
— lower cost of assembly
— higher reliability of both components and equipment
— better high frequency performance.

With all components available in leadless form, boards can be made without holes for component leads and with surface mounted components on both sides. However, at the present state of component technology, some components still have leads and these still need to be mounted on the same boards. It is possible to mount leaded components on one side of the board by automatic insertion and mount the surface mounted devices on the other side by automatic placement; other combination of the two techniques are also possible.

The following pages outline the techniques, the design differences and other changes reflected in this new technology.



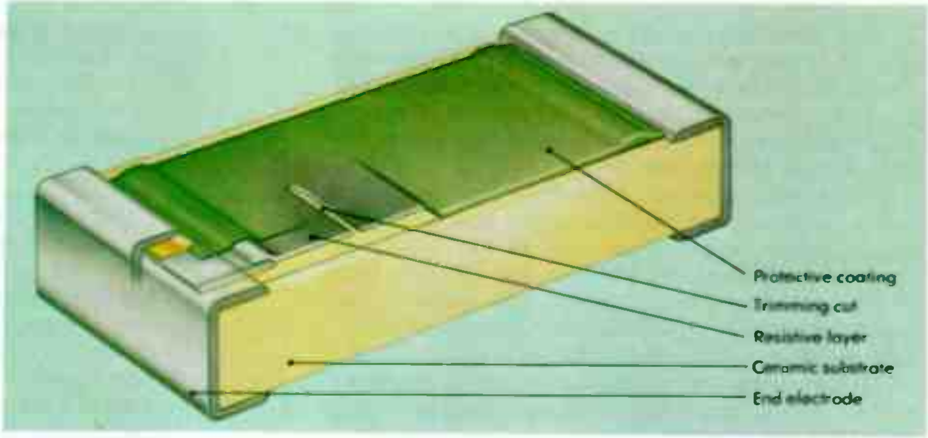
The technological shrink: comparing the sizes of a conventional plated-through hole board with the same circuitry employing surface mounted assembly.

Surface Mounted Devices

SURFACE MOUNTED RESISTORS

Surface mounted resistors are very small and yet are capable of handling high voltages and dissipating considerable power.

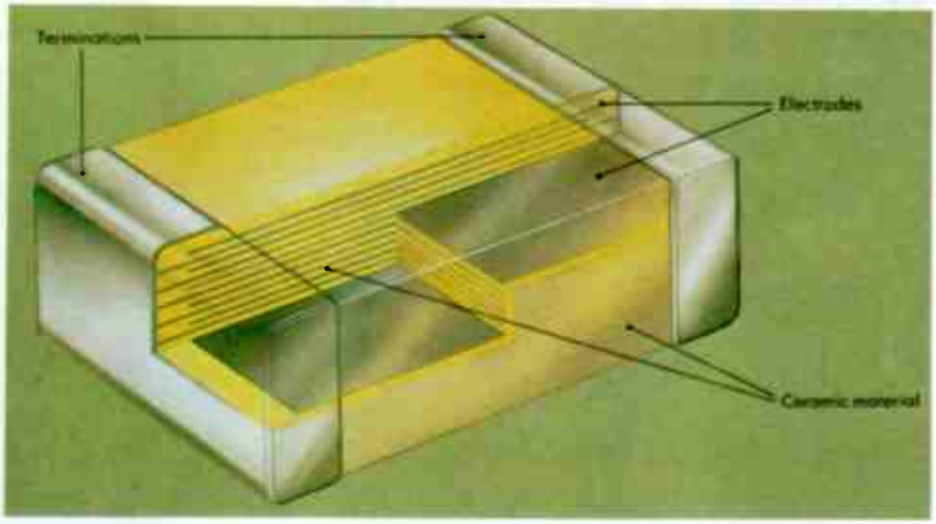
A high grade ceramic (aluminium oxide) body is used as the substrate. Internal metal electrodes are added at each end to ensure a good connection between the end electrodes and the resistive film which are added later. A resistive paste is applies between the internal electrodes, the composition of the paste being adjusted to give an approximation to the resistance required. Trimming of the resistance value if effected by laser cutting of the resistive layer. The surface of the resistive layer is then glazed, and finally the end.



CERAMIC MULTILAYER CAPACITORS

Ceramic 'multilayer' capacitors for surface mounting are available in a variety of dielectric characteristics. These dielectrics differ in the way their capacitance and loss angle vary with voltage and temperature. However, the high resistivity of all the ceramic dielectrics gives a consistently high value of insulation resistance. The ceramic also withstands high temperature, and rapid changes of temperature, thus permitting soldering by any modern method including high speed wave (immersion) soldering.

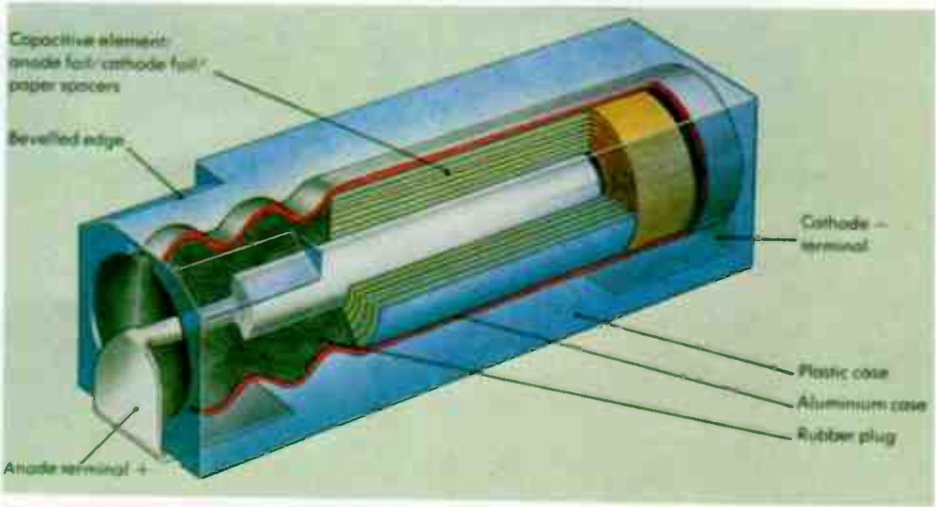
The dielectric is first made in film form, and the electrode pattern is applied by a screening process. The films are stacked and laminated under high pressure, ready for cutting into small blocks, After "binder burn-out", these are fired at high temperature to form virtually monolithic units. The metal terminations are then added, again using a firing technique, to provide the electrical connections to alternate conductive layers on each side.



WET ALUMINIUM ELECTROLYTICS

These capacitors are constructed with etched aluminium foil electrodes rolled with paper separators, impregnated with electrolyte and inserted into an aluminium case. This unit is then inserted into the moulded plastic outer case. The two connections are formed at opposite ends, and the contacts for soldering are wrapped under the moulding.

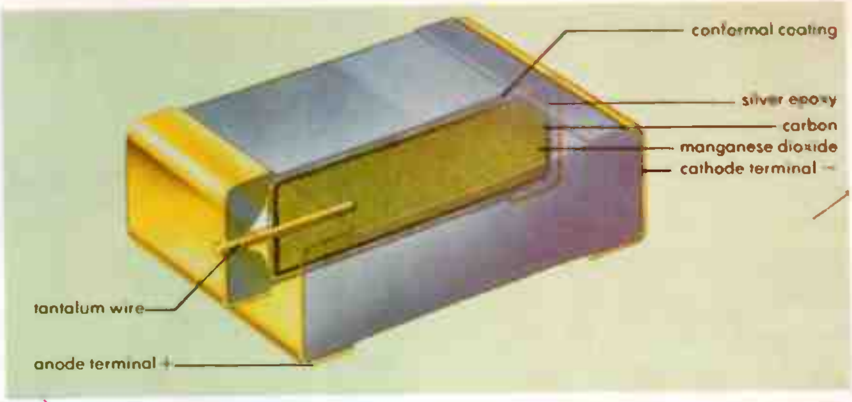
There is adequate space between the soldering terminals to allow pc board tracks to pass under the insulating moulded body of the capacitor, thus making board design easier.



TANTALUM CAPACITORS

Surface mounted tantalum capacitors have already earned for themselves an excellent reputation and manufacturers of professional electronic equipment need no introduction to the high capacitance values and high reliability that characterise these small capacitors.

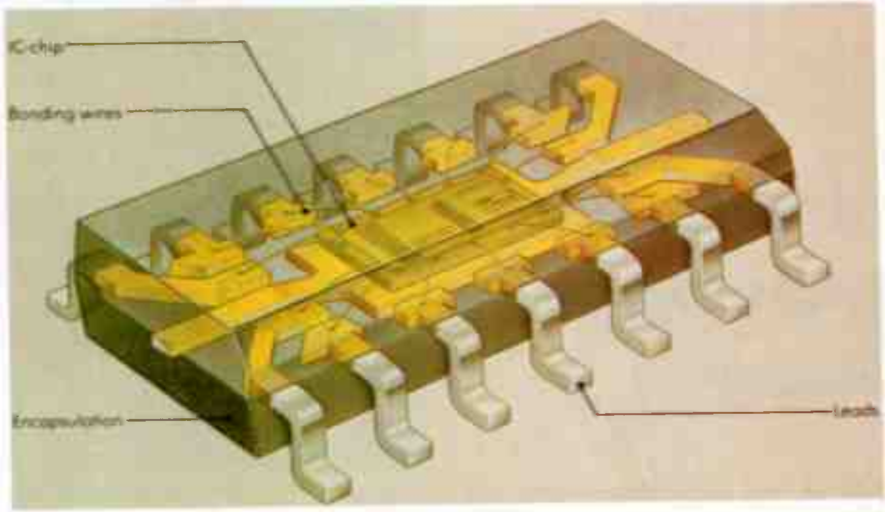
Each capacitor contains a rectangular anode of high-purity sintered tantalum. The anode has an electrolytically formed oxide dielectric layer. This is encapsulated with its solid electrolyte in an extremely rugged body, to which shock-proof and vibration-proof solderable terminals are attached.



INTEGRATED CIRCUITS

Developed originally for use in electronic watches, they have proved valuable for all forms of hybrid circuits (thin film and thick film) and in the miniaturisation of printed circuit boards.

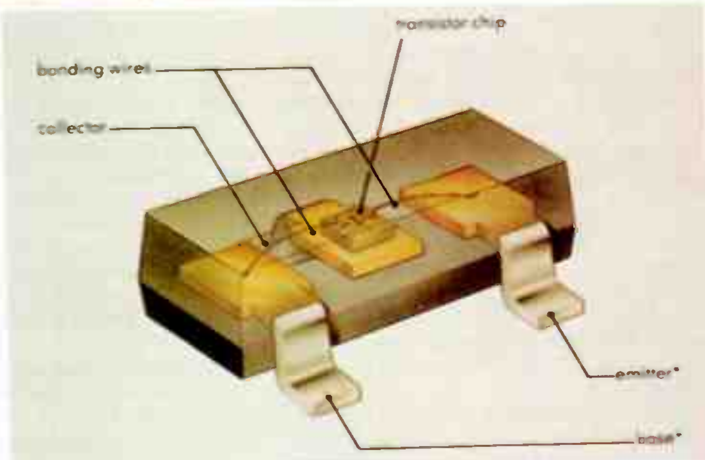
They contain the same integrated circuit chips as their larger counterparts, but the metal connections and the plastic encapsulations are designed to make the final device very much smaller. A lead-frame of ferro-nickel alloy is spot-plated for "die-attach", and connections to the leads are made with gold wire. The encapsulation is of high-grade epoxy, and the external leads are tin-plated.

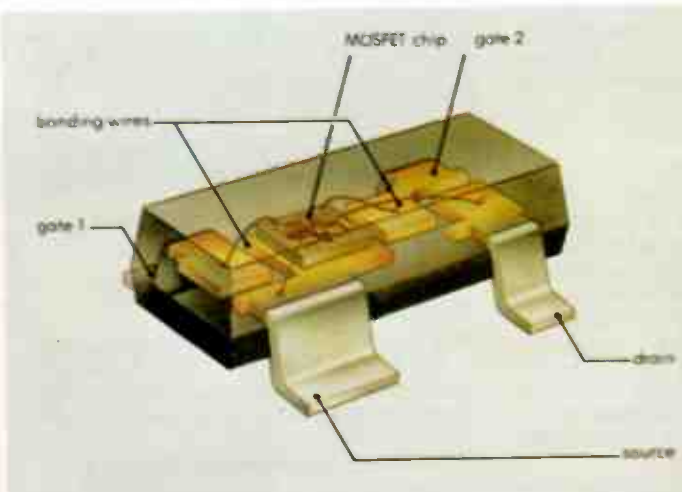


TRANSISTORS AND DIODES

Surface mounted transistors and diodes have a well-established reputation, earned over many years. The SOT-23 encapsulation was introduced in the late 60s, the SOT-89 in the mid-70s, and the SOT-143 in the early 80s, and now there's the SOD-80, the leadless surface mounted diode encapsulation.

High reliability is a feature of the gold-aluminium bonded transistors which are now also included in the range of SM devices. Virtually any of the standard "leaded" types are available in SM form.





SMD SMA

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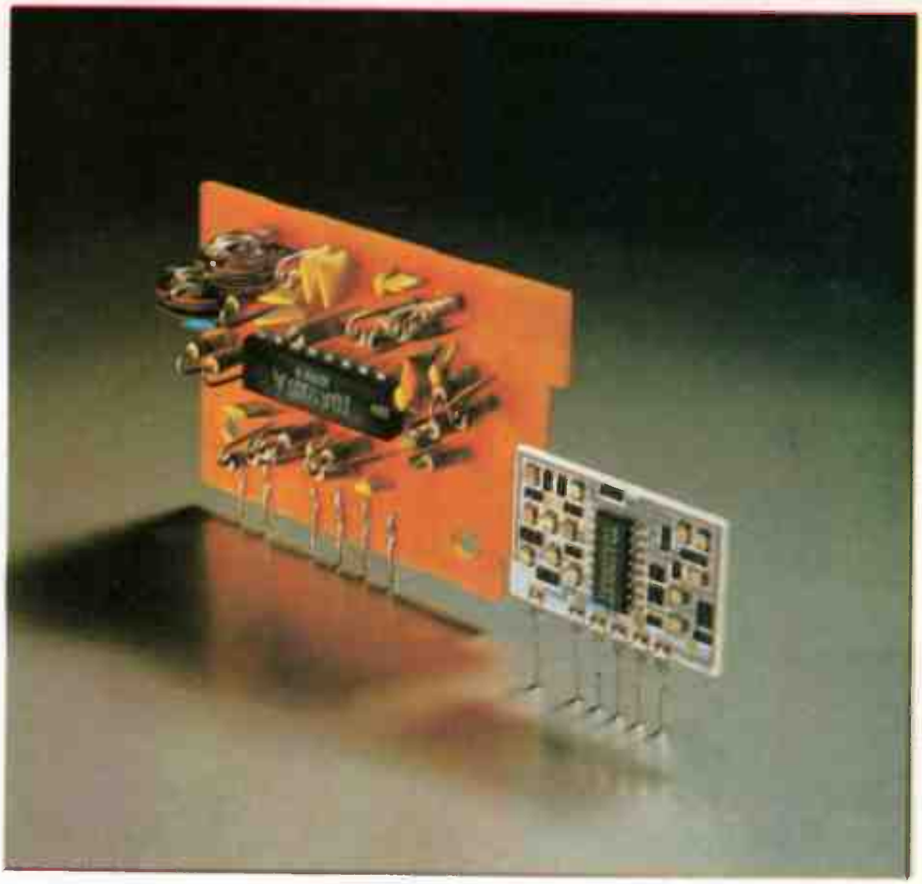


THE PURPOSE of this article is to outline the differences in the design and assembly of substrates using SMDs and in particular, "mixed print" substrates, utilising a mixture of leaded components and SMDs. However, since SMA is a very new technology and one that is evolving and changing fast, this information should not be seen as representing a set of SMA rules: instead it should be viewed as an illustration of the applications.

Apart from using much smaller components, SMA is fundamentally different in that placement is relative, not absolute. When a leaded component is inserted, there is an absolute go/no go situation. Either the device goes through the holes, or it does not, and when it does, it's in the correct position for subsequent soldering.

However, with SMDs this is not the case. A *small* shift, either way, caused by a combination of variations in component size and positioning accurately is not critical, though big shifts obviously are.

But placement accuracy does not stop there. If the component has (1) small dimensional tolerances and (2), the placement system can position the device accurately above the solder pads, there is still (3) the relative position of the solder pads. If the accuracy of the substrate pattern is low, then the solder pads will not be where they're supposed to be, and as a result placement will not be correct.

In the case of "mixed prints", the application of an adhesive is another new parameter that has significant influences on the automated assembly of SMDs. Not the least of these is its influence on the design of the substrate pattern.

Another very important and new parameter is the packaging of SMDs. Leaded components are, of course, also "packaged" on tape for automatic insertion, but with SMDs, packaging takes on roles other than those of transportation. The system's aspect of packaging is reflected in the following four packaging criteria.

One, the packaging medium must convey the devices in a protected environment from the shop floor of the component supplier to the component user.

Two, it must maintain the devices in the correct orientation.

Three, it must ensure that there is an uninterrupted flow of devices to match the high placement potential of modern systems e.g. 32 devices placed simultaneously in under three seconds.

And four, it must ensure that a device is always available at the precise place needed for the system to pick it out of the tape and place it on the substrate.

Only tape, and in particular blister tape, can meet these criteria and only tape manufactured to a high, well defined standard.

Therefore SMD packaging is an important and *integral* part of the assembly process.

Partitioning and reflow soldering

Before considering "mixed prints", it is important to remember that an all-SMD substrate is the one that optimises the benefits of the technology. When this is not possible a 'partitioned' design is used, with part of the circuit made on an all-SMD substrate (ceramic or epoxy) and the remainder on a conventional or mixed-print substrate. The very small dimensions of an all-SMD circuit often allow such a circuit to be repeated several times on a single substrate, as illustrated here. (Fig. 1)

All-SMD substrates can employ the reflow solder technique. The solder paste is applied to the metallisation pads (Fig. 2) and its adhesive quality serves to hold the SMD in place until the substrate is heated and the solder has reflowed.

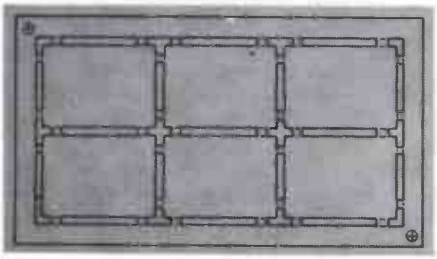


Figure 1.

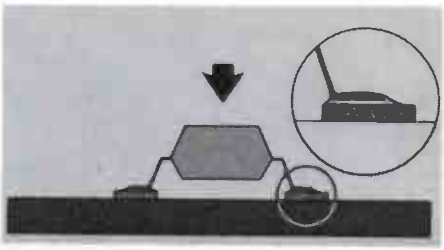


Fig. 2. All-SMD substrates can employ reflow soldering.

Mixed prints

The basics of mixed print assembly are shown in Figs. 3a, b and c. First the leaded components are inserted automatically or some automatically and some manually and the ends clinched. Then the substrate is turned over and adhesive applied either to the component or to the substrate. The SMDs are then placed in position and the adhesive forms a bond between component and substrate. When all SMDs have been placed the substrate is transported to a curing station, where the adhesive cures so as to form a good bond before soldering.

Note that it is also possible to put SMDs on the same side of the substrate as the leaded devices.

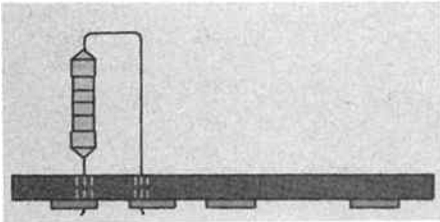


Fig. 3a. Mixed-print assembly. The first stage... insertion of leaded components.

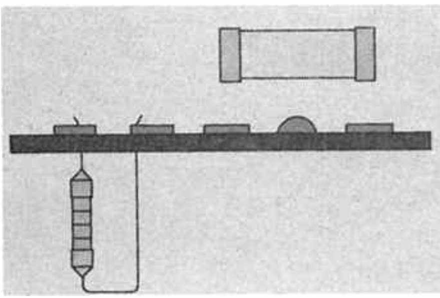


Fig. 3b. Following insertion, substrate is turned over and adhesive applied.

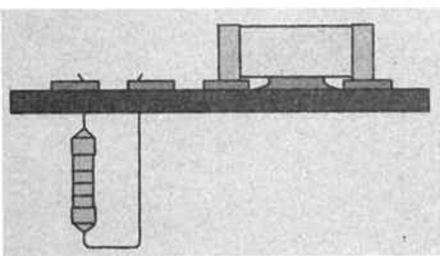


Fig. 3c. SMDs then placed in position and retained by adhesive.

Minimal adhesive

The application of adhesive either to the component or to the substrate is a new factor that must be taken into account when designing substrate. As shown (Fig. 4) the amount of adhesive is critical since "C" must be greater than the combined height of the metallisation height of the substrate "A" and that of the device "B" (or in the case of SOT and SO devices, the lead height). If it is not, then no bond is made. However, if too much adhesive is applied, then it may be forced out onto the solder pads and prevent a good solder joint being made.

It is therefore clear that the minimal amount of adhesive should be used that will ensure a good bond being made.

In order to meet this important objective, some figures are needed for "A" and "B". Fig. 5a shows typical metallisation heights for a print-and-etch substrate and 5b for a plated-through-hole substrate. The following table shows how these metallisation heights are derived. Thus "A" is around 35μ for a 'print & etch' substrate (common PC board) and can be 135μ or more for a plated-through hole substrate. In addition, for the latter "A" has a wide tolerance, varying from around 75 to 135μ.

Thickness of metallisation (μ)		
	P&E	P.T.H.
Copper	35	35
Galvanic copper	—	30-60
Galvanic Pb/Sn (Reflowed)	—	10-20 (20-40)
Total	35μ	75-135μ

Fig. 6a illustrates a device having a metallisation height "B" of between 10 and 50μ (depending on the individual SMD) on a print-and-etch substrate and Fig. 6b is the combination of a SOT-23, with a lead height of 100 to 200μ, on a plated-through-hole substrate having a 135μ metallisation height. Clearly this poses problems for the $C > A + B$ criteria when normal assembly procedure (details later) is to apply the same amount of adhesive to all placement positions.

Therefore a special "low profile" SOT is used (Fig. 7). The lead height of this device is between 0 and 100μ, which is much closer to the 10 to 50μ of passive SMD devices. In practice this means that variations in the value of "B" are not significant. However, in the case of plated-through-hole substrate, the tolerance of "A" is almost 100% and "C" cannot be allowed to vary by this percentage.

The solution to this apparent problem is to put a track under the device, as shown in Fig. 8a and Fig.8b. Quite often the high component density of SMA makes this essential for layout purposes. Where it does not, then a short dummy track can be introduced. This is an elegant solution since changes in metallisation height (due to the nature of the galvanic plating) influence the real/dummy track in exactly the same way as the metallisation height "A". Thus "A" is eliminated from the $C > A + B$ criteria and in practice this means that C can be a virtual constant.

C is also a virtual constant for print-and-etch substrates, since the metallisation height is constant at around 35μ. However, here too the use of real/dummy tracks is recommended since this further reduces the amount of adhesive required.

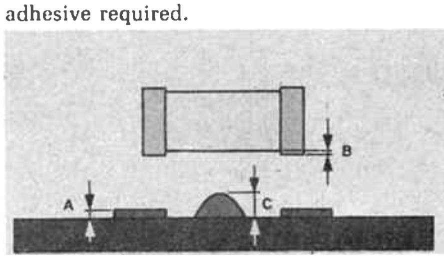
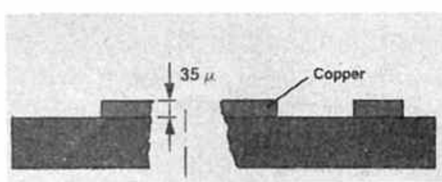


Fig. 4. SMDs only adhere when $C > A + B$.



Punched hole

Fig. 5a. 35 µ metallisation height for P&E substrate.

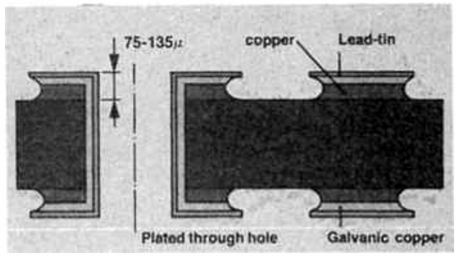


Fig. 5b. 75 to 135 µ metallisation height for P.T.H. substrate.

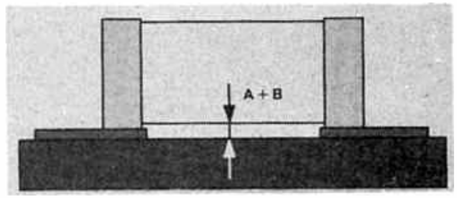


Fig. 6a. Passive device on P&E substrate. $A + B = 45$ to 85 µ.

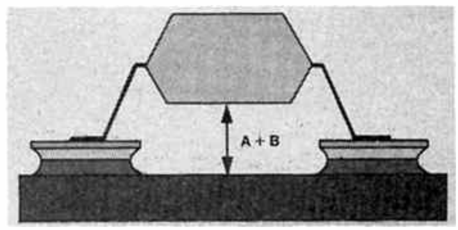


Fig. 6b. SOT-23 on P.T.H. substrate. $A + B = 175$ to 335 µ.

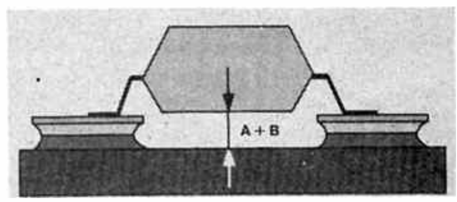


Fig. 7. Low-profile SOT reduces A + B. Now 75 to 235 µ.

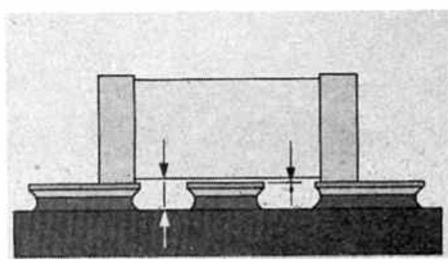


Fig. 8a. Dummy track employed with 75 µ metallisation height P.T.H. substrate.

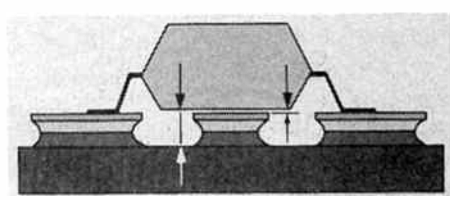


Fig. 8b. Idem for 135 µ metallisation height.

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In practice it is possible to employ double tracks under some sizes and other devices and these are normally covered with solder resist, as illustrated in Fig. 9. This further reduces the amount of adhesive required and double tracks provide a broad base on which the adhesive can be applied.

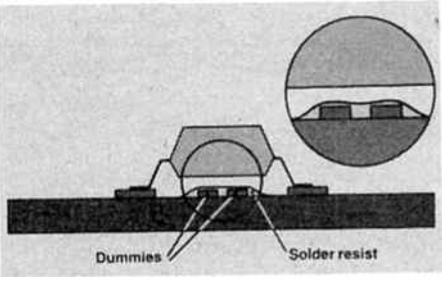

Fig. 9. Double-dummy (or real) tracks with solder resist.

Adhesive application

Adhesive can be applied in three basic ways.

(1) It can be screened onto the substrate, but not if the leaded components are inserted first since their pointed ends get in the way. And if the leaded components are not inserted first, high densities cannot be realised, since space must be provided for the clinching operation.

(2) It can be applied using a software-controlled syringe, which allows different amounts of adhesive to be applied to different placement positions. Moreover, by using an adhesive with a specific rheological characteristic, a relatively high dot height can be realised, as illustrated in Fig. 10. However, this technique is difficult and expensive if the adhesive must be applied simultaneously to different placement positions. This therefore places a limit on the high productivity potential of SMA.

(3) Adhesive can also be applied using the pin transfer system, which does permit simultaneous application onto all placement positions. This technique employs an adhesive having a relatively low dot height, as shown in Fig. 10. However, since the use of real/dummy tracks under devices enables minimal amounts of adhesive to be employed, this is not a problem.

Pin transfer is a simple but highly effective technique. A squeegee first passes over a tray of adhesive to make the surface level. An array of pins is then dipped into the adhesive, as shown in Fig. 11a. A small amount, determined by the shape and dimensions of the pin plus the thickness of the adhesive layer, is retained when the array is withdrawn. This is subsequently deposited on the substrate, Fig. 11b, when the array is lowered onto the surface.

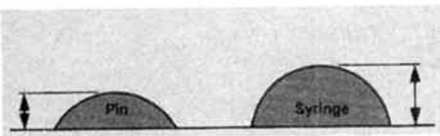

Fig. 10. Adhesive dot height determined by type of adhesive and application method.

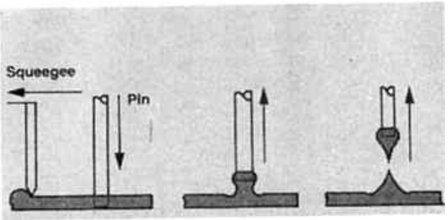

Fig. 11a. Array of pins picks up adhesive.

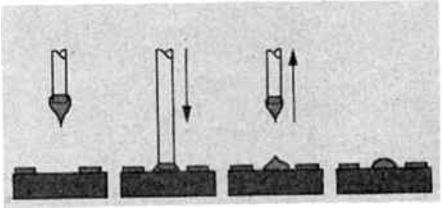

Fig. 11b. Transfer of adhesive to placement positions.

Which adhesive?

Thermoset epoxy is an excellent adhesive, with characteristics that are well known to the electronics industry. It retains the SMD in position during the adverse environments of the defluxing and soldering operations and has no long-term influence on device or substrate. As its name implies, it is cured by heat and Fig. 12 shows the curing characteristic, the time axis of which excludes warm-up.

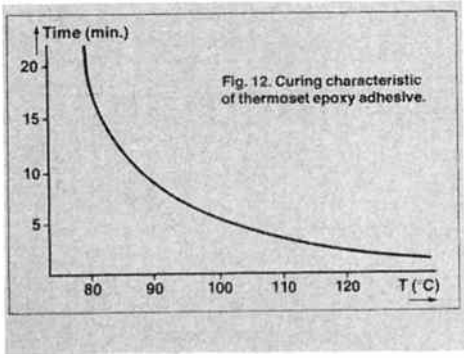

Fig. 12. Curing characteristic of thermoset epoxy adhesive.

Defining footprint guidelines

The space between solder pads is an important and critical parameter, since it must be as wide as possible in order to accommodate the tracks, yet narrow enough to allow the metallisation ends of the device to make an overlap with the solder pads. This second criteria is determined by the accuracy with which the device can be placed with respect to the solder pads.

Fig. 13 illustrates how placement accuracy is made up from a combination of:

(1) *positioning accuracy*, determined by the placement system

(2) *pattern accuracy*, determined by the substrate manufacturing process

(3) *dimensional tolerances*, determined by the SMD manufacturer.

Thus the space between the solder pads must allow for a situation in which positioning error is in one direction, while the pattern error is in the opposite direction, and at the same time the SMD has minimal dimensions, (assuming the normal situation whereby the placement system centres the SMD with respect to a reference).

Fig. 14 shows the equation that determines this distance between solder pads (D_{max}) is related to the minimal length of component (L_{min}), minus the positioning error (Δp) and substrate error (Δq) together with an empirical figure for minimal overlap (O).

Fig. 14 is a similar equation for the distance between SMDs (F_{min}). Thus the minimal distance is related to the maximum width of the device: (W_{max}), the positioning error (Δp) and a second empirical figure (I), which is a necessary minimal distance to avoid short circuits occuring when soldering the substrate.

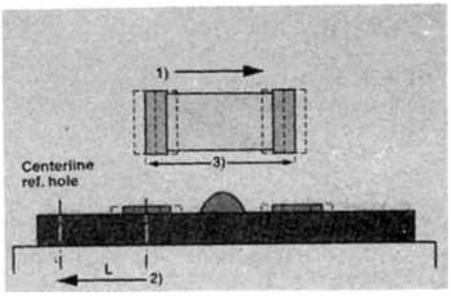

Fig. 13. Placement accuracy determined by three interactive parameters.

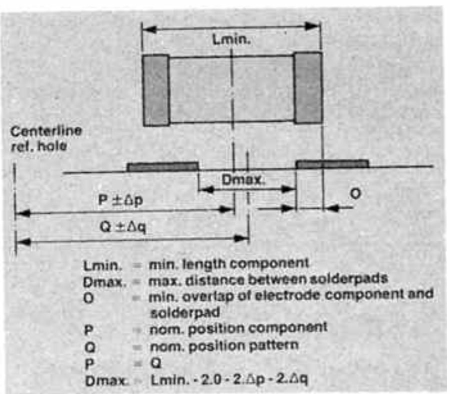

Fig. 14. Determining space between solder pads.

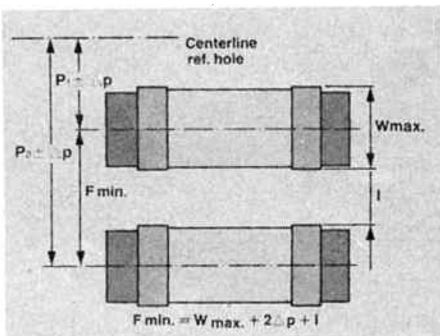

Fig. 15. Determining space between components.

Fig. 16 concerns the rotation of the SMD with respect to the print pattern. The illustration is exaggerated, since in actual practice the amount is just a few degrees. Typical figures for the various parameters are:

— positioning error (Δp) ± 0.3 mm

— pattern accuracy (Δq) ± 0.2 mm

— rotation ± 3°

— normally an empirical figure of 0.1 mm is selected for the metallisation overlap (O) ▶

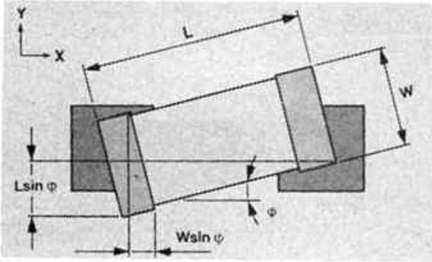

Fig. 16. The influence of rotation.

Soldering the substrate

A correctly soldered SMA substrate is illustrated in Fig. 17. The criteria for a correct soldering process are three-fold:

(1) the solder must reach the solder pad and the metallisation of the device
(2) there must be no short circuits between devices or between devices and tracks
(3) there must be no flux gases trapped.

With a conventional substrate using leaded components, the solder can easily flow right around the clinched end of the leaded device. And the flux gases can escape up the insertion holes.

SMDs however, are placed directly onto the substrate. This means that the solder cannot flow underneath the device to reach the metallisation areas, instead it must flow around the device. Thus in situations such as Fig. 18a and Fig. 18b, one end of a device can block the other from the flow of solder (the so-called shadow effect). Obviously this phenomenon becomes more critical due to the kind of high component densities that can be achieved with SMDs. And equally obviously, drag soldering is impractical since it relies on a horizontal flow of solder over the substrate.

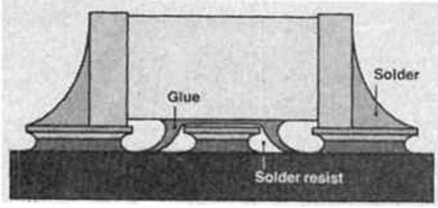

Fig. 17. A correctly positioned and soldered SMD.

Therefore since the first objective cannot be met with a horizontal flow of solder, it must come from the Z-axis. Instead of moving the substrate through a bath of solder we must direct the solder up against the underside of the board using a jet or wave of solder. However, a relatively large amount of solder is required to accomplish good wetting and this can introduce short circuits.

The use of double wave soldering is recommended as illustrated in Fig. 19. The first wave directs a jet of solder up in order to ensure good wetting of the metallisation areas and hence meet the first soldering objective. The second, gentler, wave removes the excess solder and ensures that there are no short circuits.

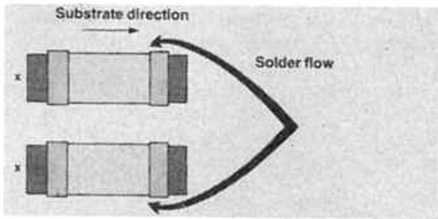

Fig. 18a. Solder only reaches one end of high-density SMDs (the "shadow effect").

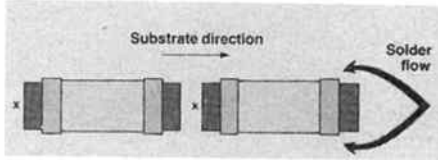

Fig. 18b. One SMD blocks flow of solder to another SMD.

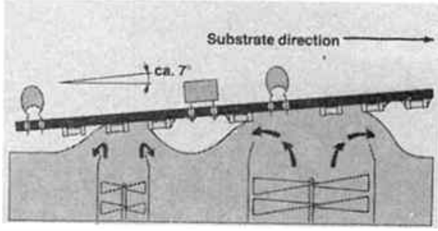

Fig. 19. Double-wave soldering accomplishes objectives.

Other techniques are constantly being developed and evaluated since soldering is the primary constraint on component density for SMA substrates.

We gratefully acknowledge the assistance of Philips Electronic Components & Materials for the supply of information used to compile this feature and for permission to reproduce diagrams and illustrations from company material.

Applications of surface mounted assembly

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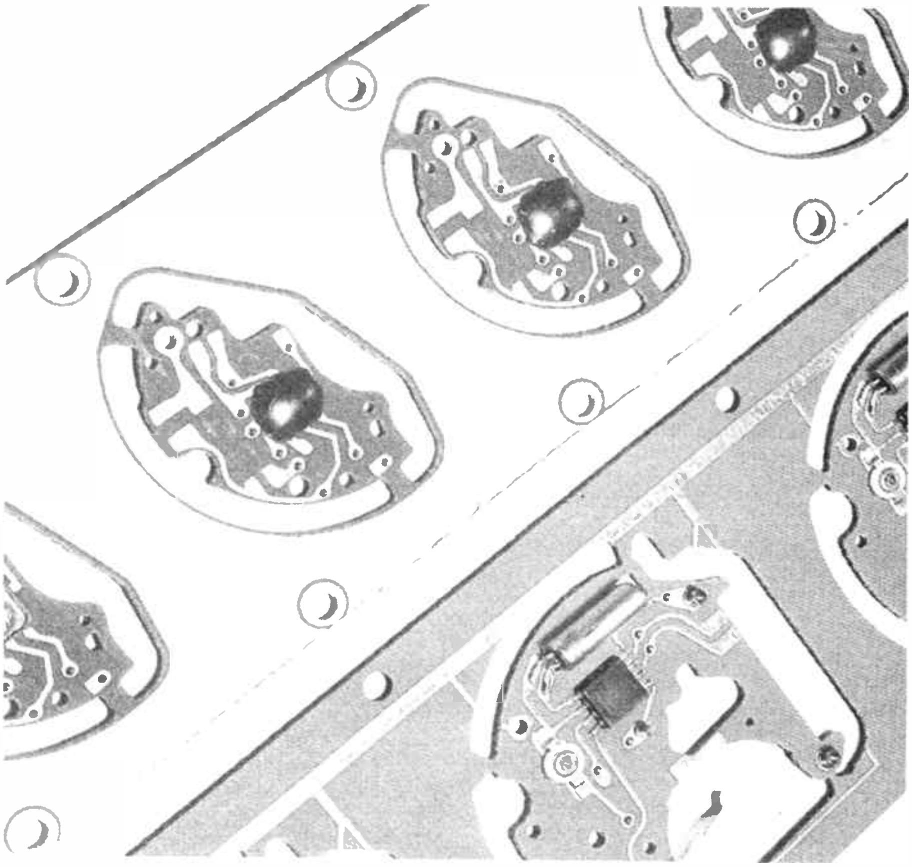
- Portable cassette recorders
- Portable radios
- Radios with automatic tuning
- Advanced hi-fi
- Video recorders
- LCD driver circuits
- Automobile circuits
- Telephone headsets
- Handheld transceivers



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Sony debuts 8mm tape technology

The era of a 'universal' audio/video analogue/digital tape standard has arrived, according to Sony, who launched the long-awaited 8 mm tape standard in releasing their new video camera-recorder, the CCD-VS in July.

The new 8 mm tape cassette may be used for both analogue and digital sound recording, as well as video recording in a single format. The tapes are not much larger than a compact audio cassette, measuring just 95 x 62.5 x 15 mm (length/width/depth).

The new tape standard first appeared in prototype in 1980, following some 102 Japanese and 25 other companies from around the world agreed to form the "8 mm Video Conference". In February 1984, agreement was reached on the new format and a n umber of manufacturers have been working on it ever since.

When 8 mm tape offers is much improved recording density with greatly increased recording time per cassette. Two types of tape will be offered: a 'super' grade evaporated metal tape and a lower quality metal powder-coated tape.

Video8 recording permits either FM audio or PCM (digital) audio recording, laid down along with the video tracks which are helically scanned using two heads with a track width of 34.4 microns.

Two erase methods are available: full erase and 'flying' erase. Full erase covers the whole tape width and employs a stationary head while flying erase employs a rotary head, getting rid of problems associated with the former.

Sony's CCD-V8 camera employs a unique charge-coupled device (CCD) retina in place of the vacuum tube image orthicon employed in current cameras. The CCD has advantages in lower power consumption and no image retention from bright sources which leaves streamers, or 'comet tails', on the image from conventional camera tubes. The CCD image sensor is rated to 22 lux, according to Sony's literature.

The CCD-V8 features an electronic viewfinder through which you can playback anything you've just recorded. The whole camcorder is smaller than most current conventional camera-recorders, and the recorder includes most of the features found on domestic VCRs. The CCD-V8 is expected to retail for around $2200

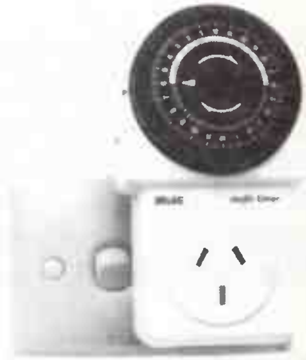
Plug-in timeswitch

Until now there have been a number of serious drawbacks with the timeswitches that have been available on the home user market, Arlec say. The sophisticated types have been somewhat difficult to set and operate, whereas the simpler ones have offered little more than a single ON/OFF period in 24 hours. Others have been clumsy, unreliable or inaccurate.

Arlec has just introduced the PC737 Multitimer Plug-in Timeswitch which is accurate and provides up to 96 switchings every 24 hours, they claim.

Completely self-contained, the PC737 plugs directly into any 240 volt power socket and can control a wide variety of electrical appliances, such as heaters, electric blankets, air-conditioners, cooking appliances, swimming pool filters, security lighting etc.

Extremely simple to set and operate the PC737 has 96 switch buttons around the rim of the time dial, each one representing a 15 minute time interval. Switch-on time is set by pressing down one or more of the switch buttons according to the length of time the appliance is required to operate.



Further information on the PC737 Multitimer is available from the manufacturer Arlec **Pty Ltd, 30 Lexton Road, Box Hill 3128 Vic (03) 895 0222**

ABC CHOOSES LOCAL MONITOR SPEAKERS

The ABC chose 'Australian-made' when they came to install monitor loudspeakers in their control room at the Sydney Opera house recently. Audisound Laboratories' Linz 8066 monitors were chosen for the installation, manufactured in North Curl Curl, a northern Sydney suburb.

According to Ron Cooper, of Audiosound, the 8066s have an extended sub-woofer performance in the bass end and with excellent mid-range and HF smoothness, were preferred to Quad ESLs in an independent test report. Copies of the test report can be made available. Full details are available from **Audiosound Laboratories, 148 Pitt Rd, North Curl Curl 2099 NSW. (02) 938 2068.**

Eyes up! — tracks and trends from the Perth Electronics Show

Roger Harrison

In seven years the Perth Electronics Show has grown from a small local event to the largest consumer electronics show staged in the southern hemisphere. It is now a show of national commercial importance and attracts international attention from companies and clientele alike. Here's a rundown on equipment and market trends discernible from the 1985 Perth Electronics Show.

Philips previewed a portable CD player, to be launched against the Sony D-50 which has been on the market six months.

CD PLAYERS and stereo hi-fi VCRs were the dominant new products at the 1984 show, while the industry was 'standing around' in the marketplace asking ". . . where next?" It seems from the 1985 show the industry has shaken off it's 'where next' malaise, for there were dominant new products in just about every arena.

Topping the list would have to be satellite TV receive-only (TVRO) terminals — of particualr interest to West Australians living in remote areas, but something that looks like being a considerable influence on quite a large sector of the population.

The video marketers were tight-lipped last year about the fate of the new 8 mm video format, meanwhile the VHS camp, led by JVC, launched their VideoMovie camcorders, using the VHS-C compact video cassettes against the BetaMovie. This year, Sony stole back their lead with the 'Video8' camcorder using the 8 mm video cassette format while the VHS camp companies squabbled over the spoils of the camcorder market.

In the compact disc arena, this year it is "CD to go" and "CD with pictures." Philips previewed a portable compact disc player which will be launched against Sony's D-50, released six months ago. Philips has not indicated a release date for this product, yet. However, "Walkman" style players weren't the only new thing in CD. Both Philips and Sony showed transportable "ghetto blasters" built around a CD player.

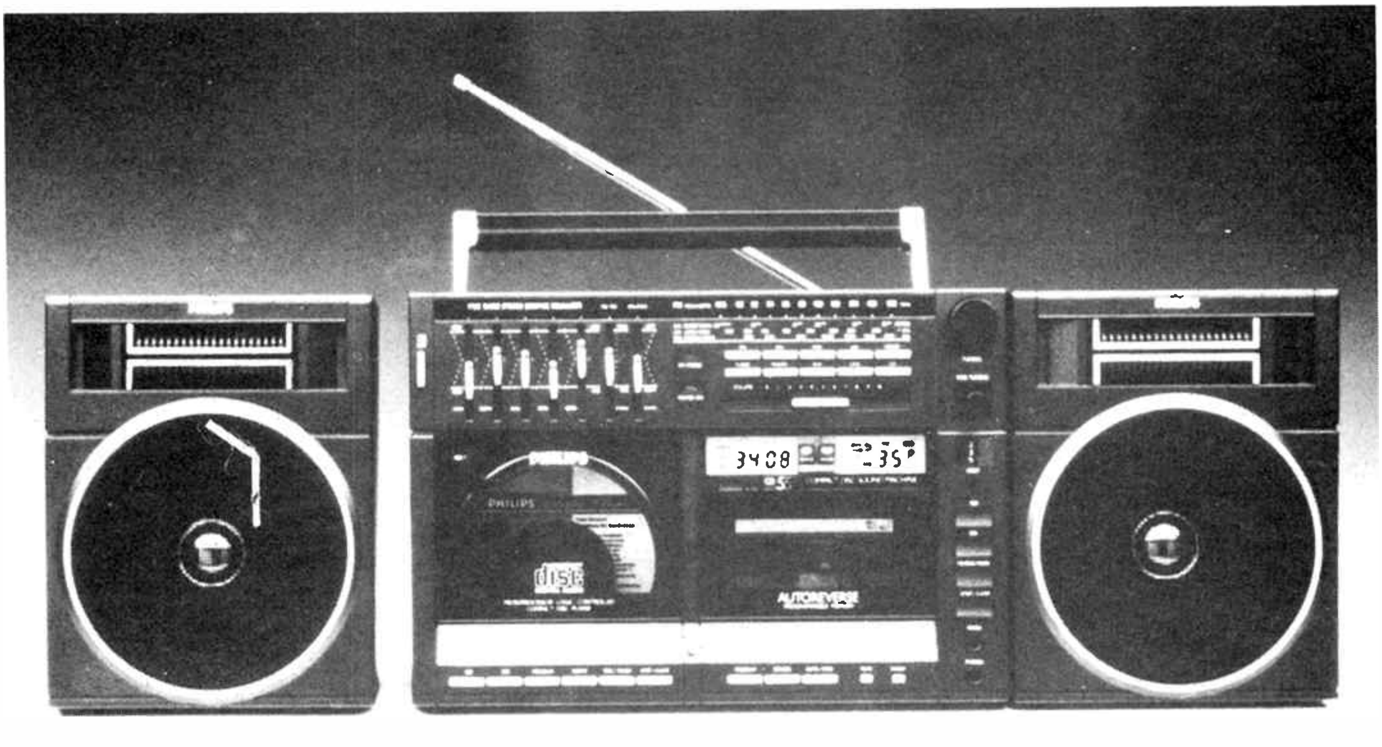
Philips clearly stole the march in CD technology this year. They demonstrated the 'CD with pictures' concept with working prototype machines. The trend towards integration of domestic audio and video equipment into a 'home entertainment' package is clearly not far off. And the word is, the home computer might well be included.

The big move in hi-fi this year was — into the car! It seems some people are willing to spend as much on their car audio gear as on their home hi-fi. Even though AM stereo station programming is reported as almost universally abysmal, AM stereo car sound tuners are leading the big growth in this area. Pioneer dominates the market, but Sansui, Fujitsu, Mitsubishi, Nakamichi and Yamaha are moving-in in a big way; and KEF launched a car speaker.

The digital audio era seems to have brough on a re-think among amplifier and loudspeaker designers. The wider dynamic range and much lower noise performance of compact disc is responsible. New amplifiers from Luxman, NAD and Nakamichi were exhibited plus John Bowers' new 'active' loudspeakers with the amps incorporated.

On the computer front, the 'serious' machines now dominate the market. 'Toys' are well and truly a thing of the past. It seems consumers have travelled up that 'learning curve' far enough to realise the power and utility of personal computers and they're now much more discerning, and prepared to pay more. Prominent at this year's show were AWA-Thorn with the Amstrad and Mitsubishi MSX computers; Commodore — who released their new 128K machine, and Australia's own Applied Technology with the Microbee. A surprise, however, was in store from Atari.

That newest of all growth industries — information technology — raised its ubiquitous head at this year's show for the first time. While Viatel, Telecom's public videotext in-



The CD ghetto blaster arrives this summer, to blow you away at the beach! This is Philips' CD-555.

teractive information service, is currently leading the way, private enterprise is eager to grab or create a few niches for itself. Directronix, a WA firm, seem set to make their mark in this arena while Rank Klarion ran up a flag for videotex, too.

But all that deals mainly with the 'here and now'. AWA-Thorn contributed the 'futuristic' with the Mitsubishi "Home Automation" system. The concept employs a bus cable run throughout the home with terminal/controllers where you want them so you can control room lighting, domestic appliances, even security systems — or whatever. And it links into the telephone/home-intercom system. So even if you're away from home, you can call your house and operate anything you like.

Naturally, it's all controlled from a central computer, which Mitsubishi dub the 'Invisible Silent Robot' (ISR). By installing slave 'phone modules, which also act as system controllers as well as an intercom, you can activate any function from any room where one's installed.

The system was first shown at the Chicago Electronics Show in June and it's second public showing was at Perth. A team of Japanese technicians were flown in to instal it.

AWA-Thorn took over a whole pavilion and reportedly spent some $60 000 on their exhibition. Curiously, the big and the small among the exhibitors mix quite happily at this Show. Philips dominated one of the main pavilions, occupying a huge area with an open, flow-through exhibit that allowed them to show a lot of product in 'thematic' areas. And it was 'hands on' all over.

Sky high-lights

Some five of companies fielded satellite TV receiving equipment, but AWA-Thorn gave the concept and their system the 'gee-whizz' push with an impressive sound-and-light audio-visual spectacular.

The Sydney-based company, Acesat gave their terminal equipment a solid push for it seems the largest early purchasers for TVRO will be West Australians living in the remote regions.

CD grows apace

Over the past year, CD players for the car market became available and exhibitors did not waste this opportunity to show them off. However, personally I have reservations about the mobile environment with CD as you just can't get the dynamic range — the car's interior is too noisy (Rolls Royce's reputation notwithstanding).

No doubt we'll be confronted by CD's on the beach this summer with the introduction of the "ghetto blaster" with CD player concept. The Philips system, dubbed the CD 555, includes an auto-reverse cassette deck, a 4-band stereo tuner, two-way detachable speakers and a 25 W/ch. amplifier with graphic equaliser.

Sony's system, the CFD-5, has a similar line-up and features an automatic music sensor for both the disc and tape to help you find favourite tracks. You can tape from CD to cassette and a 'synchro' facility inserts a four-second pause between selections for use with the automatic music sensor. Both are due for release this summer.

Sounding off

Luxman's radical Brid series featuring (?) valve/MOSFET hybrid circuitry was on-show with Vince Ross Audio but audio results would have to be judged 'inconclusive' without an in-depth analysis.

Falk Electrosound teamed the new NAD 2200 (see 'Consumer News' in last month's issue) with KEF's 104/2 speakers for stunning demonstrations (using the Telarc Straussfest CD — you have to hear it to believe it!).

Convoy teamed Nakamichi's new amp with B&W's 802 speakers and stunned the crowds where they stood. It was a curious experience watching the crowd at the end of a demo session just stand there, while the silence roared around them, taking 20 seconds to recover. Impressive! Nakamichi's amp features the "Stasis" circuit topology currently causing not a little controversy in the overseas hi-fi press.

It seems amplifiers and loudspeakers will get closer together in future — if Britain's innovative speaker design- ▶

For a glimpse into the possibilities of the future, AWA-Thorn created a little switched-on excitement with the Mitsubishi Home Automation system display.

er, John Bowers, has any say in it. 'Active' loudspeakers, with the power amp in the speaker enclosure is a distinct new trend and Convoy seems set to lead the way as they demonstrated Bowers new speakers to some incredulous customers. I was priviliged to get a private preview early one morning. The sonic results were remarkable, especially when driving the speakers direct from a CD player's output (no preamp, no volume control!)

Video revamp

Video8 was not the only new thing in video launched by Sony. In an effort to push Beta technically yet further ahead of the rival VHS system, Sony has launched 'Super Beta', an enhanced Beta system claimed to give a 20% improvement in the picture as well as upgraded sound quality.

Meanwhile, autofocus is the latest addition to the VHS cameras and camcorders, designed to appeal to the mass market as well as the videophile.

The VHS manufacturers are now concentrating on the audio systems in the domestic VCRs. Both National Panasonic and Akai brought out 'surround sound' VCRs.

Stereo TV was a genuine new product at last year's show, but few companies had them. This year stereo TVs joined the 'rank and file' consumer products, but they're still placed at the top-end of most companys' product range.

When it comes to video screens, high resolution monitors made their debut this year. Ever one to lead the way, Sony launched a hi-res colour monitor with both analogue and digital RGB inputs plus composite video and an audio input. It's designed for use with both VCRs and computers. Using a refined Trinitron construction, they've managed to achieve 80-column character resolution. Sony expect it will appeal to IBM PC and compatible market. It is expected to sell for around $800.

Keyboard kings

Atari, under new boss Jack Tramiel (ex-Commodore), seems set for a Phoenix-like rise from the ashes of its home computer crash last year. The new Atari 520 ST (dubbed the "JackIntosh," after Tramiel) looks like setting new performance standards in both hardware and software if it delivers what it promises.

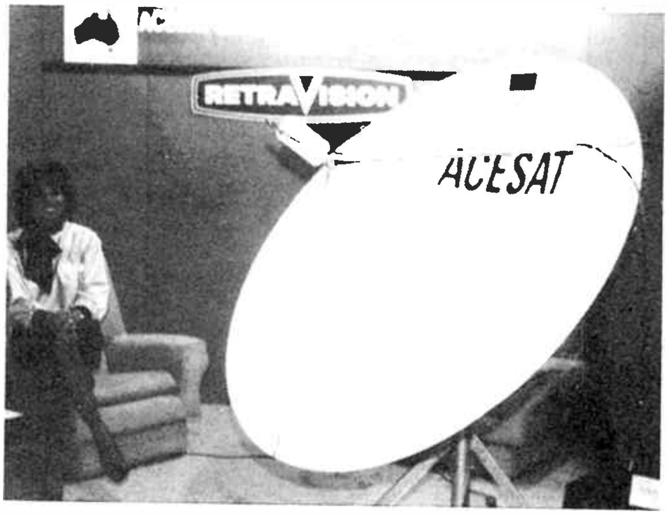
Atari currently has no Australian distributor, but Perth businessman Jeff Krasnostein, who owns a chain of consumer electronics stores in the WA capital, has an agreement with Atari to import and sell their products until a distributor is appointed.

The 520 ST employs the Graphics Environment Manager (GEM) operating system and a 16/32-bit 68000 processor running at 10 MHz. It will come with half a meg of RAM, 192K of built-in ROM software, expandable to 320K through plug-in cartridges. The cartridge port is configured to interface with 'compact disk ROMs' when they become available.

You get three graphic display modes, each screen being bit-mapped and taking 32K of memory. Low-res mode gives 320 x 200 pixels in 16 colours, medium-res gives 640 x 200 pixels in four colours and high-res 640 x 400 in mono. The 520 ST offers similar features to the MacIntosh, with icons, multiple windowing, pull-down menus and mouse operation. It has the ability to do bit-block transfers and has a unique vector graphics drawing feature.

Sophisticated sound facilities are included, so Atari see such as not the province of toy computers alone. Just to reinforce that, they've included a midi interface which allows you to connect it to electronic musical instruments like synthesisers and drum machines.

Back on the home computer front, MSX computers quietly made their debut on a number of stands. MSX is the home computer 'standard' adopted by nearly all the major Japanese electronics manufacturers (except for Sharp and NEC).



With Aussat up, the satellite TV terminal market is set to flourish. Satellite dishes sprouted like mushrooms at this year's show.

Where next for the show?

It seems the show organisers will give more encouragement to the trade side of the show in future, to bring retailers and dealers in from all over Australia. This year a whole day was devoted to the trade (no public access), as against a half-day in 1984. Over 3000 registrations from retailers were recorded, coming from all over Australia.

A series of industry seminars were organised this year and all were well attended. Topics covered included "The laser disc and electronic shopping", "CD with pictures" and "8 mm video". It seems such seminars will now become a permanent feature of the show.

Year by year, the foreign principals of the major local distributors are taking this show more seriously. Witness the effort expended by AWA-Thorn and Philips this year. Attention from the local retail distributors was markedly up this year and the organisers will emphasis the trade aspect of the show in future, it seems. Next year, they're talking about changing the dates to capitalise on the runup to the 1987 America's cup.

Whatever, for the consumer electronics industry in this country, the Perth show is where it all happens.

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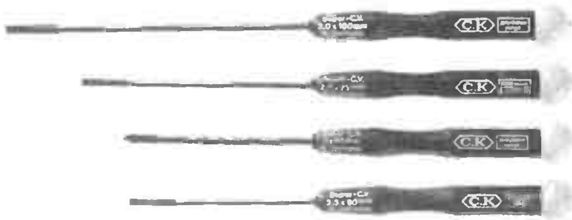

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0.00001% distortion! Really? But mine sounds better!

Robert Fitzell

How many times have we heard the argument that laboratory testing is a load of rubbish and that the only true performance test for audio components is to listen? In fact I have, on occasion, agreed with the latter claim although I believe that in many cases the subjective test does not tell which is the BEST performer. Instead it answers "which one do I *prefer?*"

WHETHER we like it or not, we all suffer from the "coloured ear" syndrome (not a Van Gogh). We are all more familiar with aspects of performance which are pronounced in our own sound equipment and then tend to like or dislike those aspects in other equipment. So, irrespective of any exactness, the subjective test is a necessary and valid one — it doesn't matter a hoot how good the measured performance of a component is if you simply can't stand listening to it.

I do think it unfortunate, however, that criticism of objective testing (i.e.: test measurements) frequently comes from persons marketing equipment or advising intending purchasers in a hi-fi store. The fact is, that listening tests are essential, take *time* and are the first step one should take in assessing suitability of some intended purchase, but you should not be discouraged from examining and making your final decision on the basis of *both* listening tests and the results of laboratory performance testing.

Which leads me to the most important question — why do some components perform well in laboratory tests but sound just terrible? Hopefully I can explain why, and also why this problem should reduce.

Laboratory testing technology

This magazine is devoted to technology. Our subjective testing is dependent entirely on the state of technology and it will always lag behind what we may want. It takes the thought to develop the science to permit technological advancement, so to the cynics who view that as a criticism, I'll say I don't think any scientist or technician would expect it to be otherwise.

So our objective opinions have to be restricted to what we *can* measure, not what we may wish we could. In a broad sense, until recently all laboratory tests on audio equipment were carried out for static conditions, that is signal amplitude and frequency were unchanging for the duration of the test. Using laboratory instruments, it has been possible for many years to obtain very accurate measurements of, say,

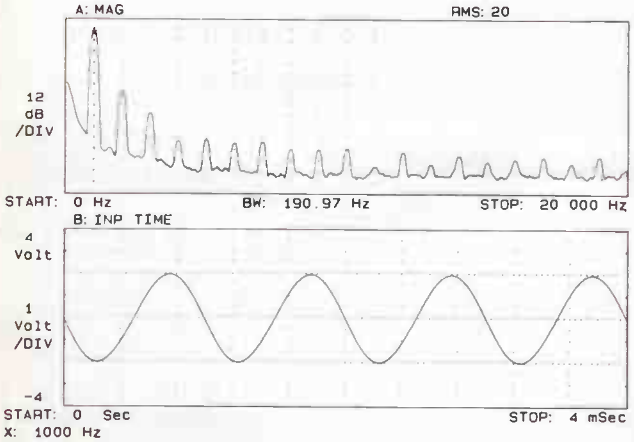


Figure 1a(top)/1b(bottom). Frequency content and waveform.

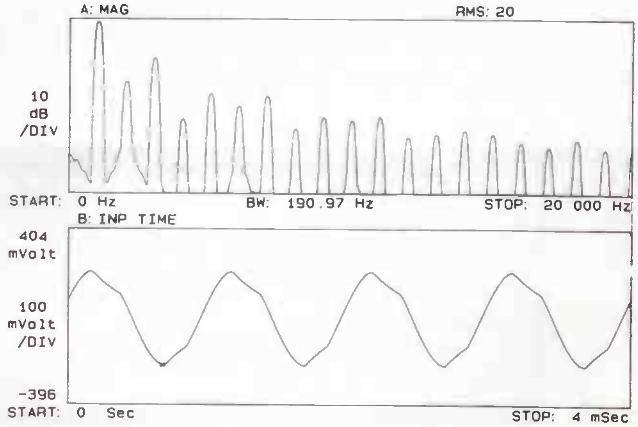


Figure 2a(top)/2b(bottom). Frequency content and waveform.

how accurately an amplifier can reproduce a 1 kHz pure tone of 1 volt peak to peak amplitude. Distortion could be measured by subtracting the amplifier response from the input signal and measuring how much spurious noise remains. Frequency shift could be measured — is the output 1000 Hz or 1002 Hz? etc.

This of course represents a problem to an audiophile. If Beethoven had scored his 9th solely for 1 kHz pure tones this testing would be eminently useful. Fortunately, Beethoven found others.

An improvement to single-tone testing is multiple simultaneous tones, again of fixed frequency and amplitude, from which interaction effects (intermodulation distortion) may be observed. Whilst two tones are musically more interesting than one, there have not been many two-tone compositions and this still does little to indicate performance of a component under the test of actual musical reproduction.

Music is complex in both frequency and amplitude content. The reason that a violin sounds different from a flute and a piano different from an oboe lies in the characteristic waveforms of each instrument type. Middle C is middle C on all instruments. However, each will carry with the fundamental tone a vast array of harmonic overtones, the amplitudes and distribution of which determine the characteristic tonal quality.

If we plotted the frequency analysis of a stringed instrument tone and showed it to an amplifier designer his imediate response would be "look at the distortion!!!" The result would be the fundamental plus strong harmonics at each integral multiple of the fundamental. So, just to produce one solitary tone of a real instrument our audio system has to cope with multiple frequencies without introducing many others, otherwise our violin starts to sound more like say, a steel guitar, due to the waveform distortion.

To reproduce music our system has to handle complex waveforms, varying almost constantly in both amplitude and frequency content. Just to give you some idea of what I am describing I have manufactured Figures 1, 2 and 3 which show frequency content and waveform still much like a sine wave; Figure 2 is decidedly distorted and Figure 4 is approaching a square wave.

This does not eliminate the need for static tests. If an amplifier cannot reproduce above 15 kHz under static tests then we can confidently assume that it will be worse when tested dynamically. The analogy is that if your family car needs to seat six then the basic specifications start at that point and the performance under road testing follows later.

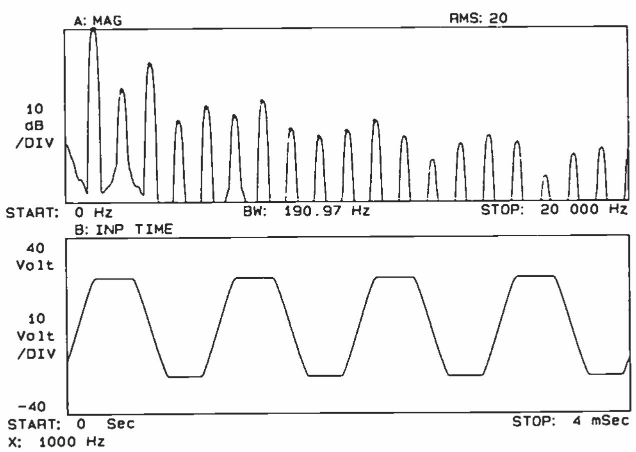


Figure 3a(top)/3b(bottom). Frequency content and waveform.

A confident guide to performance under actual operating conditions can only be obtained using dynamic tests and until recently, such tests remained in the realm of the thought experiment (or perhaps locked in the laboratories of heavily funded institutions, if any such beasts still exist).

Until we are shown something better I will continue to believe that assessment using wideband pulse sources or pulsed square waves with analysis by an instrument which can examine the system frequency response with time, is the most likely candidate for meaningful objective assessment. With increased availability of analysers using fast fourer transform techniques we can now look at electronic component response over time using *map displays* — frequency output traces each perhaps 1 millisecond apart — to examine the component performance with input pulses.

Frequency/time response

The concept of frequency versus time response of a system is nothing new to those working in architectural acoustics. Exploded balloons, starting pistols and other similar impulse sources have been used for years to examine early decay effects, early reflection patterns in rooms and overall frequency balance. For technical reasons, the measurements have usually been bandlimited octave or one-third octave decay traces, however the concept and areas of interest have been identical.

Eighty years ago, Sabine developed the concept of reverberation time and whilst the importance of reverberation is now evaluated quite differently, the original step was fundamental to the development of architectural acoustics. Perhaps now that we are better able to examine audio equipment frequency/time response, we may see similar improvements to design sophistication.

For those unfamiliar with architectural acoustics, who may be wondering why we could measure room response 80 years ago and are only now able to do similarly with electronics, the answer lies in the time periods involved — 0.5 to 3 second decay time in rooms can be satisfactorily processed by mechanical pen traces and analogue filters. Electronic equipment requires examination from microsecond periods up to about 0.25 second, which is about the lower limited of pen level-recorders.

Hidden in the decay times given above is an important bottom line. It is a *fact* that the listening environment is the true performance determinant. If you are unlucky enough to have a bad listening room, no matter how good your audio equipment is it will never sound good except through headphones. More about that problem later, but remember it when next you are trying listening tests of equipment. Don't just listen in one room once and hope that you will be satisfied.

What tests and why

There will be many who are very familiar with interpretation of test results that we publish. In last month's article on the Philips loudspeakers I pointed out that the frequency/time response of equipment is not able to be easily compared with static tests with which we are more familiar.

In the same way architectural acoustic design went through a period of learning before room decays were able to be confidently interpreted, we will have to accept a similar learning curve for our audio tests. I will be learning all the way and if any readers have any comments or suggestions to make I would be delighted to hear from them. In the meantime, I feel it is appropriate to summarise the interpretation of the map display and of the static test so that readers will be sure thay are interpreting our tests results correctly. For those who think they know it all, read on anyway. I might make an error. ▶

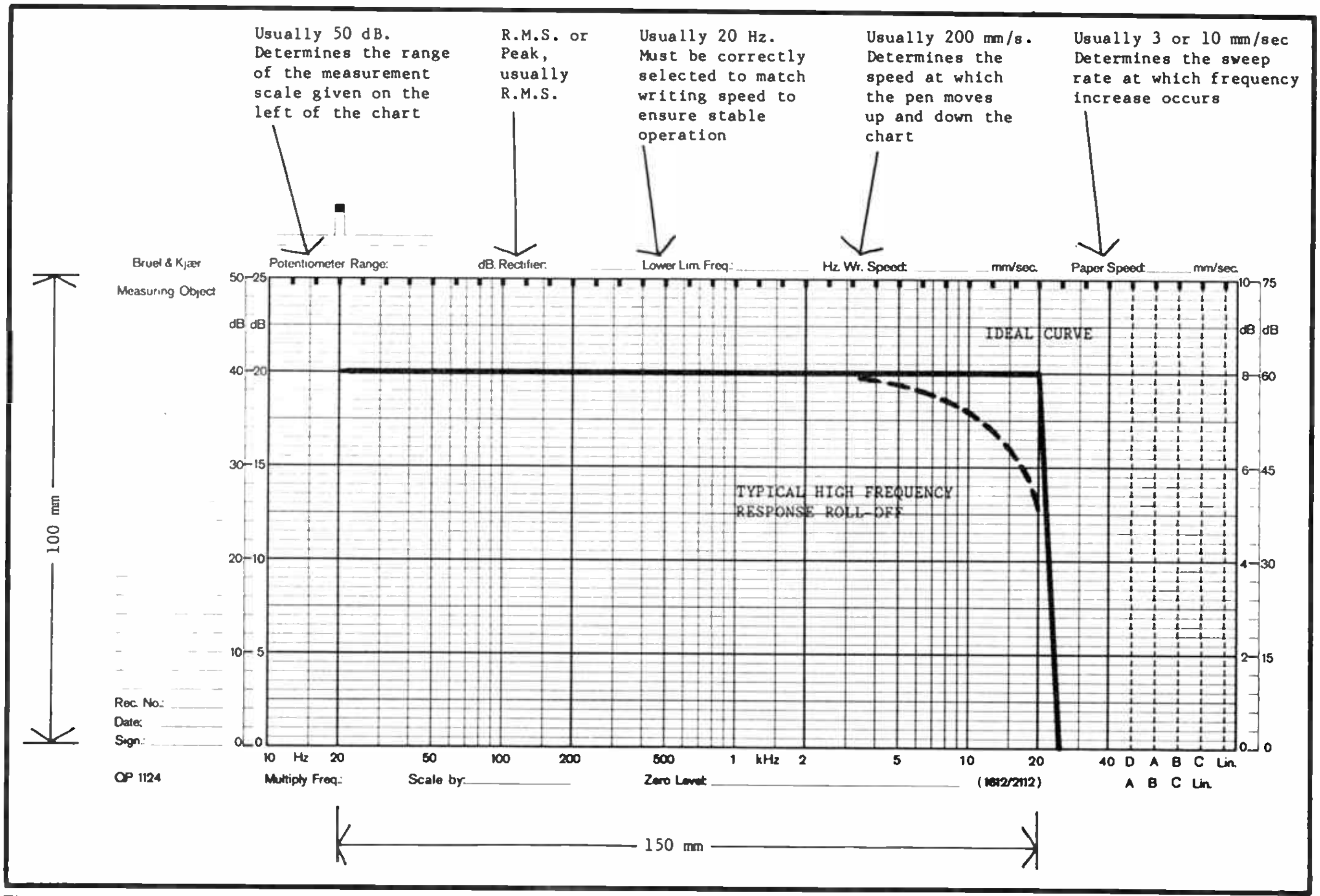


Figure 4. Frequency response chart.

Frequency response

Figure 4 shows a Bruel and Kjaer swept-tone frequency response chart with an ideal responsive curve. We obtain this by feeding a B&K oscillator tone through the test device into a B&K amplifier and then to a B&K graphic level-recorder. The typical roll-off of many items of equipment (expecially tape recorders) is shown dotted. Apart from amplifiers and similar signal processors, we rarely see ideal curves. Test results summaries are usually given in one of two ways — as a bandwidth contained within a plus or minus 3 dB envelope, that is a 6 dB wide envelope, or as a 3 dB down point relative to a specified frequency, usually 1 kHz. Figure 4 broken curve results are 20 Hz to 12.5 kHz +/- 3 dB, or a 3 dB down point, relative to 1 kHz, of 8 kHz.

The dimensions of the original chart are given in Figure 4 so that the paper and writing speeds make sense. Remember you are usually looking at reduced scale traces. The settings we usually use are a potentiometer range of 50 dB, RMS rectifier response, a lower limit frequency of 20 Hz with a writing speed of 200 mm/second, and a paper speed of either 3 or 10 mm/second. I had not thought the latter choice to be particularly important until we tested the Philips speakers last month.

Notice that the frequency scales are logarithmic. This is most consistent with what we hear, but in some cases does lead to loss of detail at high frequencies compared with a linear frequency scale.

Signal/noise and crosstalk

Signal-to-noise results are usually given as a single number or on the same B&K charts as Figure 4. Crosstalk between channels is also given on these charts with the two curves respresenting the two channels. The separation between each curve is the crosstalk in dB.

Distortion

Most of our distortion measurements are obtained using a Hewlett Packard FFT analyser in conjunction with B&K measuring and signal equipment. We also use an AWA ultra-low distortion oscillator.

For the distortion analysis we can choose either logarithmic or linear frequency scales. Whilst for consistency and familiarity I prefer logarithmic scales, it is true that distortion products are frequently easier to see using linear scales. This is because the distortion peaks occur at regular spacing across the diagram. Figures 5 and 6 show 1 kHz distortion analysis for the same source, Figure 5 being logarithmic and Figure 6 being linear. The harmonic distortion components are seen as peaks at 2 kHz and 3 kHz (called second and third harmonics) with very slight peaks at 4 kHz and 5 kHz.

The total harmonic distortion (THD) result for Figures 5 and 6 is -71.19 dB. Figure 7 shows a distortion test for a recording tape, with a logarithmic frequency scale and a pronounced 3rd harmonic distortion component may be seen. The total harmonic distortion is -44.01 dB.

To obtain maximum accuracy we average the input signal to the analyser to effectively cancel spurious noise. The number of averages is shown at the top of each figure.

Figure 8. Rectangular pulse source and responses. ▶

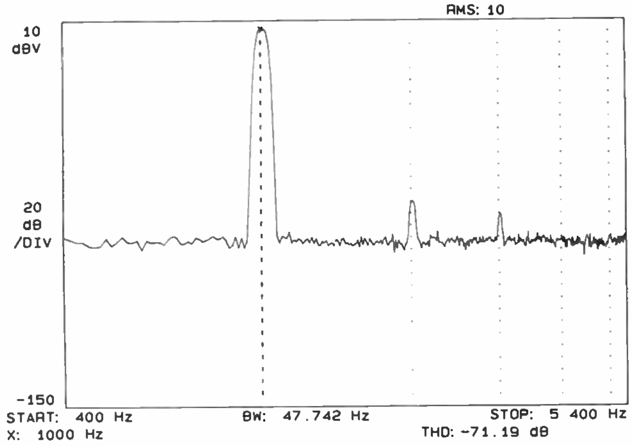


Figure 5. Distortion — log. frequency scale.

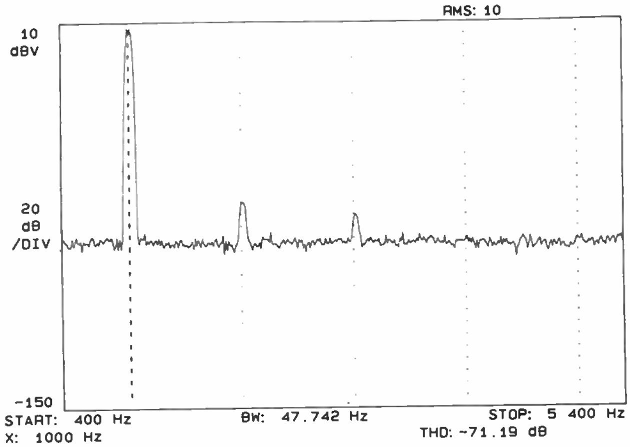


Figure 6. Distortion — linear frequency scale.

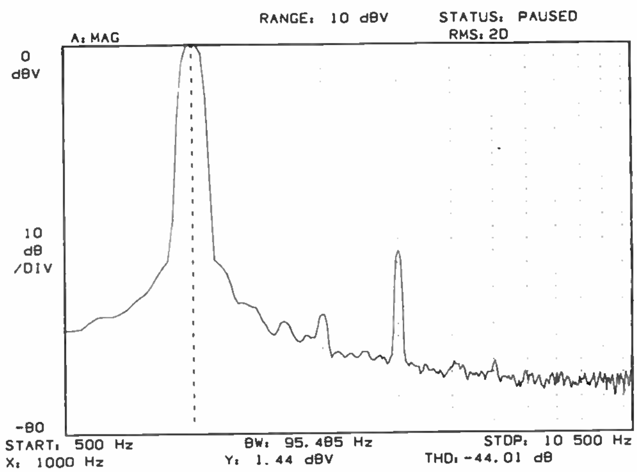
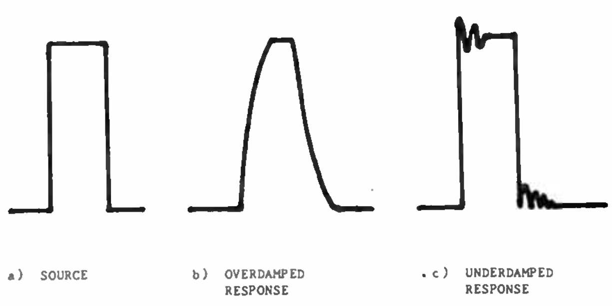


Figure 7. Pronounced third harmonic distortion.



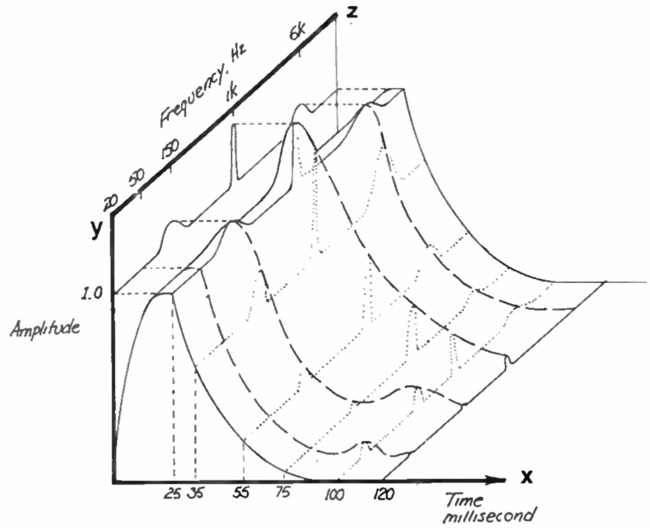


Figure 9. Frequency/time diagram, response to a rectangular pulse.

Frequency/time

This is where the history of performance testing is short. We do not use tone-burst testing, although this is mainly due to belief that the alternative we have, map displays of transient response for the full frequency bandwidth, is better. In the absence of this we also would do tone-burst testing.

Figure 8 is a simplistic diagram of a response to a square pulse. The source is a rectangular pulse of duration T and the two response anomalies. Figure 8b is an overdamped response, one where the response cannot follow the imposed source and lags behind. Figure 8c is an underdamped response, one where the device responds rapidly but cannot stop in response to an amplitude plateau.

Either response may occur, and the two responses will occur within the one device but at different frequencies. This leads to non-linearity of frequency response, but is only identified when the response is examined with time. The tone-burst does this, as do square waves to some extent, however, to represent musical response by an audio component it is obviously necessary to examine amplitude, frequency and time concurrently. Our map displays do precisely this.

Since the concept of response with time is usually presented with time across the bottom of the diagram, I have included Figure 9 before discussing the Hewlett Packard analyser output further. Figure 9 shows a freqency/time diagram for a hypothetical rectangular pulse response of 25 millisecond duration. The hypthetical item being examined is generally overdamped and does not follow the source well. It is non-linear, particularly at 50 Hz, 1 kHz and 6 kHz.

The steady-state response of the system is reached before the pulse terminates and is shown as a projection onto the Y-Z plane. This is a flat response except for a high peak at 1 kHz and wider but shallower peaks at 150 Hz and 6 kHz.

The response with time shows the types of anomalies which we are seeing in the frequency maps using the analyser — at 35 milliseconds, shortly after thepulse terminates, the anomalies are more pronounced. At 75 milliseconds the non-linearities at 150 Hz and 6 kHz are almost gone and the 1 kHz peak reduced. However, at 100 milliseconds an anomaly at 50 Hz has appeared and the 150 Hz anomaly has reappeared. Figure 9 is not taken from any test but describes typical features seen in the analyser maps.

The frequency/time map displays obtained from the Hewlett Packard analyser look at Figure 9 from a different direction, giving instead frequency increasing across the page ▶

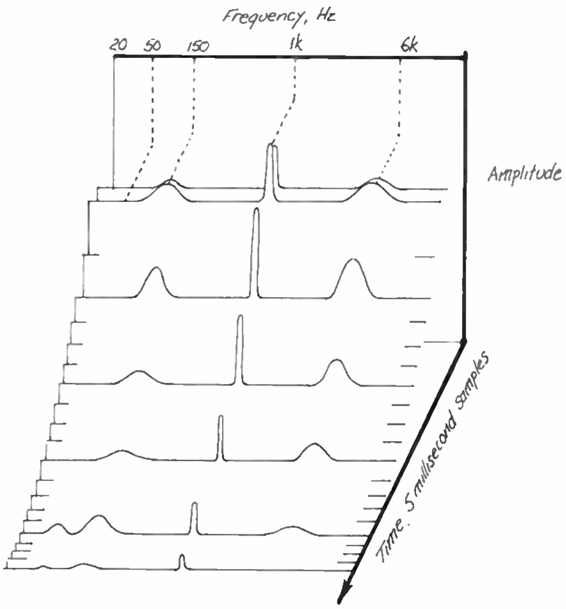


Figure 10. Frequency/time diagram, response to a rectangular pulse.

and time advancing toward or away from the page. While this format, which is shown on Figure 10 for the same hypothetical example, does not show time quite so clearly, it is a necessary format where ampliture or frequency content is the main aspect of interest. To measure time it is simply necessary to count the traces. You will note that we always indicate the direction in which time is advancing since we show it either way according to how well particular effects show up. Usually we use logarithmic frequency scales although again there will be instances where the linear trace is more meaningful.

Figures 11, 12, 13 and 14 show the real difference between static and dynamic tests. Figure 11 is an averaged response at a distance of 50 mm for a mid-range loudspeaker with pulsed pink noise of 400 Hz to 4400 Hz. Figure 12 is the same test but at a distance of 900 mm from the cone. As can be seen spurious effects are visible since the two traces are not equal. The dotted lines for both figures are 10 dB apart so the trace of Figure 12 is +/- 8 dB. Whilst this test is meaningful the information in Figures 13 and 14 tell a great deal more.

Figures 13 and 14 give 25 sequential frequency response traces each 1.6 millisecond apart, or a total time of 40 millisecond with time advancing toward the reader. Figure 13 shows the response at 50 mm and is therefore primarily the driver alone. Anomalies are few and whilst they start at about 5 to 10 millisecond do not become marked until after 30 millisecond. Figure 14 however shows anomalies throughout. The ragged commencement of the map trace is due to the trailing effects of the previous pulse and quite severe dips in performance may be seen at 700 Hz, 1 kHz, 2 kHz and 2.3 kHz. A late dip occurs at 275 Hz after about 25 milliseconds.

Interpretation of frequency/time maps requires some caution. Dips which extend throughout the map traces may be due to anomalies in the equipment, such as a crossover phase problem, but for loudspeakers may also be due to phase cancellation caused by a reflection from an adjacent surface.

Reflection from a remote surface will cause discrete dips as the out-of-phase reflection passes the microphone and cancels the source signal. These components can be identified by adjustment of the test configuration and looking for corresponding changes to the suspected reflection cancellations, however, a fully interpretation for environmentally affected tests, particularly loudspeakers, requires more knowledge than the map alone provides. Anechoic test conditions will remove these problems.

The real problem signals to look for are delayed lumps of energy or sharp dips in performance, particularly inside ten millisecond from the pulse. *Many* of the anomalies which occur later are room effects although not all. Loudspeakers which have appeared to suffer from dips and troughs at longer delays have proven to sound muddy, delayed high frequency spikes have been consistent with sounding harsh and irregularities at low frequencies have clearly coincided with uneven or untidy subjective bass performance.

At the moment, we still need to test many more components before we can really establish criteria for subjective assessment. We are presently looking at test results which make more sense compared with subjective testing than any previous techniques.

The problem of identifying which aspects of time/frequency response are attributable to room effects and which are due to the loudspeaker is not trivial. It is possible to determine, by looking at the first part of the time period, what period of the sample shows the output of the source alone, guaranteed free of room effects. However this is not the entire problem.

Components do exhibit anomalies over extended periods, and others may perform well in an open or anechoic environment but suffer more strongly from interactive effects with a listening room or with other components in the amplification chain. In relation to identifying which aspects are important to typical performance of a particular item under test you will have to rely on us at present.

Rooms

As I stated earlier, the room is not the final nail in the coffin, it is the hammer that put your poor suffering sound system in there in the first place. However delightful your lounge room might be, it almost certainly has enough decay anomalies to make a frequency/time map of your pride and joy look like a pin-cushion.

In case you are wondering what such a map for a "bad" room might look like, Figure 15 gives some insight — 60 traces each 1 millisecond apart for a balloon burst in a room with significant speech intelligibility problems. Compare Figure 15 with Figures 13 and 14 and you can see the potential for distortion. The dips in Figure 15 are typically on the order of 30 dB!

The problems of room acoustics are too extensive to describe here, although we hope to carry articles on the subject in the future. It is correct to say the influence can be of the order of 30 dB, and can occur over periods from milliseconds to two or three seconds. In terms of distortion the room effect could be as high as 300 per cent!

What can you do about it? Unless you have a fairly free budget, do as most acoustic consultants do — weep bitter tears!

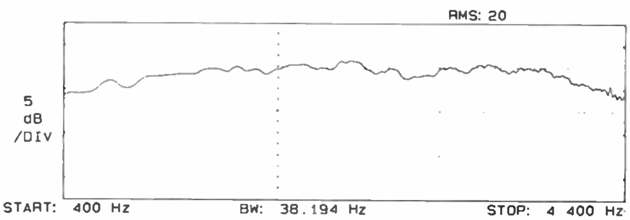


Figure 11. Frequency response, loudspeaker at 50 mm.

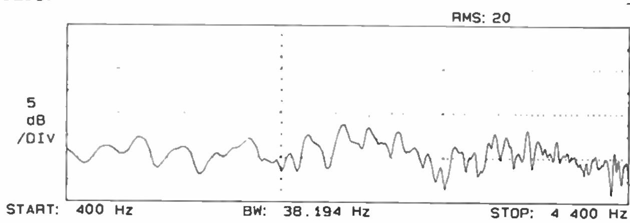


Figure 12. Frequency response, loudspeaker at 900 mm.

Figure 13. Frequency/time response, loudspeaker at 50 mm.

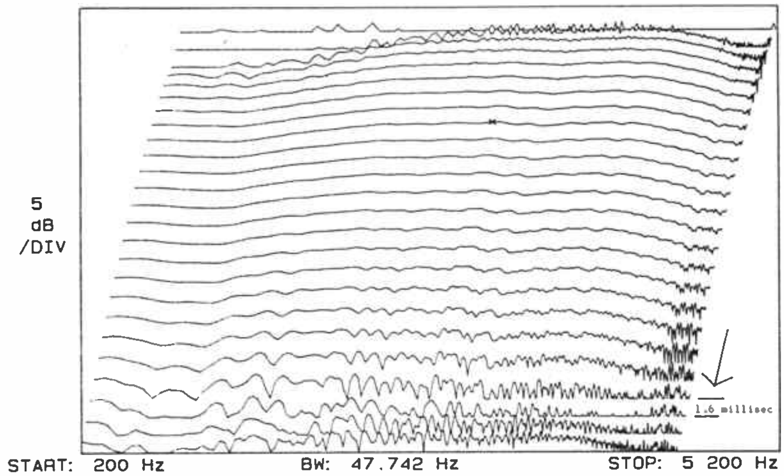


Figure 14. Frequency/time response, loudspeaker at 900 mm.

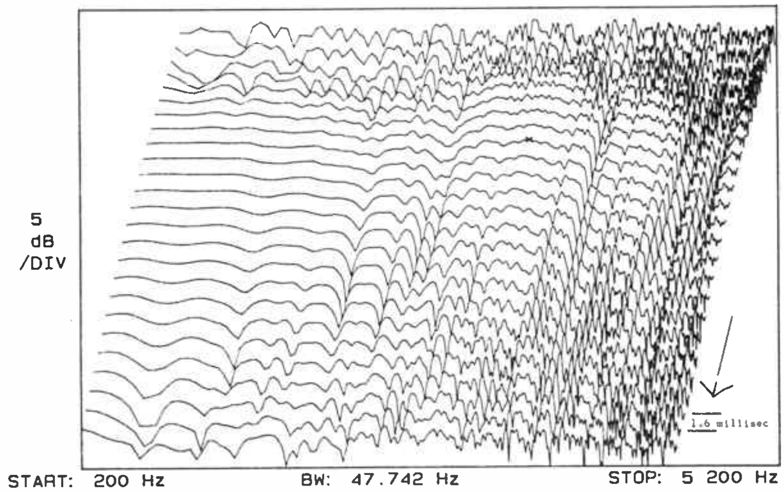
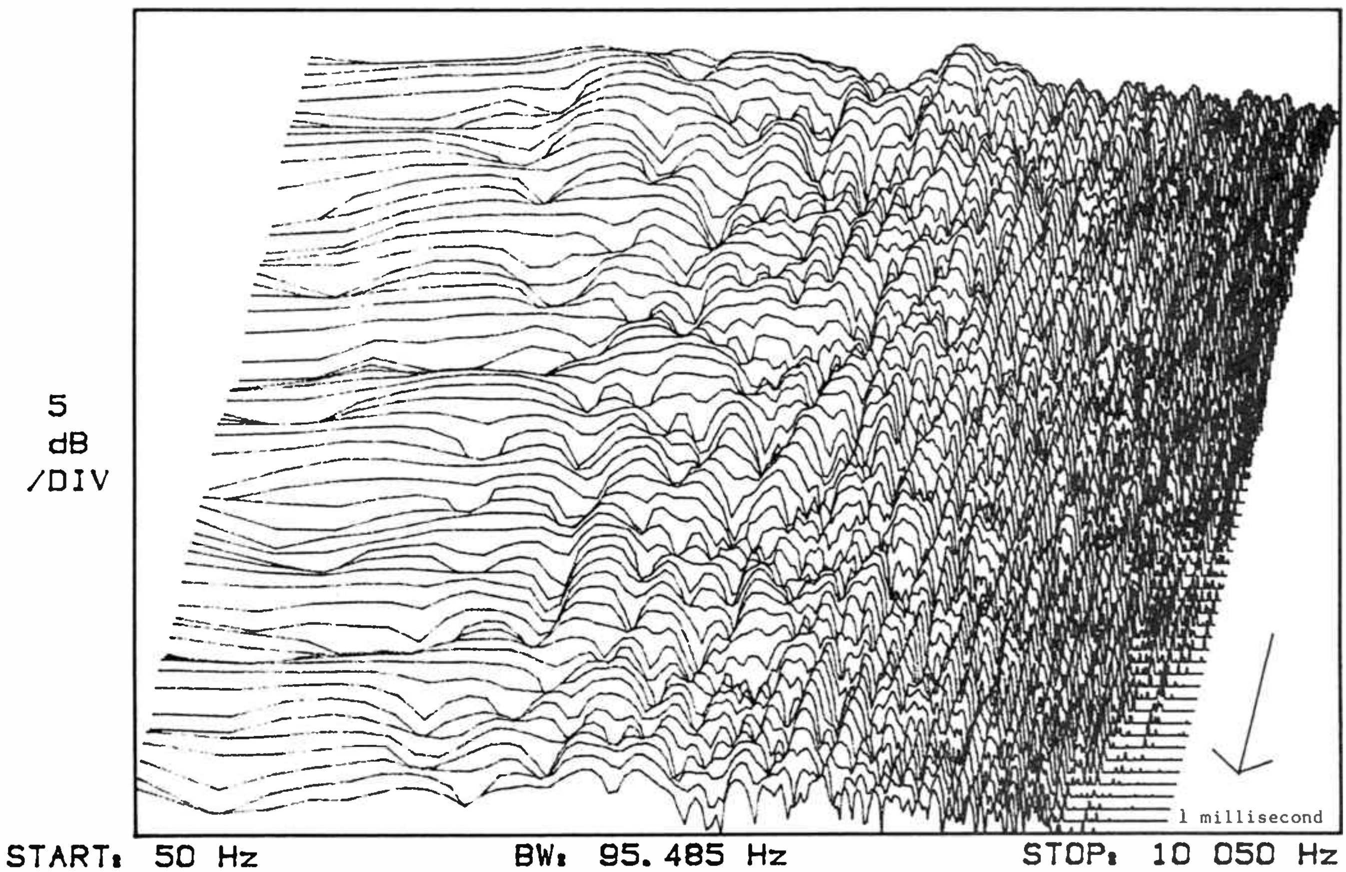


Figure 15. Room decay, impulse source.



AUTHOR! AUTHOR! AUTHOR!

So you've written this **great** article.

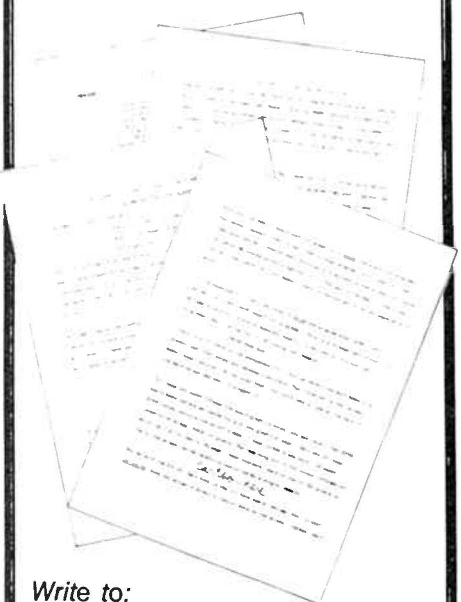
Tell us all about it then!

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

You've got to fan it to keep cool!

Spring is sprung, the temperature's riz, I wonder where the coolers is? When it comes to getting rid of heat inside equipment, you've got to fan it, the saying goes.

Hypec Electronics has by happenstance a happy bargain in fans this month. Made by Sunon in Taiwan, these three-inch huffers from Hypec hoperate from hundred and fifteen volts 50/60 Hz and draw but 130 milliamps. The label says they're himpedance protected. H'nuff!

Normally, they're priced at $14.50, but this month Hypec wish to hurry them ha-long at $8.50! We don't know their cubic feet/minute capacity, but they'll out-huff you any day (all day!). Overall width of these fans is 80 mm, with the mounting hole centres at 72 mm spacing.

Hurry to **Hypec, 21 Ryedale Rd, West Ryde 2114 NSW. (02) 808 3666 or 808 3050**

PROJECT BUYERS GUIDE

Computer hobbyists will be pleased to note that kits for the AEM4501 8-channel Relay Interface might be found in Jaycar stores in Sydney and Brisbane, as well as All Electronic Components and Active Electronics in Melbourne.

Audiophile hobbyists seeking a kit for David Tilbrook's AEM6010LL Low Level Cartridge Preamp might enquire with All Electronic Components or Active Electronics in Melbourne, or with Jaycar in Sydney and Brisbane. However, for those hardy types getting it all together 'from scratch', components will be found generally stocked by most electronics retailers.

For the boys in the band, our Bandbox project this issue will be of interest. The power amp and four-input preamp modules are available from firms like Active Electronics and All Electronic Components in Melbourne, Jaycar in Sydney and Brisbane, Geoff Wood Electronics in Sydney and Dick Smith Electronics stores all over. We did not know at press time who would be carrying a complete kit, with 19" case and all.

If readers experience any difficulty obtaining printed circuit boards, we keep a stock at our office. You can order your requirements by filling out the card in this issue, located between pages 34 and 35.

Farads for sale

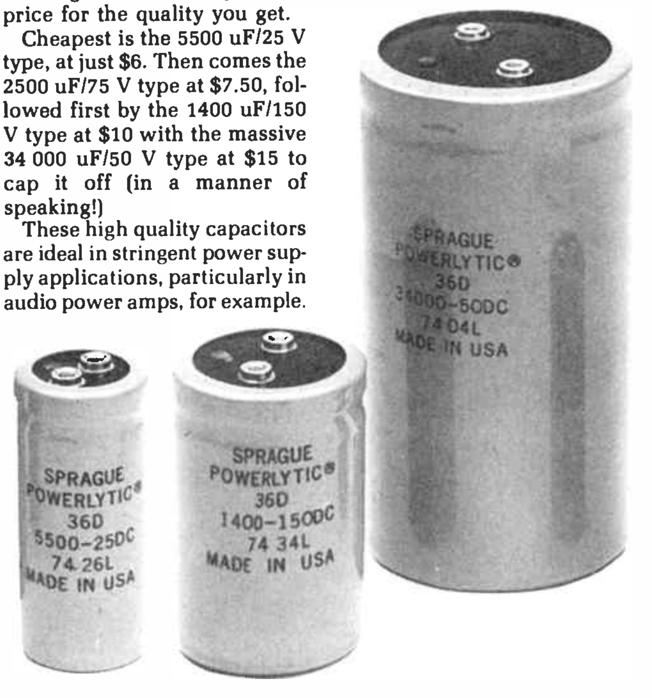
Melbourne components and kit retailer, All Electronic Components, currently has stocks of high-farad, high voltage electrolytic capacitors made by Sprague and they're offering them at respectable price for the quality you get.

Cheapest is the 5500 uF/25 V type, at just $6. Then comes the 2500 uF/75 V type at $7.50, followed first by the 1400 uF/150 V type at $10 with the massive 34 000 uF/50 V type at $15 to cap it off (in a manner of speaking!)

These high quality capacitors are ideal in stringent power supply applications, particularly in audio power amps, for example.

But, the catch is, All Electronic Components advise that stocks cannot be replaced — once they go, that's it!

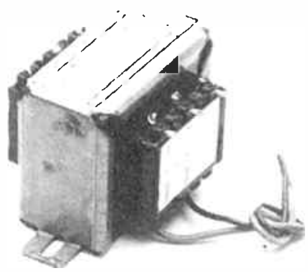
Amble over to **All Electronic Components, 118-122 Lonsdale St, Melbourne 2000 Vic. (03) 662 3506.**



'Universal' 60 VA tranny

Perth based retailer and mail-order house, Altronics, has recently added a versatile little 60 VA transformer to their range, featuring two separate multi-tapped windings.

Essentially, the new tranny comprises two 12 V/5 A windings, each tapped at 9 V. By linking the appropriate terminals, you can obtain a wide variety of output voltages and currents, ranging from 9 V at 6.6. A, through to 24 V (centre-tapped) at 2.5 A. A label attached to the top of the transformer includes a table showing the various combinations and how to obtain them.

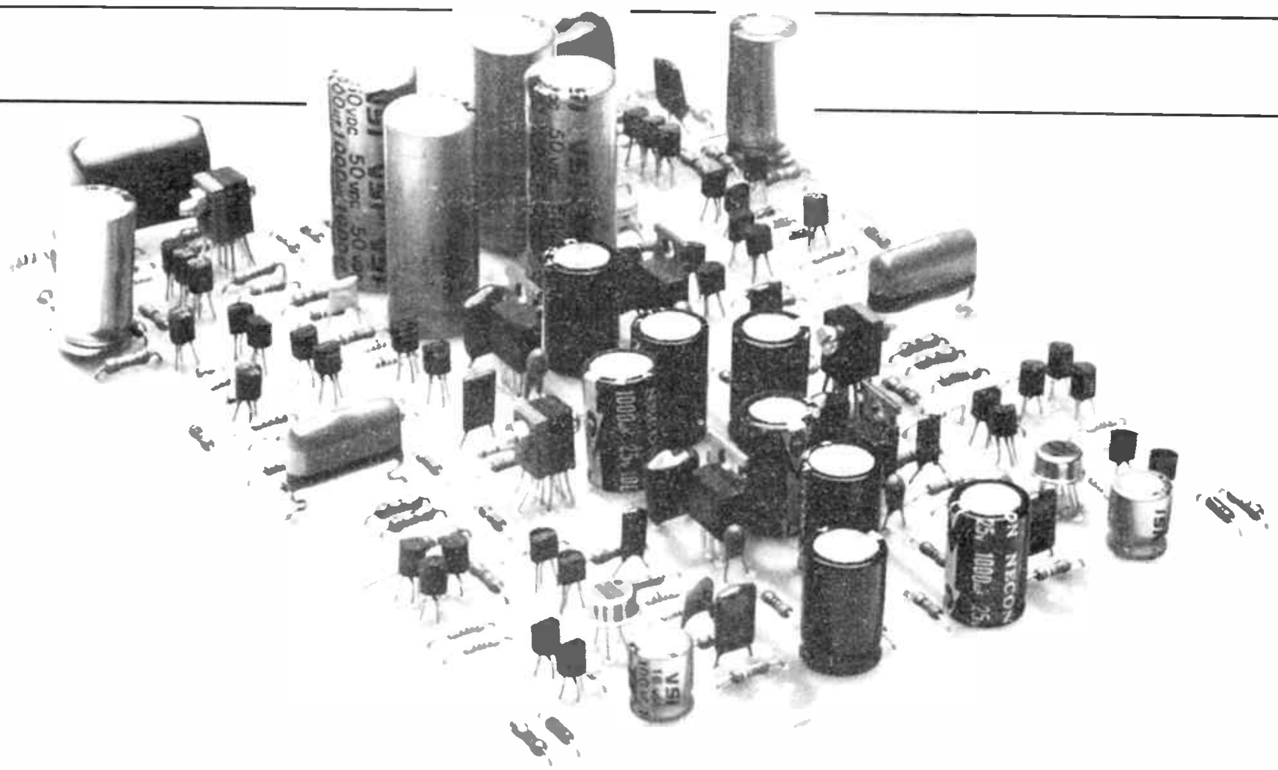


Altronics list the transformer as cat. no. M2165. Details from **Altronics, PO Box 8280, Stirling St, Perth 6000 W.A. (008) 99 9007.**

HARRISON & TILBROOK ON-TAP

Enter it in red in your diary now — messrs Harrison (esteemed Editor) and Tilbrook (esteemed Engineer) will be appearing in Jaycar's York Street Store, Sydney, on the morning of the third Saturday in November (the 16th), from 10.30 am to noon. You'll be able to hear for yourselves the AEM6102 two-way bass reflex speakers, and possibly the new 'ultra-fidelity' preamp. You're free to quiz the lads on any subject electronic that takes your interest, or discuss the latest in projects, etc.

Don't miss the opportunity!



An 'ultra-fidelity' preamplifier

Part 1

David Tilbrook

This project is an ultra-fidelity linear preamplifier designed to meet the demands of the serious audiophile. The aim of the project was to design a unit that would challenge the finest commercial designs. The increasing use of compact disc players has placed new demands on the entire audio chain and this applies just as surely to the electronics as it does to the loudspeakers.

IT IS BECOMING a widely recognised fact that systems combining CD players with inferior integrated amplifiers or preamp/power amp combinations tend to sound considerably inferior to the same units used with cassette deck or cartridge sources.

The reasons for this would appear to be the increased demands placed on the electronics through the higher signal slopes and dynamic range generated by a CD player. Combine this with an otherwise clean signal source, excellent frequency response and distortion characteristics, and any inability of the subsequent electronics becomes particularly noticeable and objectionable.

The 6010 has been designed with the accent on acoustic performance. Its dynamic range, noise, distortion and frequency response characteristics are all extremely good. But just as important to the acoustic performance are such parameters as channel seperation, power supply regulation, to ensure freedom from certain types of dynamic distortion mechanisms, and maintainence of the integrity of the signal earth line.

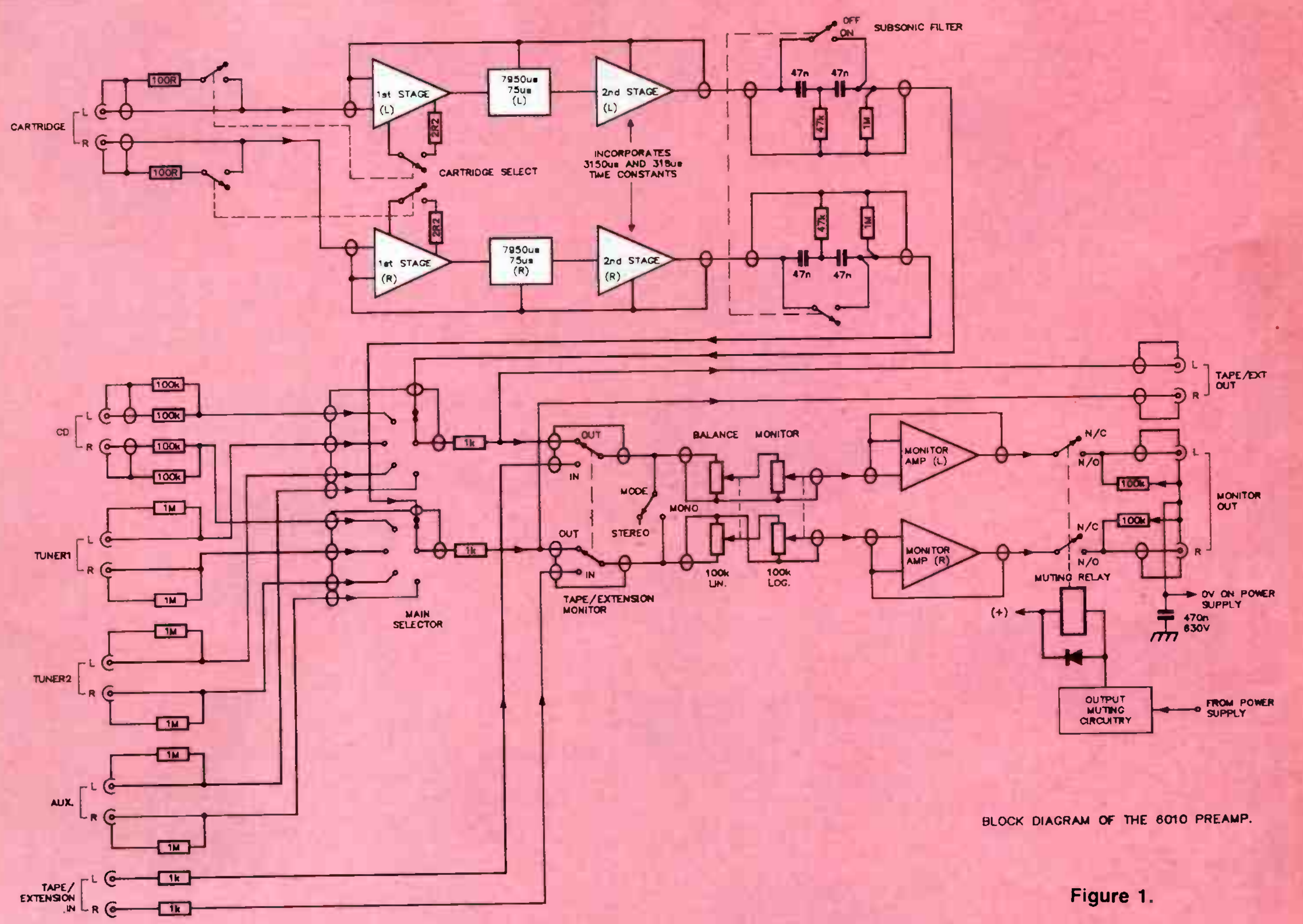
In order to ensure good performance in these respects the pc board layout must be done correctly. Many an otherwise good design has been ruined at the pc board design stage. All of these characteristics are important to the acoustic performance of audio electronics as undoubtedly are many others.

The design of a really good preamplifier (or power amplifier) at the present time is as much an art as it is a science because we simply do not understand all of the parameters that determine the acoustic performance of this equipment. The AEM6010, and the AEM6000 series of power amplifiers soon to be published, are the culmintion of a great deal of experiment and trial and error to develop a comprehensive range of audio equipment with impeccible acoustic as well as measured performance.

A block diagram of the 6010 is shown here.

The cartridge input can be configured for either a moving coil or a moving magnet cartridge by the appropriate setting of the input cartridge select switches. These two switches are mounted on the rear of the preamp chassis.

The low level (LL) cartridge input stage consists of two separate active gain stages and a passive filter stage which provides one half of the RIAA frequency correction. The rest of the RIAA is generated by feedback around the second stage. A detailed description of the topology of the LL stage is given later in the circuit operation section.



BLOCK DIAGRAM OF THE 6010 PREAMP.

Figure 1.

An important characteristic that should be mentioned at this stage, however, is its overlaod margin. The gain of the total LL stage is around 100, so that a 2 mV input signal at 1 kHz will produce an output around 200 mV RMS which is comparable to the level expected at the other high level inputs. As will be discussed later, it is possible for signal levels in the final LL stage to reach around 20 V RMS. To ensure that these very large output signal voltages do not cause clipping of the final LL stage it is powered from a regulated 70 V supply.

The high level inputs provided are compact disc (CD), two tuner inputs (TUNER 1 and TUNER 2) and an auxiliary input (AUX). The two tuner inputs are provided to enable separate FM and AM stereo tuners to be connected to the system. Alternatively, a video cassette recorder can be connected to some of these inputs.

The high level inputs provided are connected to the main selector switch together with the output of a passive subsonic filter that follows the output of the LL stage. This filter is used rather than a more sophisticated active filter to ensure minimum colouration of the low-frequency audio content. The filter provides a 12 dB/octave attenuation below 10 Hz and can be bypassed with a filter on/off switch located on the preamp front panel.

The output of the main selector switch is fed via the monitor switch and mode switch to the balance and monitor volume controls. There are no active gain stages provided between the selector switch and the monitor potentiometer to ensure complete freedom from any possibility of overload in this part of the preamp.

The final gain stage follows the monitor pot. This stage is powered from a regulated 30 V supply which provides more than ample overload margin since this stage will have a typical maximum output signal of around 1 V RMS. Remember that the output of the preamp is connected to the input of a power amp that will be driven to full power, and hence into clipping, by a typical 1 V output signal.

The output of the preamplifier is provided with relay muting that is driven from a control circuit and provides freedom from turn-on and turn-off thump.

Since the aim of the design was to produce a very high quality linear preamplifier at a reasonable price, additional features such as tone controls and level meters have been omitted. Nevertheless the demand for these facilities is such that they cannot be completely ignored.

In order to solve this problem a preamplifier extension unit is planned which provides additonal control facilities such as tape/tape dubbing for several tape decks, tone controls and headphone amplifiers. This unit expands the capabilities of the main linear preamplifier and is connected via the monitor switch on the 6010. When used without the extension unit this switch serves as the tape monitor and is therefore labelled EXTENSION/TAPE MONITOR. The use of the monitor ▶

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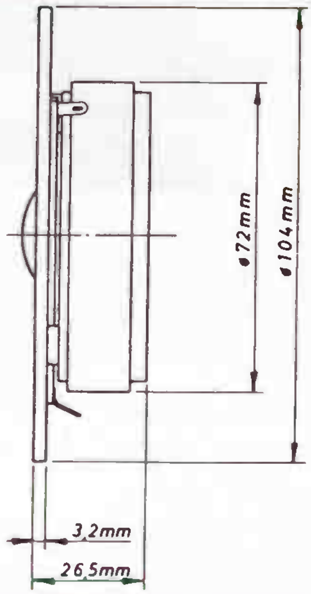

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Technical Data - Woofer

Nominal Impedance	8 ohms
Frequency Range	26 - 4000Hz
Free Air Resonance	33Hz
Operating Power	2.5W
Sensitivity (1W @ 1m)	92dB
Nominal Power	60 watts
Voice Coil Diameter	40mm
Voice Coil Height	12mm
Air Gap Height	6mm
Voice Coil Resistance	5.8 ohms
Effective Diaphragm Area	222cm²
Moving Mass	20 grams
Thiele/Small Parameters	
Qm : 2.4	
Qe : 0.41	
Qt : 0.35	
Vas : 80 1	
Weight	1.65kg

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Technical Data - Tweeter

Nominal Impedance	6 ohms
Frequency Range	2 - 24kHz
Free Air Resonance	1500Hz
Operating Power	3.2 watts
Sensitivity (1W @ 1m)	90dB
Nominal Power	90 watts
Voice Coil Diameter	25mm
Voice Coil Height	1.6mm
Air Gap Height	2.0mm
Voice Coil Resistance	4.7 ohms
Effective Diaphragm Area	7cm²
Moving Mass	0.3 grams
Weight	0.53kg

switch enables all of the extension circuitry to be bypassed for critical listening.

The basis of the AEM6010 Preamplifier is a fully discrete amplifier stage that was developed to provide high supply rejection, low static and dynamic distortion and extremely low noise and output impedance. These factors were determined to be of major importance to the acoustic performance of a preamplifier after extensive listening tests were carried out. Although the performance of op-amps such as the NE5534AN is extremely good, tests carried out on a number of op-amp based stages revealed that they lacked sufficiently low output impedane and could not be powered from sufficiently large supply voltage to meet the specification required. A combined op-amp/discrete design was considered but the complexity of the stage approached that of the fully discrete design and was consequently ruled out.

The only solution was to design a fully discrete amplifier stage that could be modified to optimise those characteristics regarded to be of most importance for a particular application. The input noise figures subsequently obtained are significantly better than the best op-amp designs and exceed the specifications of the best commercial preamplifiers.

The low level cartridge amplifier

All phono cartridges, whether moving magnet or moving coil types, generate a signal voltage due to the relative movement of a coil of wire and a magnetic field. In the moving magnet type the coil of wire is held stationary while the stylus/cantilever assembly is magnetised by small stationary magnets to provide a magnetic field, the strength of which is varied by the moving cantilever. This produces a small electric current in the coil. In the moving coil cartridge, the magnet is stationary while a small, very light coil is attached to the cantilever assembly. This coil is considerably smaller than that fitted to the moving magnet types and generates only a fraction of the output signal voltage. A typical moving coil cartridge, for example, would generate around 50-100 uV as compared to 1-2 mV for the same recorded signal with a moving magnet cartridge.

The MM cartridge has a typical coil resistance around 200-800 ohms and usually requires to be loaded by a 47 kohm resistance shunted by several hundred picofarads of capacitance. The MC cartridge, on the other hand, has a typical coil resistance of only a few ohms and MC input amplifiers are usually provided with input impedances of around 100-200 ohms. In both types the source impedance of the cartridge can be considerably higher than their resistances and is generally highly non-linear and a function a frequency.

An essential characteristic of both MM and MC input amplifiers is that they represent an essentially flat load across the audio spectrum. This can be particularly difficult in the case of MM stages since the required resistance of 47k is much higher than that required for the MC stage. It is usually necessary to apply negative feedback to increase the input impedance of the first stage. An increasing number of commercial designs are opting for JFET front ends to overcome this problem but the noise performance is often disappointing. If a bipolar transistor front end is employed, negative feedback is often used since the input resistance of these devices is a function of the emitter current flowing, as is the noise performance.

The most common design approach, and the one which yields the best noise performance, is to set the current in the first stage to optimise the noise performance for the expected source resistance. For most bipolar transistors this gives rise to an input resistance which is incapable of loading an MM cartridge correctly. The input resistance is then increased to several megohms by the use of a fairly large amount of overall negative feedback. A 47k resistor is then placed in parallel to load the cartridge correctly.

In practice, some degree of interaction usually takes place between the negative feedback loop and the non-linear source impedance of the cartridge. This is called "cartridge impedance interaction" and is responsible for the inferior acoustic performance of many MM phono stages.

The problem is further compounded when the same feedback loop is used to generate the RIAA equalization which must be implemented in any cartridge amplifier. Since the RIAA equalization is frequency dependent the amount of overall negative feedback becomes frequency dependent and hence the input impedance varies across the frequency range.

The RIAA equalization

To understand RIAA equalization it is necessary to look more closely at the concept of recording audio signals on a record. As stated above, the signal voltage is produced by the interaction of a coil of wire and a magnetic field. Specifically, the equation that describes the voltage generated is given by Faraday's law

$$\epsilon = -\frac{d\phi}{dt}$$

Where ϵ is the induced signal voltage
and ϕ is the magnetic flux.

The equation indicates that the signal voltage is proportional to the rate of change of the magnetic flux with respect to time. A well designed cartridge will ensure that as close as possible to a linear relationship exists between the displacement from the equilibrium position of the cantilever assembly and the magnetic flux intensity. In this way the induced signal voltage will be proportional to the time rate of change of the position of the stylus.

In other words, the induced signal voltage is proportional to the velocity and not the position of the stylus assembly. The waveform recorded in the grooves of the record is not the actual acoustic waveform but its integral with respect to time. If, for example, a 20 Hz square wave is to be reproduced from a record groove, then the waveform recorded in the groove will be its time integral i.e: a triangle wave.

COMPARISON OF THE ELECTRICAL SQUARE WAVE RESULTING FROM THE TRIANGULAR RECORD GROOVE

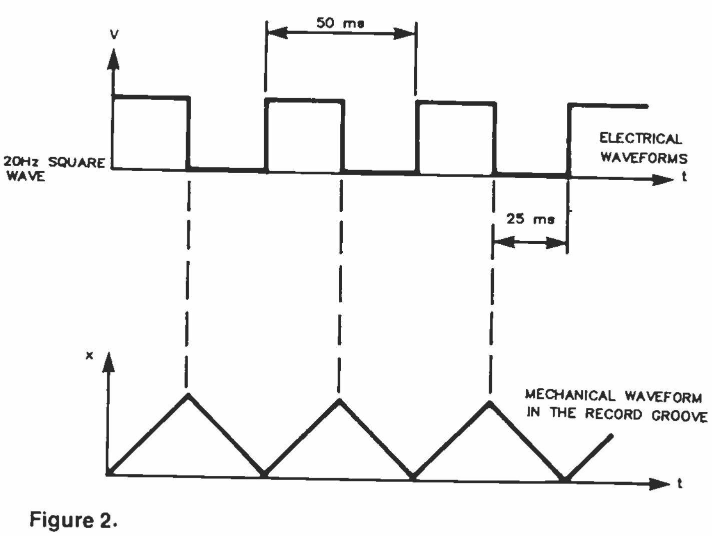
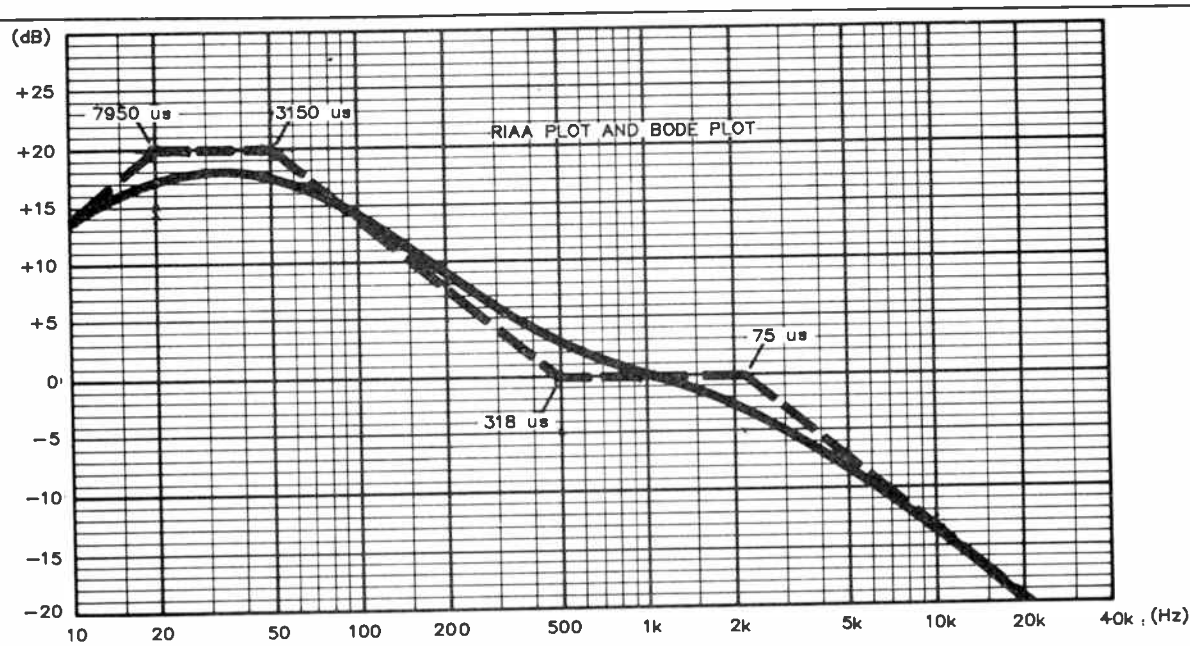


Figure 2.



The 20 Hz square wave consists of 25 ms of constant dc voltage followed by 25 ms of a zero voltage. In order to produce a constant voltage for a period of 25 ms, the stylus assembly must move at a constant velocity for that period. If we now consider the case of a typical MM cartridge producing around 1 mV/cm/sec then, in order to produce a 10 mV square wave, the recorded velocity must be 10 cm/sec. The total distance the cartridge will travel in the 25 ms is:

25 ms x 10 cm/sec = 2.5 mm

A different problem occurs at the opposite end of the frequency spectrum. If we wish to reproduce a 20 kHz square wave with the same amplitude as the one above, the stylus traces a triangle wave in the groove, but this time for only 25 us. The stylus moves a total distance of only 2.5 um. Such extremely small displacements at high frequencies mean that the surface irregularities of the vinyl are increasingly significant and an unacceptable signal/noise ratio results.

These problems are overcome when the record is cut by boosting the high frequencies to improve the signal/noise ratio and cutting the low frequencies to reduce the necessary stylus displacement. In order to do this, the frequency response of the recording amplifier is modified to conform to a special curve called the RIAA equalization (RIAA stands for Recording Institute Association of America).

It is the responsibility of the MM input amplifier to correct for this equalization so as to restore the overall flat response. The RIAA correction that must be incorporated in the playback electronics consists of four single-pole filters (a single-pole filter is one that can be formed by a single resistor/capacitor pair). These filters are:

high-pass, time constant RC = 7950 us
low-pass, time constant RC = 3150 us
high-pass, time constant RC = 318 us
low-pass, time constant RC = 75 us

The overall effect of the time constants is shown in Figure 3 which compares the Bode plot showing the individual time constants and the actual frequency response that results if the RIAA is implemented correctly. The MM preamp must have the frequency response shown here by solid line.

Notice that there is a 40 dB variation in the gain required of the MM stage. The low frequencies are amplified over 100 times more than the extreme high frequency.

As mentioned earlier, some designers (in fact most, until recent times) incorporated the RIAA equalization into the overall feedback loop around the first stage. Since the gain must vary over a 40 dB range, so must the amount of feedback. With almost all conventional designs this represents a major proportion of the overall negative feedback and the input impedance tends to become highly frequency dependent. Combine this with an already frequency dependent source impedance of the cartridge and it is not surprising that problems like cartridge impedence interaction arise.

The LL staged developed for the AEM6010 completely overcomes these problems by having a two-stage circuit and a combined passive/active RIAA equalization filter. The first stage is a completely linear preamplifier with an extremely low noise input differential pair formed from an LM 394 super-matched pair. There is no RIAA equalization in this stage and the frequency response extends from less than 1 Hz to well over 100 kHz. Since the stage has a flat gain of 11 when switched to the MM position and around 225 when switched to the MC position it will almost completely determine the overall noise figures of the input stage.

Since the overall gain of this first stage is flat, and the applied negative feedback very large, the input impedance of the stage is a constant over the entire audio range.

During the development of this input amp several experiments were conducted in which the stage was inserted between various moving magnet cartridges and the phono input of several commercial amplifiers. The improvement in overall acoustic performance over some of the commercial stages was stunning and this added considerable weight to the cartridge impedance interaction argument. Experiments were also carried out to ensure that the stage was free of cartridge impedance interaction by incorporating a FET buffer amplifier between the cartridge and the input of the 6010MM input stage. The only difference in the acoustic performance seemed to be a significant increase in the input noise when the FET was used. Another advantage of the two-stage approach is that the gain of the input amplifier can be divided between two stages and hence the distortion is reduced.

The output of the stage is connected to the passive filter forming the 7950 us and 75 us time constants of the RIAA. The 7950 us time constant is formed by capacitor C8 and resistors R21, R20 and R19. The 75 us time constant is formed by R22, R23 and capacitor C11. ▶

As mentioned earlier the other two time constants are formed by an RC filter placed in the feedback loop around the second stage. The filter consists of resistors R46, R45, R47, R48, R43, R44 and capacitor C16. In Figure 4, the distribution of the various filters among these two stages is shown together with the resulting Bode plot.

The second of the two stages is similar to the first but has a cascade amplifier included to form the main voltage gain stage. This is necessary since this stage incorporates two time constants for the RIAA equalisation in its negative feedback loop and it is essential that adequate feedback exists to ensure a reasonably constant input impedance. As mentioned earlier, this stage is supplied by a 70 V dc supply to help reduce the possibility of overloading by excessive drive from a high output cartridge.

Since the output of this amplifier can drive to within several volts of the supply, the maximum signal voltage that can be delivered from this stage without clipping is around 23 V RMS. Since the overall gain of the LL stage when switched for MM cartridges is 120.56 at 1 kHz, the maximum input signal that will not cause clipping of the second stage is 190 mV. Most MM cartridges have sensitivities around 1 mV/cm/sec and hence have typical maximum output voltages around 30 mV RMS.

Experiments carried out during the development of this preamplifier using digitally recorded discs showed typical maximum outputs from a variety of cartridges around 80-120 mV. The 190 mV input figure, which represents an overload margin of 40 dB with respect to a 2 mV input signal should therefore be ample for the vast majority of MM cartridges.

If your cartridge has a particularly large output, the gain of the first stage can be decreased by increasing the value of the 47 ohm resistor, R9. If this value is increased to 100 ohms for examle, the gain of the first stage is halved with consequent improvement in the overload margin.

Noise

One of the outstanding problems associated with all low level input stages is that of noise. Because the output signal levels from cartridges are so small the noise generated by the input stage must be kept to an absolute minimum or an unacceptable signal/noise ratio results. Unfortunately, there is a fundamental limit to the minimum noise voltage that can be present at the input since the resistance of the cartridge generates a type of noise called 'thermal noise'. This comes about due to thermal agitation of electrons and is not the result of any fault in the manufacture of the resistance. It is simply a fundamental law of nature. The equation that predicts the amount of thermal noise is:

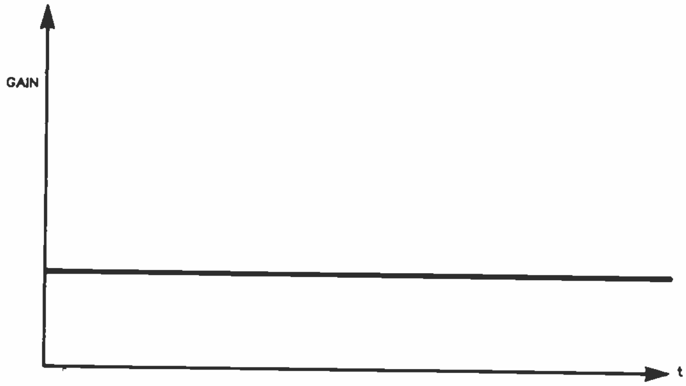
$$e_n = \sqrt{(4kTR\Delta f)}$$

where k = Boltzmann's constant
T = absolute temperature
Δf = noise bandwidth
R = resistance
e_n = average noise voltage.

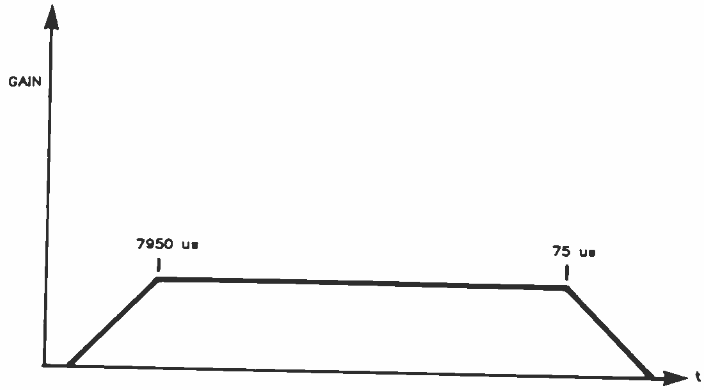
The equation predicts that the thermal noise is increased if either the temperature, resistance or bandwidth is increased. We can use this equation to calculate the minimum possible noise and hence the best possible signal/noise ratio using common MM cartridges. Assuming a noise bandwidth of 20 kHz, an absolute temperature of 290K and a source resistnace of 500 ohms which is correct for most cartridges, the thermal noise is:

$$e_n = \sqrt{(4 \times 1.37 \times 10^{-23} \times 290 \times 500 \times 20 \times 10^3)} = 399\text{nV}$$

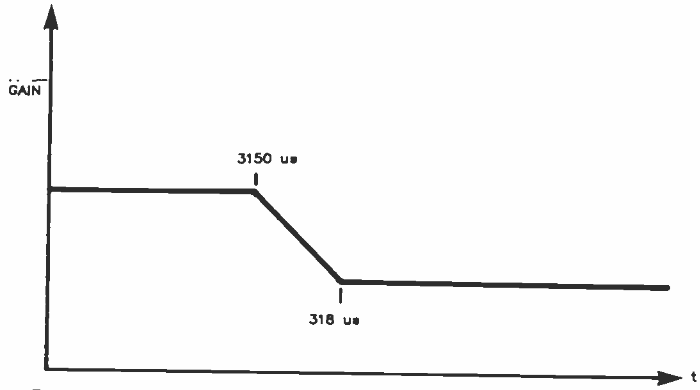
GENERATION OF THE RIAA EQUALISATION USING THE TWO STAGE LOW LEVEL AMP DEVELOPED FOR THE AEM 6010



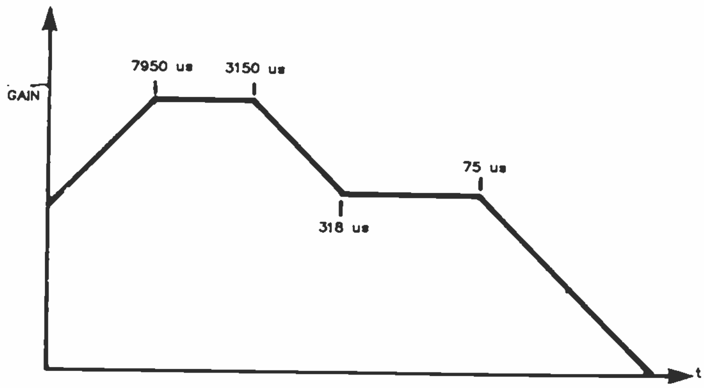
THE FREQUENCY RESPONSE OF THE FIRST STAGE IS FLAT ACROSS THE AUDIO SPECTRUM



THE TIME CONSTANTS OF 7950 us AND 75 us ARE DETERMINED BY THE PASSIVE NETWORK



THE TIME CONSTANTS OF 3150 us AND 318 us ARE GENERATED BY THE FEEDBACK AROUND THE SECOND STAGE



THE TOTAL RIAA EQUALISATION FORMED IS CORRECT EVEN WELL OUTSIDE THE AUDIO SPECTRUM

Figure 4.

This is equivalent to a signal/noise ratio of 88 dB with respect to a 10 mV input signal. The RIAA equalization has the effect of decreasing the noise bandwidth and therefore results in a considerably increased S/N ratio figure of around 100 dB. These noise figures are all based on a flat, or unweighted, noise frequency response.

The human ear, however, does not detect all frequencies with equal sensitivity, so that two amplifiers with identical noise figures càn be subjectively very different. An amplifier with a high average noise figures can be subjectively very different. An amplifier with a high average noise voltage in the 1 kHz to 5 kHz region will sound considerably noiser than another amp with identical flat noise figures but with the noise concentrated around a lower frequency.

To attempt to correct for this most noise measurements done for audio purposes are carried out with some type of weighting applied. The most common is called "A"weighting. The frequency response of an A-weighting filter is shown in Figure 5. Notice that the curve accents the midrange, for which the human ear is most sensitive.

When A-weighting is applied to the thermal noise figures discussed above, the theoretical best signal-to-noise ratio, based on the 500 ohm source resistance, lies around 105-110 dB. Few commercial MM amplifier stages approach this figure, with the finest preamps usually quoting figures around 85-95 dB A-weighted with respect to a 10 mV input signal.

The AEM6010LL low level cartridge amplifier stage achieves a signal-to-noise ratio of 105 dB A-weighted, with respect to a 10 mV input signal and with the input shorted. With the input connected to a 500 ohm source resistance, the signal-to-noise ratio is still greater than 100 dB which is substantially better than the published specifications of any commercial designs seen to date.

The specifications for the stage in both moving magnet and moving coil modes have been included with this article. The total harmonic distortion of this stage cannot be measured using conventional noise and distortion analysers because the distortion generated is below the resolution of these instruments. The figures quoted here were measured using a Hewlett Packard 3561A Dynamic Signal Analyser.

In order to ensure good acoustic performance the output impedance of all of the stages is extremely low and is dominated by series output resistors that ensure a stable feedback loop within the stage by providing isolation of the loop from complex impedances that may occur in the output load.

All the stages are isolated from each other by substantial filtering capacitors as interaction via the supply line was found to be one of the major contributing factors to the poor acoustic performance of many of the experimental circuits developed in the design of this project. Another parameter found to be significant to ensure good audible performance was channel separation and this was particularly true with CD sources.

Most CD players quote channel separation figures of at least 90 dB over the entire audio range. The usual amplifier figure of 40-60 dB therefore represents a considerable degradation of the performance of the signal source which is of course unacceptable. The 6010 ensures excellent channel separation characteristics by isolating the power supplies of both channels through the entire preamp.

Similarly, the signal earth lines are isolated from each other at all points, except for a single connection at the output terminals of the preamplifier. This is also the only point at which a connection is made between the power supply 0 V lines and the signal earth lines. This earthing system will ensure that the performance of the amplifiers is not degraded by loss of integrity of the signal earth lines.

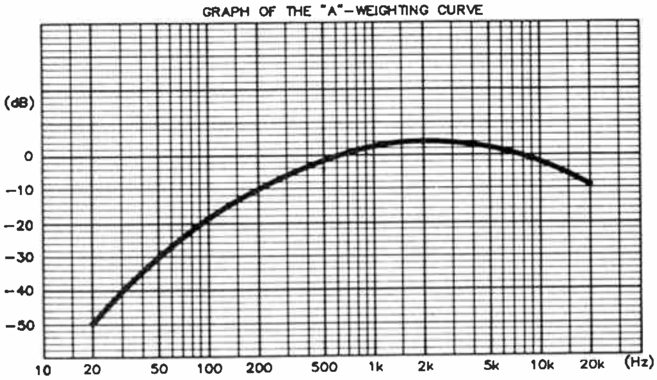


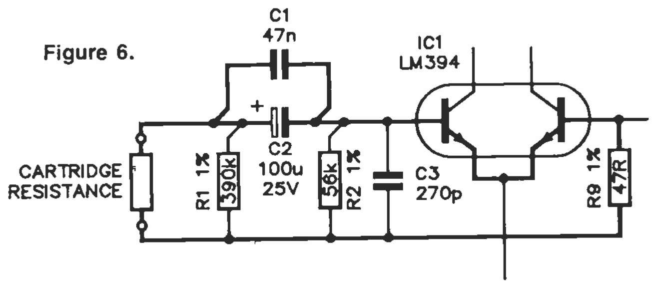
Figure 5.

Moving Coil cartridges

One of the big problems with moving coil amplifer stages is noise. MC cartridges produce only a fraction of the output signal voltage of a typical moving magnet cartridge having average outputs around 40-50 uV. If a conventional MM amp stage was used for the MC cartridges, with an appropriate gain increase, the signal-to-noise ratio would be only around 60 dB A-weighted, which is an unacceptably low figure. Fortunately their very low output impedance and the requirement to be loaded by a relatively low amplifier input impedance helps to reduce the noise problem.

A major proportion of the noise is due once again to thermal noise. To decrease this, the source resistance must be made as low as possible. In the case of the MC cartridge, however, with a typical resistance of only a few ohms, any resistance in series with the input circuit will contribute to the total source resistance and hence to the thermal noise.

Figure 6.



Differential input circuit employed in the AEM 6010LL
The main input circuit is shown in bold

Figure 6 shows the input circuit of the 6010LL differential input stage. In the case of differential input stages such as used in the 6010LL amp, two base emitter junctions are included in the circuit, both of which contribute to the noise figure and consequently degrade the signal-to-noise ratio. The overall degradation is only minor, however, if the full potential gain of the input stage is employed. Furthermore the differential input stage is intrinsically more linear than the single ended input stage and obviates the need for large emitter capacitors. The resistor R3 must be included in Series with the input source resistance and must therefore be at least the same order of magnitude as the cartridge source resistance or it will seriously degrade the noise performance.

The input stage of the AEM6010LL input amp is based around the LM394 which is manufactured by National Semiconductor. As mentioned earlier, this is a 'super-matched' pair of bipolar transistors in a single encapsulation. This device has a relatively low input resistance, reasonable h_{fe} (around 500) but most importantly for this application, it has an extremely low noise figure. ▶

The use of this device in the input stage together with a careful selection of emitter current used to bias the stage and a fully differential voltage gain stage results in a cartridge amplifier with excellent noise performance. With the input shorted and the stage set up for the MC cartridges the total equivalent input noise is around 34.6 nV A-weighted. This is equivalent to a signal/noise ratio of 83 dB with respect to a 500μV input, which compares well against the more usual figures of 70-80dB for most MC amplifiers.

The standard reference input level used for S/N figures in relation to MC input stages is 500 uV and, although this seems a little optimistic, the figures quoted in this article use this as a reference for the sake of uniformity.

Construction

The construction of the AEM6010LL stage is not particularly difficult, since all of the construction is limited to the soldering of the pc board. The board is reasonably complicated however, so care should be taken to ensure that all of the components are soldered into their correct positions. The two halves of the board are approximately mirror images, not direct copies of each other, so some of the components are oriented slightly differently. Since the pc board holds a number of large electrolytic capacitors, these tend to get in the way if soldered in place too soon. Leave these until last and start by soldering the small non-polarised components in place, such as the resistors and non-polarised capacitors. When this is done move on to the active components — the diodes and transistors.

Note that certain transistors must be bolted together so that they are in close thermal contact with each other. Each set of these transistors consists of two BD139s and a BD140, which should be bolted together using an appropriate length 6BA bolt and nut before soldering the assembly to the pc board. The correct positions for these are shown on the component overlay. Be careful however, to check that the transistors have the correct orientation on the pc board, otherwise the emitter and base of each of the transistors will be reversed. The metal faces of each of these devices are connected internally to their collectors and must remain insulated from each other after the devices are bolted together. This is not difficult, however, since the metal face of each transistor is in contact with the plastic face of its neighbour. Also, the mounting holes of the devices are insulated from the metal faces. It is probably a wise precaution to check that the collectors are all insulated from each other, using a multimeter on a resistance range, before soldering the transistor sets into position.

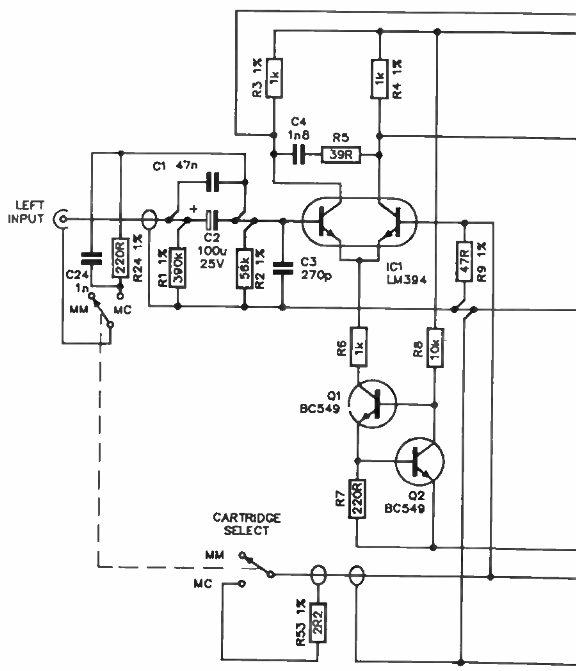
Capacitors C5, C6, C7, C13 and C14 provide freedom from RF instability. These devices are soldered on the copper side of the pc board. Their leads should be cut as short as possible and capacitors C5, C6, C13 and C14 should be soldered directly between the collector and base of the output transistors Q9, Q10, Q23 and Q24, as shown in the rear pc board overlay diagram. Capacitor C7 is soldered directly across resistor R17. The area in the centre of the pc board remains unpopulated at this stage. This provides possible power supply expansion for future additions to the preamp.

Powering up

As discussed above, the signal earth line and the power supply 0 V line are not connected to each other on either of the pc boards. In the completed preamp, to be described next month, this connection is made at the output terminals which ensures freedom from hum and maintains the purity of the signal earth line. In order to test the board at this stage therefore, it is necessary to make this connection externally before powering up. To do this, join all signal earth lines and 0 V connections to each other at the output end of the board and then join these to the 0 V line on the dc power supply used.

In order to power the boards correctly a split 70 V supply (i.e: +35 V/0/-35V) must be used.

(Next month we conclude the construction details of the preamplifier and discuss the monitor amp stages and the regulated power supplies.)



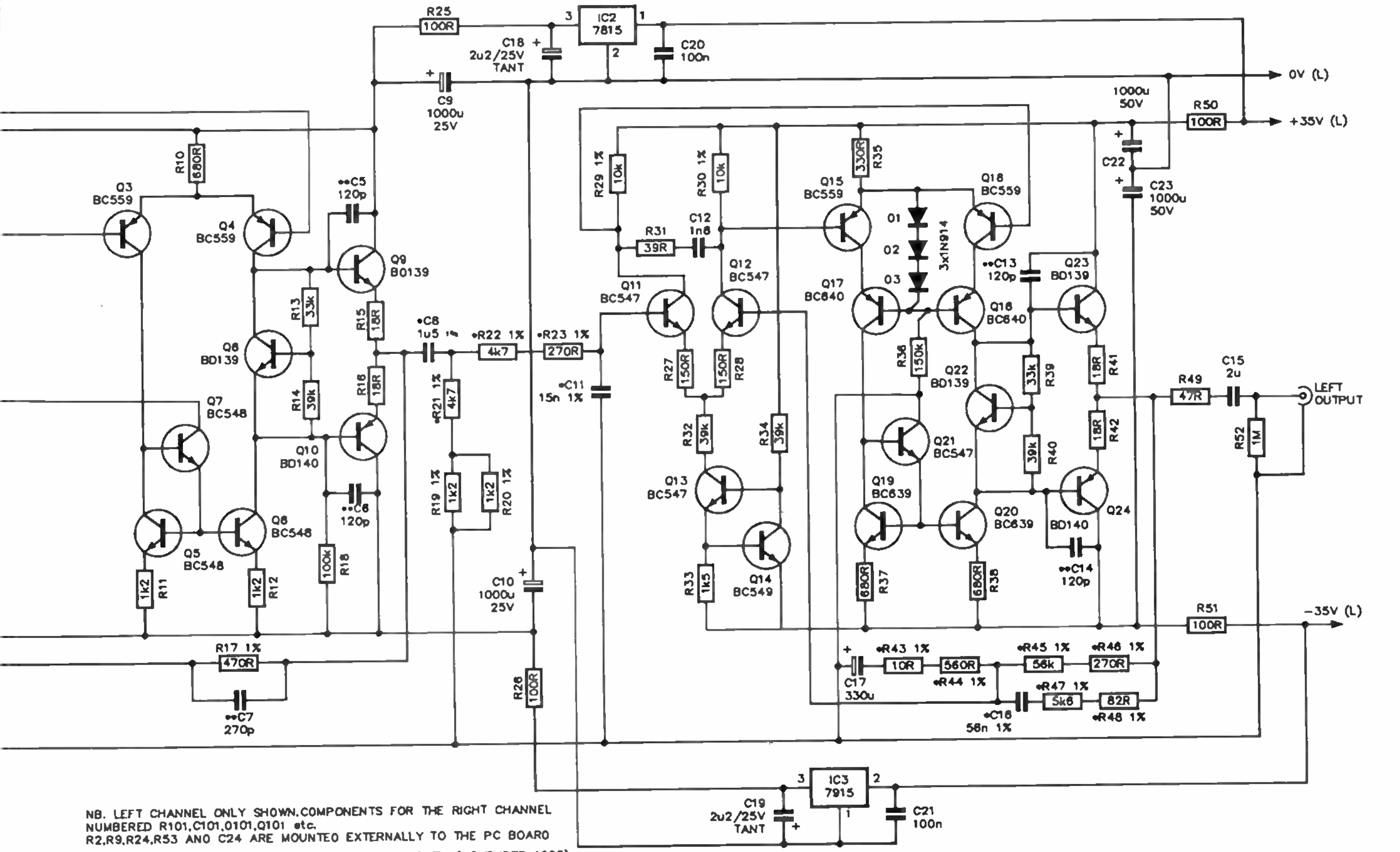
CIRCUIT OPERATION AEM6010LL

The circuit is divided into two active stages plus a passive filter stage that generates two of the time constants, 7950 us and 75 us, required for the RIAA equalization. The remaining time constants are generated by an RC network incorporated into the feedback loop around the second stage.

The first of the two active gain stages is a linear stage with an extended frequency response. Both of the amplifier stages are entirely dc-coupled with the exception of the input and output coupling.

The input to the preamp is ac-coupled via capacitors C1 and C2. C1 is included to offset any capacitor increase in the impedance of C2 at higher frequencies. Resistor R1 maintains the dc voltage at the input side of these capacitors at 0 V. Resistor R2 reduces the overall impedance to around 48k (i.e: the parallel combination of R1 and R2) to load a moving magnet cartridge correctly. This assumes that the input impedance switch is open. If this switch is closed the 100R resistor, R24, and 1n capacitor, C24 are shunted across the input, reducing the input impedance to 100R to suit moving coil cartridges. Similarly the parallel input capacitance is increased from around 270p to around 1n3 due to the parallel combination of C24 and C3.

The input differential pair is formed by the LM394, IC1. This is an extremely low noise 'super-matched' transistor pair. The emitter current is determined by a constant current sink formed by Q1, Q2, R8 and R7 while R6 serves to decrease the power dissipation in transistor Q1.



NB. LEFT CHANNEL ONLY SHOWN. COMPONENTS FOR THE RIGHT CHANNEL NUMBERED R101, C101, D101, Q101 etc.
R2, R9, R24, R53 AND C24 ARE MOUNTED EXTERNALLY TO THE PC BOARD

SEE MAIN PREAMP CONSTRUCTION DETAILS NEXT MONTH (NOVEMBER 1985)

• DENOTES COMPONENTS USED TO GENERATE THE RIAA EQUALIZATION. 1% TOLERANCE COMPONENTS SHOULD BE USED.

•• SOLDERED ON REAR SIDE OF PC.BOARD.

The collector load to the input pair consists of the two main collector resistors R3 and R4, a high frequency compensation network R5 and C4, and the second stage differential pair Q3 and Q4.

The bulk of the voltage gain of the input amp is generated by the second stage. The differential pair Q3, Q4 have a current mirror load formed by Q5, Q6, Q7 and resistors R11 and R12.

The output stage is an emitter follower to provide a very low output impedance. This consists of transistors Q9 and Q10, resistors R15, R16 and R18. The transistor Q8 and its associated resistors form a "variable diode" which serve to ensure that the output stage quiescent current remains constant for all output voltages. These three output transistors are bolted together enabling Q8 to provide thermal correction so that the quiescent current will remain constant for a broad range of operating temperatures. Capacitors C5 and C6 ensure stable operation of the output stage by decreasing the impedance of the bases of the output transistors at high frequencies.

Overall negative feedback is applied by resistor R17 and the parallel capacitance C7. The gain of the stage is determined by this resistor plus resistors R9 and R5. With the gain switch in the MM position only the 47R resistor is in circuit and the gain of the input amp is 11. When the gain switch is closed, the 2R2 resistor R5 is connected in parallel with R9 and the gain is increased to around 225.

Supply isolation is provided by the resistor/capacitor combinations R25, C9 and R26, C10.

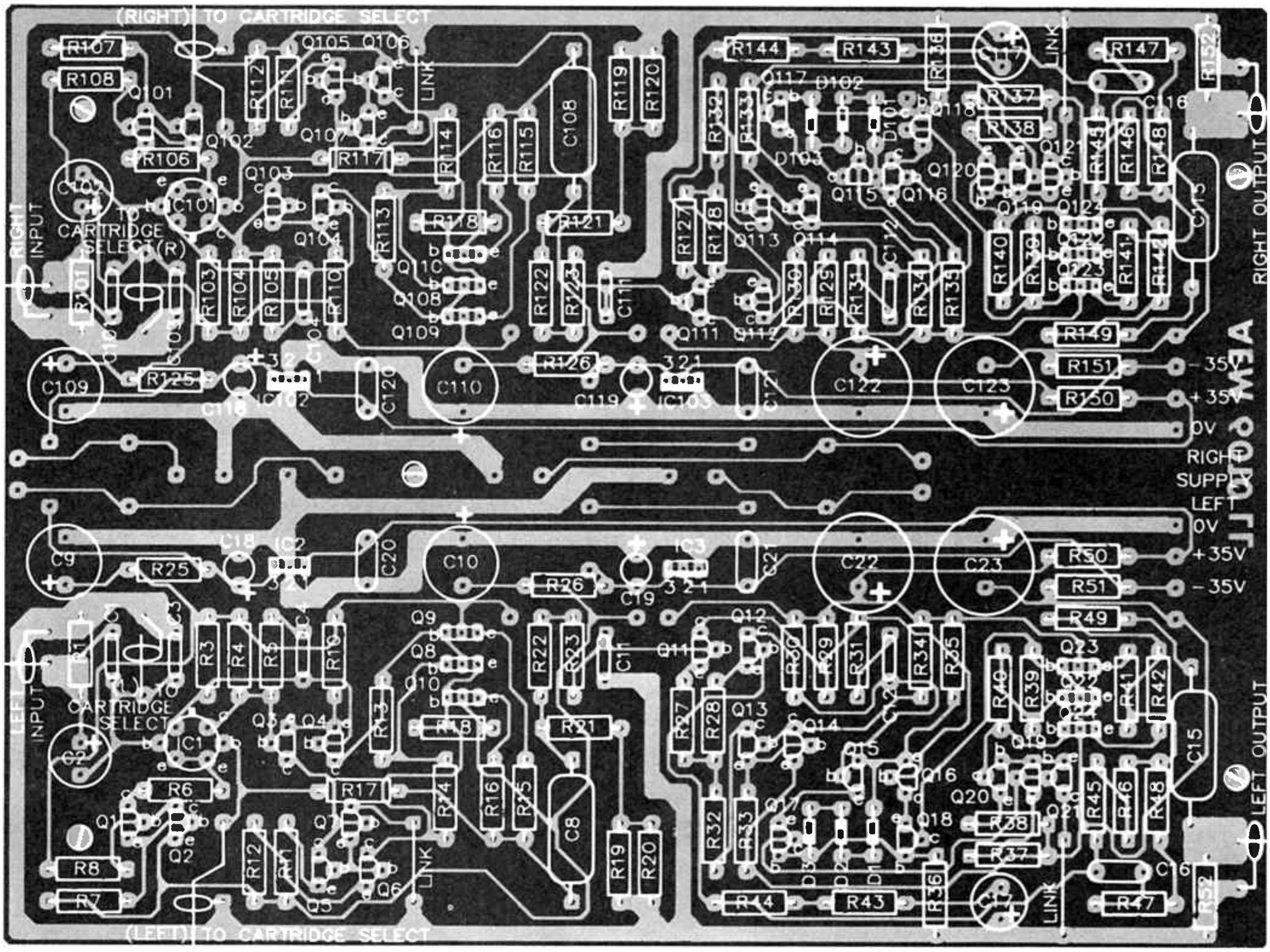
The output of the first stage is connected to the input of a two-stage passive filter that, as mentioned earlier, generates two of the time constants associated with the RIAA equalisation. Capacitor C8 serves the dual funtion of output coupling capacitor for the first stage and, together with resistors R21, R20 and R19, forms a high pass filter with a -3 dB point at 20 Hz (i.e: a time constant of 7950 us). Resistors R22, R23 and capacitor C11 form a low pass filter with a -3 dB point at 2122 Hz (i.e: a time constant of 75 us).

The output of the passive filter network is connected to the input of the second amplifier stage. This amplifier is similar to the first amplifier stage but has higher open loop gain due to the inclusion of the cascade stage in the voltage amp formed by Q17, Q18 plus diodes D1, D2, D3 and resistor R36. The higher open loop gain is necessary to ensure that sufficient negative feedback exists so that the input impedance will be constant with respect to frequency. If this is not the case the non-linear load on the passive filter degrades the accuracy of the RIAA equalisation.

The remaining two time constants necessary for the RIAA are generated by the RC network consisting of R43, R44, R45, R46, R47, R48 and C16. This network introduces a high pass filter with a -3 dB point at 500 Hz (i.e: a time constant of 318 us) and a low pass filter with a -3 dB point around 50 Hz (i.e: a time constant of 3150 us). Capacitor C17 serves to reduce the gain of the stage to unity for dc operation, decreasing the dc offset to a minimum. This increases the maximum signal level that the stage can reproduce without clipping by ensuring that the stage clips symmetrically.

The output from the preamp is coupled through resistor R49, which serves to isolate the feedback loop from the load, and capacitor C15 for dc isolation. R31 maintains a 0 Vdc level at the output of C15.

Supply isolation of the second stage is provided by resistors R50 and R51 and capacitors C22 and C23. The second stage assumes a supply voltage of around 70 Vdc centre-tapped, which is regulated down to the 30 V dc centre-tapped, required by the first stage. This is done by the IC regulators IC2 and IC3 and their associated filtering and stability capacitors C20, C21, C18 and C19.



AEM6010LL PARTS LIST

Resistors

All ¼W, 5% unless noted otherwise.

R1, R101 .... 390k, 1%
R2, R102 .... 56k, 1%
R3, R103, R4, R104 ... 1k, 1%
R5, R105 .... 39R
R6, R106 .... 1k
R7, R107 .... 220R
R8, R108 .... 10k
R9, R109 .... 47R, 1%
R10, R110 .... 680R
R11, R111 .... 1k2
R12, R112 .... 1k2
R13, R113 .... 33k
R14, R114 .... 39k
R15, R115, R16, R116 .... 18R
R17, R117 .... 470R, 1%
R18, R118 .... 100k
R19, R119, R20, R120 1k2, 1%
R21, R121, R22, R122 4k7, 1%
R23, R123 .... 270R, 1%
R24, R124 .... 220R 1%
R25, R125, R26, R126.... 100R
R27, R127, R28, R128 ... 150R
R29, R129, R30, R130 10k, 1%
R31, R131 .... 39R
R32, R132 .... 39k
R33, R133 .... 1k5
R34, R134 .... 39k
R35, R135 .... 330R
R36, R136 .... 150k
R37, R137, R38, R138 ... 680R
R39, R139 .... 33k
R40, R140 .... 39k
R41, R141, R42, R142 .... 18R
R43, R143 .... 10R, 1%
R44, R144 .... 560R, 1%
R45, R145 .... 56k, 1%
R46, R146 .... 270R, 1%
R47, R147 .... 5k6, 1%
R48, R148 .... 82R, 1%
R49, R149 .... 47R
R50, R150, R51, R151 .... 100R
R52, R152 .... 1M
R53, R153 .... 2R2, 1%

Semiconductors

Q1, Q101, Q2, Q102 ... BC549
Q3, Q103, Q4, Q104 ... BC559
Q5, Q105, Q6,
Q106, Q7, Q107 .... BC548
Q8, Q108, Q9, Q109 ... BD139
Q10, Q110 .... BD140
Q11, Q111, Q12, Q112 . BC547
Q13, Q113 .... BC547
Q14, Q114 .... BC549
Q15, Q115, Q16, Q116 . BC559
Q17, Q117, Q18, Q118 . BC640
Q19, Q119, Q20, Q120 . BC639
Q21, Q121 .... BC547
Q22, Q122, Q23, Q123 . BD139
Q24, Q124 .... BD140
IC1, IC101 .... LM394
IC2, IC102 7815
IC3, IC103 7915
D1, D101, D2, D102,
D3, D103 .... 1N914

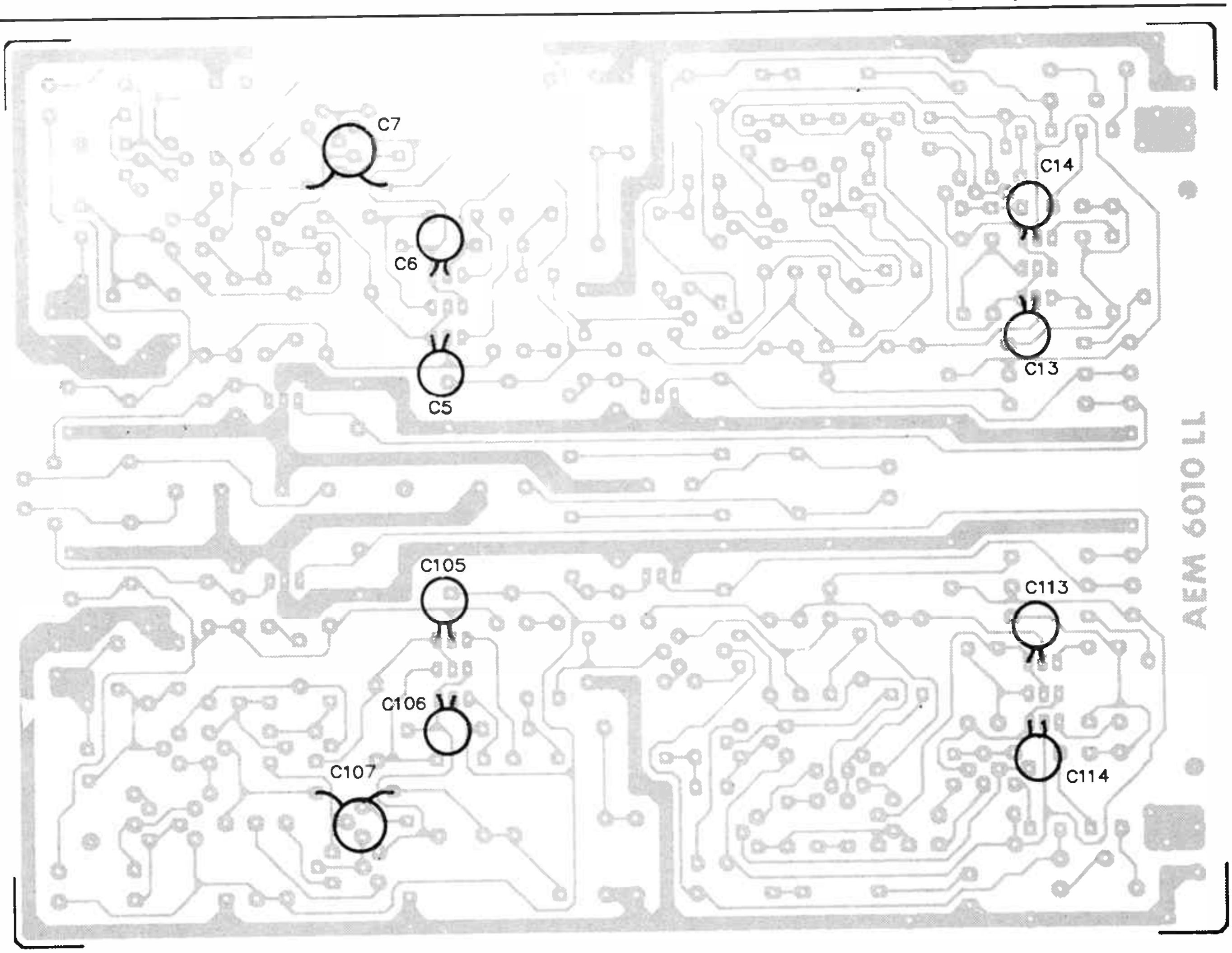
Capacitors

C1, C101 .... 47n greencap
C2, C102 100u/25 V RB electro
C3, C103 .... 270p ceramic
C4, C104 .... 1n8 greencap
C5, C105,
C6, C106 .... 120p ceramic
C7, C107 .... 270p ceramic
C8, C108 .... 1u5, 1%
C9, C109, C10,
C110 ... 1000u/25 V RB electro
C11, C111 .... 15n 1%
C12, C112 .... 1n8 greencap
C13, C113
C14, C114 .... 120p ceramic
C15, C115 .... 2u greencap
C16, C116 .... 56n 1% poly.
C17, C117 330u/63 V RB electro
C18, C118
C19, C119 .... 2u2/25 V tant.
C20, C120,
C21, C121 .... 100n greencap
C22, C122,
C23, C123 1000u/50 V RB electro
C24, C124 .... 1n greencap

Miscellaneous

AEM6010LL pc board; 2 x DPDT miniature toggle switches; nuts, bolts etc.

Expected cost: $80-$88



MEASURED SPECIFICATIONS AEM6010LL

Input Sensitivity/impedance for 250 mV output
MM cartridge .... nom. 2 mV/48k shunted with 290 pF
MC cartridge .... nom. 100 uV/100R shunted with 1 nF

Maximum output .... >20 V RMS

Maximum input before output overload
MM cartridge .... nom. 190 mV @ rated sensitivity
i.e: overload margin is 40 dB w.r.t. 2 mV input
MC cartridge .... nom. 10 mV @ rated sensitivity
i.e: overload margin is 40 dB w.r.t. 100 uV input

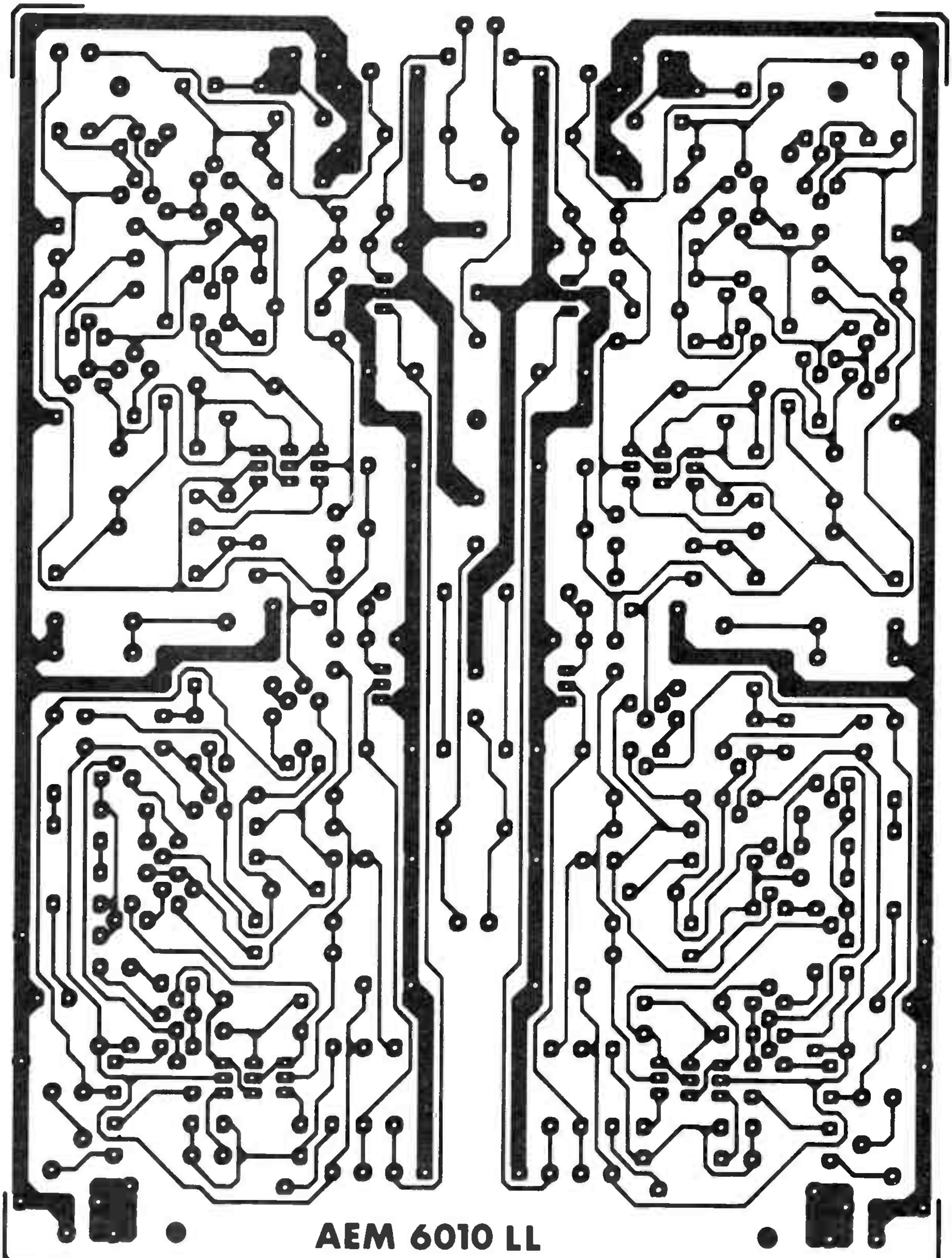
Frequency response .... conforms to RIAA within +/– 0.2 dB typical with 1% components. RIAA accuracy can be improved further by choosing component values exactly.

Total harmonic distortion
MM cartridge .... <0.001% @ 100 mV output, 100 Hz-10 kHz.*
MC cartridge .... <0.004% @ 100 mV output, 100 Hz-10 kHz

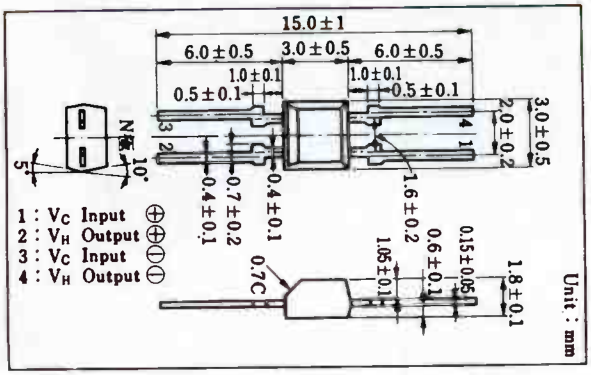
Total equivalent input noise
MM cartridge .... <56 nV A-weighted, input shorted
<88 nV A-weighted, 500R source
MM cartridge .... <35 nV A-weighted, input shorted
<43 nV A-weighted, 3R3 source

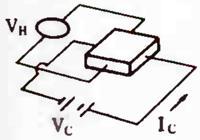
Signal-to-noise ratio (with respect to 10 mV input)
MM cartridge .... >105 dB A-weighted, input shorted
>102 dB A-weighted, 500R source
MC cartridge .... >83 dB A-weighted, input shorted
>81 dB A-weighted, 3R3 source

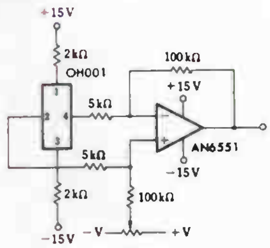
*Measured by increasing gain 10 times to overcome instrument resolution of 0.003%.

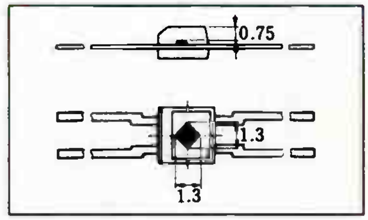

AEM 6010 LL

GaAs HALL ELEMENT FROM NATIONAL PANASONIC

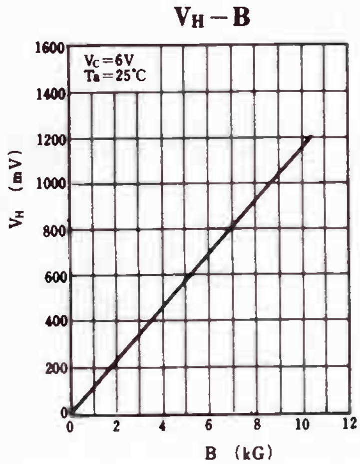


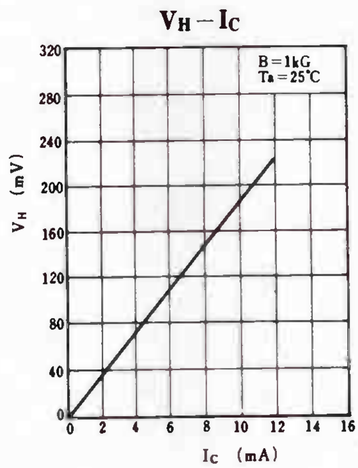


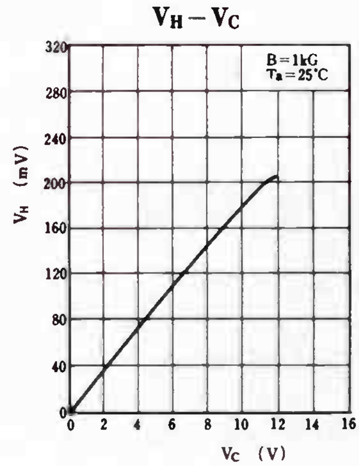




The location of the chip







Absolute Maximum Ratings (Ta = 25 ℃)

Symbol	Value	Unit
V_C	12	V
P_D	150	mW
T_{opr}	−55 ~ +125	℃
T_{stg}	−55 ~ +150	℃

FEATURES:
- Small temperature coefficient of Hall voltage.
- Good linearity coefficient or magnetic field dependence of Hall voltage.
- High Product sensitivity.
- 1k input resistance, DC voltage directly applicable.

APPLICATION:
- Brushless DC motors
- Micro switches
- Rotation detectors
- Magnetic detectors
- Proximity switch
- Gauss meters

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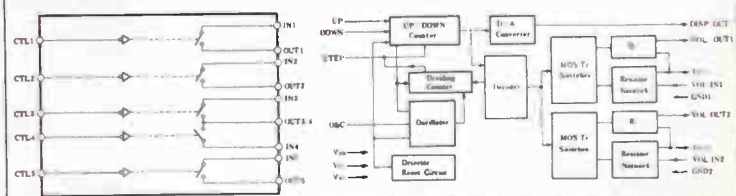
MN6631A
5 Channel CMOS Electronic Switch
The MN6631A is a 5-channel CMOS electronic switch for Hi-Fi audio signals. This switch has large input capability up to 40VPP and very low total harmonic distortion. This switch can conduct current in either direction in the ON condition. Control voltage level is compatible with TTL.

MN6632A
2 Channel CMOS Electronic Volume Control LSI
The MN6632A is a 2-channel CMOS electronic volume control LSI for Hi-Fi audio signals. This device can attenuate audio signals of 40VPP with low distrotion at a supply voltage of 5V. Display out, oscillator, back-up and reset circuits are included.



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An infrared remote control repeater

Marshall Gill
Dick Smith Electronics
R&D Department

With this project you can use the infrared remote control from your VCR/TV/hi-fi gear in another room in your house to control extension equipment. Just take your controller(s) with you!

SO YOU'VE FINALLY completed the installation of your grand TV/stereo extension-in-the-bedroom scheme and you're lying back in bed with the VCR running in the other room, watching your favourite video movie. Then the 'phone rings. Get up, answer the 'phone — damn it, missed the end of the movie! Frustrating, what? You'll have to go back to the other room, rewind the tape, start it off again and go back to bed. But what about when the tape finishes? You're going to get out of bed and turn off the VCR? Not likely!.

This project could be your answer; it's a box of tricks that allows you to use the convenience of your VCR infrared (IR) remote control in another room, away from where the VCR is installed. All that is needed is a 75 ohm coaxial cable line from your main viewing room to the extension in the other room. You may be fortunate enough to have this cable already installed as part of the existing TV antenna system.

This same operating principle could be applied to other IR remote controlled appliances, including audio systems. With such a system, you may have extension speakers in-

The system uses an infrared receiver to convert the signal from the remote control handset to a level that can be transmitted back down the same line as the incoming video sig-

stalled in another room but still need to go back to the system to alter the volume or change the track on the compact disc. Here is the answer. Simply install a 75 ohm coaxial cable line and you have full IR remote control at your fingertips. With the line installed, there is an added bonus of an extension for an extra TV set in this room.

nal from the VCR. At the signal source end, a dedicated splitter separates this IR information and transfers it to the VCR via an IR light-emitting diode.

CONSTRUCTION

The printed circuit board for the receiver is a relatively simple construction job. All components are inserted, trimmed and soldered to the positions shown on the overlay diagram. The on-off switch is a direct-mount pc type. The body fits flush on the board surface. The two feet on the front overhang the edge and are soldered to the copper foil at the points provided.

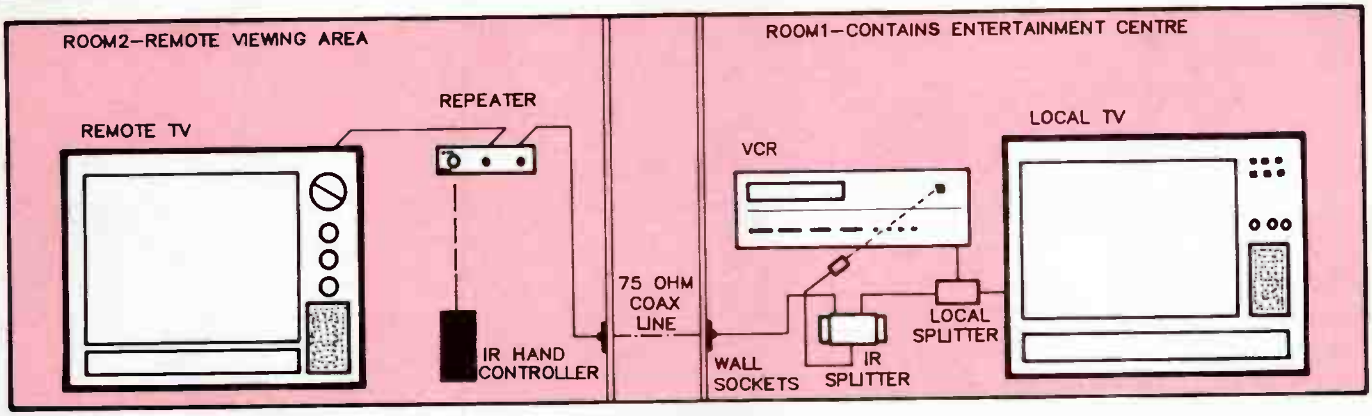
The only other components that need any explanation are the coils, LED, photodiode and metal shield. The two coils are tightly wound 22 B&S or 20 B&S enamelled wire on any 6.5 mm diameter mandrel. A pencil, drill or similar round section object will do. The requirements are not crtitical. Don't forget to scrape off the enamel at the ends where it is to be soldered into the board.

The leads of the red LED have to be bent so the body fits into the hole in the zippy box. Do not cut the leads until you get the bend at the right point. The photodiode also needs some manipulation to get it to fit over the centre of the case hole. Again, cut off the excess lead only when the final position has been decided.

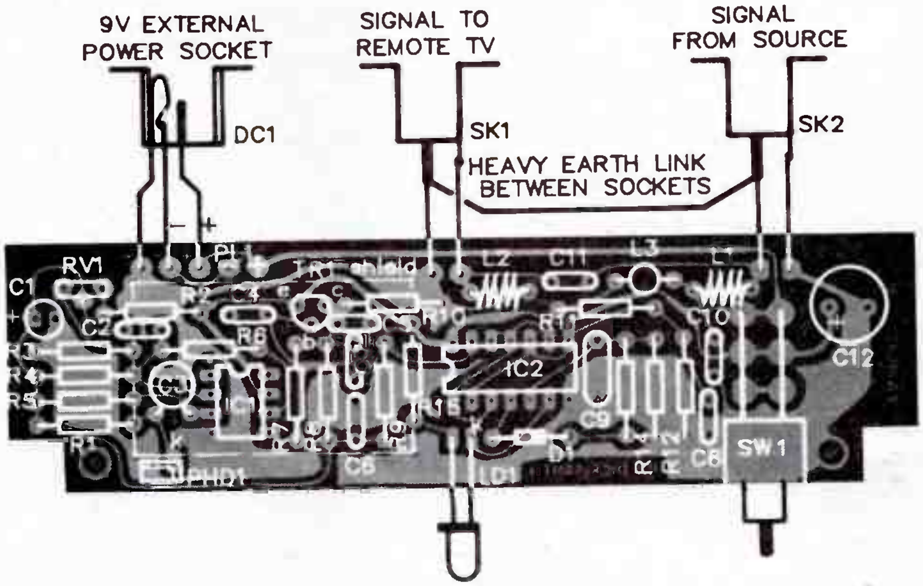
The metal shield fits neatly inside the four pc board pins as shown. Let the bottom edges sit on the shoulders of the pins. Solder the tinplate at each pin. Only a small amount of solder is necessary. It only has to be tacked into position.

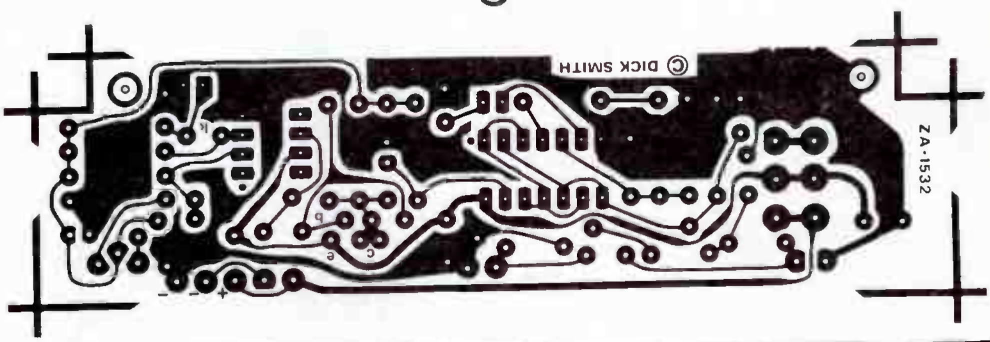
Wire the two leads of the battery snap to the board as shown. Connect a short length of hookup wire to each other point as shown, three for the external dc points and two each for the coax sockets.

This month's ★ Star Project ★ is from Dick Smith Electronics who will be marketing complete kits, available through any of their stores, or via mail order to DSXpress, PO Box 321, North Ryde NSW 2113. (02) 888 3200.



EXAMPLE OF A TYPICAL INSTALLATION





PARTS LIST IR REMOTE CONTROL REPEATER

Transmitter-Receiver

Semiconductors

IC1	CA3140
IC2	40106*
TR1	BC557, DS557
LD1	5 mm red LED
PHD1	BPW50
D1	1N4148, 1N914

* Makes, in order of preference:
Signetics 40106
Motorola MC14584
SGS or RCA 40106
National 74C14

Resistors all ¼ Watt 5%.

R1	100k
R2, 3	6k8
R4	100k
R5	1M
R6	10M
R7	1M5
R8	4k7
R9	100k
R10	10k
R11	220R
R12	1k2
R13	1k8
R14	1M
R15	1k
VR1	50k min. vert. trimpot

Capacitors

C1	10u/25 V RB electro.
C2	68p ceramic
C3	270p ceramic
C4	1n ceramic
C5	33p ceramic
C6	47n ceramic
C7	1n ceramic
C8,10,11	180p ceramic
C9	100n ceramic
C12	220u/16 V RB electro.

Inductors

L1 .... 33 uH RF choke
L2, L3 ... 9 turns, 20 or 22 B&S enamel wire wound on 6.5 mm mandrel and slipped off (requires 250 mm per coil)

Hardware & Miscellaneous

Printed circuit board, ZA-1532; SW1: S-1180 pc mount toggle switch; SK1, SK2: P-2040 75 ohm coax chassis sockets; DC1: P-1661 2.1 mm dc switching socket; PL1: P-6216 No. 216 battery snap; tinplate shield (folded, 45.5 x 39 x 0.3 mm); hookup wire; 4 x pc pins; 4 x No. 4 x 6 mm PK screws: zippy box 130 x 68 x 41 mm (H-2753) 2 x 15 mm insulated spacers with screws; 1 x red No. 18 Swann bezel; 1 x 3-part Scotchcal label; 2 x solder lugs; 4 x small rubber feet.

Splitter module

LD2 CQY89/LD271 5 mm IR LED
C13 .... 39p ceramic cap.
C14, C15 .... 180p ceramic cap.
L4, L5 ... 9 turns 20 or 22 B&S enamel wire wound on 6.5 mm mandrel and slipped off (as per L2, L3).
L6 .... 33 uH RF choke
SK3 P-2040 75 ohm coax sockets
DC2 .. P-1231 3.5 mm chassis-mount earphone socket
DC3 .. P-1134 3.1 mm earphone plug

Two metres of W-2030 single-shielded mic cable; P1236 3.5 mm line earphone socket; 4 x No.4 x 6 mm PK screws; 50 mm of 20g tinned copper wire; zippy box 68 x 44 x 32 mm H-2765; 1 x Scotchcal label.

Expected Cost: $36-$40.

The two insulated spacers can now be fitted. Note how the one nearest the switch has a solder lug between it and the board.

Drill case

In order that the case fits neatly inside the zippy box, the holes have to be drilled with reasonable accuracy. See the drilling diagram for details. Clean all burrs from around the holes. Drill the aluminium lid as shown.

Receiver case assembly

After all holes have been drilled, the two lables reproduced here may be cut out and stuck to the front and rear panels. If you have a Dick Smith kit, these two labels are provided on a separate single sheet. Use a sharp pair of scissors or Stanley-type knife to carefully cut these out.

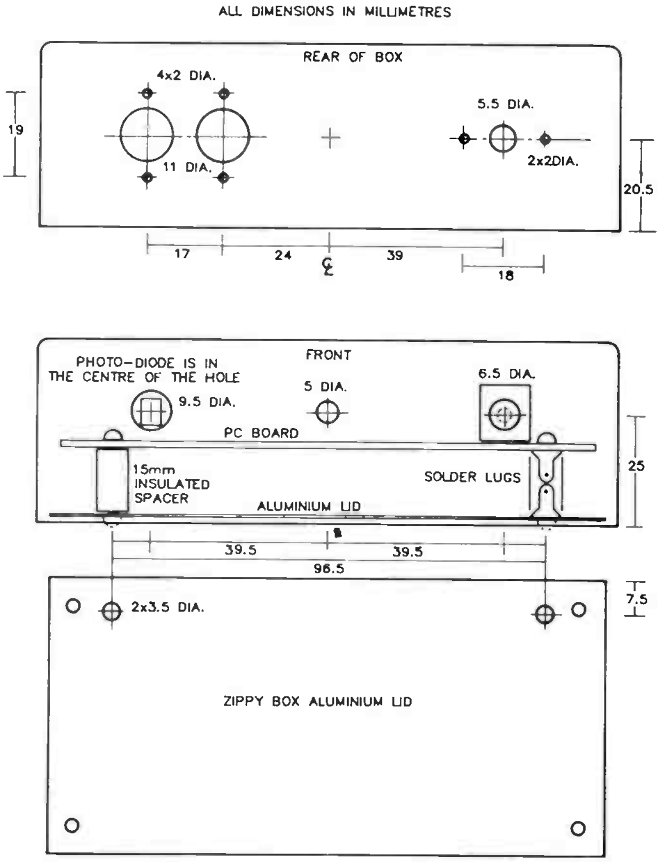
The panel lables can now be carefully placed in position. Make sure you align each properly before burnishing it into position. The component holes can be cut around the perimeter by using a fine-blade scalpel. Do this very carefully. It would be a pity to degrade the project by damaging the panels.

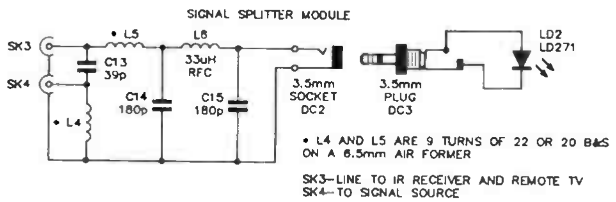
The dc socket and the two coax sockets can now be fitted. Two M2 screws are needed for the dc socket and four No. 4 x 6 mm self-tapping screws to hold the coax sockets.

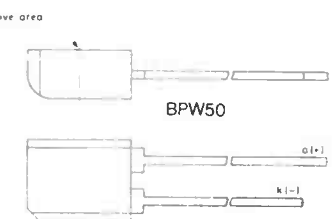
The completed pc board can now be wired to the components in the case. Firstly, solder the earth lug of each coax socket together using a short length of heavy gauge copper wire. Connect all other points on the board with short lengths of hookup wire previously soldered.

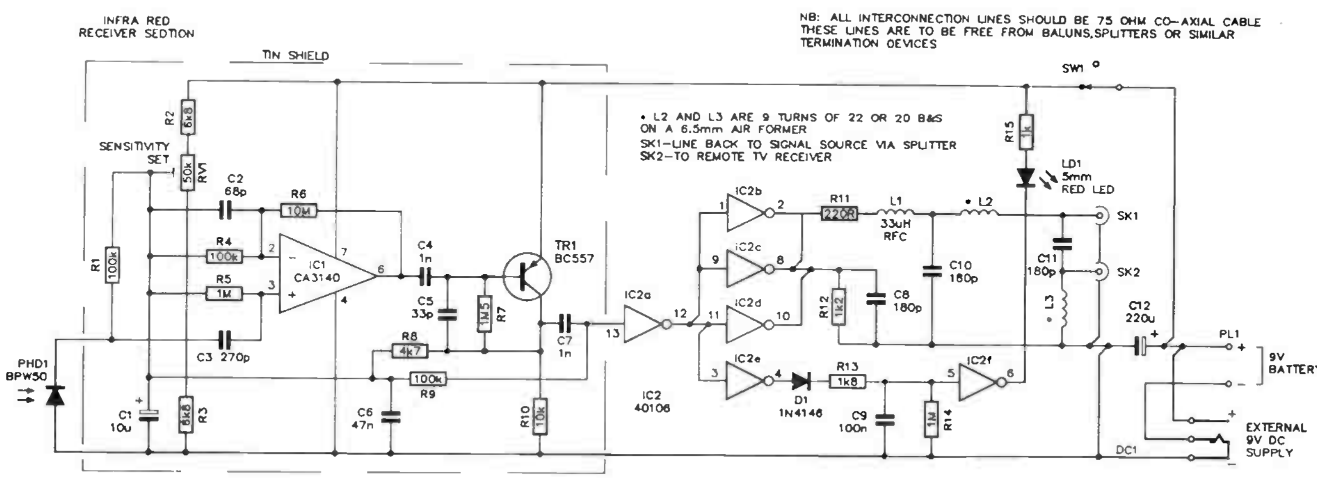
Now is a good time to see how the assembly fits into the case. You should be able to manoeuver the switch and LED into the holes in the front panel. If all is well, it should fit neatly into position. Try the aluminium lid for fit. The insulated spacers should align over the holes. Fit the spacer screws and remove the total lid and pc board assembly. You can now see how the second solder lug fits between the lid and the spacer. Obviously, the screw will have to be removed to fit this lug. Bend the two lugs together and solder.

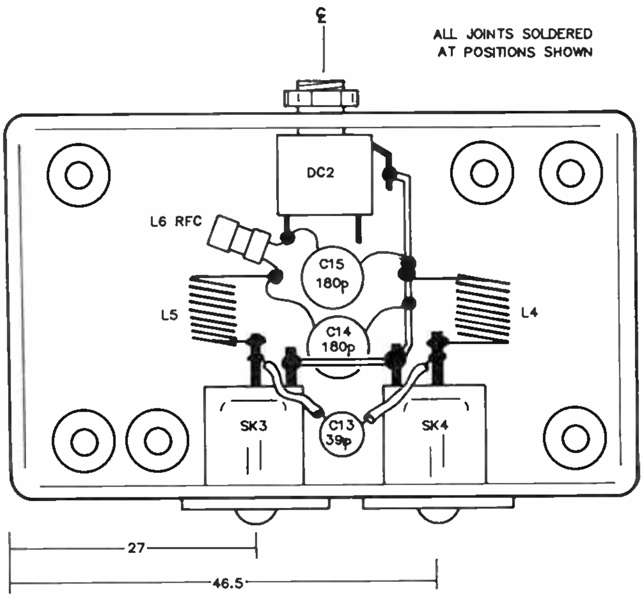
The red plastic bezel supplied with the Dick Smith kit will fit snugly into the photodiode hole. Cut off the excess of the legs that penetrate the inside ribs of the zippy box. These legs should face up to the shoulders of the diode when the assembly is reinstalled in the case. Use a little glue if necessary to hold it in place. The receiver is now at the stage where it can be tested.



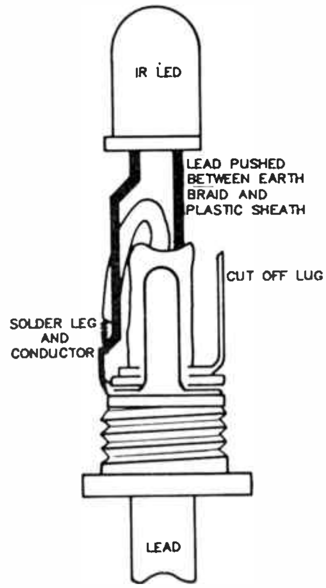




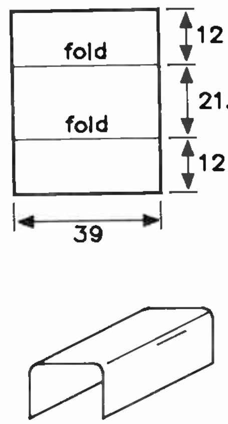




SPLITTER MODULE—COMPONENT LAYOUT



IR LED HOUSING



TIN SHIELD
Material:
0.25 to 0.35 thickness tinplate

Splitter construction

A small plastic case (DSE H2765) is used as the housing. The coax connectors and the 3.5 mm socket are installed as shown, the latter being centred in the panel. The coax sockets are positioned offset and mounted in 11 mm holes. They are fixed with No. 4 x 6 mm self-tapping screws.

As only a few components are involved in this assembly, a point-to-point wiring technique is used. Before any passive components are mounted, shape and solder a piece of heavy gauge copper wire as an earth link between all sockets as shown. Wind the two coils as previously described, scrape and tin each end. Each component leg can be threaded through the socket lugs. The other legs can be wrapped around the earth wire and soldered. Only L5, L6 and the 180 pF (C4) capacitor require a little fiddle. A small hook formed on each leg makes the assembly a little easier when soldering. If you wish, small lengths of spaghetti can be threaded over the capacitor legs as shown.

Check the assembly and screw on the aluminium lid. ▶

CIRCUIT OPERATION

Most receivers in infrared remote control systems use a dedicated, high gain preamplifier with some form of gain control and signal conditioning circuitry. This stage is tuned for peak performance at the clocking frequency of the IR transmitter.

With this project, because the receiver is to be used with many different controllers, a tuned circuit cannot be employed. We have to adopt an "all band" approach to cater to these various input signals.

The photodiode amplifier "front end" is a relatively simple design. A CA3140 operational amplifier is used in a high gain, non-inverting mode to increase the signal level from the reverse biased BPW50 (PHD1). The following stage is a self-biased transistor to give further amplification. These two stages are designed to operate in the frequency range of IR remote control handpieces. Most systems fall into the 30 kHz to 60 kHz region. Although the CA3140 may be stretched to the limit to give any real gain at these frequencies, the combined stages perform quite happily within this requirement.

A primitive form of signal level handling control is employed by the inclusion of the feedback resistor R8(4k7) between the output stage and the common rail of the input amplifier. This prevents saturation of the stage when the controller handpiece is operated at close range.

This common rail for the op-amp also plays a significant role in the operation of the next stage. One section of a 40106 CMOS Schmitt trigger package is used as a signal conditioner. Because the hysteresis voltage of this device is around 0.7 to 1 volt (9 V supply rail), a high level of noise immunity is established. Only the true, higher level pulses of the signal will pass the upper level threshold point of this Schmitt and therefore eliminate unwanted noise. The input to this switching threshold can be changed by the sensitivity control, VR1. The range of this potentiometer is sufficient to cover the parameter spreads of various devices that may be used in this application. We used a Signetics device to give the best sensitivity figure.

VR1 is adjusted so that the voltage on pin 13 of this device (via R9) is just below the high level threshold point. It can be seen that this adjustment changes the common rail of the CA3140, but in operation, it has little effect because of the device's high CMRR and ability to handle input signals close to the negative rail. The coupling capacitors C4 and C7 isolate TR1 from any dc level shift problems.

Sections b, c and d of the 40106 are wired in parallel to transfer the reconstituted signal via the external coaxial line to the remote IR LED. The inductors L1, L2 and the current limit resistor R11 pass this pulsed-dc information but isolate the RF signal also present on the line. L3, capacitors C10 and C11 are also part of the RF handling technique.

The remaining two inverters, e and f are used to give a "signal received" indication. Components D1, R13, C9 and R14 form a simple charge pump circuit with a short time constant. This will operate the LED, LD1, when a frame of information is received from the hand controller. It does not necessarily mean that the information contained within the signal is correct but it is a simple indicator that an IR signal has been received. It is however, a good indicator of the range of the system and it does tell you if the controller is at least pointed in the right direction.

Signal splitter

This module is a means of terminating the line at the signal source end. It also extracts the pulsed-dc to drive the IR transmitting LED, LD2.

IR transmit diode

The method of housing the IR diode is up to the individual constructor. We used a 3.5 mm line socket as a protection system. Refer to the diagram for detail.

As this diode has to be pointed towards the signal source VCR etc, it may be advantageous to have some means of securing the housing. Maybe a stand, foot, clip or even double-sided sticky tape could be used.

INITIAL SET-UP AND TESTING

Your completed IR receiver can be set-up for basic operation without the need to connect the splitter or external line.

Connect a 9 V battery to the No. 216 plug. If you are going to use an external 9 V supply, plug this into the dc socket. Be sure the polarity is correct before making connections.

You now need the IR hand controller from the equipment to be operated for this testing. Carry out the procedure in normal household lighting, not in strong light. Switch on the receiver.

Point the controller at the photodiode and press any button. The "signal received" LED should come on in response. Try moving away from the receiver to establish its operating range. It normally should work for at least five metres. Some adjustment of the sensitivity control (RV1) may be necessary to get the best results. Moving the control to one extreme end will severely limit the range. The other end of travel will 'lock-on' the LED. Try swinging the pot. through the full range. You will see that the LED will come on near one end of travel but it will not go off at the same point as the direction is reversed. This action results as a function of the Schmitt trigger. The correct maximum sensitivity point is just beyond the "turn off" position. Normally, this point will be somewhere around the centre of the pot. range.

This ends the basic set-up. If the receiver does not operate in this manner, you may have to go back and check the pc board for construction errors.

FINAL ASSEMBLY

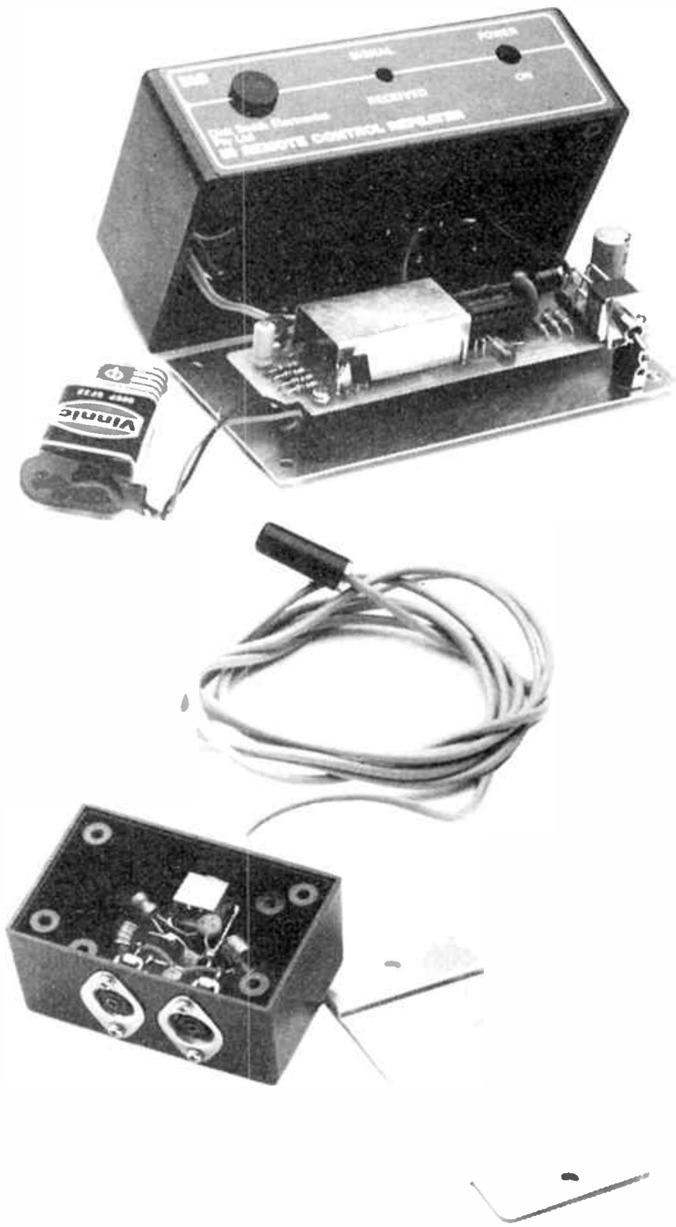
The receiver assembly can now be refitted to the zippy box. Make sure the IR photodiode aligns over the hole. Keep the output wires away from the input stage and the photodiode. The battery fits neatly between the dc socket and the coax socket. Screw down the aluminium lid. Stick four small rubber feet onto this lid. This completes the construction.

OPERATION

The system can now be put into service. The IR receiver is wired between the remote TV set and the interconnecting line. The splitter is installed at the signal source end.

Note: Many houses have 75 ohm coaxial lines installed as part of the antenna system. The appropriate part of the line can be used as the interlink. There is, however, one problem that must be considered. The line between the IR receiver and the splitter must be direct. This line carries dc to the Tx diode as well as signal information. Baluns, other splitters or similar coupling devices cannot be connected. It may be necessary to modify your wiring to satisfy this requirement.

The equipment to be used with the IR repeater have to be connected together. A typical system is shown in the diagram. Some 75 ohm coaxial adaptor leads may be needed between sections and components of the system.



The system IR diode is pointed towards the internal VCR (or similar IR remote control equipment used) IR receiver. The distance should not exceed 200 mm. As mentioned previously, some form of stand or mount may be necessary to get the diode assembly to sit and point in the right direction.

The system should now be operational. In some cases, it may be necessary to reset the sensitivity control in the IR receiver. Because extra noise can be introduced by the added wiring, the "signal received" LED may come on. Back off the control slightly to set the new sensitivity point.

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

The 'Bandbox'

David Currie
David Tilbrook

Here's an economical four-input power amp for bands or small groups. It delivers 150 watts-plus into four ohms and features individual level controls on each input together with bass, treble and presence tone controls. But its best feature is the flying Kookaburra on the front panel!

THIS PROJECT is an assembly of two projects previously described in the magazine, housed in a 19" three-unit high rack-mount box, together with a power supply, to form what we've dubbed 'The Bandbox'. The power is supplied by the AEM6500 120 watt MOSFET power amp module, described in the July '85 issue, while the preamp employed is the AEM6501 four-input mixing preamplifier from the September '85 issue.

To power the project, we used a toroidal power transformer to obviate hum problems from transformer radiation, with a concomittant reduction in weight and heat compared to a conventional transformer. A bridge rectifier and a pair of 8000µ/75 V chassis-mount electrolytics provide the positive and negative supply rails required by the power amp. The preamp module requires a 30 Vac centre-tapped supply. Some toroids available have such a winding, but the one obtained was without it, so we wound-on our own. The procedure is detailed later.

In assembling this project, you should commence by first obtaining all the parts for the preamp and power amp modules, then construct and test each individually. We refer you to the relevant articles as detailed above. However, while you're about it, we recommend a small modification to each, as follows.

Firstly, while the 6500 power amp is an inherently stable design, even with complex non-resistive loads, the use of inductive source resistors with the n-channel output pair, Q9 and Q12, may cause oscillation. If inductive OR22/5 W source resistors are used for R23 and R29, we recommend you add ▶

BANDBOX — SPECIFICATIONS

Power output	>110 W into 8 ohms >170 W into 4 ohms
Distortion:	<0.015% across the audio bandwidth (limited by the preamp)
Hum & Noise:	>–118 dBm flat >–126 dBm A-weighted (with respect to 200 ohm source impedance)
Tone controls	
Bass:	+13/-14 dB @ 30 Hz
Presence:	+15/-14 dB @ 1200 Hz
Treble:	+15/-12 dB @ 12 kHz

NEW PRODUCTS:-

ULTRASONIC HOUSE ALARM

This alarm is fully self-contained, even includes the siren. Place it on a shelf, (it looks like a speaker) and the ultrasonic waves detect movement. Great for single room protection, or can be used as a master control for a whole house.
You can connect an external on/off switch, external horn siren. It has provision for N/O instant circuit and N/C instant and delay. A battery compartment is there for C cells, but we recommend a 1.2A 12V Gel battery. Cat SB-2480 $26.50 and 240V power supply Cat MP-3019 $22.50
Cat LA 5140

This sold well last month for $69.00. We need to clear the last few.
This month only
$59.00
SAVE $40.00
That's almost ½ price.
10 Alarm Stickers FREE - worth $8.50

WIRELESS HOME ALARM

This is the fabulous alarm system you've seen us advertising recently and has been reviewed in Australian Electronics Monthly July 1985 page 36. Guess what we're overstocked, and need to clear some. The system incorporates the control panel (pictured), 2 sets of wireless reeds and magnets, 1 passive infra red detector, 1 siren and one remote control.
All this normally costs $599 (pre-devaluation). This month you can purchase the set for $499 and we'll give you free another reed and magnet set worth $49.50. This means a lot saving of almost $150. If you need additional components, they are all available separately. IR detector $99. Reed/Magnet $49.50. Siren $99. Remote Control $39.50
Cat LA 5410

ONLY $499.00
PLUS FREE REED/MAGNET SET WORTH $49.50
SAVE ALMOST $150

LA 5400

SAVE $100

MAIL ORDER HOTLINE (02) 747 1888

MAIL ORDER HOTLINE (02) 747 1888

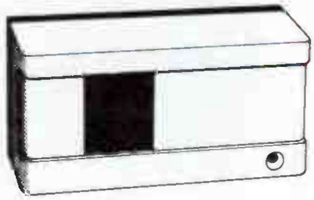
INFRA RED MOVEMENT DETECTOR

The Infra red or IR detector for short, falls into the Black Magic category. It basically is a high gain passive tuned receiver of a particular IR band. The heart of the unit consists of a high gain lens (antenna?) which has a "Commutated" field of view. Its reception pattern is comb like, but highly tuned to the IR wavelength of human bodies. When a human passes within proximity of the pickup area, the lens will selectively pick up IR radiation and then not. Movement across the pickup area will result in a series of pulses sent to a detector circuit.
IR detectors are very reliable as they do not transmit and will not respond to non heat radiating objects. Curtains, for example, can wave about without tripping the alarm. Even the cat is unlikely to trip the unit.

FEATURES:
- 12V DC powered
- Small 77mm x 62mm x 51mm
- Double sensor
- Computerised OC to lower failure rate
- Built-in test lamp
- Alarm output SPST 30V DC @ 1A
- NO or NC terminations

Cat LA-5017

SAVE $20.00
ONLY $89.00 ea



AT LAST! A low cost 10 Amp Digital Multimeter with transistor test facility

Digital multimeters are very popular these days but good quality ones with 10 amp scales generally cost well over $100. We think that is too expensive so we've decided to do something about it.
Jaycar is pleased to announce a direct import digital multimeter with sensational specifications at an unheard of price!
Check the specs

DC VOLT	0.1mV - 1000V
AC VOLT	0.1mV - 700V
DC CURRENT	1uA - 10A
AC CURRENT	1uA - 10A
RESISTANCE	0.1 - 20 Mohm
CONTINUITY	less than 30 ohm @ 1mA
hFE TEST	0-1000 10uA 2.8V NPN/PNP
DIODE TEST	1mA

Basic accuracy of Volts, Current & resistance is between 0.5 - 1.2% depending on range
DIMENSIONS 170(H) x 90(W) x 35(D)mm

FEATURES
- ★ 0.5" high digits
- ★ High quality probe set supplied!
- ★ Vinyl carry case supplied!
- ★ Built in tilting bail!
- ★ LED & buzzer continuity test!
- ★ Precision thin film resistors used for long term accuracy!
- ★ CMOS logic 1000-2000 hours battery life!
- ★ Single function range switch
- ★ Complete with battery, spare fuse (2AG) and instruction manual
- ★ Protected ON/OFF switch!
- ★ Auto polarity
- ★ Protected
- ★ Floating decimal point

Cat QM-1530

$89.95

AT LAST! A low cost 10 Amp Digital Multimeter/ Transistor Tester & Capacitance Meter!

Jaycar is proud to announce a genuine low cost high performance combination Multimeter/Capacitance meter for the enthusiast! This unit is all the most commonly needed test gear rolled into one!
Similar units are on the market to sell from around $150 to over $200. Why pay more when you can get a Jaycar direct import for less?

DC VOLT	0.1mV - 1000V
AC VOLT	0.1mV - 700V
DC CURRENT	1uA - 10A (20A max 30 secs)
AC CURRENT	1uA - 10A (20A max 30 secs)
RESISTANCE	0.1 - 20M ohms
CAPACITANCE	1pF - 20uF (2%)
CONTINUITY	less than 30 ohms @ 1mA
hFE TEST	0-1000, 10uA 2.8V
DIODE TEST	1mA (Buzzer & LED)

FEATURES
- ★ 0.5" high digits
- ★ High quality probes supplied!
- ★ LED and Buzzer continuity test
- ★ Precision thin film resistors for long term stability
- ★ CMOS logic 1000 - 2000 hours battery life!
- ★ Meter protection Fused
- ★ Complete with battery, quality probes, spare fuse
- ★ Floating decimal point
- ★ Auto polarity
- ★ Impact resistant case

Cat QM-1540

$129.00

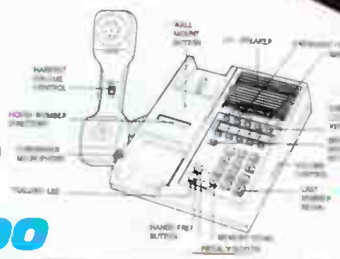
NOW OPEN: Our Gore Hill Store is open till 4 pm Saturdays

MAIL ORDER HOTLINE (02) 747 1888

Hands-free 10 Memory Desk/Wall Telephone

- Loud and clear fully duplex handsfree 2 way speaker
- 10 direct access memories
- Telephone line powered
- Unauthorised call restriction lock (optional)
- Adjustable volume control switch on handset
- Adjustable speaker volume control
- Privacy muting button
- Ringer Hi Lo control
- Ten 18 digit memories plus one 22 digit last number redial
- Wall mounting or table use
- Programmable PABX pause

Cat YT 7092



ONLY $175.00

ULTRASONIC PEST REPELLER

We were staggered by the price increases on the pest repeller we used to sell, so we found a new one at a more realistic price. Will repel mice, blowflies, birds, spiders, bats, rats, cockroaches, flies, moths and fleas. It's cosmetically appealing and is supplied with a 240 volt power adaptor. We are so sure this product works we will give you a 14 day money back guarantee (less postage costs). Power consumption only 1½ watts.

WHAT HAVE YOU GOT TO LOSE EXCEPT THE BUGS!

ONLY $55.00

Cat YS-5510

AN ECONOMICAL MAINS FILTER

250V AC @ 3A

250V AC @ 3A - insertion loss line to line 20dB 0.8 - 30MHz. Line to ground 30dB 0.7 - 30MHz. Ideal for computers, amps etc. Quick connect lugs. DOT approved.
Cat MS 4002

ONLY $22.50

DESK MOUNTED LAMP MAGNIFIER

This unit magnifies any object under a clear cool fluorescent light. The magnification is the maximum obtainable (lens 127mm diameter biconvex 4 Dioptres focal length 254mm) consistent with minimum distortion and eyestrain and good off angle viewing.
It is NOT cheap but then again it will definitely last a lifetime. It is built like a Rolls Royce. (We doubt whether 20 years continuous use would wear out the German made flexible arms for example.) Spare fluoro tubes are available either from us or electrical outlets. If you have trouble with fine PCB work or component identification but still want both hands free, this is for you. We thoroughly recommend this quality Australian made product.

Technical Information
Illumination **22W Fluorescent**
Weight **8.16kg**
Lateral Extension **254mm**
Vertical Extension **254mm**
Fixing **Heavy table base (grey) with two chrome plated flexible arms.**
Lens **(see text)**

ONLY $169

Cat SL 2700

Book/Software Combinations

TI99/4A - 51 fun & educational programs - As the title suggests, 51 good examples of TI BASIC in action. Programs can be changed to meet specific needs. The book has 94 pages and contains 4 sections. The cassette has all programs listed in the book, on one side in standard form and on the other in enhanced form. Both book and cassette come in a colourful vinyl case.
Cat BS 0750

ONLY $27.95

TI99/4A - 24 BASIC programs
This book/software product runs from child/adult entertainment games to highly applicable household utility and service programs. The cassette supplied has both standard and enhanced program listings.
Cat BS 0754

ONLY $29.95

TI99/4A Entertainment games in TI BASIC and extended BASIC
Arcade games at a very cheap price. Add the TI joysticks and extended BASIC module and you can use this product to its fullest extent. 20 programs in 21 chapters. The cassette supplied has both standard and enhanced listings - great fun - great value.
Cat BS 0752

ONLY $29.95

TI99/4A BASIC programs
This combination of book cassette goes through each line of a BASIC program to enable you to more fully understand what BASIC is all about. There are many programs for you to work on. Helps you learn while you enter, run and modify the programs.
Cat BS 0755

ONLY $29.95

BASIC tricks for the TI99/4A
A valuable programmer's reference that's filled with hard to find ideas, examples and special BASIC subroutines to help you crank out powerful TI99/4A programs.
Cat BS-0756

ONLY $29.95

TI99/4A graphics & sounds
Sparkling routines that add showmanship to any program with brilliant graphics and sound. This is a must.
Cat BS-0757

ONLY $29.95

JAYCAR IS No1...

40 WATT DC INVERTER
Ref: EA August 1985
An upgrade of a previous design featuring a smart new ABS case.
Cat. KA-1598

NEW!

$79.95

300 WATT INVERTER
Ref EA Sept 1985
This totally new design is a vast improvement over the EA June 1982 project. It features a modern all-plastic case, easier assembly, toroidal type inverter transformer, auto start up and double, switched power outlets.
And it's cheaper than the old model!!
The Jaycar kit contains all specified parts to enable you to complete the project in one go.
Cat KA-1610

ONLY $199.00

NEW!

Car Booster Amp
Ref: EA August 1985.
This project enables you to have 2 x 50 watts RMS!! of power for your car sound system. In order to do this, a special high voltage power supply forms part of the system. Absolutely stunning value for money. Around half the price of inferior commercial units.
The Jaycar kit is, as usual, absolutely complete.
Cat. KA-1600

ONLY $179

NEW!

BRAKE LAMP FLASHER
Ref: EA November 1984
What is the best way to avoid rear end collisions when you hit the brakes? According to tests conducted among Sydney Taxi Drivers, the best way is to have additional FLASHING stop lamp installed on the parcel shelf. This project provides this facility. The Jaycar kit includes all specified parts but NOT the automotive stop lamps which are available from motor accessory or hardware stores for about $20.
Cat. KA-1564

WAS $16.50
NOW ONLY $12.50

MAIL ORDER HOTLINE
(02) 747 1888

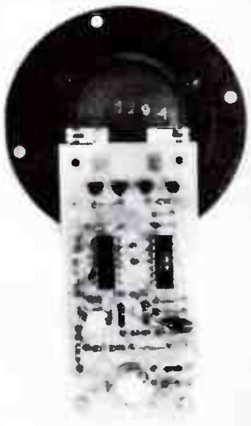
TOUCH LAMP DIMMER
Ref EA April 1983
You can turn lights on and off (AND dim them) with one touch! Uses high tech Siemens IC. Features attractive HPM wall plate (supplied). The Jaycar kit contains ALL the necessary components including the small contact spring. Watch out for similar products that don't!
Cat KA-1508

ONLY $24.95
REMOTE OPTION Cat KA-1509
ONLY $14.50

INFRA RED DIMMER
INCLUDES HAND CONTROLLER WITH I.R. DIODES
Ref EA January 1984
Now you can dim or turn off the lights from the comfort of your own armchair. This shortform kit contains all parts for the I.R. kit.
NOTE: Kit must be used in conjunction with the Jaycar KA-1508 Touch Lamp Dimmer.
Cat KA-1529

SUPER SIREN
Ref EA November 1982
Earsplitting sound from a CMOS that only draws 5mA on average! Includes a powerful imported piezo siren.
Cat. KA-1055

ONLY $17.95
SHORT FORM (Electronics Only)
Cat KA-1484
ONLY $8.50



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

ONLY $89.95

ETONE 10" SUBWOOFER
As used in the Electronics Australia subwoofer system.
★ Size 10" (250mm) ★ Cast frame, QT = 0.39 VAS = 631 ★ Power handling 100 watts rms ★ Free air resonance 32Hz ± 1Hz ★ Voice coil diameter 2" ★ Magnet assembly 3kg (6.6lbs)
Cat CW-2119

ONLY $99.95

'BEACHCOMBER' DELUXE METAL DETECTOR
Ref EA December 1984
This unit is sensitive, accurate, has discriminate control and has automatic zeroing, as well as cancelling facility. It comes in a specially imported plastic case facility and pre wound, sealed search head. The final project looks great and compares favourably with units costing up to $700.
Cat KA-1554

THIS MONTH - $169
SAVE $70 - usually $239

300W PLAYMASTER AMPLIFIER
Ref EA June 1980
This rugged design provides 200W rms into 8 ohms and 300W rms into 4 ohm loads. All parts fit onto a single PCB. It also features comprehensive protection circuitry, and will even withstand short circuits for short durations without adverse affect. Unlike other high powered amps, it is unconditionally stable. It will not therefore break into supersonic oscillations, overheat and fail.
The Jaycar kit of this project provides a quality roller tinned fibreglass PCB and other quality components down to the heatsink compound.
Cat KA-1115

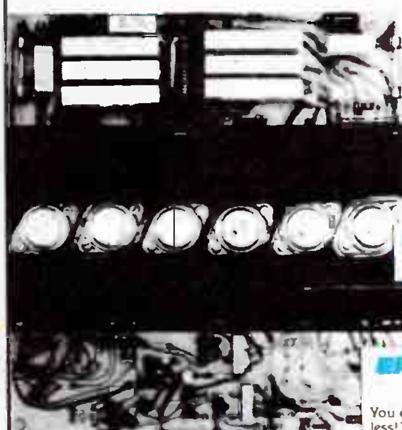
ONLY $99.95

300W AMP POWER SUPPLY KIT
This basically consists of a 300VA power transformer (PF4363), rectifier and filter capacitors. It also has 15VAC power for the speaker protector.
Cat KA-1116

ONLY $79.95

Speaker Protector for Playmaster 300W amp
Ref EA July 1980
This device is designed to mate with the Jaycar KA-1115 Playmaster 300W amp module. It also provides the handy facility of switch on mute. This disconnects the speakers for the first few seconds when the amp is switched on, avoiding the horrifying 'thump' in the speakers. If you have expensive speakers (whether you have the EA 300W amp or not) this speaker protector is cheap insurance. The Jaycar kit provides all PCB parts including the relay.
Cat KA-1117

ONLY $14.95



NOW OPEN:
Our Gore Hill Store is open till 4 pm Saturdays

Deluxe Red Light Flasher
This kit is simply the easily identifiable pushbutton square dash mounted switch with a flasher circuit on the back! Very sneaky! You get the deterrence of a flashing red light (the original light switch as used on the real alarms) but without the cost or installation hassle of a full alarm. Kit includes 2 BONUS car alarm window stickers.
Cat KJ-7000

ONLY $24.50

EL-CHEAPO RED LIGHT FLASHER
(ETI 260 12V FLASHER)
A 12 volt chrome bezel fits to the dashboard and flashes continuously. Cheap but effective.
Cat KE-4012

ONLY $7.95

NOW OPEN:
Our Gore Hill Store is open till 4 pm Saturdays

MAIL ORDER HOTLINE
(02) 747 1888

Electronic Crossover
Ref EA November 1984
NEW SHORT FORM KIT!
You can NOW build this desirable project for a lot less! There have been requests for a version of this kit that can be built into other equipment. This is it!
The kit contains PCB and all board components etc. The box (including front panel) and selector switches are not supplied but everything else!
Cat KA-1571

ONLY $79.00

Jaycar ELECTRONICS
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a 47n greencap connected directly between the sources of Q9 and Q12 (the 2SK134s). It is also important to ensure that the output HF load capacitor, C13, is a non-inductive type. Most 630 V polyester (greencap) capacitors, as often found in TV chassis, are non-inductive and ideal for this application. 'Monobloc' capacitors are also recommended, but note C13 should be rated to at least 150 V.

On the 6501 preamp module, the power supply filter capacitors, C33 and C34, are best increased in value to around 2500µ we found, to reduce the amount of turn-off thump.

If you know the preamp input impedances required for your application, then it's best to set up the preamp at this stage to suit, using the information detailed in the article describing the 6501.

Once these modules are complete the box construction can be tackled. If you have a kit which supplies a pre-punched chassis, then proceed to the power supply assembly.

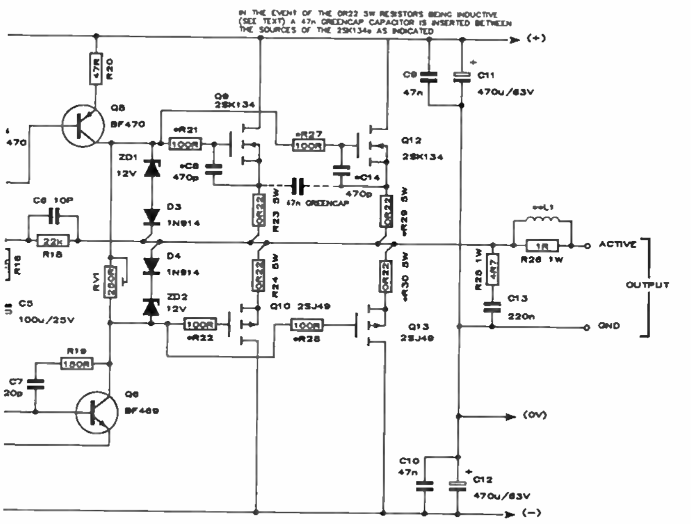


Figure 1. If inductive source resistors are used in the power amp, output stage oscillation can be prevented by adding a 47n greencap between the sources of Q9 and Q12.

CHASSIS DRILLING

Front panel

We used a common rack-mount chassis that employs a separate front panel with a sub-panel mounted behind it. The two sides and rear form a 'U' which is affixed to the sub-panel. Top and bottom plates are screwed onto this assembly.

First assemble the main front panel and the sub-panel together then mark out the front panel as detailed in Figure 2. Note that six holes are needed in the sub-panel to mount the preamp module on 25 mm standoffs. Do not drill these six holes yet as they are done when the panels are separated.

Once the main assembly has been marked out (there should be 14 holes) use a small drill bit to drill pilot holes through both panels. The panels should then be separated and the six mounting holes marked on the sub-panel. Note that the dimensions for these six holes given in Figure 2 are shown from the main front panel. To make these dimensions correct, subtract 1" (25.4 mm) from the horizontal measurements. The six holes can then be drilled to size. The main holes can now be drilled in both panels, taking care not to burr the holes. Deburr holes by using a larger drill bit to 'twist' the burrs out.

Heatsink and back panel

Using Figure 3, mark out and drill the bottom panel holes. Use Figure 4 to mark out and drill the rear panel. The heatsink cutout can be removed using a nibbling tool or by carefully drilling four large holes within the corners and using a hacksaw to cut along the marked lines. Use a file to clean up the rough edges.

Use Figure 5 to drill the four heatsink mounting holes. The two centre holes in the heatsink should line up with the two mounting holes in the 40 × 40 mm angle mounting bracket on the amp module. Note that the bracket should be centred on the heatsink.

CHASSIS ASSEMBLY

Bolt the six 25 mm spacers to the inside of the sub-panel using countersunk bolts. The box can now be fully assembled, except for the top and bottom panels, and the Scotchcal front panel label (if used) attached. There's a trick to doing this successfully. Use water.

First wet the front panel and the sticky side of the Scotchcal. Then position the Scotchcal on the panel and carefully slide it around until it's accurately in position. Now, wipe it gently with a sponge to squeeze out the excess water until it's dry. Cut out the holes with a sharp-bladed knife such as a scalpel or 'hobby' knife.

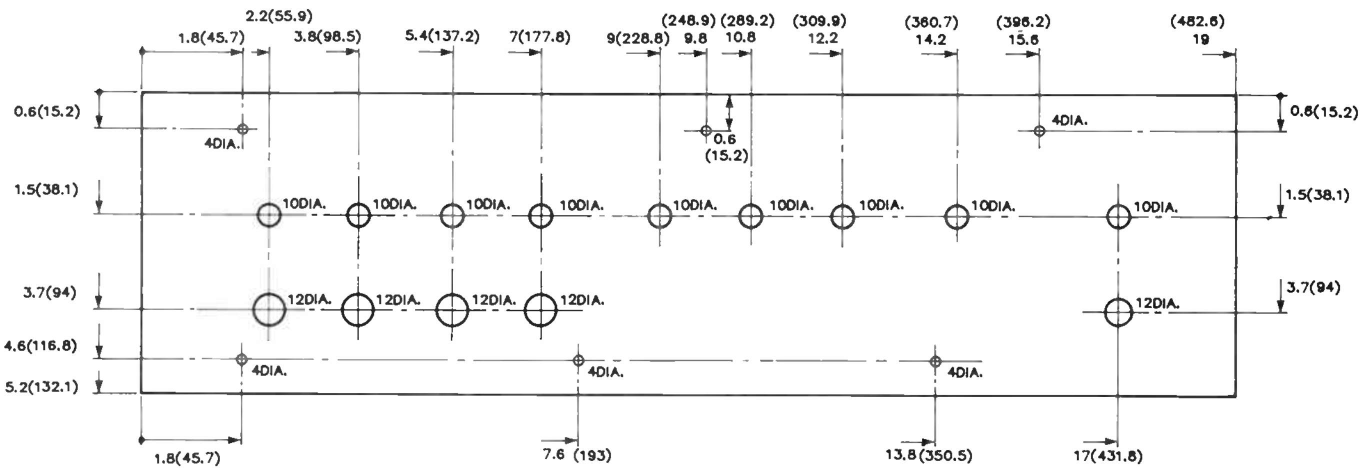


Figure 2. Front panel drilling details.

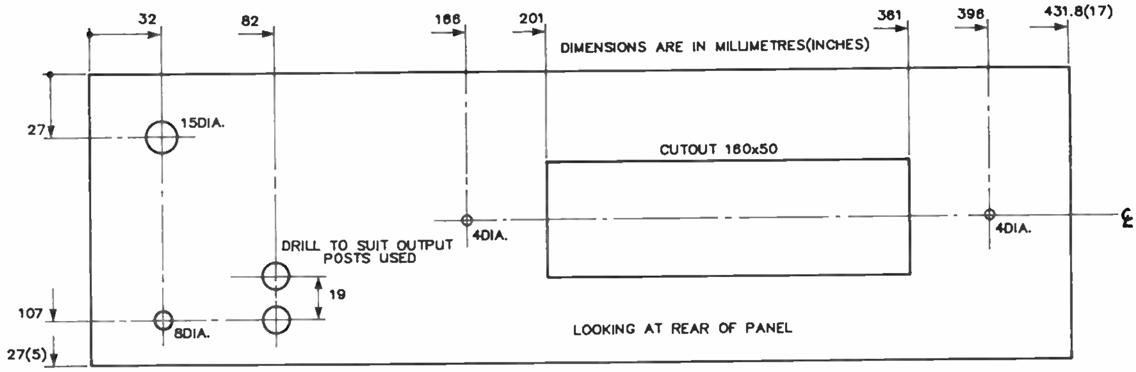


Figure 4. Rear panel drilling details, showing the heatsink cutout.

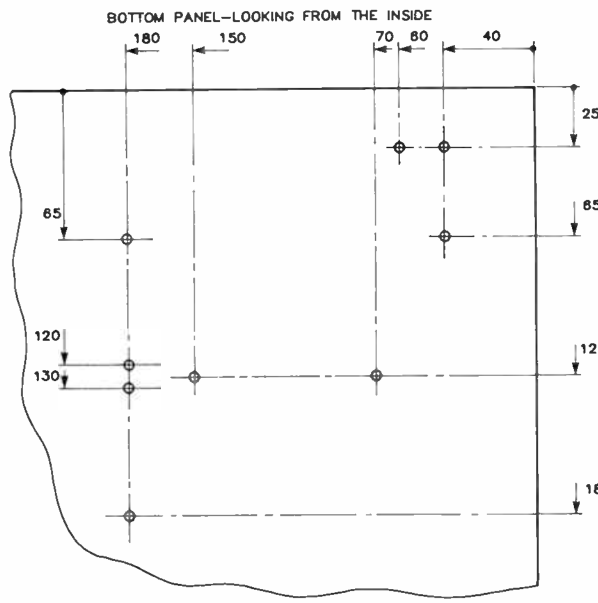


Figure 3. Bottom panel drilling details. ▶

AEM6502 BANDBOX PARTS LIST

As this is an assembly of several existing projects, we are presenting this parts list in a different way.

1 x AEM6500 120 W MOSFET module
1 x AEM6501 4-input preamp*
1 x 35-0-35 V/160 VA toroidal transformer
1 x 300 mm length radial-fin single-sided heatsink
1 x 19″ 3-unit high rack-mount case
2 x 8000u/75 V chassis-mount electrolytic capacitors
1 x MDA3504 400 V/35 A bridge rectifier
4 x 6.5 mm mono insulated phono jack sockets
1 x 3AG chassis-mount fuseholder
1 x DPDT 240 Vac/3 A-rated mains switch
1 x 240 V neon bezel indicator
2 x heavy duty 4 mm binding posts
8 x knobs
1 x mains cable and plug
1 x terminal block and cable clamp
1 x double-ended solder lug
1 x 3AG 3 A fuse
12 x 4BA washers (if needed)
6 x cable ties
4 x 4BA 6 mm long bolts with nuts
6 x 4BA 6 mm long bolts
6 x 25 mm 4BA-tapped spacers
6 x 4BA 12 mm long bolts with nuts
1 x 6BA 18 mm long bolt with nut
1 x 6BA 12 mm long bolt with nut
8 x 30 mm lengths 7 mm dia. heatshrink tubing
One metre heavy duty hookup wire
18 metres of 0.8 mm enamelled copper wire
300 mm medium duty hookup wire
500 mm shielded cable (single wire)
Spaghetti for mains insulation
Scotchcal label for front panel
Four rubber feet if case not rack-mounted

Estimated Cost: $275 — $295

* Use 2500u/50 V electrolytics for C33 and C34

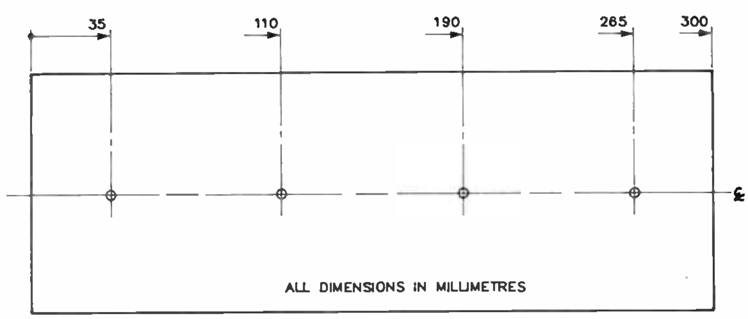


Figure 5. Drilling the heatsink. This view is drawn as if the heatsink were mounted, looking toward the chassis rear.

LEVEL

We expect that constructors of an

INTERMEDIATE

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

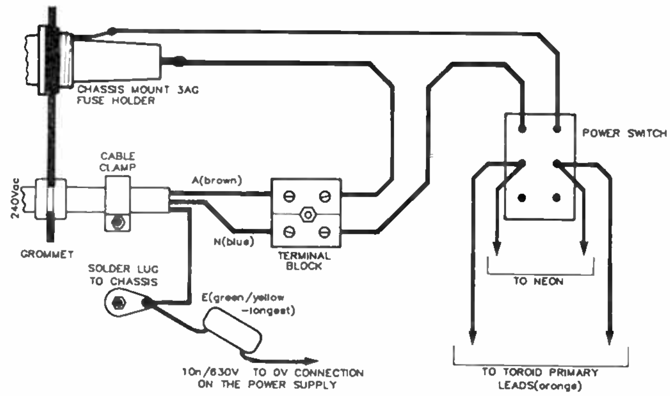


Figure 6. Mains wiring details. All exposed mains connections should be sleeved for safety. The earth lead should be the longest so that it's the last to break if untoward stress pulls the mains cable adrift.

ELECTRONICS ASSEMBLY

The preamp power supply

If the toroidal power transformer you obtained does not have a 30 Vac centre-tapped secondary, then you can wind your own, as follows:

For this, you'll need a 17 metre length of 0.8 mm enamel-covered copper wire, as detailed in the part list. Divide it into two equal lengths. Twist the two equal lengths together with the aid of a slow-turning drill, either battery or hand operated, until there is one turn every 10 mm. This done, the winding can be added to the toroid.

To make the series connections required to get the two 15 Vac windings and centre tap easier, two nine-metre lengths of different coloured enamel wire may be used.

Begin winding by feeding half of the twisted length through the centre of the toroid, opposite the primary and secondary flying leads, then wind 23 turns each way so that both ends finish next to the flying leads. Leave a 200 mm length of each twisted lead and mark one end the start, the other the finish. Scrape the enamel from each of the four leads to a length of 10 mm using a small file, a penknife or emery paper.

Use a multimeter to find the beginning and end of each wire (this is where different-coloured enamel wire makes things easier). Join the start end of one winding to the finish end of the other. This now leaves a total of three wires (twist the joined wires together) — the two singles are the 30 Vac output and the twisted wires the centre-tap (15-0-15 V, if you wish).

The three wires connect directly to the preamp module where indicated on the overlay. Do not connect these wires yet as this is done when the preamp board has been bolted in position.

Mains wiring

Strip the mains cable sheath back to show 50 mm of the three mains wires. Cut the active (brown) and the neutral (blue) back to a length of 30 mm, leaving the earth (green/yellow) lead the longest, and strip all three wires to a length of 10 mm. Attach a three-pin mains plug to the other end of the mains cable.

Mount the mains switch, terminal block, neon bezel, the 3AG chassis-mount mains fuse holder and the two output binding posts to the chassis. Take care you don't damage your front panel when securing the mains switch.

Route the mains cable through the box via a rubber grommet and cable clamp to a terminal block where the active and neutral are terminated. The earth wire (green/yellow) is connected to chassis via a solder lug bolted close to the terminal block.

Wire the active (brown) wire via the fuse to the power switch SW1 (note that not all mains-rated switches have the same switching action). Connect the neutral (blue) directly to the switch. Wire-in the transformer mains winding and the neon mains indicator bezel. Note that the neon is wired on the transformer side of the switch. The complete mains wiring is shown in Figure 6.

Power supply wiring

Mount the two 8000μ/75 V power supply capacitors, C1 and C2, the bridge rectifier (PB40) and the transformer (complete with 30 Vac windings) in position.These can now be wired-in using heavy duty hookup wire. Refer to Figure 7 for the colour codes of the transformer flying leads and general connection details of the power supply.

To link the negative of C1 to the positive of C2 (which forms the O V connection), use a small length of enamelled wire, hooked around the capacitor terminals and soldered in place. The enamel should be cleaned from each end of the link to enable the solder to properly adhere. A 10n/630 V capacitor should be connected between the chassis connection of the mains and the O V point on the power supply filter capacitors (8000μ/50 V). This is done to ensure that the chassis acts as an RF shield. The amp module power supply is now ready for connection.

The inputs

The inputs to the preamplifier are provided by four mono 6.5 mm insulated jack sockets. Use a multimeter to find the input (tip) and earth (sleeve) connections, the earth is usually on the side. Cut off all the other unwanted connection lugs as they might short against the other components during the final asembly.

Cut and strip four 100 mm lengths of shielded cable and connect the four input sockets to the appropriate inputs on the preamp board.

Final assembly and wiring

Wire the output of the amp module to the output binding posts via two 300 mm lengths of heavy duty hookup wire. Use solder lugs on the binding posts and ensure that the 'active' goes to the red binding post and ground to the black.

Solder a 200 mm length of shielded cable to the input of the amp module and prepare the other end for connection to the preamp.

Wire the positive, negative and 0 V from the amp module to the main power supply using heavy duty hookup wire. Bolt the module to the heatsink throught the cutout in the rear panel. Use heatsink compound between the mating face of the module's angle bracket and the flat side of the heatsink to ensure efficient heat transfer.

Next mount the four input sockets to the front panel and mount the preamp board in position. Cover the pot. shafts with heatshrink tubing to prevent contact with the chassis

In the setup procedure for the 6500 MOSFET module described in July '85, set the quiescent current to 60 mA instead of 100 mA. This helps to keep the output stage cooler. It increases crossover distortion slightly but this is not important in sound reinforcement as the module will be operated at high levels.

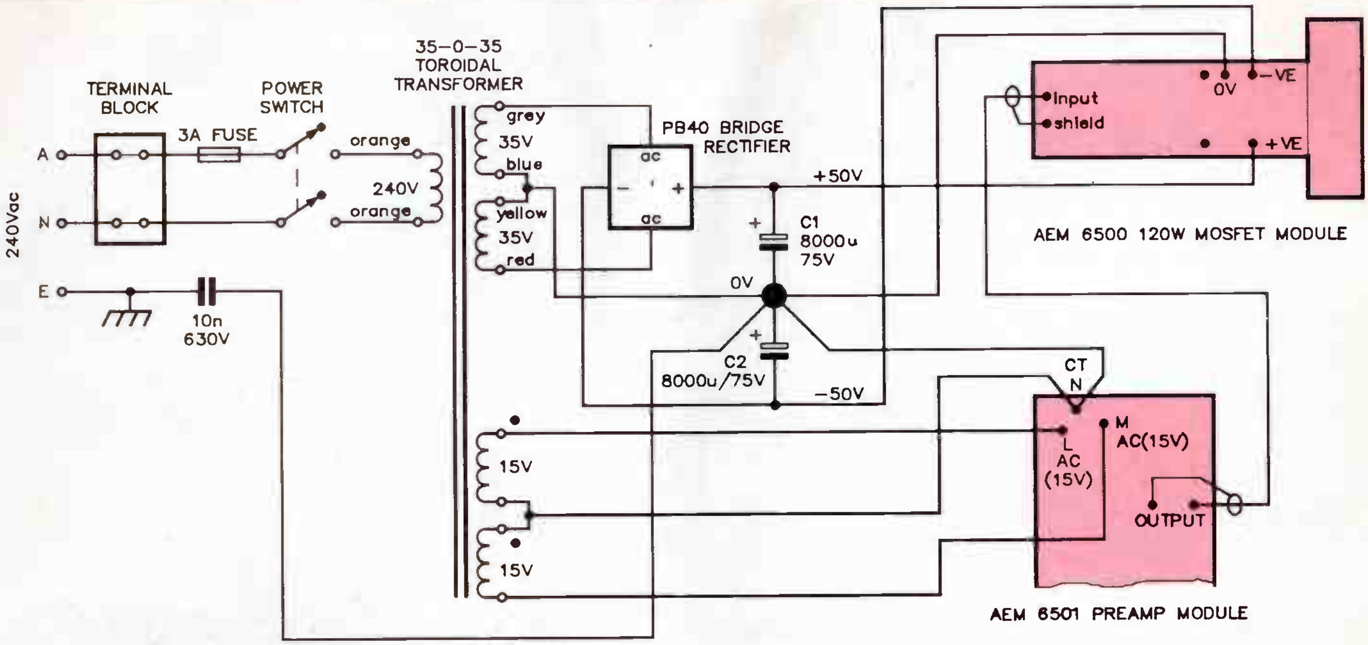
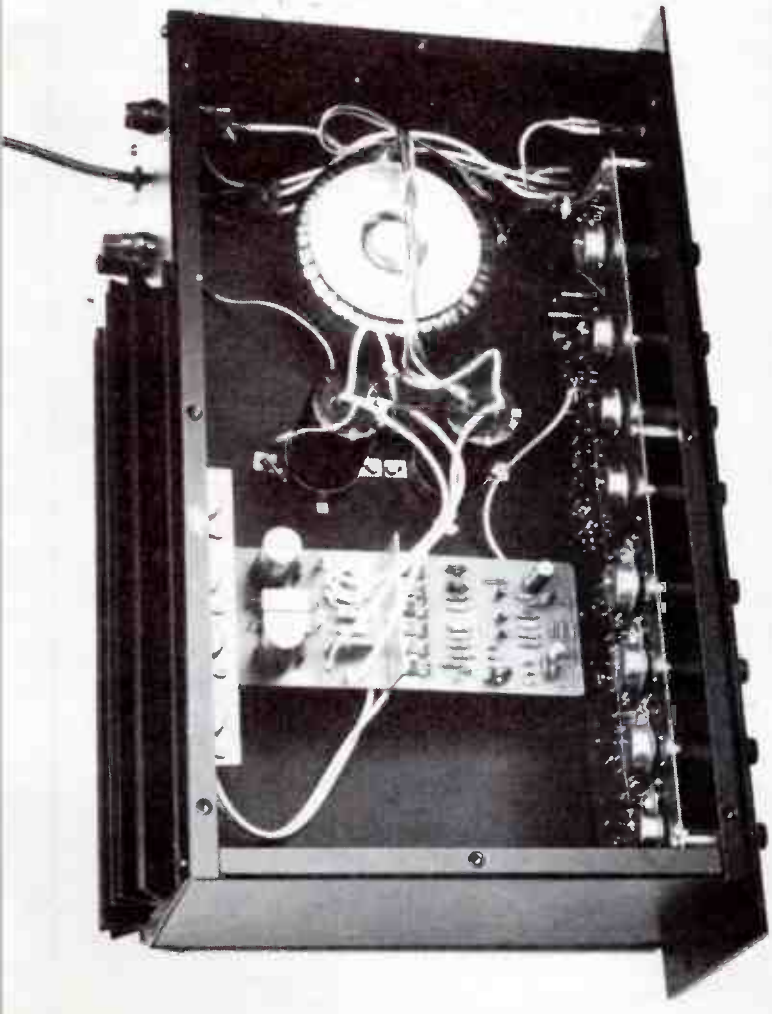


Figure 7. Circuit/wiring diagram of the Bandbox. The chassis is only connected to the 0 V rail of the circuitry via a 10n/630 V greencap or ceramic capacitor. This provides an 'ac earth' for the chassis preventing unwanted RF pickup or other electrical noise.



where they pass through the front panel. This prevents possible RF pickup.

Connect the input of the amp to the output of the preamp using the shielded cable already connected to the amp. The two 15 Vac wires and the centre-tap (0 V) from the auxilliary transformer winding can now be connected to the preamp.

All the inter-module cabling was tidied up with plastic zip-up cable ties.

A 300 mm length of enamelled copper wire has to be joined between the centre-tap connection of the preamp supply's 30 Vac winding (labelled CT on the preamp component overlay) and the 0 V point of the MOSFET amp power supply, at the junction of C1 and C2. This links the two 'common' (0 V) rails of the preamp and power amp, without having common power supply or signal return currents flowing in it, hence obviating any hum problems. The project is free of hum without inputs plugged in and with the gain wound full up.

Now for the final check. See that all mains and power supply wiring is correct. Double check the switch operation and install a fuse in the fuse holder.

The smoke test

Set the tone controls mid-way and turn all level controls fully anticlockwise. Attach a speaker and . . . gingerly, turn the power on. Advance the output level pot. and check that you have no hum present. If you do, carry out a thorough check to trace the source. If, or when, all's well plug-in a microphone or guitar, advance the input level control and let 'er rip!

It's a good idea to 'have a good play' with the project, to get the feel of all the controls and how it sounds under various circumstances.

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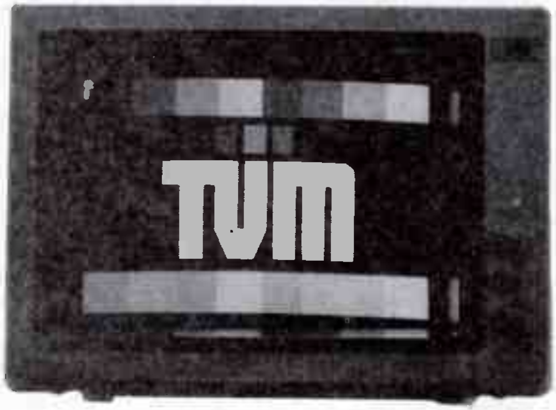

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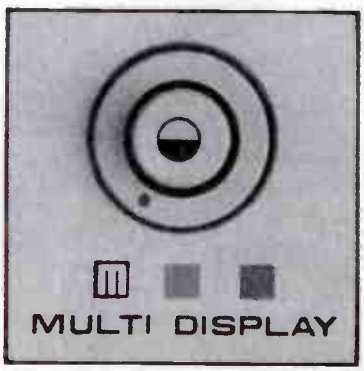

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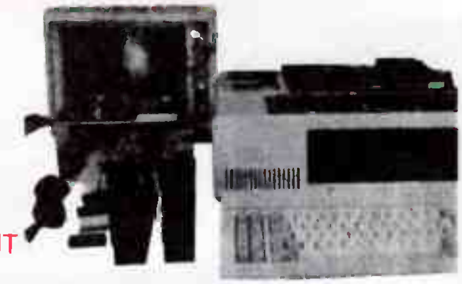

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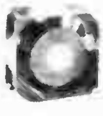

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New computer display can be photocopied

News comes from Britain of a development which will allow permanent records of information appearing on personal computer screens to be reproduced through a photocopying machine.

It has been alleged that those normally gentle and self-effacing individuals, the Photocopier Salesmen, are galvanised by this new development. And fledgling Hackers may now distribute umpteen copies to all their friend(s) of that first BASIC program listing and run ("hELlo N$, how are you ?. . .")

This will be possible through using a new 4 mm-thick flat glass screen, called Smectic, which consists of a glass sheet "sandwich" containing liquid crystals to give the display.

Information on the screen is made up from a series of tiny dots, each of which is told electronically whether to be black or white, so that an overall picture can be built up.

With Smectic, once a dot has received its instruction it stays there until another instruction is given, whereas on conventional liquid crystal displays the dots need regular reminder signals at frequent intervals — otherwise they "forget" and the image fades away.

The elimination of this reminder process means that Smectic does not consume any electricity once the picture has been formed, and battery life on portable computers will be increased as a result. Also, the screen can be disconnected from the computer and power source without loss of image, allowing it to be placed on a photocopying machine to obtain a copy without the need for a special printer, according to the designers.

There is no theoretical limit to the size of the new screens because they do not need the reminder signals, and this will also allow Smectic to double the size of screens for use on portable computers.

Technologists who developed the device at Standard Telecommunications Laboratories in Harlow, near London, say that the new display could spell the end for cathode ray tube visual display units, and it is ahead of other technologies for VDUs with lower cost, potential for colour and lower voltage/current requirements, they say.

The Smectic display has won the Finniston award for innovation based on a recent scientific breakthrough. This is one of the annual Achimedes Awards — *(presented in Bath? — Ed)* for excellence in engineering, sponsored by the technology transfer journal *Eureka* and the organisers of Britain's Design Engineering Show.

Further information from **British Consulate-General, Gold Fields House, Sydney 2000 NSW. (02) 27 7521.**

Commodore PC-10 sales take off

Commodore tell us that their new PC-10 personal computer has been an instant success, with sales of more than 500 units in its first three weeks on the market they claim. The rush to purchase the new computer has caught Commodore and its dealers off-guard — and there is already a lengthy waiting list.

Reaction to the launch of the PC-10 is said to have caused many industry observers to revise their views about the unit, which is claimed to be fully compatible with the IBM-PC.

Managing Director of Commodore Business Machines, Mr Nigel Shepherd, said the demand for the PC-10 has been widespread, covering country centres as well as major metropolitan areas.

Commodore believes sales will take another leap forward with the release of a hard disk IBM-PC compatible unit in the next few months.

Sanyo to release low-priced PC-compatibles

Sanyo Office Machines Pty Ltd has announced a major computer launch for Australia. The company is releasing three new models, being the MBC 670, MBC 770, and MBC 880. The announcement follows the recent visit to Austrlia by senior marketing and product development executives from Sanyo Japan.

According to the Company's managing director, Ross Radford, the introduction of these IBM compatibles will position Sanyo computers as both price and performance leaders in the Australian computer market.

Mr Radford said Sanyo Japan fully recognised the key to success in the computer market was to produce hardware which will run the world's most popular software. In line with this philosophy the three new models had a 256K RAM as standard, and complete media, screen, keyboard, CPU and I/O compatibility which allows them to run IBM PC software.

The new compatibles join the current MBC 500 which has been particularly successful in the USA, Europe and Australia. Mr Radford said the 550 series is being marketed as an inexpensive product forming the base of value added systems aimed at penetration of vertical markets in accounting, points-of-sale, and word processing.

He said that the low cost 16-bit MBC 550 colour computer's high speed and ability to run multiple terminals made this model particularly suitable for building systems which are inexpensive yet sophisticated in performance.

The new Sanyo computers are fully supported through the Company's offices in all mainland capitals, including Darwin and ACT.

Mr Radford can be found at **Sanyo Office Machines Pty Ltd Level 5, 5-9 Harbourview Crescent, Milsons Point, NSW 2061 (02)929 4644**

Lapping it up at Dick Smith's

Dick Smith Electronics is to market the revolutionary Toshiba T1100, an IBM compatible lap-top computer, throughout Australia.

The lightweight, 4.1 kg battery-powered machine was selected following an extensive investigation of lap-top computers which would expand the Company's activities in the computer market.

DSE is to package the T1100 with Access IV, a personal productivity software package from Software Products International, the developer of the famous Open Access.

The outlook for projected sales is extremely healthy, according to Stephen Wilson, General Manager of Computer products for DSE.

"The T1100 is the only lap-top computer with IBM compatibility and the functionality of a desktop computer, at an affordable price, which we have found during our extensive investigations," Mr Wilson said. ▶

Hard disk subsystems for the IBM-PC/AT

Mostyn Enterprises Pty Ltd announce that Innovative Data Technology has begun production of internal and external hard disk drives for IBM's AT personal computer.

Available for immediate shipment, the 5.25" Winchester drives are configured in popular capacities of 56, 64, 88 and 120 Mbytes (formatted).

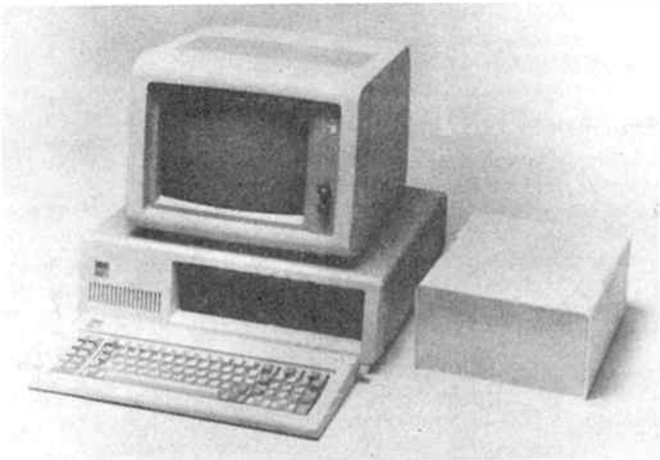
The drives are easily installed in the AT through connection of two cables to the AT's disk controller card. The external drive features a separate internal power supply and a cabinet designed to match the AT's colour scheme.

Each drive includes appropriate software from which the user may select the drive, perform formatting and certification operations, partition the drive for default or user-selectable partitions, and exit to the disk operating system through the escape key.

Performance features include: 5 Mbts/second data transfer rate; high volume servo track writing; automatic thermal compensation for on-track stability; rugged construction for improved reliability; 10 000 hours MTBF, 30 minutes MTTR; disk heads and actuator fully sealed in a clean air chamber.

IDT's hard disk subsystems carry a full 6-month warranty and are also available for installation in IBM's PC/XT series computers.

W. Tainsh at Mostyn Enterprises will be pleased to tell you more if you call him on **(02) 871 6297 or 6311.**



It's only folly where ignorance is bliss

Microprocessor Applications Pty Ltd announced the WYSEpc, claimed to be yet another IBM compatible computer.

MPA claim that the machine is "truly" IBM compatible, with over 250 software packages thoroughly tested, including Lotus 1-2-3, Symphony, pfs, Framework, WordStar, Microsoft Word, dBase II, Microsoft Flight Simulator, and many more.

The basic system includes the processor unit with 256K memory, two diskette drives, keyboard, display adaptor, monitor, two serial ports, and a parallel board. It also includes the MS-DOS 2.11 operating system, GW-BASIC, and a complete set of user manuals.

The machine may be bought in dual diskette configuration, or with IBM XT-compatible 10 Mbyte hard disk and single diskette drive. Monochrome or colour monitors, including provision for graphics, are also available, as is an extended backplane with 256 Kbyte of add-on memory and a built-in clock/calendar with battery backup.

MPA's head office is in Melbourne, **(03) 890 0277.**

When in trouble don't shoot the technician

Elmeasco Instruments has released a software package for troubleshooting the IBM PC using the Fluke 9010A or 9005A Micro-System Troubleshooter.

This package which has been engineered and produced by Diversified Data Corp., utilises many of the 9010A/9005A's features, particularly the automatic tests and programmed routines.

Using this system test personnel with a variety of skill levels will be able to successfully troubleshoot microprocessor-based IBM PCs, Elmeasco claim.

Complete fault location with a fully programmed instrument requires only that the PC contain a functional power supply system clock and microprocessor socket. Testing can begin immediately on powering up the PC, and the technician can choose to test any portion of the system he wishes.

In programming a set of test tapes for the PC, Diversified Data Corp. set out to realise several goals: ● The test should provide cost effective support by putting affordable hardware and software into the hands of technicians. ● The automatic tests should transcend the capabilities of available disk-based diagnostics and support troubleshooting to component level. ● The accompanying user documentation must prove to be an asset rather than a hindrance, serving to minimize time spent on activities other than troubleshooting.

The challenge that confronted this effort began with the PC itself. A repair shop sees many different PC configurations which include IBM or third party expansion boards and several different memory sizes.

The test set would have to support these various configurations. In addition, many of the signals being tested are asynchronous, independent of bus timing. This is particularly true on display adaptors and certain other expansion boards. This would necessitate use of guided probe tests in unsynchronised modes.

The PC also has very few socketed chips (fortunately, the processor is socketed) which frustrates most attempts at trial-and-error or "shotgun" troubleshooting.

Finally, the magnitude of the anticipated effort due just to the number of nodes and chips in the system place great importance on the software documentation and user's manual development.

The final product is a modular set of tapes and documentation which has been tested and claims to allow relatively unskilled technicians to troubleshoot the PC to component level in a short time, frequently in less than fifteen minutes.

The basic test consists of four minicassettes. The first tape is dedicated to autotests and functional tests and the remaining three contain GFI routines for the system board, monochrome adaptor, and disk controller, respectively.

Additions to this basic library will be made available in the future using a separate tape for each adaptor or expansion board.

More information available from **Elmeasco** on **(02) 736 2888** in NSW, **(03) 879 2322** in **Victoria**, or other State branches.

Retail price of the T1100 and Access IV package will be $2995.

The machine has 256K RAM and an integrated 720K, 3.5" floppy disk. It will also support an optional, external 3.5" or 5.25" floppy disk. It will run for up to eight hours under rechargeable battery power and has an optional ac adaptor for mains power. The computer is claimed to be capable of running all the popular IBM PC programs.

The software package bundled with the machine incorporates a diary planner, business card directory, graphics, spreadsheet and calculator functions. The machine incorporates a low energy consumption LCD screen or can be connected to a video monitor.

The T1100 will be sold through the Dick Smith Electronics network of 56 stores across Australia, with hardware support being provided by Toshiba's service network.

DSE expects the lap-top computer to further their expansion into the competitive computer market which now accounts for about 30% of its $60 million a year turnover.

Canon lobs a likely one

Canon Australia has developed a fully integrated software package that is a sophisticated aid to advanced and quick decision-making.

Appropriately named "Super Canobrain," the totally new software program is described as the "perfect partner" for the Company's new personal computer, the AS-300, providing interactive solutions to both routine and complex management tasks in brilliant colour reproduction.

Five important business functions are brought together in Super Canobrain which utilises advanced multi-windowing techniques:

- Datafiling — for counting very long tables;
- table and spreadsheet preparation;
- graph generation — for drawing in colour a wide range of graphs and charts;
- picture drawing — of virtually any type of figure including cut and paste;
- advanced word processing — for preparing, editing and printing documents.

Super Canobrain has been developed specifically for full colour printed reproduction, enabling superb presentation of reports and documents, say Canon.

Another feature of this new integrated software package is the ease with which data prepared with one function can be used with another. Each of the functions can be mixed and matched in numerous combinations sharing the same data and enabling the easy creation of reports and documents that incorporate all the relevant charts and illustrations for internal down the right-hand side of the AS-300 screen by way of symbols.

Super Canobrain's multiwindow function enables the operator to see clearly several different functions on the same presentation or for impressing clients and customers.

The System is not complicated to learn even for the "uninitiated" executive who is not a computer convert. Each function is clearly displayed screen. A spreadsheet, for example, can be referred to while a graph is being drawn.

Running on the AS-300 personal computer, Super Canobrain can be linked to Canon's new laser beam printer, allowing virtually any form of data to be combined and printed out at high speed and with brilliant reproduction.

More information from **Canon Australia Pty Ltd on (03)200 6200.**

Deutschland PCs unter alles?

Logo Computers from beautiful Birkenhead Point has announced the NCR PC4i PC-compatible personal computer. Although the PC4i is built in Germany, the price is actually lower than the current flood of Taiwanese compatibles, say Logo.

The PC4i provides very high resolution (600 x 400) in monochrome and colour, and produces "solid" colours rather than the raster lines of other PC-compatibles (and the IBM itself for that matter). The colour version of the PC4i is only marginally more expensive than the monochrome version.

Serial and parallel ports are standard, and a RAM disk utility to speed operation is included. The keyboard is carefully thought out with separate cursor and data entry pad. Data entry is claimed to be faster and easier than with the standard IBM layout yet fully compatible with the IBM. The PC4i is also compatible with the industry standard IBM PC range of software.

The computer is highly expandable, with seven industry standard expansion slots and memory expansion to 640K. An important feature for NCR users is the ability of the PC4i to interface with the NCR financial and retail point of sale (POS) terminals as well as other terminals using NCR In-house DLC Communications protocol.

For futher information contact Peter Klanberck at **Logo Computers on Sydney 819 6811.**

Name change for Ran Data Communications

Sydney-based Ran Data Communications Pty Ltd has announced a change in name following its listing on the Sydney Stock Exchange.

Ran Data Communications is the distributor for Perth-based Ran Data Limited, the developer and manufacturer of data encryption equipment, reported recently in the Sydney Morning Herald as having "potential for enormous world-wide sales."

The new company is Netmap Corporation Limited, which will continue to market Ran Data security encryption equipment as well as its namesake, Netmap, a unique Australian developed computer-based "decision support system."

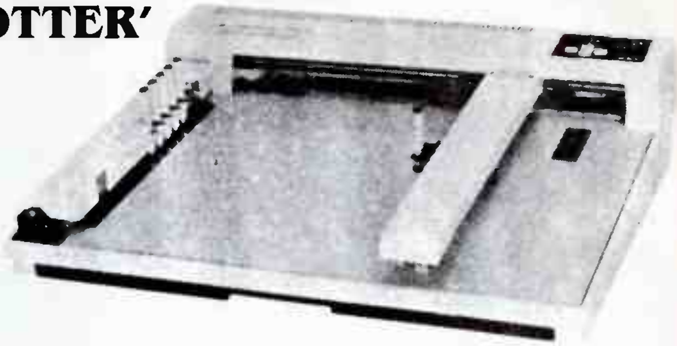
Netmap are on **6th Floor, 66 Berry Street, North Sydney. (02)922 2711.**

UNIQUE OPPORTUNITY!

Only for readers of Australian Electronics Monthly — here's a unique opportunity to obtain a

6-PEN, A3 'PERSONAL PLOTTER'

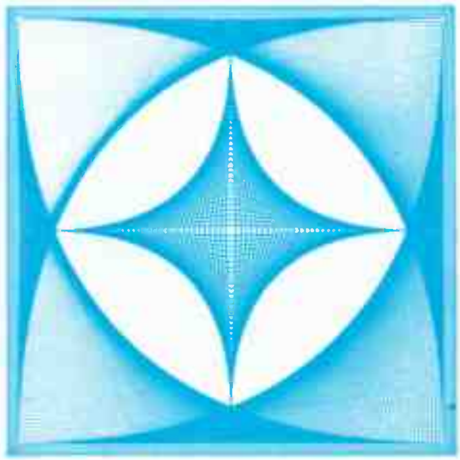
at under half cost!



These plotters, made by Iwatsu (model SR6602), were part of a shipment brought into the country for a client who subsequently ceased business before completion of the purchase order. They are brand new and come complete with a handbook, a set of 10 pens and a three-month warranty.

LIMITED NUMBER ONLY

This is a strictly limited opportunity, as only 30 plotters are available.



Features:

- *240 V ac operation*
- *standard RS232 interface (protocol selectable)*
- *plot area of 270 x 365 mm (A3 sheet)*
- *plot step of 0.1 mm*
- *takes commonly available plotter pens*
- *variable plot speeds — 2 x switch selectable — 6 x software selectable*
- *ten pens supplied, 0.3 mm diameter tip, four black ink types, six different coloured-ink types.*

Simple command parameters permit driving the SR6602 from a terminal or from ASCII strings sent to the serial port of your computer.

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Only 30 units are available, so hurry before they're all snapped up.

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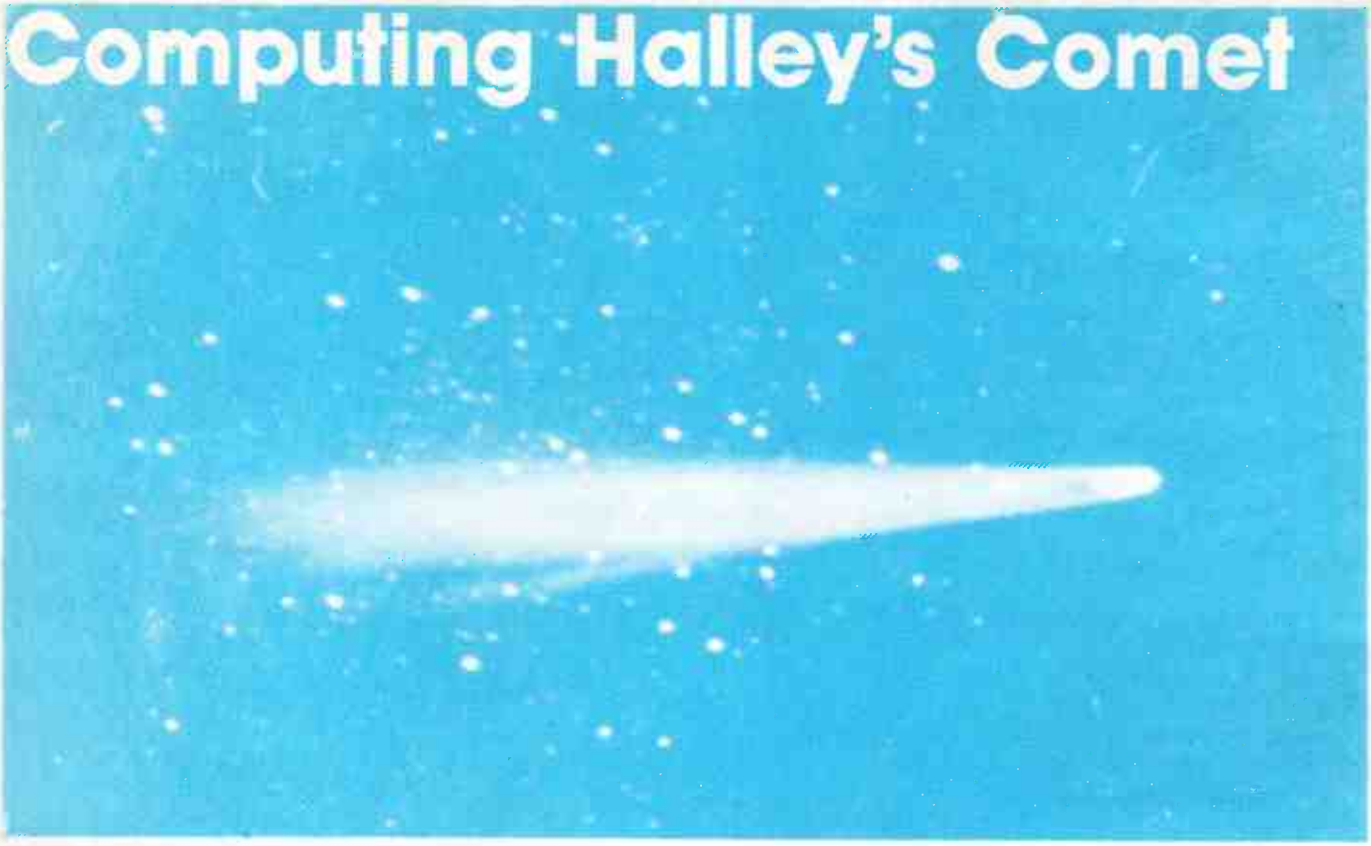
Cheque or Money Order No: . . . .

- If you would like to inspect one of these units, call into our office any weekday during business hours. We're located at: WB Building, Cnr Fox Valley Rd and Kiogle St, Wahroonga NSW. The entrance is in Kiogle St.

Computing Halley's Comet



A 1910 photograph of Halley's comet.

Neil Duncan

LATE IN 1985
THE COMET SEEN BY HAWLEY
WILL ONCE AGAIN COME IN TO VIEW
EVEN IF RATHER POORLY!

It is common knowledge that Halley's comet is about to enter our neighbourhood. Indeed, it is currently entering "stage right" and is starting to make itself rather an item of attraction. The interest in this celestial wonder is universal and many people are making great efforts to prepare for it. Telescopes both on Earth and in spacecraft will gaze at it.

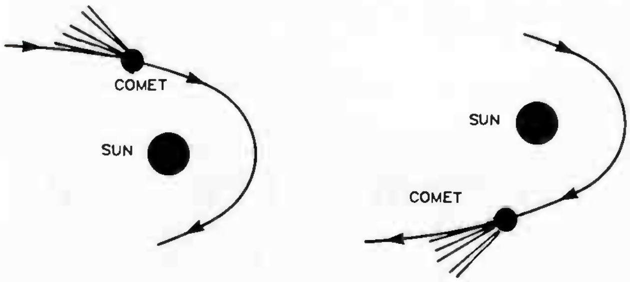
On a more down-to-Earth level, let us start by pronouncing the word 'Halley'! What is this 'Hawley' word in the homemade ditty above? Edmund Halley was referred to in old royal documents with a 'w' in his surname on more than one occasion during his lifetime in the late 1600s. This is a likely reference to the manner in which he pronounced his own name. Early in this century however, the Royal Astronomical Society (London) most likely pronounced his name to rhyme with the word 'rally'. It seems popular these days to rhyme his name with 'Bailey'. On this point, you decide! The little verse questions the clarity of the coming view of the comet. It is true that, unfortunately, this coming re-appearance will not be one of the comets best displays.

For many people, this time around will be their second view of the comet. The average period of the comet is 76 years (plus or minus two years or so), so those in the autumn of their lives as they read this (there is tact!) may have seen Halley's comet before — when they were ankle-biters.

So what is it?

So what is a comet? Comets are bits and pieces flying about space which appear against the background of predictable stars and planets as rather temporary and transitory objects. Some of these objects enter our atmosphere and burn up (or impact). The 'tail' which is so characteristic of a comet is somehow 'lit up' by radiation from the Sun. It is known that the tail is highly positively charged. Because of the effect of the Sun, the tail stretches away from it at all times.

Direction of the comet's tail.



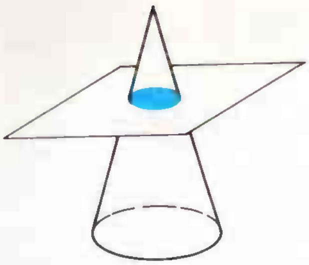
Approaching the Sun. Leaving the Sun.

Just what the comet and the tail itself is made out of is not really known. There is a lot of debris left in the wake of a comet, as noted by the increase in meteor activity when the Earth passes through space where a comet has been. On the other hand, comets (which are not very large) do not seem to 'run out of gas'. This may be explained by a model of the comet as being rather like a bride dragging its veil, dress and other stuff along behind her.

The path taken by a comet is highly influenced by our Sun. Some comets are *periodic* (i.e: they re-appear every now and again). Some are once-only visitors.

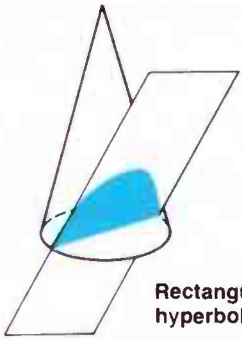
The periodic ones stay *captured* in the Sun's gravitational web. Others are tempted by it, but escape.

In addition, the path taken is always a 'conic section' (if we ignore the influence of the planets). Conic sections are a family of graph shapes studied in secondary schools. The title comes about because the graphs can be produced by taking sections of cones at various angles —



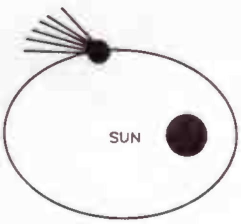
Circular section

Elliptical section

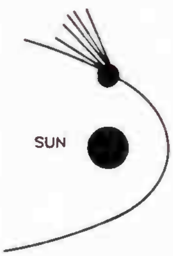


Rectangular hyperbole

The four conics of concern here are the circle, ellipse and retangular hyperbola. The 'focus points' of these shapes is of interest — the Sun occupies this position in the path of comets.

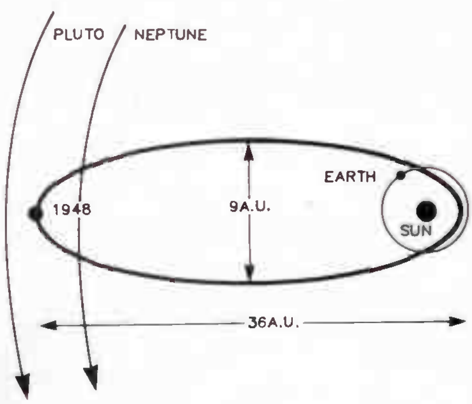


A periodic comet.



A non-periodic comet.

The most important parameter of a conic graph is the eccentricity (e), of the path. If $e = 1$, the path is a parabola. If $e > 1$ then the path is an hyperbola. If $0 < e < 1$ the path is an ellipse. As e tends to zero, the path becomes circular. Halley's comet moves with a very large eccentricity, about 0.967.



Illustrating the orbital eccentricity of Halley's coment.

Here is a computer program, suitable for the Apple computer, which draws a conic graph if you enter a value of 'e'. Try the program with these e values: 0, 0.2, 0.5, 0.967, 1, 2, 10.

The graphics has been organized for the Apple computer. To use another machine, remove line 20, modify line 810 and 910 for your graphics and change line 920 to respond to 'any key press'.

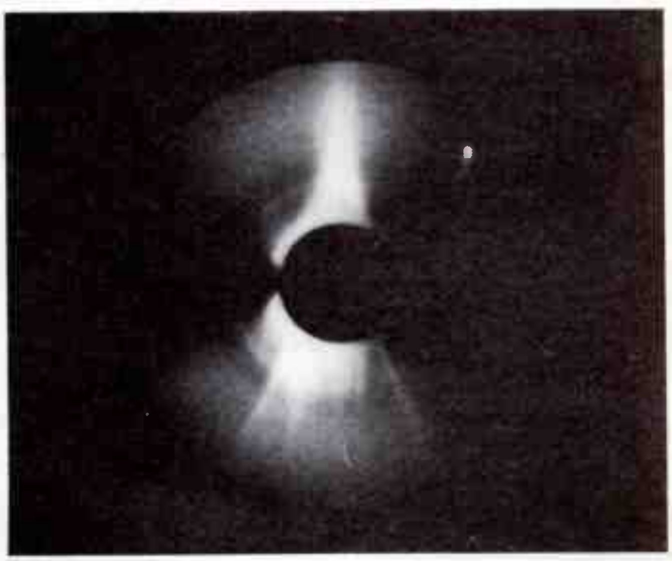
```
10  REM  CONICS
20  ONERR  GOTO 30
30  GOSUB 1000: HOME : VTAB (10): PRINT "SUPPLY E (0,0-1,1 OR>1)"
    : INPUT E
40  HCOLOR= 3: IF E < 0 THEN 30
50  IF E = 0 THEN E1 = 1: GOTO 70
60  E1 =  INT (E + 2): IF E > 1 THEN E1 = 4
70  ON E1 GOSUB 100,200,300,300: TEXT : HOME : GOTO 10
80  GET A$: GOTO 30
100  GOSUB 800:R = 50:A = 0
110  FOR TH = 0 TO 6.28 STEP .1: GOSUB 900: NEXT TH: GOTO 110
200  GOSUB 800:R = 0:E =  SQR (E) * .65
210  FOR TH = 0 TO 6.28 STEP .1
220  X =  COS (TH): IF  ABS (X) < .999 THEN R = E * 50 /
    (1 - E *  COS (TH))
230  GOSUB 900: NEXT TH: GOTO 210
300  GOSUB 800:A = 20:R = 0
310  FOR TH = 0 TO 6.28 STEP .1
320  X =  COS (TH): IF  ABS (X) < .999 THEN R = A / (1 -  COS (TH))


330  GOSUB 900: NEXT TH: GOTO 310
800  VTAB (21): HTAB (1): PRINT "E = ";E;"...THIS IS ";B$(E1):
     PRINT "PRESS ANY KEY"
810  HGR : HPLOT 130,1 TO 130,140: HPLOT 1,80 TO 240,80: RETURN
900  IF R > 100 THEN  RETURN
910  HPLOT 130 + R *  COS (TH),80 - R *  SIN (TH)
920  IF  PEEK ( - 16384) > 127 THEN  POKE  - 16368,0: POP : RETURN
1000 B$(1) = "A CIRCLE":B$(2) = "AN ELLIPSE":B$(3) = "A PARABOLA":
     B$(4) = "AN HYPERBOLA": RETURN
```

If you try this program, the various conic shapes can be seen. The 'origin' of the graph axes shown represents the focus point (the place where the sun will be relative to the orbit of a comet).

When a comet is 'captured' by the Sun, it tends to swing around it and head out to one of the outer planets, then back in. The path in such a case is essentially that of an ellipse. The gravitational attraction of other objects will cause all kinds of perturbations to the neatness of a comet's path. Such an effect is seen in the variation in the period of the cycle mentioned for Halley's comet.

The 100 or so known comets are heavily influenced by Jupiter. It is thought that only Halley's comet travels out as far as Pluto and the rest swing around the massive planet. Bennett's comet was readily visible in 1970 and Kohoutek's comet was seen in 1973, but very weakly. Several others have been by this century, but were not able to be seen with the naked eye. ▶



Comet Kahoutek, photographed through a solar telescope (which obscures the bright disc of the Sun). December 1973.

When has it been before

The earliest records of sightings of Halley's comet are probably those of the Chinese in 239 BC. Other sightings have been suggested in view of such evidence as drawings on the Bayeux tapestry (1066 and all that). A probable list of dates which have some historical documentation may be —

989 AD, 1066, 1145, 1222, 1301.
1378, 1456, 1531, 1607, 1682, 1759, 1835, 1910

and of course, now.

Just how man has interpreted the heavens in times past makes a nice study! One of my favourite snippets (if I may digress) is an ancient Greek view of matter 'Celestial' and matter "Terrestrial'. If you took a lump of celestial stuff and let it go, it would fly away parallel to the Earth's (flat) surface; if you took a lump of terrestrial stuff and let it go, it would fly towards the centre of the Earth. I have observed the latter effect. Until someone brings me a lump of comet (they are obviously celestial) and disproves the idea, I'm sticking with the ancient Greeks!

A very interesting view of the superstition of man can be observed by looking at reactions to various visits of Halley's comet. Omens, predictions of disaster and a fortelling of the outcome of battle have been gleaned from this gleaming body. Even in the 1910 effort, people displayed panic when it was announced that cyanide was present in Halley's trail.

Actually, the Palomar observatory has already seen the start of the latest passage. It recorded the comet at a distance of 1600 million km in 1982. So it seems that the comet is on the way and will be here soon. Perhaps someone will see omens already! Me — I'm keeping my doors locked just in case!

When will we see it?

The nearest point to the Sun reached by a comet is referred to as the *perihelion* distance (the furthest away point is the *aphelion*). It is reasonable to assume that Halley's comet will be at perihelion on the 9th of February 1986. The comet will be obscured by the Sun for a couple of days either side of that time.

The point of time at which it will be nearest to the Earth will be on the 12th of April 1986 but that is not the time at which we will see it best. The 'tail' of a comet is set glowing by radiation from the Sun. It is this feature, rather than its proximity to Earth which will make it most visible.

Readers of this article will probably wish to have the following questions answered —

- When can I start looking?
- How bright will it be?
- Where will I look?

Let us define some more terms. First, the distances involved with comets (and other items out there) are measured in the *Astronomical Unit*, or a.u. It is quite a sensible unit really. The average distance from the Earth to the Sun (i.e: the radius of the Earth's orbit) is one a.u.

This latest passage of the comet will bring it to within 0.42 a.u. In 1910, it came within 0.15 a.u.

The comet has probably come within 0.05 a.u. in some of its earlier passes. It is little wonder that ancient paintings (and relatively recent ones such as Giotto's "Adoration of the Magi") feature a comet ripping by.

Next, the intensity of the comet. This is measured in a unit called the *magnitude*. This follows a logarithmic scale. A magnitude of 1 is quite bright (an approximate definition: the brightness of a star which can be easily seen with the naked eye). A magnitude of 6 is just about the weakest you could see. The eye responds to changes of magnitude in steps of 1. Anything less than that is pretty hard to perceive. A magnitude change of 1 is, however, about a change of 2.5 times. Mathematically:

$$\Delta m = 2.5\log_{10}(B_1/B_2)$$

Where Δm is the change in magnitude and B_1/B_2 is the ratio of the magnitudes. A negative magnitude is very bright. A magnitude of, say 10, is typical of comets seen by amateur astronomers.

To approximate the magnitude of Halley's comet at present, as it approaches the date of perehelion, is found with the equation:

$$\text{Magnitude} = 4.1 + 5\log_{10}RE + 11.1\log_{10}RS$$

Where RE is the distance of the comet from the Earth and RS is the distance of the comet to the sun.

When and how bright?

It should by now be realized that this is quite a complex matter. After all, the Earth moves, the comet moves and the equation is non-linear. The plane containing the passage of the comet is not the same as that containing the path of any of the planets. Thus, to calculate RE and RS is no mean feat!

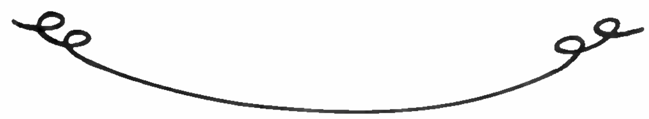
For those who, like me, can tolerate an approximation, here is a computer program (yes, it will work on many different computers) which will give quite a good estimate of the magnitude of Halley's comet at a date after September 1, 1985. It becomes unreliable after 12 months from that date. The program contains rather a nifty little date conversion routine at line 1000 onward, incidently.

```
10  REM  COMET MAGNITUDE
20  D = 1:M = 9:Y = 1985: GOSUB 1000:D1 = D2
30  HOME
40  PRINT "DATE REQUIRED.."
50  PRINT "ENTER YEAR (198)5 OR 6";: INPUT Y
60  IF Y < 5 OR Y > 6 THEN  PRINT "NO..": GOTO 50
65  Y = 1980 + Y
70  PRINT "ENTER MONTH";: INPUT M
80  IF M < 1 OR M > 12 THEN  PRINT "NO..": GOTO 70
90  PRINT "ENTER DAY";: INPUT D
100  IF D < 0 OR D > 31 THEN  PRINT "NO..";: GOTO 90
110  GOSUB 1000
120  D3 = D2 - D1:M1 =  - .0606 * D3 + 12.6969
140  M2 =  - 2.22E - 03 * (D3 - 190) ^ 2 + 5
150  M3 = .0833 * D3 - 13.66
160  M = M1: IF D3 > 159 THEN M = M2: IF D3 > 212 THEN M = M3
170  PRINT "THE MAGNITUDE WILL BE "; INT (M * 10) / 10
180  PRINT : PRINT : GOTO 40
1000  IF M <  = 2 THEN G = Y - 1:FX = M + 13: GOTO 1020
1010  G = Y:FX = M + 1
1020  D2 =  INT (365.25 * G) +  INT (30.6 * FX) + D
1030  D2 = D2 - 694006
1040  RETURN
```

As pointed out earlier, the dates of best magnitude will be when the comet is nearest the Sun. For some of that time, however, the Sun will obscure it. Actually, there is more bad news. In the period *before* the perehelion, the best viewing place on our planet will be from positions in the *northern* hemisphere. It will not be until after the perehelion passage that we in the southern hemisphere will have our best look at it.

Where?

To state where the comet will be also requires some defining of terms. If the Earth would stop revolving and rotating, the matter would be less complex. The position of the comet would be in a path relative to the background stars like this —



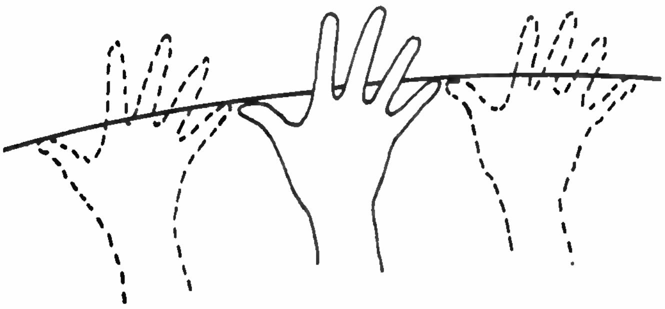
The path of Halley's comet relative to a fixed background.

The problem is, therefore, how to describe it relative to the horizon and direction systems available to us. In addition, the comet will not be visible during the day, it is simply not bright enough.

Azimuth and elevation

Face north — that is an azimuth of 0 degrees. Turn through 360 degrees. With any luck, you are facing north again. At night, and when you can't find a compass, it may be easier to make use of the 'hand span method'. Count how many stretched hands are needed to 'paint the horizon' as you turn through 360 degrees. Compute the number of degrees per hand span:

DPH = 360/N; where N = number of hand spans needed



The 'handspan' method.

Now, if you require an azimuth of, say 130 degrees, then estimate how many hands will be needed around the horizon to reach such a point.

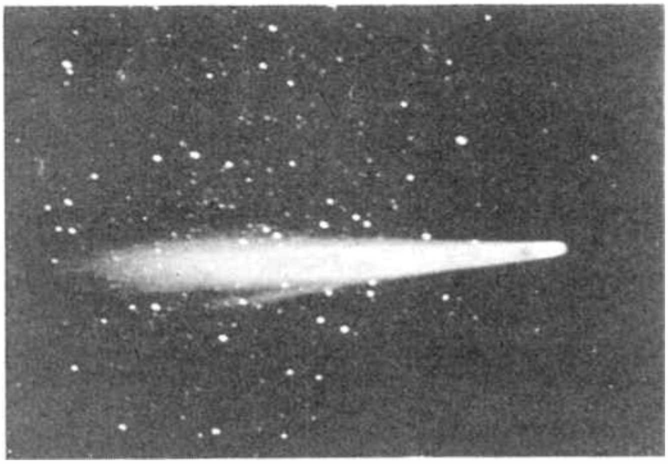
Finding a reasonable approximation for elevation is somewhat more interesting in view of the gross under-estimation we tend to make if we guess at this figure. Elevation is the number of degrees from the horizon *up* to the point you are looking at.

Use the hand-span method again. The figures you gained from the last experiment should work again, if you consider that we are standing in the centre of a dome! An elevation of 90 degrees means that you are looking straight above you and that is about as far as elevation goes! The equator is at an elevation of zero.

To describe where to look for a celestial body, it is necessary to state both the azimuth and elevation of it. The hand-span method of approximation works well. Unfortunately, the calculation of the azimuth and elevation at any point of time for Halley's comet is *very* complex. The factors which determine 'where to look' include —

- When does it rise?
- When does it set?
- When is evening twilight?
- When is morning twilight?
- What is the time?
- Where are you (latitude)?

The following computer program will tell you at which times you should have a look. A detailed program of *where* to look is not included. Broadly, at evening twilight you could look west from December until mid January and East in April and May. High in the sky in December and May, low in January and April.



```
10  REM  COMET VIEWING
20  D = 1:M = 9:Y = 1985: GOSUB 1000:D1 = D2
30  HOME
40  PRINT "DATE REQUIRED.."
50  PRINT "ENTER YEAR (198)5 OR 6";: INPUT Y
60  IF Y < 5 OR Y > 6 THEN  PRINT "NO..": GOTO 50
65  Y = 1980 + Y
70  PRINT "ENTER MONTH";: INPUT M
80  IF M < 1 OR M > 12 THEN  PRINT "NO..": GOTO 70
90  PRINT "ENTER DAY";: INPUT D
100  IF D < 0 OR D > 31 THEN  PRINT "NO..";: GOTO 90
110  GOSUB 1000
120  D3 = D2 - D1
130  DARK = 0.015 * D3 + 18.66: IF D3 > 143 THEN DARK =  - .0164
     * D3 + 22.644
140  LIGHT = 0.0112 * D3 + 2.7148
150  GOSUB 500: IF D3 < 89 OR D3 > 218 AND D3 < 239 THEN
     GOSUB 300: GOTO 200
160  IF D3 > 88 AND D3 < 135 THEN HS =  - .158 * D3 + 41.56:
     GOSUB 350: GOTO 200
170  IF D3 > 171 AND D3 < 219 THEN HR =  - 4.509E - 03 *
     (D3 - 172) ^ 2 + 28.06: GOSUB 400: GOTO 200
180  IF D3 > 239 THEN HS = 4.2E - 03 * (D3 - 271) ^ 2 + 25:
     GOSUB 350: GOTO 200
190  PRINT : PRINT "WILL NOT BE VISIBLE"
200  PRINT : GOTO 40
300  REM  ALL NIGHT
310  PRINT : PRINT "WILL BE VISIBLE ALL NIGHT": RETURN
350  REM  SETS
360  PRINT : PRINT "VISIBLE FROM SUNSET UNTIL ";
370  IF HS > 24 THEN HS = HS - 24
380  T = HS: GOSUB 600: PRINT T1;".";T2;" HOURS"
390  RETURN
400  REM  RISES
410  PRINT : PRINT "VISIBLE FROM ";
420  T = HR: GOSUB 600: PRINT T1;".";T2;" HOURS UNTIL SUNRISE"
430  RETURN
500  T = DARK: GOSUB 600: PRINT
510  PRINT "SUNSET AT ";T1;".";T2;" HOURS"
520  T = LIGHT: GOSUB 600
530  PRINT "SUNRISE AT ";T1;".";T2;" HOURS"
540  RETURN
600  REM  TIME CONVERSION
610  T1 =  INT (T):T2 = T - T1
620  T2 =  INT (60 * T2 + .5)
630  RETURN
1000  IF M <  = 2 THEN G = Y - 1:FX = M + 13: GOTO 1020
1010  G = Y:FX = M + 1
1020  D2 =  INT (365.25 * G) +  INT (30.6 * FX) + D
1030  D2 = D2 - 694006
1040  RETURN
```

Hopefully you will see much more information published about Halley's comet as the next six months pass. Perhaps, rather than bringing bad omens, the international scientific co-operation currently under way will lead to good omens!

Out with the camera and ASA 400 film with long exposures; you know when to look and what to look for. Good luck!

Flashprint!!

— cupid for mating Wordstar and the dot matrix printer

With the current flood of advanced, low-cost dot matrix printers many people have tried mating them with Wordstar and end up with a very disappointing hybrid. Well, what can you do about this mangy mongrel of a mixed-up missive? The answer is FLASHPRINT!!

Jamye Harrison

WHAT IS FLASHPRINT!! ? It's a program that allows Wordstar to successfully print anything of which your dot matrix printer is capable. What do I mean, anything? Anything comprises double width, compressed, and italic text, superscripts, subscripts, elite font, underlines, coloured text (with colour printers) and graphics. You can't do that with Wordstar alone.

In other words, Flashprint gives the Wordstar/printer couple a helping hand; helps them make a match. (Reminds me of a tune I know, how does it go? ... "Matchmaker, Matchmaker, make me a match, catch me a catch ...")

Preliminaries

The package comes from J.R.T. Software in South Australia and costs $58, which includes a comprehensive manual. It was written, and is wholly produced and marketed by one Jim Tucker. The review package was designated 'release J'. What I found on the disk was FLASHPRINT!!, FLASHGEN and an installer, plus a number of printer tables. The files are as follows:

FLASH22J.COM Executable FLASHPRINT!! program (for WordStar 2.26).

FLASH30J.COM Executable FLASHPRINT!! program (for WordStar 3.0).

FLASH33J.COM Executable FLASHPRINT!! program (for WordStar 3.3).

FLASHGEN.COM Compiled MBASIC program to generate graphics characters.

FLASHGEN.BAS Microsoft BASIC program to generate graphics characters.

CONVERT.COM Installing program for FLASHPRINT!!

Plus a number of **.TBL** files for most popular printers (explained soon).

Flashprint is available on 8", 5.25" and 3.5" disks in over 100 formats to suit the Osborne, Kaypro, Apple and Microbee, for example, or anythhing which runs CP/M. An MS-DOS Version is also available, but this costs $88.

FLASHnnJ.COM is your actual FLASHPRINT!! program. You boot this which in turn boots Wordstar.

CONVERT.COM is the INSTALLER used to convert .TBL (printer) tables for Flashprint usage.

FLASHGEN.COM is the compiled version of the Microsoft BASIC program which allows you to create bit image characters and the relevant coding for an Epson or C.Itoh printer.

The .TBL files mentioned are tables ready for installing for your printer. These files contain instructions for Flashprint.

Let's get into it

There are quite a few Wordstar modification programs around, many of which even allow you to print graphics, but I have not seen any that offer as many of the features as Flashprint does without actually modifying Wordstar; the only thing Flashprint modifies is memory. Because of this you can use Wordstar by itself if need be, or, due to the way Flashprint is converted for your printer, you can re-install Flashprint for as many printers as you may have. Note that you are not restricted to using dot-matrix printers — any type can be used (but graphics is not available on daisy wheel types, for example).

Many people these days have more than one type of printer. Usually a daisy wheel type for letter-quality printing and a dot-matrix type for quick, simple drafts, schedules, etc. Although, with the amazing quality available from some dot-matrix printers these days the daisy wheel printer may fast become an endangered species.

The times are a-changing

If you wish to add or change a command or code sent to your printer with the conventional Wordstar installing utility (WINSTALL.COM) it is difficult, if not downright tedious. It requires the entering and exiting of many menus, a basic understanding of hexadecimal and ASCII character systems, and a lot of time.

With Flashprint, all that needs to be done is to boot Wordstar, open your printer table file and edit it from there. The only knowledge required is that of Wordstar, which, presumably, you will already have if you've bought Flashprint, or alternatively, you will have in the near future if you're a first-time user.

This system also means that you do not have to boot separate installing programs if you wish to alter your printer file. Separate installer programs do not allow the use of comments so, if needed later on, your printer codes and commands are usually not self-explanatory which then requires your printer manual to be consulted. Inevitably, this is written in either computer-ese or Taiwanish style English, making the situation even worse.

Limits

Another drawback with special installer programs is that they offer a very limited range of codes you can alter or create. The only limit placed on the amount of information in a Flashprint table is the amount of memory available and your version of Wordstar. Here you can see how much data can be contained in a file for each operating system and Wordstar version (comments may be used freely as they are not included in the final definition file):—

WORDSTAR v2.26 running on CP/M-80 allows a massive 15 000 bytes.

Wordstar v3.0 running on CP/M-80 allows 10 000 bytes.

Wordstar v3.3 running on CP/M-80 allows 8000 bytes. (This may seem small but I have not even come close to it yet while testing Flashprint and see only a small number of cases where this would be a restriction). On the MS-DOS version of Flashprint, which users Wordstar v3.3, there has been no limit found to this date.

Commands & features

Flashprint accepts four types of commands which allow for absolutely any command to be sent to any printer ever made, even if for some strange reason you have a special printer prototype made for you specially by a friend who works in a printer manufacturing plant, which has never been and never will be, mass produced.

Here are the valid command types in summary form:

A simple command entry.
A byte entry.
A translation entry.
A hex entry.

The simple command is probably the one you will use the most. This command enables the alteration of standard text to other faces — such as double width, condensed, italics, etc. An example is probalby the easiest way to show you exactly what happens.

In my printer table I have put this:

C 'I 27 '4
C i 27 '5

Let's take the first line as an example:

1 2 3 4 5
C ' I 27 '4

1. The "C" here tells Flashprint what sort of command line to expect. In this case the C indicates a simple command.

2. The " ' " here tells Flashprint to accept the next character in ASCII form. (Alternatively I could have used the decimal, hexadecimal or binary forms of the letter "I").

3. As already indicated, the "I" character is in ASCII form. This is used to tell Flashprint that the letter "I" will invoke the command.

4. 27 is the decimal code for the ESCAPE character; this is the first part of the codes sent to the printer.

5. 4 is accepted in ASCII form because a ' character preceeds it. The '4 forms the second part of the printer command. On an Epson printer, ESCAPE 4 invokes the italic font.

This is all very well but how do we achieve italics, for example, in our Wordstar document? Well here is the solution.

In the document you type:

Part of this sentence @I will be in ITALICS@ and the rest won't be.

On paper it looks like this:

Part of this sentence *will be in ITALICS* and the rest won't be.

The simple command can be used for things such as changing line height, typefaces, resetting the printer, changing languages (or the more advanced printers), etc.

The translation command is similar to the simple command in final usage, but not in the way it is implemented in your Wordstar document. The simple command needs repetitive use of the @ character.

With the translation command, all you do is type — @ [at the start of your document. From thereafter any characters that have been defined as translation characters will eventually be printed as you have defined them. If no translation entry is found for a character, that character is printed as if by Wordstar alone. Here is an example of what is in my .TBL file:

T '0 "JAMYE HARRISON"

Here is what I type in my Wordstar document:

@[0]

And here is what prints:

Jamye Harrison

The translation command would be used in place of the simple command where you use the relevant command a lot, thus eliminating the need for "@@" all the time.

The byte command

This command would have to be the most dramatic, gee-whiz, effective, shazzam!!, whoopeedoo command available! As most of you are probably aware most dot-matrix printers available have a graphics mode; some even allow the downloading of characters. Now these graphics characters and designs are all invoked in the normal way by sending a control or escape sequence to the printer.

Most, if not all, dot-matrix printers require a series of 'magic' digits to be sent in the graphics mode, as well as the escape code. These define which dots are 'set' in each character block and which are not. For example, the number 255 tells an Epson printer that all dots in that row are set. Similarly, a value of 0 will tell the printer that no dots be set. Here's an example from my .TBL file:

B " 27 'K 8 0 60 66 189 165 165 165 66 60

Flashprint interprets the "B" character as the start of a byte command, the " tells Flashprint that the ' character is to be accepted in ASCII form and that this character sends the following code for the graphic character. The 27 is, of course, the escape character which is sent with the ASCII value for "K". This invokes the normal density graphics mode. The 8 tells the printer the character is eight dots wide, and the zero is there as part of the graphics command. The following eight numbers are the coding for the eight rows of the bit-image character.

Therefore to get this symbol in my document all I have to type is:

@(')

The "@" character tells Flashprint that a command follows. The rounded opening bracket tells Flashprint it is a byte command. The ' is intercepted to tell Flashprint which of the many defined characters to print, and the closing bracket turns off the facility.

ITALICS and NOT ITALICS
CONDENSED and NOT CONDENSED
EMPHASISED and NOT EMPHASISED
SUPERSCRIPT and SUBSCRIPT
<u>HOW ABOUT THIS CONTINUOUS UNDERLINE</u> WHICH, OF COURSE, CAN BE STOPPED
Now we have Double Width, or WIDE printing.

And last, but certainly not **least** we can print GRAPHICS!!!!!!

Here's one I designed myself with FLASHGEN!!:

PLUS THE ASSOCIATED BIT IMAGE CODE:

```
;  CONTAINER
B ']     27 'L 50 0 0 0 2 254 254 174 214 175 215 175 215 174 214 174 214 174 214
 174 214 174 214 174 214 174 214 174 214 174 214 174 214 174 214 174 215
 175 215 175 214 174 214 174 214 174 254 2 2 2

;  CABIN

B ';     27 'L 15 0 2 2 7 7 135 135 254 142 143 143 79 47 30 14 0
```

AND THIS IS ALL I HAVE TO TYPE IN MY WordStar DOCUMENT.

@(];)

Just a sample of the sort of things you can do with Flashprint. With a little imagination and an evening's work, there's no limit to the sort of fancy things you could concoct! The facilities provided by Flashprint would be a real boon to club or association newsletter producers. Not only would you be able to reduce necessary workload on boring, repetitive things, but you could jazz up atht newsletter with some fancy graphics!

A hex on you!

The hex command is used to send codes that are seldom used and so are not included in your printer table. Here is the format of the command:

<1B 0D 0A 09 7F 3C>

This has no relevant command in the printer but would send the equivalent hex sequences, and these are as follows:

1B : the ESCAPE character
0D : the RETURN character
0A : the linefeed character
09 : horizontal tab
7F : deletes last character in printer buffer
3C : sets printer into unidirectional mode

These are all hex numbers I got off the top of my head and so have no meaning to the printer when strung together like this; but the hex command could just as easily be used to turn on double-strike mode, super- or subscripts, or whatever you can think of.

Generally, if you are going to use a command you include it in your .TBL file.

An extra!

At this stage I should introduce another feature of Flashprint — FLASHKEY!!. As the name suggests, this allows you to define function keys on your computer for use under ▶

Wordstar. It is offered in two ways. The first is called the function key entry, and the other is the keyboard translation.

While only two commands are available to Flashkey, they are very, very useful. I'll take function key entry first. It is implemented as follows: To take an example I have used the words Flashprint, Wordstar and Flashkey extensively throughout this article. It would be very tedious for me to type these words in character by character, so I defined them in my table file like so:

K 'F <Flashprint>
K 'f <Flashprint>
K 'K <Flashkey>
K 'k <Flashkey>
K 'W <Wordstar>
K 'w <Wordstar>

(I defined them as upper and lower case functions so I don't have to hold in the SHIFT key if I'm in the other case).

The "K" tells Flashkey that it is a function key entry. The character following the ' is the character which invokes the function, and the characters in the angular brackets are what's printed, both on the screen and eventually, on paper.

What I actually have to type to get this is:

^f or ^F to get Flashprint
^k or ^K to get Flashkey
^w or ^W to get Wordstar

The '^' character here does not denote the CONTROL key but is the ^ (caret) character itself.

Your can include control codes in these functions if you wish.

The decimal value for a TAB character is 09, so you could just as easily put 09 outside the first bracket to set the characters inside the <> brackets across the page a bit.

The other Flashkey command is the keyboard translation entry. This is similar to the function key entry in that it can send anything to your document or even control codes to Wordstar, but there is no need to type the caret character before the defined function. In other words, it is a direct translation. Here are some examples:

X ^F ^Q'R^Q'Q^B

X 'A 'B
X 'B '4
X 'G '+

X ^J 0

The X denotes that a keyboard translation function follows. The ^F in the first example indicates that a CONTROL-F character will send the following characters or codes. The codes sent are:

^Q sends CONTROL-Q; the R combined with ^Q tells Wordstar to go to the top of your file. The ^Q and the Q invoke the Wordstar repeat function, and the command to be repeated is the CONTROL-B, (re-format). Therefore, typing CONTROL-F will reformat a whole file, from beginning to end.

In the second, third and fourth examples, pressing A, B or G, will give B, 4, or +, respectively.

The fifth example will send nothing (the ASCII null string) when CONTROL-J is sent. (You could use this function to turn off Wordstar functions you don't like).

Well that covers a fair slice of the facilities found on Flashprint with Flashkey. The old man's CONTROL-G (. . . delete) will get me if I don't wrap up somewhere around here.

As a final note, some readers may already have encountered earlier versions of Flashprint. Release J, reviewed here, has many features which would enhance these earlier versions. These include the acceptance of strings enclosed in < and >, instead of a single quote (') before each character. It also includes improved Flashkey functions.

An important improvement is the provision for a wait signal (ASCII NULL, 00) in Flashkey functions. This allows user input in the middle of a function which is terminated by a backslash character \. Flashkey then continues with or concludes the function. Here's an example:

X ^Y ^K'R 0 ^Q'C

A CONTROL-Y character sends CONTROL-KR to Wordstar which then asks for the name of a file you want loaded into your existing document which you then terminate with a backslash. This file is then loaded in and the CONTROL-QC places the cursor at the end of your document.

If you have an earlier version, you can arrange an update by writing to Jim Tucker.

The documentation

No software is worth a cracker without decent documentation. If only the legion of software produces would follow J.R.T.'s example, we'd all be better off. The manual is an excellent example of the facilities and use of the package. It is thorough and written in an entertaining, easy-to-read, conversational style. A few evenings with the manual is time well spent.

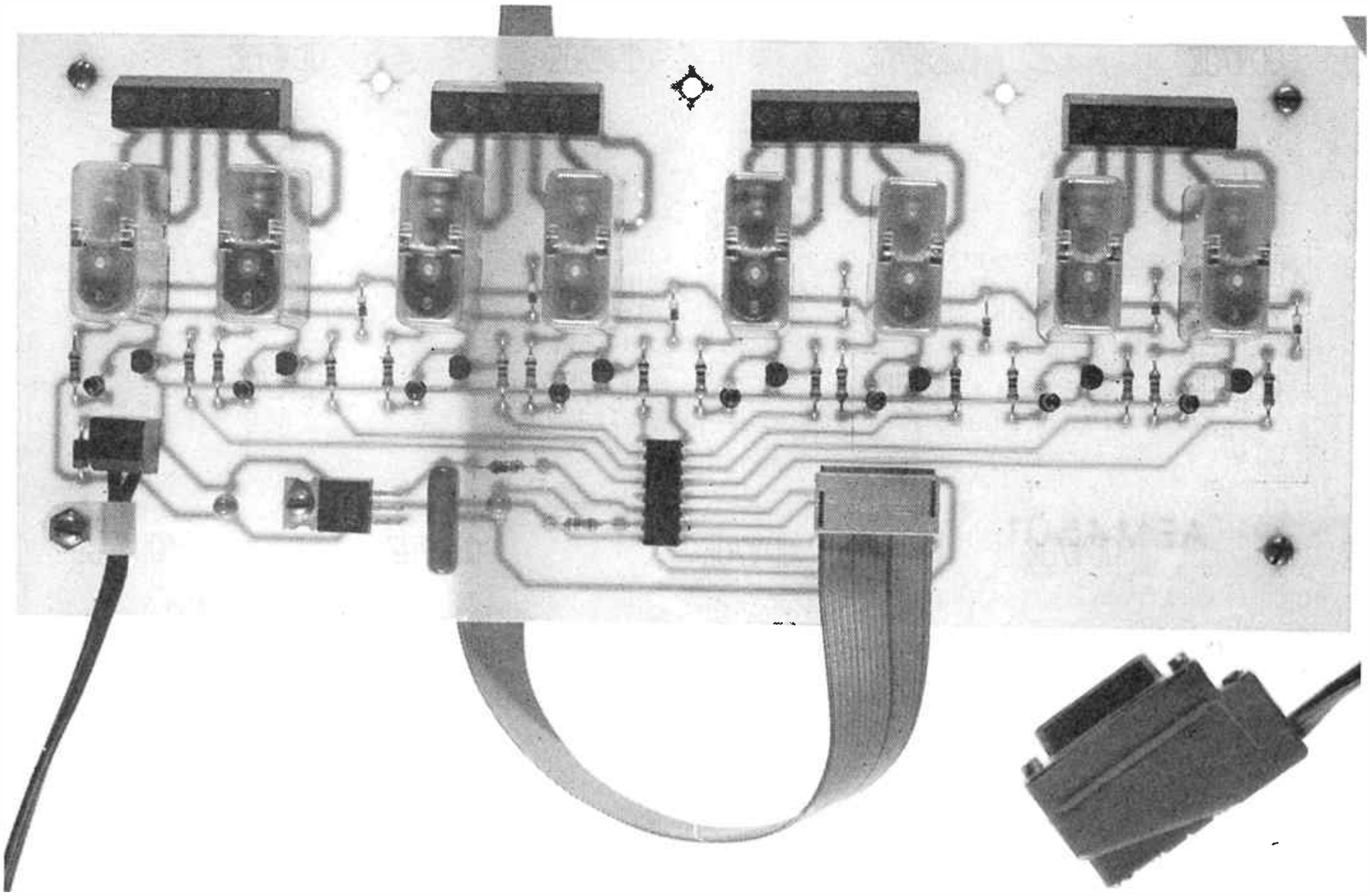
Conclusions

All in all, Flashprint with Flashkey is a very versatile package, streets ahead of any competition. Its beauty lies in the fact that, if you are already familiar with Wordstar, you do not need to learn a whole new series of rules and commands once Flashprint has been installed.

As Flashprint and Flashkey do not change Wordstar, and all your printing and other operations are done from Wordstar, this leaves many other modification packages behind, as well as significantly enhancing Wordstar itself.

At the price, Flashprint with Flashkey represents very good value. When compared to the price of dot-matrix printers, the facilities of which are wasted without an unenhanced Wordstar, it's a sensible addition to your software library.

Review package supplied by J.R.T. Software, 42 Turners Ave, Coromandel Valley 5051 S.A. (08) 278 7076.



An 8-channel relay interface for your computer

Ever wanted to have your computer actually control some appliance or process? This project enables you to do just that. Up to eight relays may be controlled from your computer's parallel I/O port or the 8-bit data bus, switching on or off according to a program you can write yourself.

Geoff Nicholls

A COMMONLY ASKED QUESTION seems to be "how do I actually get my computer to control something?" After all, you read about computers being used to control things every day. Many popular low-cost computers boast a "user I/O port", but scant few practical suggestions are included with their documentation.

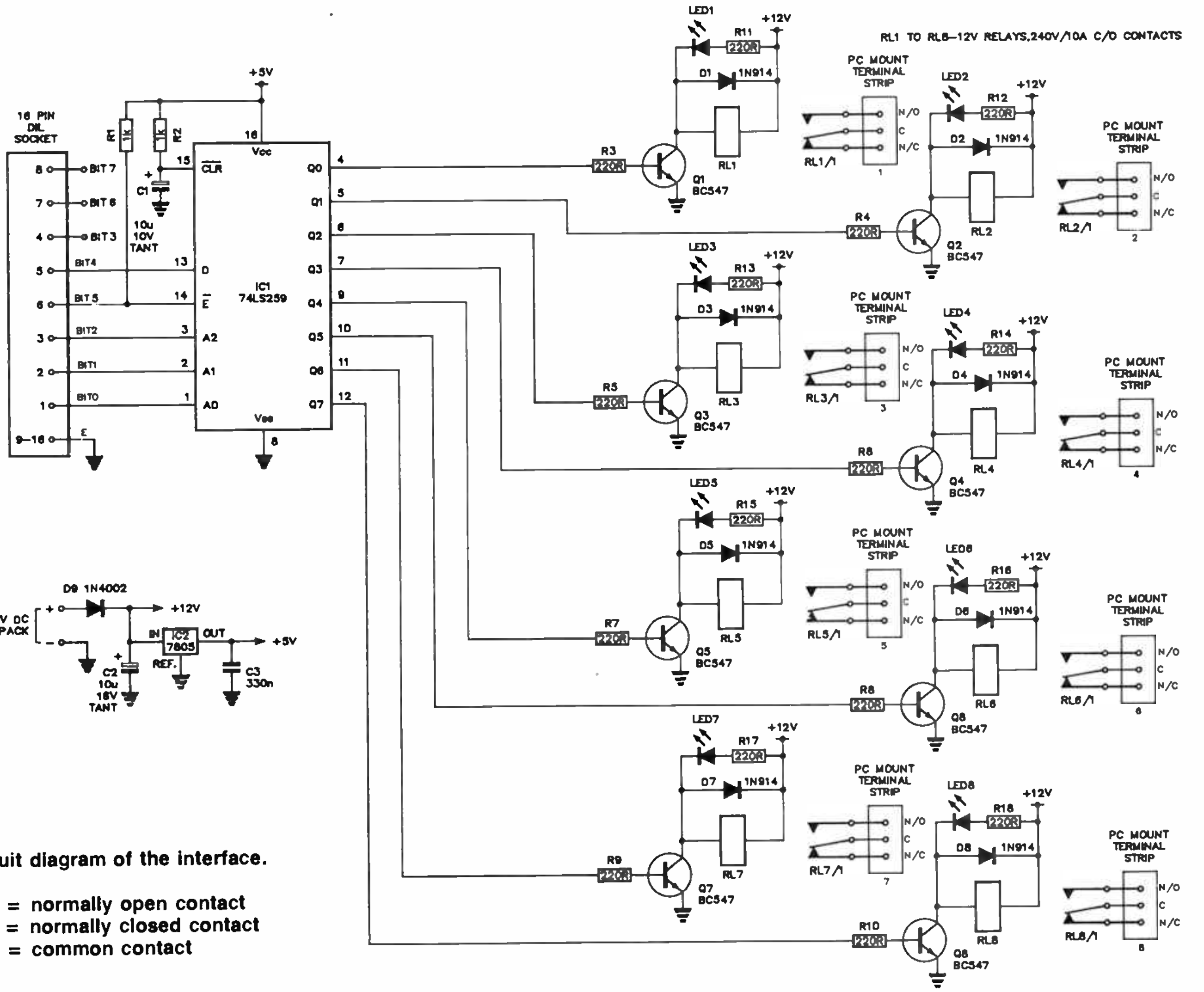
The reason I came to design and construct this project is unimportant really, because it's pretty well a 'universal' sort of computer control-type device. And while I'm using it with a Microbee, it can actually be hung off any computer sporting an 8-bit I/O port — or even the 8-bit data bus if it comes to that. Details later. First, build it.

Design niceties

I decided to use relays to switch whatever needed switching because they provide good electrical isolation, are relatively cheap and widely available, and obtainable in a variety of configurations with common pinouts — so you can suit yourself.

To simplify software design, I've used a 74LS259 8-bit addressable latch. Thus, the board 'remembers' which relay you turned on or off and you don't have to worry about that in the software.

So that the board does not power-up with some random



Circuit diagram of the interface.

N/O = normally open contact
N/C = normally closed contact
C = common contact

arrangement of relays on and off, I've incorporated 'power-on reset'. This ensures all relays are off whenever the board is powered-up.

Recognising that we all make mistakes at times, I've included reverse-supply protection so that you don't cause an embarrassing blowout at an inopportune moment. Murphy's law says that the likelihood of you making a reverse supply connection is proportional to the square of the necessity that the project works when powered-up.

If you need to switch fewer than eight circuits, then you only need use the required number of relays. To switch more than eight circuits, boards can be 'chained'.

On the physical design aspects, I deliberately adopted a spacious board layout so that it was easy to constuct and to provide easy access to the switched connections. For the latter, I used pc-mount screw terminal blocks as they're most convenient when doing a tryout or when altering things at a later time. The power supply connects to the board via one, too.

For the interface link to the computer, I employed a 16-pin IC socket on the board and a cable terminated in a 16-pin insulation displacement connector (IDC) plug.

As for mounting arrangements, I've provided holes on the board so that it may be mounted on standoff pillars located at the four corners. Another three, located between the screw terminal blocks may be used to further support the board.

AEM4501 CIRCUIT OPERATION

The heart of the circuit is the 74LS259, an 8-bit addressable latch. The data sheet for this device is reprinted elsewhere in this issue.

The outputs of the 74LS259 drive the eight npn transistor switches through 220 ohm base resistors. The base current is typically 7 mA when the 74LS259 outputs are high. The transistor switches have the relay coils as collector loads and pass about 100 mA when on, with a collector-to-emitter voltage of less than 0.2 V. The 1N914 (or 1N4148) diode is used to clamp voltage spikes that occur when the inductive relay coils are switched off, thus protecting the transistor.

Light emitting diodes are connected across the relay coils, with 220 ohm current limiting resistors, to indicate the relay state.

The three-terminal regulator provides the 5 V required by the 74LS259, and with less than 100 mA to supply under worst-case conditions, the 7805 doesn't need a heatsink.

The 1N4002 diode prevents damaged caused by a reversed power supply polarity. The capacitors on the input and output of the regulator ensure stability.

On power-up the 10 uF capacitor will be discharged and so pin 15 of the 74LS259 will stay below the logic 1 threshold for some time until the 1k resistor charges the capacitor up. This resets the IC, turning all relays off. This effects a 'power-on reset', ensuring the relays are all in the off state whenever the board is powered-up.

The 1k pullup resistor on the ENABLE input of the 74LS259 increases the noise immunity of the unit and allows the computer to be disconnected without changing the state of the relays.

PARTS LIST AEM4501

Semiconductors

IC1	74LS259
IC2	7805
Q1-Q8	BC547, BC107 etc
LED1-LED8	3 mm red LEDs
D1-D8	1N914, 1N4148 etc
D9	1N4002

Resistors all ½ W, 5%

R1, R2	1k
R3-R18	220R

Capacitors

C1	10u/10 V tant.
C2	10u/16 V tant.
C3	330n greencap

Miscellaneous

AEM4501 pc board; 8 x 12 V DPC/0 relays with 240 Vac/10A rated contacts; 1 x 16-pin DIL socket; 1 x 16-pin IDC plug or DIL header plug; 1 x connector to suit computer's parallel port; length of ribbon cable to suit interface; length of figure-8 cable (one lead striped) for power supply; 1 x cable clamp to suit latter; 4 x 6-way pc-mount terminal strips; 1 x 2-way pc-mount terminal strip; 1 x 6BA nut with bolt (to mount IC2); 1 x 4BA nut with bolt (to mount cable clamp).

Expected cost: $60 — $70

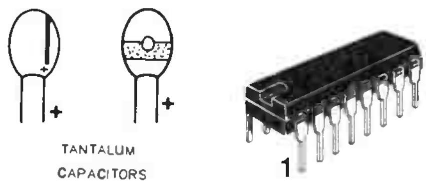
Component overlay. Watch the orientation of the diodes, transistors and LEDs, as well as the 10u tantalum capacitor.

LEVEL

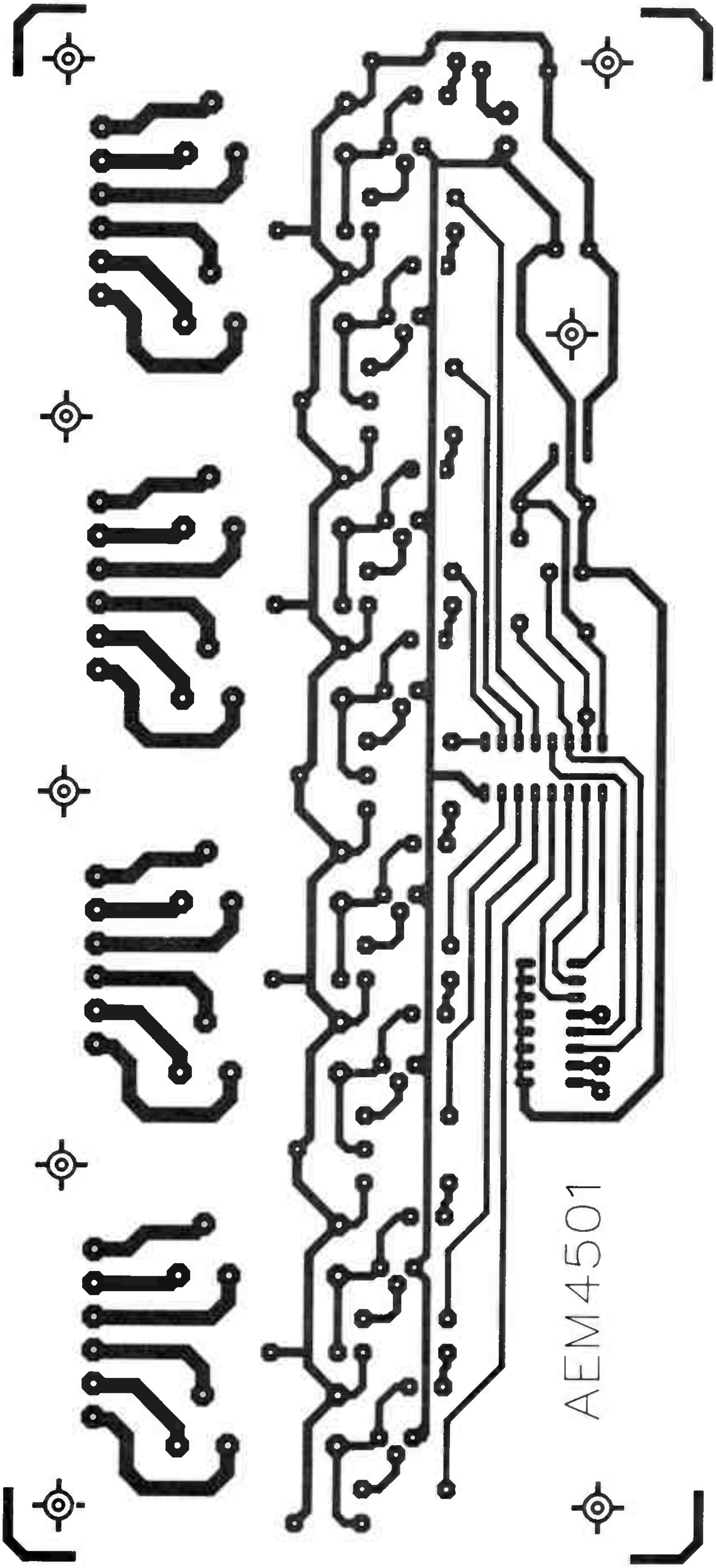
We expect that hobbyists who are

BEGINNERS

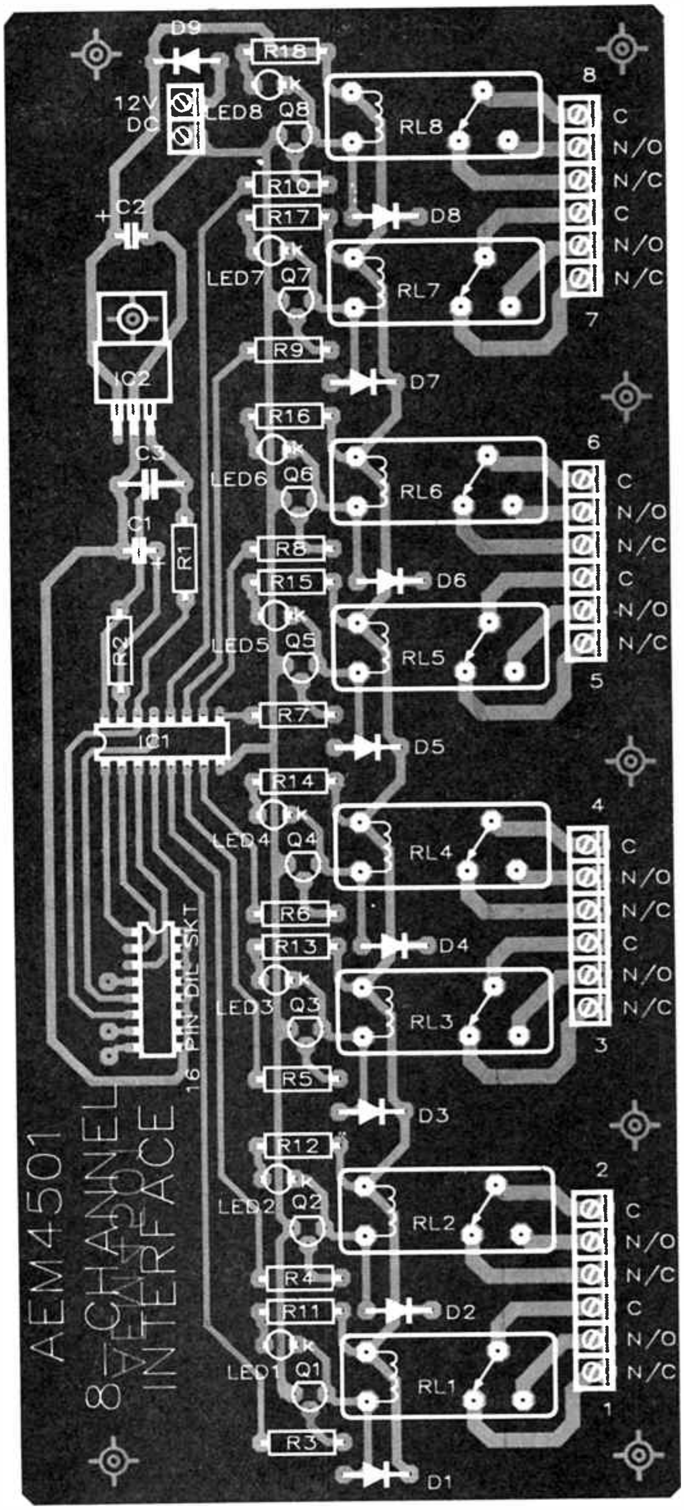
in electronics construction should be able to successfully compltete this project.



SEE 'RETAIL ROUNDUP' FOR A GUIDE TO KIT SUPPLIERS WHO MAY STOCK THIS PROJECT



Full-size reproduction of the pc board artwork.



Construction

There is nothing critical about the construction of this project. However, it's a good idea just to run a quick visual check over the board before assembling the components. See that all holes are drilled, and are the correct diameter. See that there are no cracks in tracks or solder bridges between closely-spaced tracks.

It's probably easiest to solder all the resistors in place first, followed by the diodes, LEDs and transistors. The three-terminal regulator can then be mounted and soldered in place (in that order), followed by the two capacitors. The 74LS259 may be either soldered in place, or you can use an IC socket.

The 16-pin IC socket for the interface may now be mounted, followed by the terminal blocks. Solder the relays in place last of all.

All you have to do now is to make up the power supply and interface cables. Note that the figure-8 power supply cable is secured with a cable clamp held under the adjacent standoff bolt.

Before trying it out, make a thorough check of the board. See that the diodes and LEDs are the right way round, particularly. Also see that the 10u tantalum capacitor is correctly inserted.

Driving the AEM4501

The circuit diagram shows the connections from the 74LS259 inputs to the Microbee's DB15 socket. Don't worry if you haven't got a 'Bee though, because the circuit can be driven by most parallel ports directly.

The actual parallel port lines used are tabulated here:

PORT BIT	74LS259 INPUT
DA0	A0
DA1	A1
DA2	A2
DA3	—
DA4	DATA IN
DA5	$\overline{\text{ENABLE}}$
DA6	—
DA7	—

TABLE 1

Note that three bits from the computer port are not used. The ENABLE input is active low.

I have written a driver program in Microworld BASIC for Microbee owners. It contains two subroutines that may be used by constuctors in writing control programs.

The first subroutine initialises the AEM4501 board after it sets up the Microbees' parallel port for CONTROL, or MODE 3, operation. This disables all handshaking. All bits of the port are programmed for output and then all relays are turned off before the subroutine RETURNS. This subroutine must be called before any OUT statements to the parallel port are excuted, and before the second subroutine is called.

The second Microworld BASIC subroutine is called to either turn on or off a selected relay. Only one relay can be addressed at a time, so the subroutine may need to be called several times in succession, according to your application.

The subroutine passes the relay information using the VAR statement. The variables used in the subroutine need not be the same as those in the calling statement; they are often called "dummy variables." The first variable is logical and uses the integer representation of true (on) as -1 and false (off) as 0. The second variable is the relay number and must be of the integer type.

The Microworld BASIC demonstration progam calls the two subroutines to control the relays in various ways.

For interfacing to other computers I commend the following:

(1) If an 8-bit port is available (actually only five bits are used for a single board), then connect the port lines directly to the AEM4501 using the same connections as for the Microbee.

Write your own versions of the Microworld BASIC routines. Most likely the initialisation routine will need chang- ▶

```
00100 REM AEM-4501 Demo Driver for Microbee
00110 REM ....By Geoff Nicholls 4/8/85
00120 REM
00130 GOSUB 1000 :REM Initialise PIO for Mode 3
00140 CLS : PRINT "Type one of the following ;"
00150 PRINT" Nx to turn relay x ON"
00160 PRINT" Fx to turn relay x OFF"
00170 PRINT" A - enter auto-sequence test."
00180 PRINT" C - clear all relays"
00190 A=ASC(KEY$) : IF A=128 THEN 190
00200 IF A=99 OR A=67 THEN GOTO 130 :REM Re-initialise
00210 IF A=97 OR A=65 THEN 290 :REM "A" test & branch
00220 L=2
00230 IF A=102 OR A=70 THEN LET L=0 : PRINT " OFF ";
00240 IF A=110 OR A=78 THEN LET L=-1 : PRINT "  ON ";
00250 IF L=2 THEN 190
00260 A=ASC(KEY$) : IF A=128 THEN 260 ELSE PRINT CHR$(A);
00270 GOSUB [L,A-48] 1100
00280 GOTO 190
00290 REM Auto-sequence test routine.
00300 L=-1
00310  FOR A=0 TO 7
00320      GOSUB [L,A] 1100
00330      PLAY 0 :REM 1/8 SECOND DELAY
00340  NEXT A
00350 L=(NOT L)
00360 GOTO 310
00990 REM ***********************************************************
01000 REM Subroutine to Initialise PIO
01010      OUT 1,7 :REM Disable interrupts from port A
01020      OUT 1,207 :REM Set A for Mode 3 - no handshaking
01030      OUT 1,0 :REM Set all bits in port A to output
01040 GOSUB 1170 :REM Set ENABLE-BAR of 74LS259 high.
01050   FOR N=0 TO 7  :REM Turn all Relays OFF.
01060      GOSUB [0,N] 1100
01070   NEXT N
01080 RETURN
01090 REM ***********************************************************
01100 REM Subroutine to write to AEM-4501 board
01110      VAR (P,Q)
01120 REM  P=0 to turn off ; P=-1 to turn on
01130 REM Q is Relay no. from 0 to 7 inclusive
01140      IF Q<0 OR Q>7 THEN PRINT\"Invalid Relay no.!":RETURN
01150      IF P THEN LET Q=Q+16 :REM add data bit (D4) if P=-1
01160      OUT 0,Q :REM Write to port A with bits D5,D6,D7 low.
01170      OUT 0,32 :REM Return ENABLE-BAR (D5) high.
01180 RETURN
01190 REM ***********************************************************
01200 END
```

ing unless your port is implemented with a Z-80 PIO at I/O address 00 & 01. The important thing is to set the port for output with no handshaking. If your computer expects handshaking and it is not implemented, then it will 'hang' when you try and output to it. It may be necessary to defeat the handshaking by linking a couple of lines; if you don't know how to do this, then don't try in case you damage something.

The second subroutine should run under most other BASICs with only the port address changed to suit the hardware. This subroutine shows the technique of generating the correct ENABLE signal using software only.

(2) Constructors with some hardware knowledge may want to use a hardware handshaking signal instead of using one of the data lines as I have done. You will need a negative going pulse to do this.

The Microbee can produce a positive-going pulse by tying ARDY and ASTB together, but this will have to be inverted to drive the ENABLÉ input on the AEM4501 (pin 6 of the 16-pin DIL connector). Note that ARDY and ASTB are on pins 7 and 15 of the DB15 connector on the Microbee.

Of course, Part A of the Microbee's PIO would need to be set up for mode 0 (output). To do this, change program line 1020 to OUT1,15. Also, delete the lines concerning ENABLE-BAR, that is, lines 1040 and 1170.

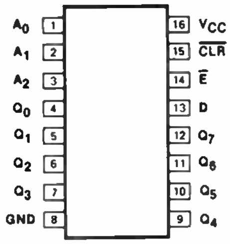
(3) More experienced hardware buffs may try hanging the AEM4501 straight off the expansion bus of their computer. Connect A0 to A0 etc, the DATA IN to D0 and decode the higher order address lines and gate with a memory write signal to obtain an ENABLE-BAR signal.

74LS259

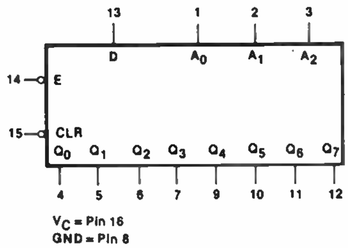
8-Bit Addressable Latch

DESCRIPTION

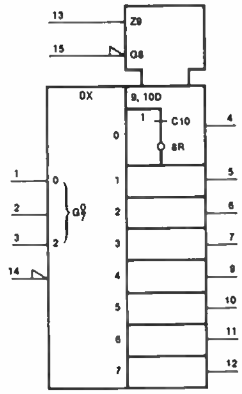
The '259 addressable latch has four distinct modes of operation that are selectable by controlling the Clear and Enable inputs (see Function Table). In the addressable latch mode, data at the Data (D) inputs is written into the addressed latches. The addressed latches will follow the Data input with all unaddressed latches remaining in their previous states. In the memory mode, all latches remain in their previous states and are unaffected by the Data or Address inputs. To eliminate the possibility of entering erroneous data in the latches, the enable should be held HIGH (inactive) while the address lines are changing. In the 1-of-8 decoding or demultiplexing mode ($\overline{CLR} = \overline{E} = LOW$), addressed outputs will follow the level of the D inputs, with all other outputs LOW. In the clear mode, all outputs are LOW and unaffected by the Address and Data inputs.



PIN CONFIGURATION



LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)

INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

PINS	DESCRIPTION	54/74LS
All	Inputs	1LSul
All	Outputs	10LSul

NOTE
A 54/74LS unit load (LSul) is 20μA I_{IH} and −0.4mA I_{IL}.

TYPICAL PROPAGATION DELAY	TYPICAL SUPPLY CURRENT (Total)
19ns	22mA

RECOMMENDED OPERATING CONDITIONS

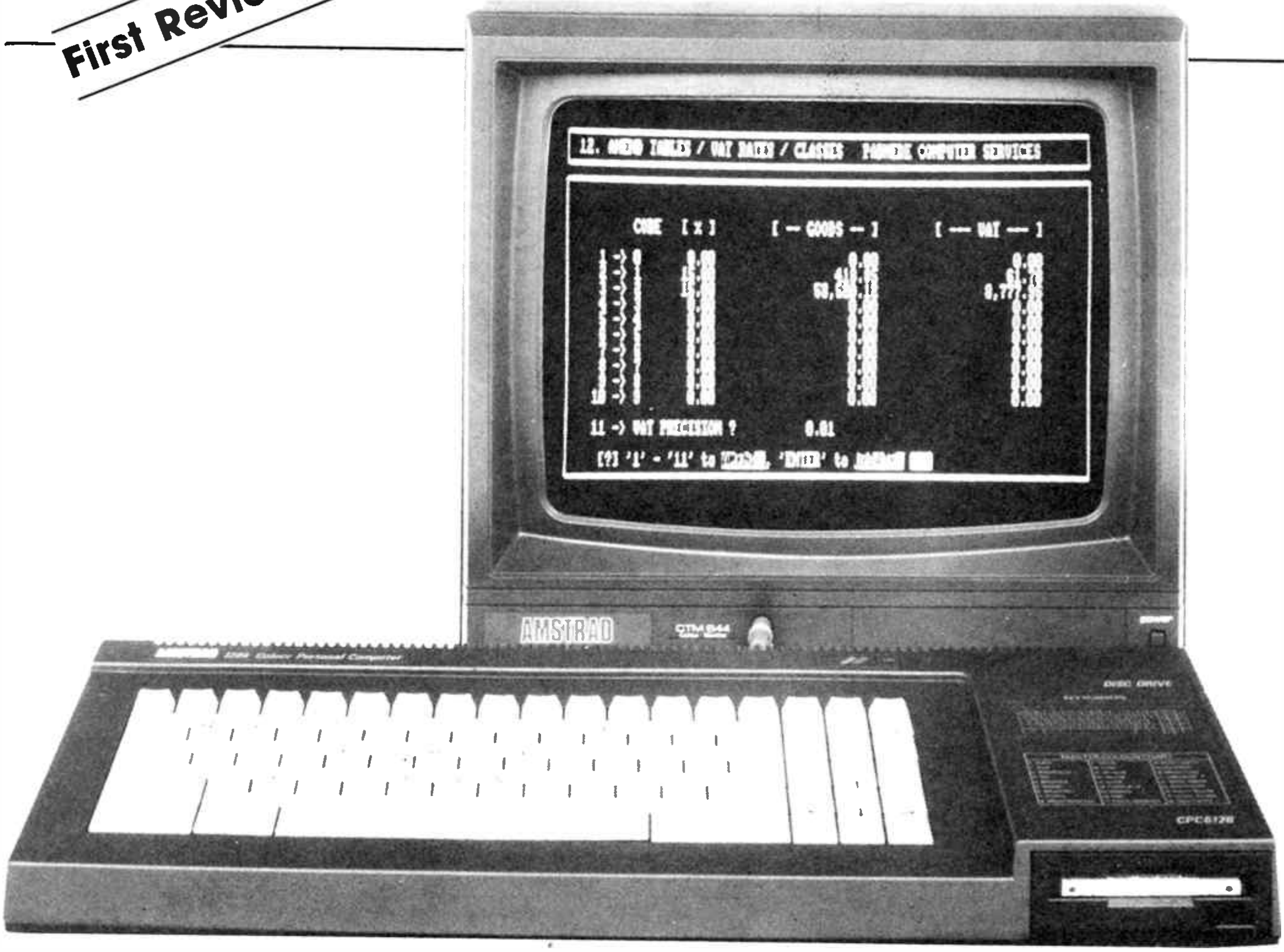
PARAMETER			54/74LS Min	Nom	Max	UNIT
V_{CC}	Supply voltage	Mil	4.5	5.0	5.5	V
		Com'l	4.75	5.0	5.25	V
V_{IH}	HIGH-level input voltage		2.0			V
V_{IL}	LOW-level input voltage	Mil			+0.7	V
		Com'l			+0.8	V
I_{IH}	Input clamp current				−18	mA
I_{OH}	HIGH-level output current				−400	μA
I_{OL}	LOW-level output current	Mil			4	mA
		Com'l			8	mA
T_A	Operating free-air temperature	Mil	−55		+125	°C
		Com'l	0		70	°C

MODE SELECT—FUNCTION TABLE

OPERATING MODE	INPUTS $\overline{CLR}$	$\overline{E}$	D	A_0	A_1	A_2	OUTPUTS Q_0	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7
Clear	L	H	X	X	X	X	L	L	L	L	L	L	L	L
Demultiplex (active HIGH decoder when D = H)	L	L	d	L	L	L	Q=d	L	L	L	L	L	L	L
	L	L	d	H	L	L	L	Q=d	L	L	L	L	L	L
	L	L	d	L	H	L	L	L	Q=d	L	L	L	L	L
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	L	L	d	H	H	H	L	L	L	L	L	L	L	Q=d
Store (do nothing)	H	H	X	X	X	X	q_0	q_1	q_2	q_3	q_4	q_5	q_6	q_7
Addressable latch	H	L	d	L	L	L	Q=d	q_1	q_2	q_3	q_4	q_5	q_6	q_7
	H	L	d	H	L	L	q_0	Q=d	q_2	q_3	q_4	q_5	q_6	q_7
	H	L	d	L	H	L	q_0	q_1	Q=d	q_3	q_4	q_5	q_6	q_7
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	H	L	d	H	H	H	q_0	q_1	q_2	q_3	q_4	q_5	q_6	Q=d

H = HIGH voltage level steady state.
L = LOW voltage level steady state.
X = Don't care.
d = HIGH or LOW data one setup time prior to the LOW-to-HIGH Enable transition.
q = Lower case letters indicate the state of the referenced output established during the last cycle in which it was addressed or cleared.

First Review



Blink! A new Amstrad — the CPC6128

Jamye Harrison

In the computer market, if you close your eyes to blink, somebody's launched a new machine! Product life is getting amazingly short these days and the advances available with each new model seem scarcely believable.

SEEMS TO ME that I finish one Amstrad review and go straight on to the next! Amstrad seems a most productive computer company. After the release of their CPC464 tape-based machine back in September 1984, a disk drive expansion (the DDI1) was available immediately, disk software was launched along with the disk drive and both software formats have expanded considerably. No one was left out in the cold, with a great machine and nothing to run on it — too often the story of the past.

The Amstrad CPC664 64K disk-based machine, with a 3" disk drive in the keyboard case, was launched a scant few months ago, and I reviewed it in AEM's first issue. Amstrad followed their past policy of having software immediately available and maintained compatibility with the 464 so that tape software could be retained on upgrading or used by new purchasers.

A big attraction of the 664 was its CP/M operating system (runs CP/M 2.2). A positively huge variety of CP/M software is available, admittedly not all on 3" disk, but that will come. (The 464 fitted with the 3" disk drive expansion runs CP/M 2.2, also).

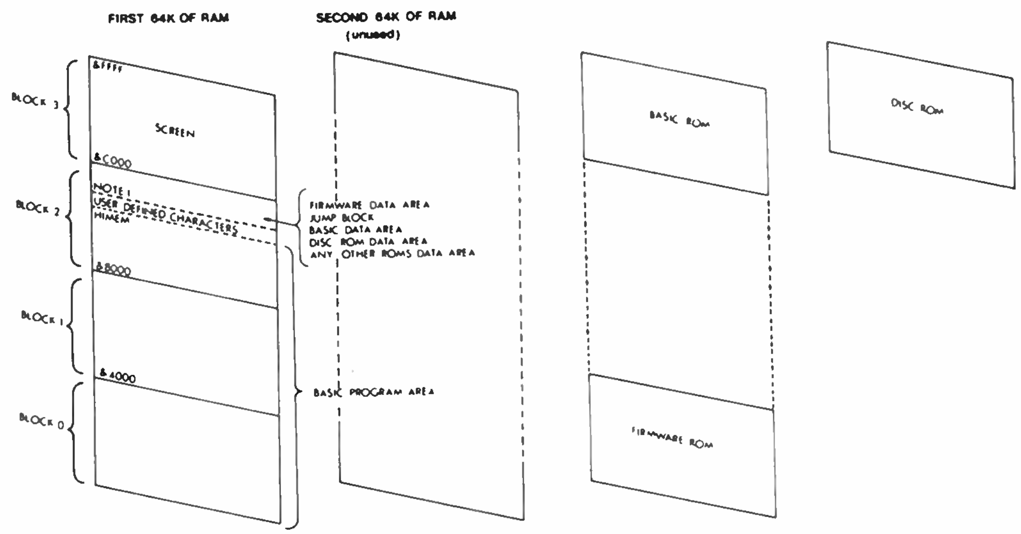
This month, Amstrad release the CPC6128, a 128K RAM machine incorporating all the major features of the 664, and then some. Well, what about this "... and then some"?

I will not re-cap on the preceding two models as these, I feel, have been covered adequately in my last two reviews. I will just point out the differences or enhancements I feel relevant.

The 6128 will be offered in two 'packages': System 1 with green screen monitor for around $800, and System 2 with colour monitor for around $1000. As you could guess from those prices, it actually supercedes the 664, but AWA-Thorn will continue support of the earlier models, I understand.

Smaller, but bigger

The first feature to strike me upon opening the somewhat small box of equipment sent to me for review was the obvious improvement in the keyboard, not that it needed that much improvement anyway. A streamlined grey keyboard now resides where the old, chunkier multi-coloured was located on the 664.



NOTE 1: DEPENDS ON EXTERNALLY FITTED ROMS - &A6FC WHEN NO EXTERNAL ROMS FITTED

The 6128 comes with 128K of RAM and 48K of ROM. The first 64K of RAM is divided into four blocks, each of 16K. The screen uses Block 3, while the upper section of Block 2 is used for system variables, etc. Usable BASIC program area extends to this point in Block 2, as shown.

The cross-style cursor control keys have now been merged into the numeric keypad, in the inverted 'T' format now pretty well standard on 'professional' keyboards. The numeric keypad itself has been pushed down next to the main keyboard. ALL this has resulting in a shortening of the whole machine by almost a quarter of the length of the 464 and 664. These styling changes give the machine a smarter, more business-like look.

The increased memory capacity has obvious software advantages, but only if it can be effectively exploited. The Z-80A CPU however, does not have the capability to access more than 64K at any one time. To overcome this the 6128 has a utility program called 'BANK MANAGER'. The 128K of memory is organised into two banks of 64K, partitioned into blocks of 16K. Bank Manager permits swapping one 16K block in the primary bank with any of the four blocks in the second bank, allowing full use of the available memory.

The next enhancement of interest involves the operating system — or should I say, systems. As mentioned above, Amstrad has employed CP/M 2.2 on their previous models, and for the sake of upwards compatibility, it comes with the 6128. However, you also get CP/M 3.1, known around the traps as CP/M Plus. Amstrad supply two distribution disks, which contain:

- CP/M 2.2
- Dr LOGO, introductory programming language.
- CP/M PLUS (3.1)
- Enhanced Dr LOGO and Help system.

The two CP/M systems are provied so that virtual total compatibility is available with available CP/M software, including new releases.

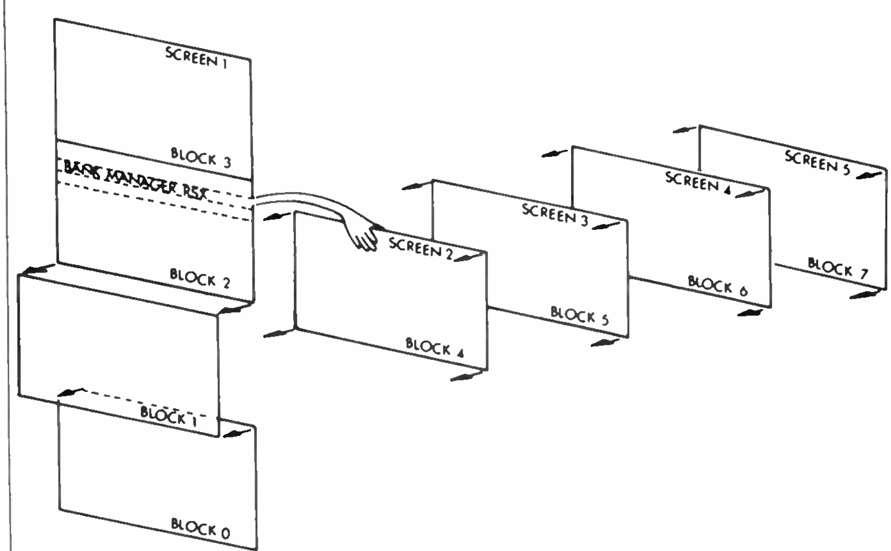
CP/M Plus offers a 61K Transient Program Area, allowing much more complex programs to be run. CP/M 3.1 also has facilities for specific emulation of terminal standards such as the VT52 and Zenith Z19/Z29 allowing software supporting these to be used without further installation.

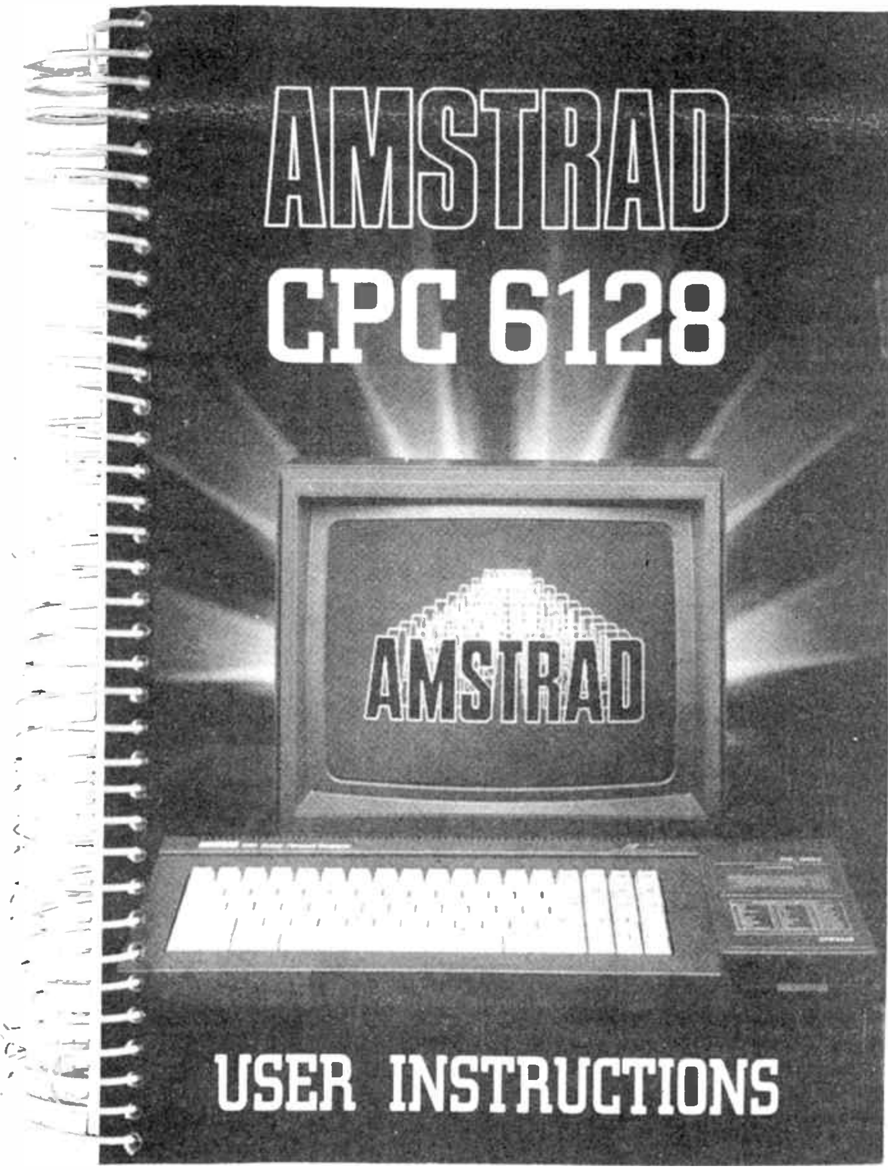
Another excellent feature CP/M 3.1 incorporates is something described as a 'Graphics Extension System'. This, as explained in the excellent documentation provided, allows application programs to support the graphics and other "non-text" facilities, not only on-screen but on printers and plotters, too.

Few machines in this price bracket offer anything like similar capabilities!

Many companies in the past have offered machines with some whizz-bang facilities but failed to ensure decent software support through the use of a standard operating system and/or failed to support it themselves with a variety of suitable software applica- ▶

The 6128 incorporates hardware memory bank switching with a utility called BANK MANAGER. This is able to switch out Block 1 of memory and switch in one of the four blocks from the second 64K in its place. The contents of Block 1 is preserved and restored later when BANK MANAGER operations are finished.





The manual: up to Amstrad's usual high standard.

tions available when the machine was launched. Not so Amstrad.

Up-front software and peripherals support has probably been the major factor contributing to Amstrad's success though a latecomer to the market. When they've released each machine they have always ensured that abundant software has been available, that peripheral hardware has been available, and when releasing a new model they continue to support the old models, and ensure that software is upwards compatible.

Watch your language!

The 6128 boots up in BASIC, like its predecessors, which is a convenient, 'user friendly', facility. Many of the software packages are booted from BASIC. This method has been used for a number of reasons but mainly so that the machine will be able to be used by a wide range of people, from beginners to business people through to the experienced hacker/experimenter.

The BASIC seems to be the same as the 664 BASIC, which has many useful, easy to use, features. Increased number handling facilities have been added, and include procedures for the displaying of numbers in exponential format and ways not available on previous machines. The Dr LOGO language was introduced with the 664 and continues with this model.

As before, the Amstrad's BASIC supports windows; you can have up to eight text windows and one for graphics. The window handling facilities have been made easier now and involve a simpler syntax.

```
WINDOW #4, 7, 31, 6, 18
```

This defines a TEXT window area from column 7 over to column 31, and (at the top of the screen) starting at line 6 down to line 18. Normal screen commands used in the normal format now apply to window zero only, but if followed by a window number then apply to that. Thus, to clear window 4, we have to setup and assign background and foreground colours and this is done in a simple series of commands taking but three lines, like this:

```
INK 3,9
PAPER #4,3
CLS #4
```

As you can see, windows are setup quite easily, giving even inexperienced programmers the ability to get sophisticated results from a program.

The 664 featured some neat graphics facilities, but the 6128 adds Sprites and sprite-handling facilities. Sprites are graphics characters or screens you create yourself. You can create a number of sprite screens and overlay one upon the other. By moving one relative to the others, which remain fixed, you can 'animate' the graphics. Great stuff. Needless to say, the sprite-handling program commands are quite simple to use.

The 6128 operating system gives you an alternate character set, selected from CP/M by the use of a LANGUAGE command file where you merely type the name of the .COM file and a number corresponding to the language set required. This is unique, especially from a CP/M system, and a very useful facility which makes the Amstrad suitable for a very wide range of applications.

Summing up

In use, the compact new design is quite functional and the smaller size is a decided improvement. I have one complaint, only a minor one, about the keyboard. This is that the CONTROL key is placed in the lower left hand corner of the keyboard where one would normally expect to find a SHIFT key. I found myself holding down the CONTROL key when what I really wanted was SHIFT.

The hardware provides for the attachment of an array of peripherals — exra disk drive, printer etc. You can even attach a cassette recorder if you want to use tape software. However, no mention is made of a modem.

The documentation was up to Amstrad's usual high standard. The handbook is spiral-bound so that the pages lay flat when the book is open on the table beside the computer.

It is evident that Amstrad will be around for a while as user support is certainly growing. A locally-produced 'Amstrad User' magazine is on sale at newsagents and computer stores and there's plenty of local software support. Apart from AWA-Thorn, some three of four independent companies are marketing Amstrad software.

In the final analysis? At the price, there's no competition.

WELLER CROSSWORD COMPETITION

CooperTools

Here's our third monthly crossword with a prize of the marvellous Weller WTCPN Controlled Output Soldering Station for the winner.

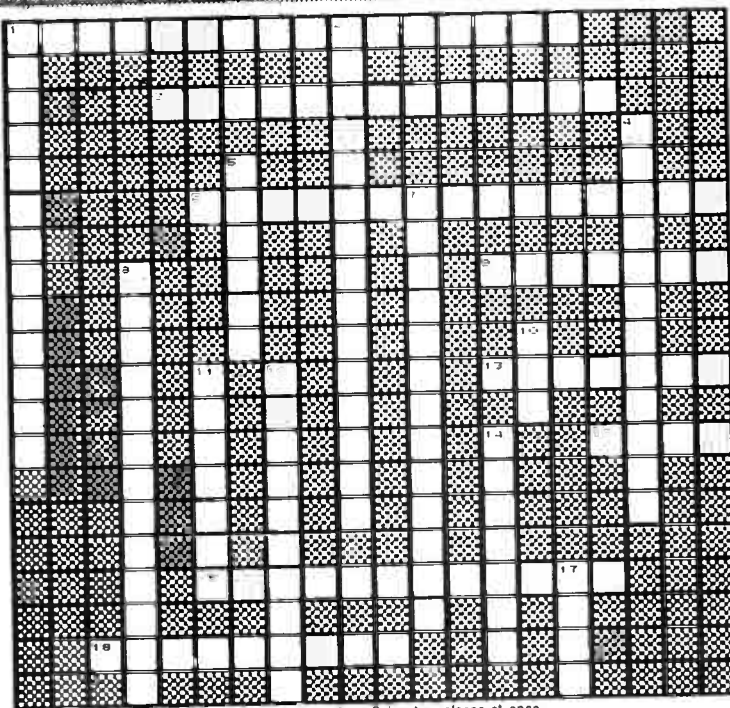
This month we are back to some tough words to find, but to make it a little easier we've added an additional set of cryptic clues. Post us your answers as soon as possible (entries close last mail November 18).

The Crosswords are prepared on an Apple 11e using "Crossword Magic' supplied by Edsoft Pty Ltd, 20 Blackburn Rd, Blackburn, Victoria. Crossword Magic is just one of the large range of educational software they sell.

The winner of the August 1985 crossword was *Mark Halliday* of Carlton, NSW. The answers appeared in our September issue on page 77.

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.



Across

1. When the input signals is connected in series with the output signal, thus becoming equal to the output signal. (2 words).
3. A device using a reproducing stylus to communicate to a coil mounted within a permanent magnet to produce corresponding EMFs in the coil. (2 words).
6. A level at which an oscillation is muffled. (2 words).
9. Deliberate interference with radio communication.
13. In an electron tube a small heated area on an anode. (2 words).
15. An audio frequency noise having a continuous spectrum.
16. Conduction of a current between two cold electrodes in an ionised gas tube. (2 words).
18. The period of blanking level immediately following the line sync signal in a television signal. (2 words).

Down

1. A method of coding information in which the coded information consists of characters which at all times can have only one of two possible values. (2 words).
2. The condition where the rate of loss of energy is just sufficient to prevent free oscillation of an oscillating system. (2 words).
4. With positive feedback the position at which the gain of the system is just sufficient to cause oscillation. (2 words).
5. A term denoting the capability for simultaneous transmission in both directions over a link.
7. Random variations of the output current causing noise in electron tubes. (2 words).
8. Transmission occuring in two directions.
10. A path from one point to another via the ionosphere.
11. A low resistance connection between conductors ensuring they have the same voltage.
12. Voltage used to supply power for the filaments of electron tubes. (2 words).
14. An amount of information.
17. An indication of the extent to which the amplitude of a signal is increased by it's passage through an electronic system.

Cryptic Crushers

Across

1. A path for your shoelace. (2 words).
3. A ute loaded with TNT and a lighted fuse. (2 words).
6. How often it takes not to feel thirsty. (2 words).
9. Whacking it on your toast.
13. Don't put your hand in the flame. (2 words).
15. Vocally disliking the villian.
16. Sometimes a moment of acute embarrassment. (2 words).
18. Where the old folks like to sit

Down

1. Adding up in two's.
2. Putting your detractors head in a bucket. (2 words).
4. Joan Sutherland's position on stage. (2 words).
5. A building in two.
7. Pulses dazzling the eyes. (2 words).
8. Going two places at once.
10. Long John Silver and his parrot both had to do it.
11. James from MI5 and a note from a bell.
12. A slight irritation will be the cause. (2 words)
14. Delivered by cleft stick no longer.
17. This is no loss.

The answers to the Crossword from our September issue are published on page 112

SEND YOUR ENTRY IN BY LAST MAIL NOVEMBER 18.

The competition is open to all persons normally resident in Australia or New Zealand, with the exception of members of the staff of Australian Electronics Monthly, the printers, Offset Alpine, and/or associated companies.
The winning entry will be drawn by the Editor, whose decision is final; no correspondence will be entered into regarding the decision.
Winners will be notified by telegram the day the result is declared and the winner's name and contest results published in the next possible issue of the magazine.

Cut out or photocopy the entry form, complete it and send to:

"Cooper Tools Crossword"
Australian Electronics Monthly
PO Box 289 WAHROONGA NSW 2076

We will accept entries postmarked no later than November 19.

In case two or more entrants correctly complete the crossword we'll have to judge who's best at waxing lyrically, in 30 words or less, over: ***"Why I think the Weller WTCPN is the soldering station for me".***

. . . .

. . . .

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Beating the 'bad load' blues

WITH SO MANY COMPUTERS sporting disk drives these days, you could be forgiven for thinking the old cassette recorder for data storage was doomed. Slow you say . . . perhaps. Unreliable . . . definitely not! Have you noticed lately the ads in the magazines for "tape streamers" to back-up disk storage? They're the familiar old cassette tape recorder in a more modern guise, being used as a medium of permanent storage for the supposedly more reliable disk drive.

I have lately been using both cassette and disk storage with Microbees. I have suffered a few "blown disks", when something unexpectedly goes wrong and garbage is accidently written onto the disk. The most recent disaster was a disk of assembler source files for some projects I've been involved with at work. There was about 6K left on the disk, and I wanted to store a 4K file on it. Plenty of room! But the system didn't think so. It wrote the file on top of the directory, preventing access to the other files described therein. I only recovered them by picking them off the blown disk, segment by segment, using a disk utility.

This would not have happened with cassette storage. The cassette system only records when I press the big red button on the recorder. It records where I want it to, not where the "system" says. It it had recorded across another file it would have been because I selected the wrong recording area, not the computer. So the inherently manual nature of cassette storage makes it more reliable than disks in some ways. Admittedly, working with disks is nicer, but for archival storage, cassettes just can't be beaten.

Of course, for the cassette system to achieve its best reliability, the recordings made onto it must be of the very highest standard. An unplayable cassette recording is just as bad as an unplayable disk. And the way most computer cassette routines are organized, if one bit of the data stream gets corrupted, the entire loading procedure is aborted. BAD LOAD!

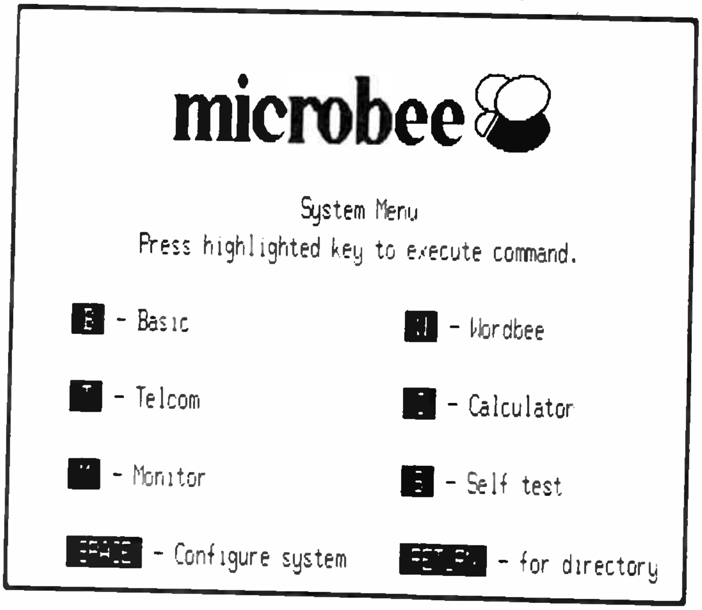
Following the release of model after model of the Microbee, Applied Technology seems to have settled down on a fairly standard cassette interface. But it's set up for a type of recorder that you probably don't have . . . one that expects its input at "Line Level" instead of "Mic Level". If you plug the recording plug into your recorder's "MIC" jack, then you're about to make a faulty recording. That is, unless you make up a special little adaptor cord.

The purpose of the gadget shown in Figure 1 is to knock the Microbee's recording voltage down from line level to mic level. It divides the Microbee's output voltage by about 100, so 1 volt from the computer becomes 10 millivolts into the cassette recorder, an appropriate "MIC" level. You can build the adaptor in a 3.5 mm socket and plug combination as shown. Check the quality of the socket before you buy it; some of them don't make very reliable contact.

After building the adaptor you should be able to make good saves and loads at 1200 bauds, every time. If this is not the case, think carefully about the quality of your cassette recorder. Maybe it's time to get something better; they do wear out, you know. As well, cassette recorders sometimes suffer from a problem called "head mis-alignment". (So do people!) If your recorder has been dropped or knocked, it could be that the record/replay head is no longer perpendicular to the travel of the tape. A simple adjustment fixes this, but don't try it yourself. You may end up misaligning a perfectly good recorder. Find someone, such as a technician, who has a known good tape to use as a standard for alignment.

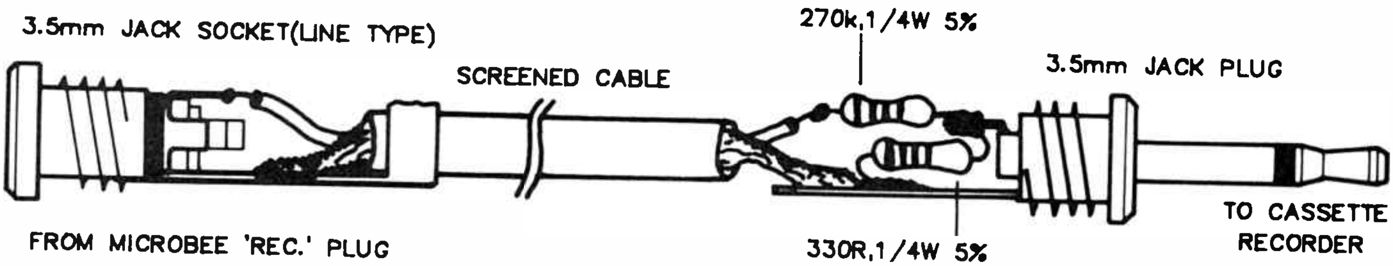
The PC-85

Have you caught up with this new Microbee model yet? It's worth taking a look, even if you're not thinking of buying a new computer, because it's a real departure from the earlier 'Bees. This isn't a proper review of the PC-85, just an observation of some interesting developments. You first notice the differences when you cold-boot the computer with ESC/RESET. No longer do you get a BASIC sign-on message. Now you get a big graphic MICROBEE sign and a menu.



You're in a program called the "shell" which lives in the PAK5 position. From the shell you can go into a configuration page, or into a directory page from where you can select the computer's various EPROM software packages.

To make this happen, A/T have made some quite drastic changes to the BASIC, which contains the computer's main operating system. Upon cold boot, the computer now looks for a shell program in the PAK5 position, and jumps if one is present. This opens great possibilities for those who would



change things, because it should be possible to make the computer automatically execute an EPROM in PAK5, even if it is not the official "shell" program. The company I work for plans to use the PC-85 as part of a dedicated marine electronics package called NaviMate, and when the computer boots, the user will get a NAVIMATE screen without ever going through BASIC to get there. In other words, the user will never really "see" a computer, unless there is a specific need for BASIC.

Besides the shell, there are some other rather radical changes. The old Microbee preference for a serial printer has been changed, so it now defaults to a parallel printer. This is in line with parallel printers becoming so cheap and easy to own. If you already own a serial printer, you can use the configuration screen to change the PC-85's output back to serial after a cold boot.

Wordbee has also been chopped around a bit so it no longer wipes the whole memory when it initializes. You can now have some machine code programs floating around in high memory and use Wordbee at the same time. Exiting Wordbee though will still zap your Wordbee file, as the start of it is re-initialized by BASIC.

There's a new memory battery system too ... they've replaced the disposable (and hard to get) 4½ volt battery with a rechargable Ni-Cd version. It is charged whenever the computer is switched on.

If, for experiment's sake, you pull the shell ROM completely out of the PC-85 or replace it with some other EPROM, it will revert to the good old BASIC computer. But there are still differences in the operating system, such as in the interrupts department. So certainly buy and enjoy your new PC-85, it's really quite a remarkable computer. But if you've got any favourite software or peripherals from earlier 'Bees, you'd better check first to be sure they can be made to work on the new one.

Our 'mole inside Microbee' tells us that A/T are running a special promotion on the PC85 between now and Christmas. For just $599, you'll be able to buy the PC85 complete with database, spreadsheet and "business" graphics in ROM plus a green/amber monitor. And it comes with Viatel capability. Hmmm. Team that with one of their thermal printers (A4 paper) for $199.50 and you'll have quite a nifty setup. Apparently, the advertising campaign for this won't start until the end of this month, or early November, so you saw it first in A.E.M!

It's about time

Good news for people who have tried to use the time-of-day clocks in ROM-based Microbees. These clocks aren't real good real-time clocks; they're really "false-time" clocks. They stop when the computer is turned off, or when you use the cassette interface; and their interrupts can really mess up data transfers.

A/T now intends to equip future 'Bee models with a *real* real-time clock, really! It's a special chip with its own crystal oscillator and its own little battery and it will run all the time, hopefully accurately. The 'Bee, when turned on, will be able to display the real time on the screen and programs will have access to the real time as well. I would like to see some arrangement incorporated that would turn on the 'Bee automatically at some pre-set time, for instance to produce some interesting facsimile picture from my Listening Post in the middle of the night. That would be really great!

New VHF/UHF propagation mode discovered?

Amateurs located in NSW and Victoria may have unearthed a previously unrealised mode of propagation that provides massively enhanced signal strengths on VHF and UHF signals over distances up to 700 km, or more.

The signal strength enhancement is associated with high-flying commercial passenger jet aircraft that fly routes which pass through or near the path midpoint between stations. The July issue of the Wireless Institute of Australia journal, Amateur Radio, has the story. From 1983 to the present, Doug McArthur VK3UM conducted regular contact schedules with Gordon MacDonald VK2ZAB north of the NSW capital, Sydney, on the 144 and 432 MHz bands. The two stations were able to maintain contact by tropospheric scatter propagation. The path length is around 700 km.

The two stations observed massive signal strength enhancements lasting some minutes on occasions, which were eventually found to coincide with the passage of commercial jet passenger aircraft through the region of the path mid-point. Fortuitously, these aircraft, when flying from Sydney to Melbourne, travel much the same route as the line between these two stations.

Amateurs in Canberra joined the contacts during periods of enhancement, also. It was this that led to the correlation of enhancements with the passage of the aircraft, apparently.

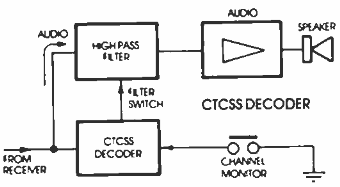
The actual signal enhancement, above the scatter signal level, is estimated to be 50-60 dB, perhaps more. Enhancement periods last from 30 seconds to tens of minutes, depending on the particular path and the height of the aircraft. Apparently enhancement periods are affected by upper air winds, at the height of the aircraft.

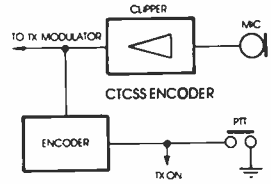
Under the worst circumstances, enhancement is minimal, but the signal increase is always observed. Speculation about the propagation mechanism range from attributing it to direct reflection from the aircraft, or reflection from the aircraft condensation trails to refraction from the aircraft wake.

A number of stations have exploited the mode in recent months, conducting contacts over path lengths as short as 400 km and up to 60 km off-path from the aircraft route. Stations normally incapable of making tropo-scatter contact over the path have had successful contacts. A curious observation, well corroborated, is that the signal 'footprint' at one path end seems to travel in the opposite direction to the aircraft.

More observations on the signal 'footprint', particularly regarding its apparent size and movement, are needed, along with research into the characteristics of jet aircraft wakes, will be needed before a clear picture of the propagation mechanism emerges. We're working on it.

— Roger Harrison VK2ZTB





Tone-coded squelch products for radio systems

Captain Communications offers a range of 'continuous tone coded squelch system' (CTCSS) encoders and decoders for installation in transceivers of a radio system to provide "quiet base" and "quite mobile" operation.

When added to the transceivers in a base or mobile radio system, a CTCSS module sends sub-audible tones along with the speech whenever the microphone press-to-talk (PTT) button is actuated. Thirty-eight standard frequency tones in the range 67.0 Hz to 250.3 Hz are employed in the system.

These sub-audible tones can be used to perform a variety of useful radio system control functions. Probably the most common use is to assign a separate tone to each user group sharing a common radio channel. The receiver is kept "quiet" until it receives its own group's allocated CTCSS tone, thus eliminating the unwanted conversations of other services sharing the channel being heard.

Four CTCSS modules, locally made by Sigtec, can be supplied by Captain Communications. The C1103 encoder/decoder is the top-of-the-range model, featuring crystal control of all 38 frequencies, frequency selection by simple solder bridges and multi-channel operation capability.

The Sigtec C1107 encoder/decoder-privacy is a specially adapted version of the C1103 which provides conversational privacy between companies or individuals sharing a single channel talk-through repeater base station.

Full details are obtainable from **Captain Communications, 28 Parkes St, Parramatta 2150 NSW. (02) 633 4006.**

RADIO CLUBS, SHORTWAVE GROUPS
— ATTENTION —

Want to publicise the existence of your club, group or association? Need to publicise club meetings or special events? We're happy to oblige!

Just drop us a note with full details, including who/where to contact. If publicising special events, contests, field days, or what-have-you make sure you send us the details well in advance — at least three months if you can manage it, certainly no later than six weeks prior to the appropriate issue month of the magazine. The service is free.

Send your information to '**Spectrum Editor**', **Australian Electronics Monthly, PO Box 289, Wahroonga 2076 NSW.**

SPECTRUM

Software for amateurs and CBers

Hi-Com Programs of Tasmania has produced a suite of computer programs designed for amateurs and CBers, to suit the VZ200/300 or the VIC-20.

Four programs come in a pack — 'Typing tutor', 'Log Book', 'Morse Code' and 'Beam Heading'. The pack is contained on a single tape casette which costs $12 (inc. post and handling).

The typing dutor is designed teach efficient touch-typing, according to Hi-Com. The log book program allows you to keep your log on cassette, storing details such as date, callsign, name and location, etc. The Morse code program is useful for those trying to gain their Novice amateur licence or for upgrading from Novice to full call, Hi-Com claim.

The beam heading program is just the thing for DX operators, according to Hi-Com. Just type in your latitude, longitude and target station and the program generates the short and long path beam headings.

Further details from **Hi-Com Programs, RSD 170, PO Exeter 7251 Tas.**

DX club celebrates twenty years

This year is the 20th anniversary of the Australian Radio DX Club which services the interests of those interested in the hobby of shortwave listenting.

The ARDXC publishes "Australian DX News" which includes station loggings, QSL (reception report) notes, equipment reviews, station news, etc. Club publications and services are available to members and monthly meetings are held in various state capitals.

For further information, send a stamped, self-addressed envelope to **ARDXC, PO Box 36, North Brighton 3816 Vic.**

D.S.E. Commander user group

For owners or constructors of the Dick Smith Electronics "Commander" two metre transceiver project kit, you may be heartened to know of the initiative taken by a small group of VK3s to form a user group for mutual support (I was going to say 'aid', but that word has negative connotations these days).

If you're interested, contact Cyril Maude VK3ZCK, 2 Clarendon St, Avondale Heights 3034 Vic.

New Radiocommunication act

Australia's new Radiocommunication act was proclaimed on 19 August. Affected acts in other areas were subsequently amended so that the effect of all relevant legislation was in-line with the provisions of the new act.

The Radiocommunication Act 1985 replaces the 80-year old Wireless Telegraphy Act, a remarkably long-lived act considering it was conceived and proclaimed when radio communications technology was in its infancy.

It seems ironically appropriate the new act should be proclaimed the month Australia launched its first communications satellite, AUSSAT 1.

WAGGA AMATEUR CONVENTION

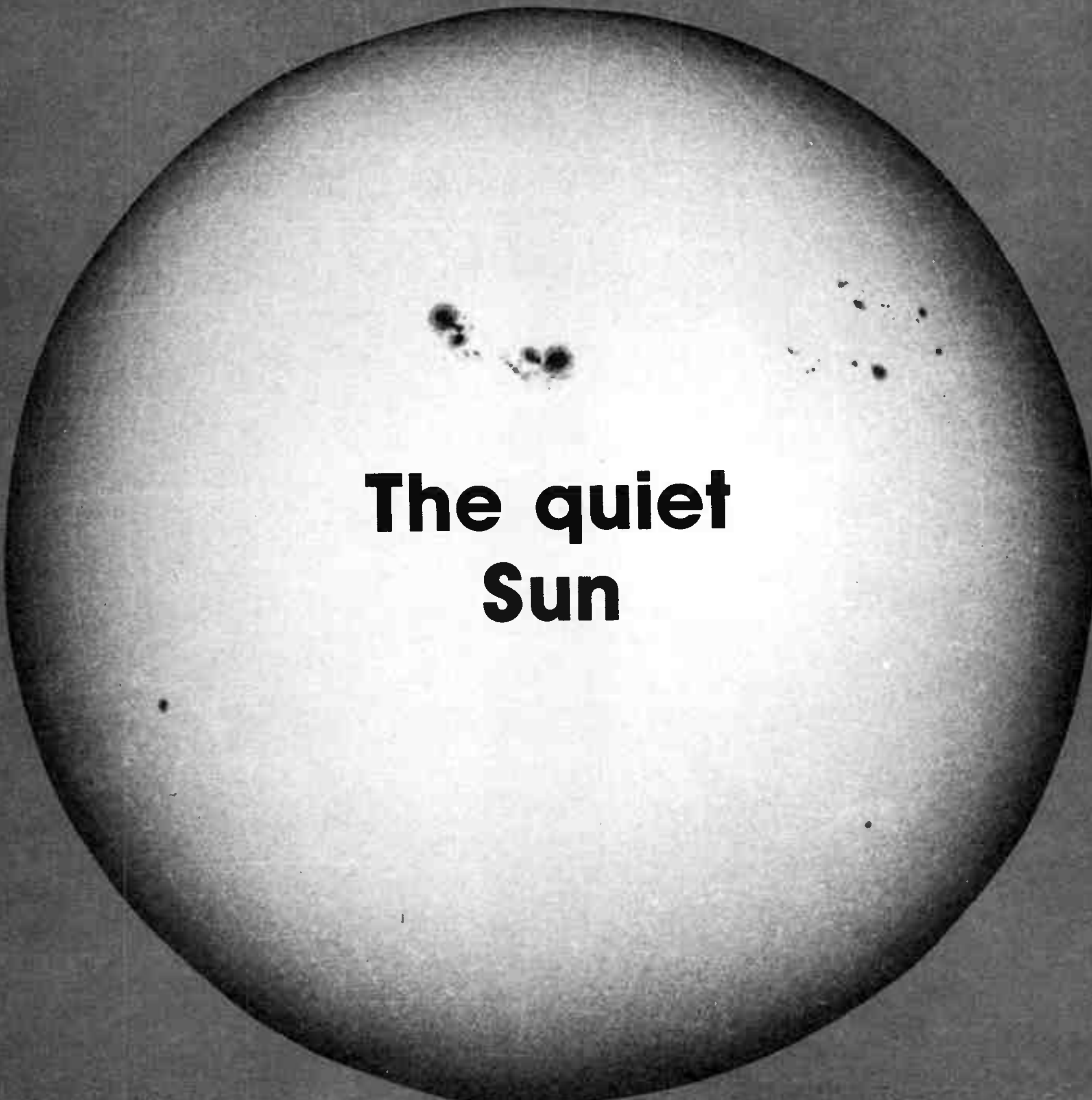
The Wagga Amateur Radio Club are holding their annual convention a little later this year. In previous years it was held on the October long weekend, but this year it will be held later to avoid accommodation problems, over the weekend of 26-27 October.

Accommodation for caravans etc is available at the convention site, located just outside Wagga. Mains power is available on-site.

The National Foxhunting (find the hidden transmitter) Championships will be held during the convention and some big prizes are being offered by Icom and Kenwood. So it looks like Wagga's the go for amateur radio this month. Full details from **Wagga A.R.C., P.O. Box 294, Wagga Wagga 2650 NSW.**

Radio communicators guide to the ionosphere

Part 2



The quiet Sun

Leo McNamara and Roger Harrison

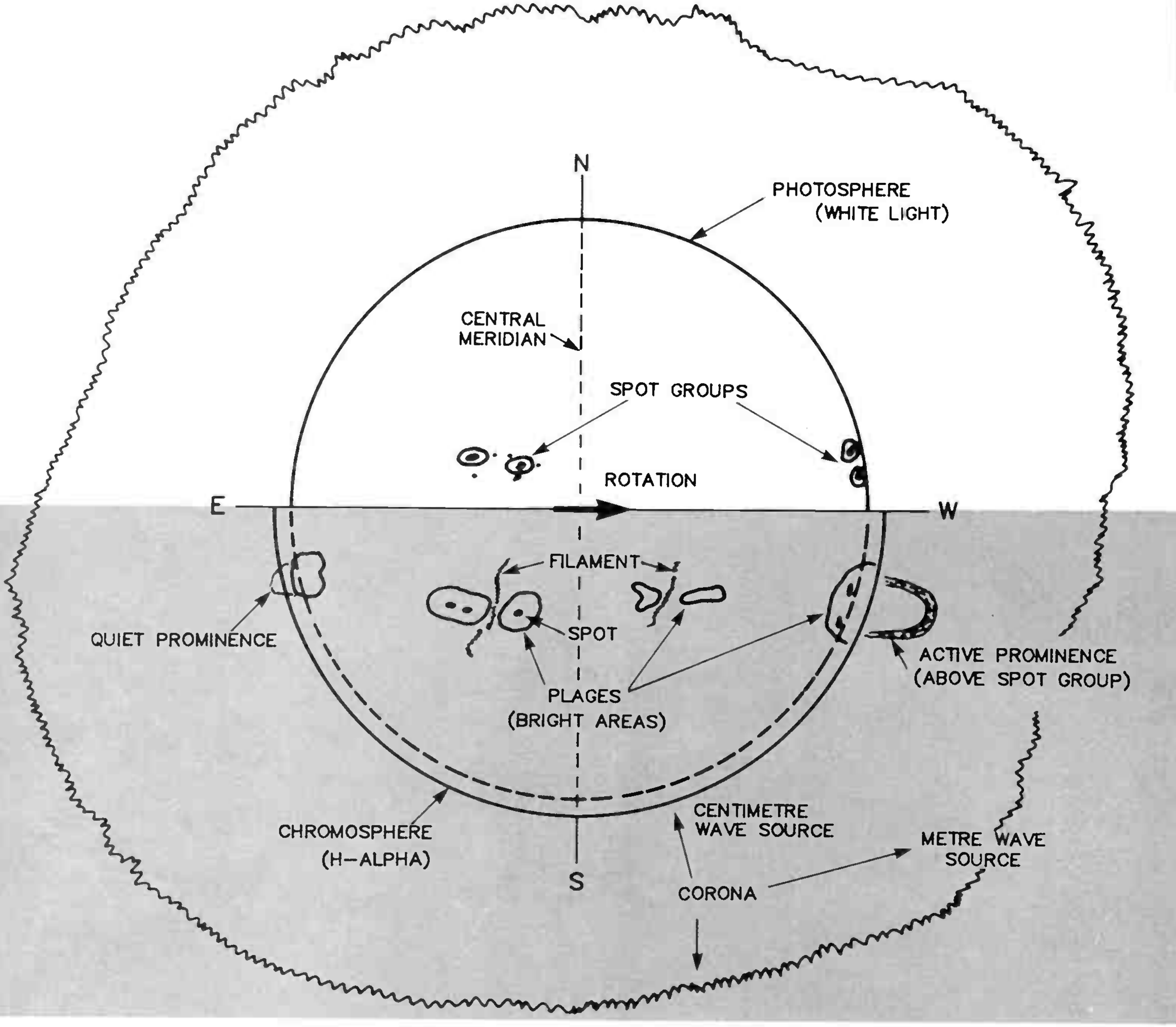


Figure 2.1. Cut-away sketch of the sun, showing its appearance at different wavelengths. When we look at the sun in ordinary white light (upper half of sketch), we see the photosphere and any sunspots that happen to be present. When we look at a wavelength of 6563 Angstroms, we see some of the light emitted by hydrogen, in this case called the H-alpha light.

At this wavelength, the chromosphere and its various features are visible — prominences, filaments, plages, and sunspots again. If we use EUV light or X-rays, we can see the corona, which appears as a tenuous halo around the chromosphere.

If we monitor the sun with radio telescopes, we would detect radiation at a wavelength which depends on the location of the emitting region.

Acknowledgement: *Many of the diagrams in this series are based on diagrams prepared by IPS Radio and Space Services of the Australian Government's Department of Science, whose kind assistance we gratefully acknowledge.*

JUST AS THINGS in our everyday life start with the sun, so do HF communications. Thus, before moving on to discuss HF communications we shall consider some of the properties of the sun and see how they directly or indirectly influence HF communications. The sun can be studied at two levels, the "quiet" sun and the "disturbed" sun. In this part we shall be concerned with the quiet sun, which means that we shall be concerned with what happens most of the time. When the sun is even mildly disturbed, HF communications can be completely disrupted, but we shall defer discussion of this problem till later in the series.

The sun is just an average beast as far as stars go, but it is huge compared to the earth.It has a radius of 7×10^5 km, over 100 times that of the earth, and a mass of 2×10^{30} kgm, over 300 000 times that of the earth. When we look at the sun*, we see different things, depending on the wavelength

*No one in their right mind ever looks directly at the sun. The sun's image is either projected onto a screen, viewed using very expensive filters, or by photographic means.

of the radiation that we decide to look at. In practice, scientists studying the sun do so at all possible wavelengths, ranging from X-rays to radio waves, and are thus able to build up a comprehensive picture of the sun.

Figure 2.1 is a cut-away sketch of the sun, as it is seen at different wavelengths. We shall look more closely at the various features in the following sections.

The sun in white light

If we use a telescope and project an image of the sun onto a sheet of paper, without using any filters, we get what is called a white light image of the sun. Basically, it will be a bright disc which will shimmer as we watch it. This shimmering is caused by the movement of the air between the sun and the telescope. Where there is virtually no shimmer, we say that the "seeing" is good and scientists go to great lengths and usually very remote locations to ensure good "seeing" conditions. The two solar observatories in Australia, for example, are near Narrabri (NSW) and Exmouth (WA), while those in other countries include Kitt Peak (New Mexico), Canary Is. and Palehua (Hawaii).

The part of the sun that we "see" in white light is called the photosphere and has a temperature of about 6000°C. It is only about 500 km thick, compared to the 1.4 x 10^6 km diameter of the sun, which is why the edge of the sun seems so sharp. The photosphere itself is of no direct concern to us here. We are more interested in the small dark patches that we can usually see on our white light image. These are called *sunspots* and have been recorded for thousands of years, Chinese observations of sunspots seen with the naked eye being available back to the first century B.C. However it was not until 1610, just after the invention of the telescope, that Galileo showed that the sunspots were actually on the surface of the sun. This caused great consternation at the time because the sun was supposed to be a perfect heavenly body and it had been shown to have warts!

Galileo found that the spots moved from east to west across the face of the sun, taking about 13 days to move the full width of the sun. The spots then disappeared for another 13 days or so, before reappearing again at the east limb of the sun. The movement of the spots indicated that the sun rotates, with a *solar rotation period* of approximately 27 days. The axis of rotation of the sun is found to be approximately north-south in the sky, approximately parallel to the axis of rotation of the earth.

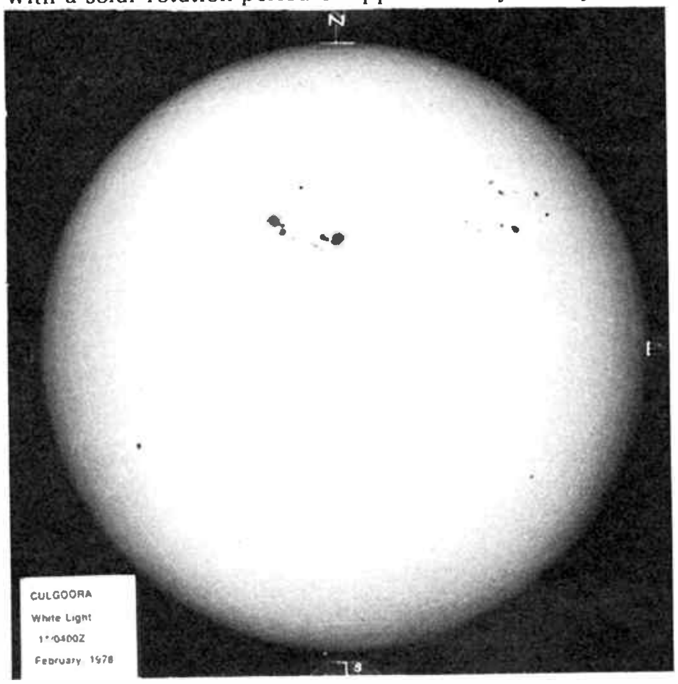


Figure 2.2. White light photograph of the sun as it appeared on 11 February 1978.

As we shall see later, the number of sunspots on the face of the sun is a good indicator of the general level of the effect that the sun is having on HF communications. We would also like to know what spots are on the side of the sun facing *away* from the earth, since we would then know what the sun has in store for our HF circuits. However until there is a satellite launched into a suitable orbit around the sun, we will have to do without this useful information.

Sunspots normally occur in *sunspot groups* which may contain several clearly discernible spots, but sunspots may also occur by themselves. Figure 2.2 shows what the face of the sun looked like on February 11 in 1978. Sunspots never occur near the north and south poles of the sun, but tend to cluster within about 30 degrees of the solar equator. On the earth, this would correspond roughly to being confined within the tropics. Sunspots look dark because they are cooler than the surrounding photosphere, but they are still pretty hot! The diameter of a typical sunspot is greater than the diameter of the Earth. Figure 2.3 shows a sunspot group observed in June 1982.

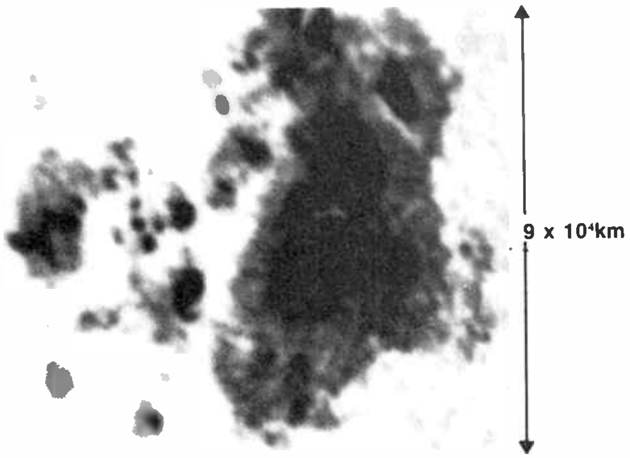


Figure 2.3. A large sunspot group observed on 21 June 1982. The north-south extent of the group is about 90 000 km, which makes it about *seven times* as large as the earth. (Photograph from Learmouth solar observatory, Aust.)

In studies of the ionosphere and HF propagation, we define a number called the *sunspot number* by counting the number of spot groups and individual spots and then forming the weighted sum

Sunspot Number = 10 x Number of sunspot groups
+ Number of individual spots

This is not another case of "add on the number you first thought of" — what we are doing is saying that a sunspot group is as important as 10 individual spots. The sunspot number can be zero (completely spot-less), eleven (one sunspot, which is also regarded as one sunspot group) or more. Sunspot numbers in excess of 250 have been observed.

The sun in H-alpha

H-alpha is one of the many spectral lines emitted by hydrogen. With a wavelength of 6563 Angstroms or 6.563 x 10^{-7}m, it lies in the red part of the visible spectrum. We can see the sun in H-alpha by fitting a special filter in front of the eyepiece of a telescope. If we fitted a special yellow filter, we could see what the sun looks like in sodium light. The common yellow street lights use sodium vapour which is heated until it emits its characteristic yellow light. Actually what ▶

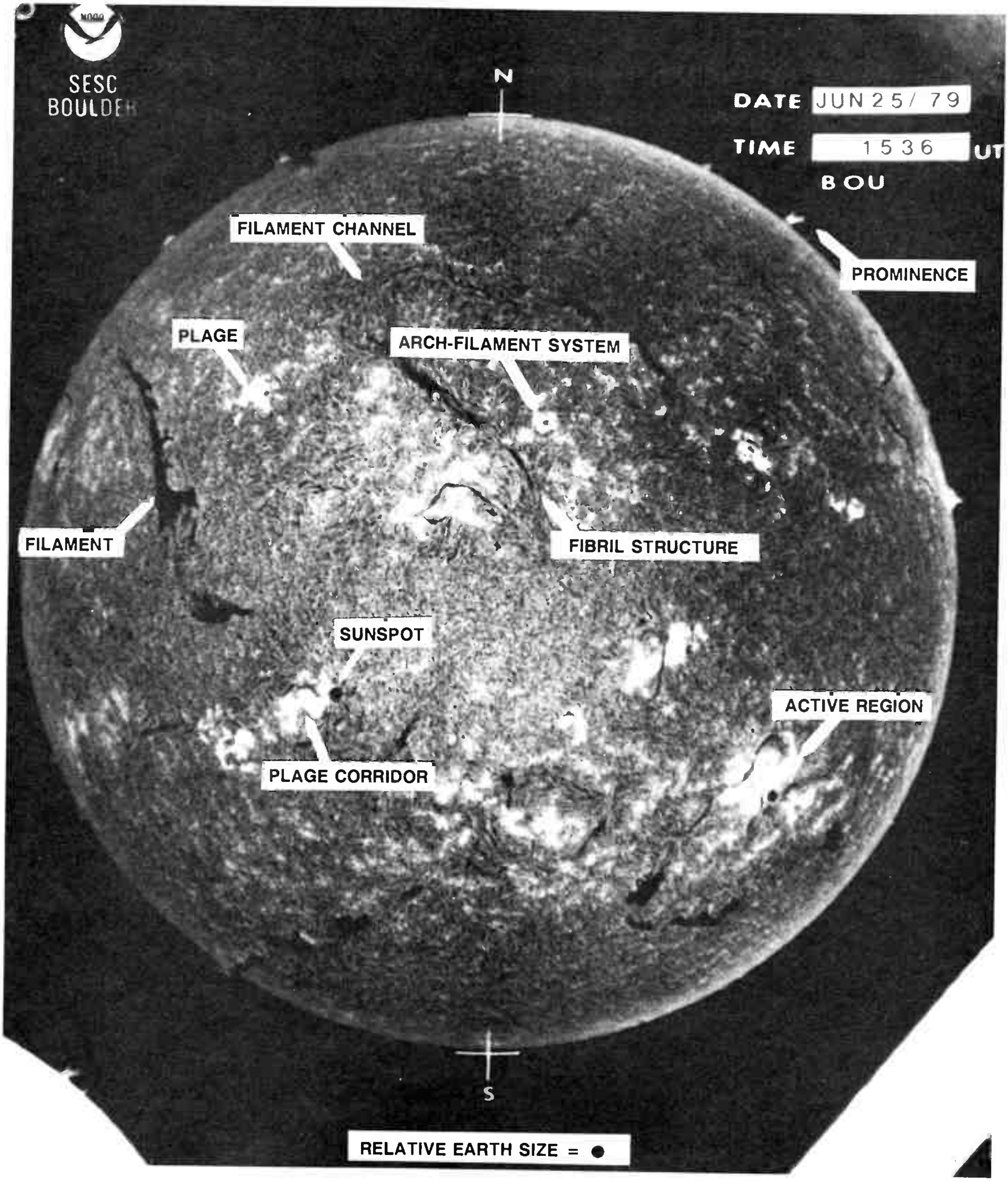


Figure 2.4. A routine photograph of the sun at the H-alpha wavelength of 6563 A, with various features labelled. Photograph courtesy of the Space Environment Services, Boulder Colorado USA.

we would be seeing is what the *sodium* in the sun is doing.

When we look at the sun in H-alpha, we cannot see as far into the sun as we do in white light. In other words, we see higher layers of the sun's atmosphere, and the sun appears larger. The layer above the photosphere which we can see only if we restrict ourselves to looking at a single wavelength or colour, is called the *chromosphere*. "Chromos" is the Greek word for colour.

The chromosphere lies directly above the photosphere, and is about 3000 km thick. The temperature of the chromosphere rises from about 4500 degrees at the top of the photosphere to nearly a million degrees at the top of the chromosphere. Such high temperatures are beyond our normal comprehension, but they can be considered simply as indicators that the particles of matter which make up the chromosphere are rushing around at extremely high speeds.

The chromosphere exhibits a wide range of very detailed structure and is a beautiful sight to those lucky enough to see it through a telescope at a solar observatory. Figure 2.4 shows some of the main features which can be seen: plages, sunspots, prominences, filaments and fibrils.

Plages (from the French word for "beach") are large, irregularly shaped bright areas, usually but not always associated with sunspots. Sunspots do not show up very well in H-alpha since they are lower down in the sun's atmosphere than the chromosphere and are thus often hidden by the overlying chromosphere. The sunspots that we see in H-alpha are usually only the large ones. Plages are important to us because they emit copious amounts of ultraviolet light (actually EUV), which we will find later to be responsible for the formation of the ionosphere and thus the support of HF radio propagation.

Plages also go by other names, depending on the wavelength of the light used to observe them. If we use white light, they are called *faculae*. The region containing plages and sunspots are known as *active regions* because they are continually changing. It is these regions which are of most importance to HF communications.

Prominences and *filaments* are the same thing seen from different perspectives. A prominence is a large cloud of relatively cool gas which is suspended above the surface of the sun by magnetic fields which restrain it from falling down. When this cloud of gas is seen on the edge of the sun, against the dark background of space, it appears bright and is known as a prominence. When viewed against the face of the sun itself, the cloud appears dark because it is relatively cool, and is known as a filament.

Filaments can reach lengths of 3×10^8 km and heights of 10^5 km above the photosphere. They can be very stable, lasting for months, but may suddenly erupt and send a cloud of solar material out into space. If this cloud hits the earth, it can cause changes to the earth's magnetic field, to the ionosphere and possibly to HF communications.

The background chromosphere between the features mentioned above shows a great deal of fine detail which is called the *fibril structure* because of its fibrous appearance. Around active regions, this structure is often ordered into large swirling patterns, apparently by magnetic fields.

The sun in EUV and X rays

With the advent of scientific satellites and space stations such as Skylab, we are finally able to get telescopes above the earth's atmosphere and see what the sun looks like at very short wavelengths in the electromagnetic spectrum. The atmosphere absorbs extreme ultra-violet (EUV) radiation and X rays, forming the ionosphere in so doing and protecting mankind from annihilation. However grateful we are for this benefit, it does mean that we cannot observe the sun in EUV or X rays from the surface of the earth.

When we look at the sun in these very short wavelengths we see what is known as the *corona*, which is a tenuous halo or crown overlying the chromosphere. The brightness of the corona is only one millionth of that of the photosphere (roughly comparable with the full moon) and is less than that of the light scattered in a clear blue sky. Consequently the corona can be seen in visible light only when the light from the photosphere is removed, as in an eclipse of the sun. Figure 2.5 shows what the corona looked like during the eclipse of 12 November 1966. The streamer structure of the corona near the poles of the sun indicates that the sun's magnetic field controls to a large extent what the corona does.

The corona can be readily seen, however, at very short wavelengths. The temperature of the corona is very high, about two million degrees, and consequently emits copious amounts of "light" in the EUV and X-ray wavelengths. The cooler photosphere does not emit much energy at these wavelengths, which means that the corona appears relatively bright. Figure 2.6 shows what the corona looked like during the Skylab mission in 1973, in EUV (284 Angstroms) and "soft" X rays (44.54 Angstroms).

An interesting and important feature of the corona is the relatively cool and therefore dark areas which stretch equatorwards from either of the poles of the sun. These are ▶

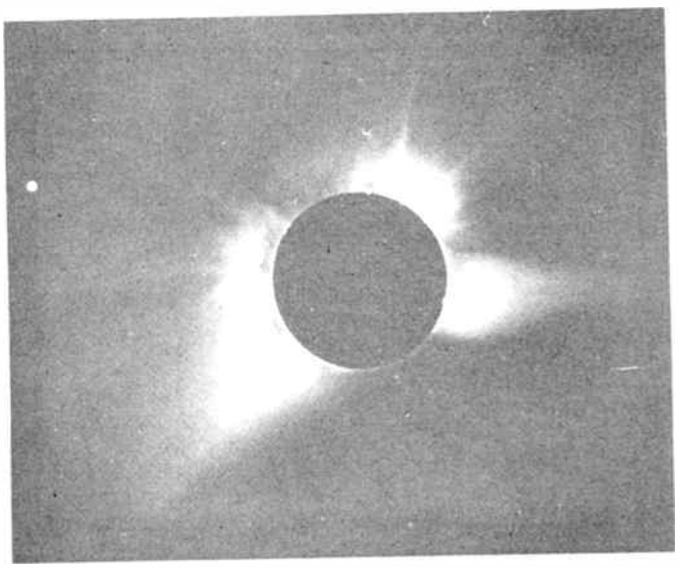


Figure 2.5. The solar corona photographed from the ground during the solar eclipse of 12 November 1966. A special filter compensated for the rapid decrease of intensity with radial distance from the sun, allowing distant features to be studied, as well as the brighter features close to the limb of the moon. A large coronal hole is clearly visible near the south pole, where there is apparently no corona.

known as *coronal holes*. The coronal hole observed by Skylab is shown in Figure 2.6. The time interval between the sets of observations is 27 days, which means that we are seeing the same coronal hole in successive rotations of the sun. The eclipse photograph in Figure 2.5 also shows evidence of a large coronal hole covering the south polar region. Coronal holes are important to the HF communicator because they are the source of streams of charged particles which affect the ionosphere as they sweep over the earth. We shall return to them later.

The corona is very dynamic and contributes to the general outflow of material from the sun into interplanetary space in what is known as the *solar wind*. This "wind" carries several million tonnes of solar material away from the sun per second — a sobering thought for a man weighing a tenth of a tonne at most. However the sun is not about to disappear. At the present rate, it would take 150 billion years for the sun to lose just 1% of its total mass. The solar wind flows at a speed of about 400 km/sec (roughly 900 000 mph), so that it takes about five days for individual charged particles to travel from the sun to the earth. We cannot feel the solar wind at the surface of the earth because there are only a few wind particles per cc, which is a density far lower than any vacuum yet achieved on earth. However the particles, being electrically charged, do affect the earth's magnetic field and the ionosphere. It is the solar wind which pushes comet tails so that they always point away from the sun.

The sun at radio wavelengths

Reversing the trend towards shorter wavelengths, we can also look at the sun at longer wavelengths, in particular radio wavelengths. To do this, we use a *radio telescope*, which is essentially just a sophisticated radio receiver coupled to an extremely good antenna pointed at the sun. We can use frequencies between about 20 MHz (15 m wavelength) and 20 GHz (1.5 cm wavelength). The lower limit is set by the ionosphere, which will not allow lower frequencies to penetrate through to the ground, while the upper limit is set by practical considerations such as attenuation by water vapour or rain in the earth's atmosphere. Radio telescopes work through cloud cover, especially at the low frequency end, and consequently offer important advantages over optical telescopes.

Many radio telescopes work on a single frequency, the output being a plot of signal amplitude versus time. The way this amplitude changes with time, and with frequency, gives us important information about what is going on in the sun. It is also possible to tune some telescopes through a wide frequency range, measuring how the amplitude changes with both frequency and time. Both these types of radio telescope, the *fixed frequency* and *swept frequency* types, look at the sun as a whole and give no information about which active region may be giving rise to the changes. A third type of radio telescope, called a *radio interferometer*, which uses a large array of receiving antennas, can actually map the distribution of radio emission at a single frequency over the surface of the sun. However interferometers are very expensive and consequently rather rare.

By studying the sun at all possible wavelengths in the electromagnetic spectrum, we are able to build up a comprehensive picture of what the sun does and how it affects the earth. Once we have built up enough experience, we can forecast some time ahead what a particular event on the sun will do to the earth, and in particular in the present context, what it will do to HF radio communications.

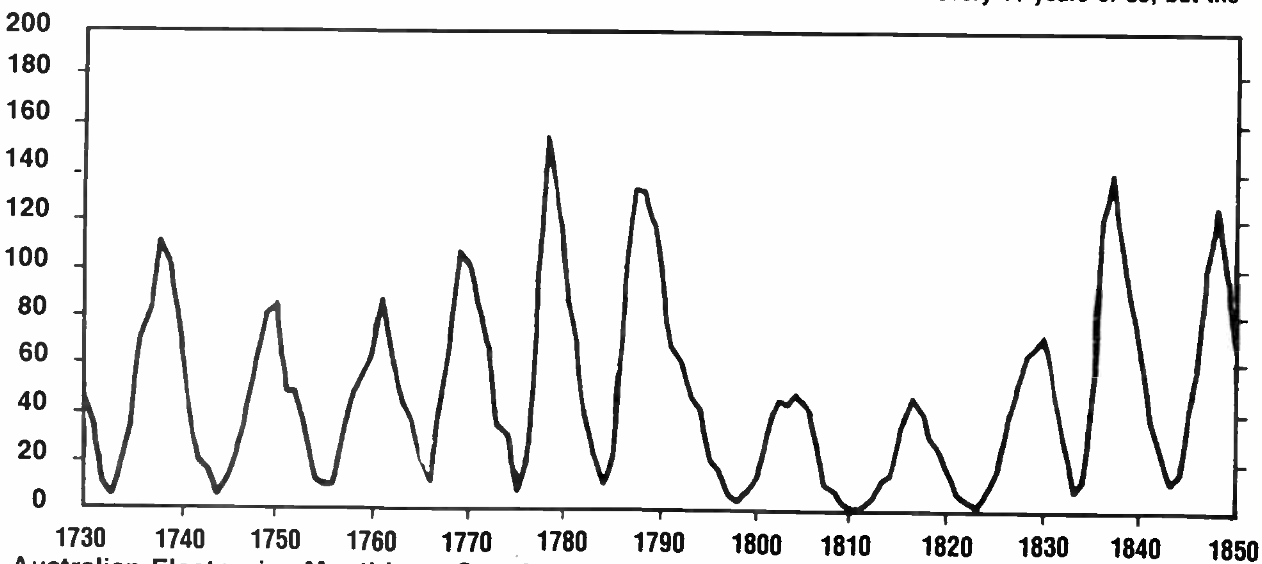
The solar cycle

If we were to observe the sun every day and calculate the sunspot number, we would find that not only would it vary as the sun rotates, but that it would also vary from zero to around 100 every eleven years or so. Of course we do not have to make these observations ourselves because scientists have been making them for hundreds of years, ever since Galileo first turned his telescope on the sun.

Figure 2.7 shows how the sunspot number, smoothed to eliminate sudden changes from month to month, has varied from the year 1730 up to 1975. The sunspot number clearly goes up and down every eleven years or so, or as scientists would say, it has a cycle of about eleven years. Virtually everything associated with the sun of relevance to HF communications occurs with an approximately eleven year cycle, hence the name *solar cycle*.

It can be seen from Figure 2.7 that all solar cycles have not had the same number of sunspots at solar cycle maximum i.e: at a time when the number has its maximum value for the cycle. The 1957 maximum was the highest ever observed. Sometimes the maximum does not get very far above the minimum — between 1645 and 1715 there seem to have been virtually no sunspots at all, and certainly no evidence for a solar cycle. This period is known as the *Maunder Minimum*, after Walter Maunder who, in the 1890's drew attention to ▶

Figure 2.7. The annual mean sunspot number (i.e: the average for a year) from 1730 to 1975. The number reaches a maximum every 11 years or so, but the



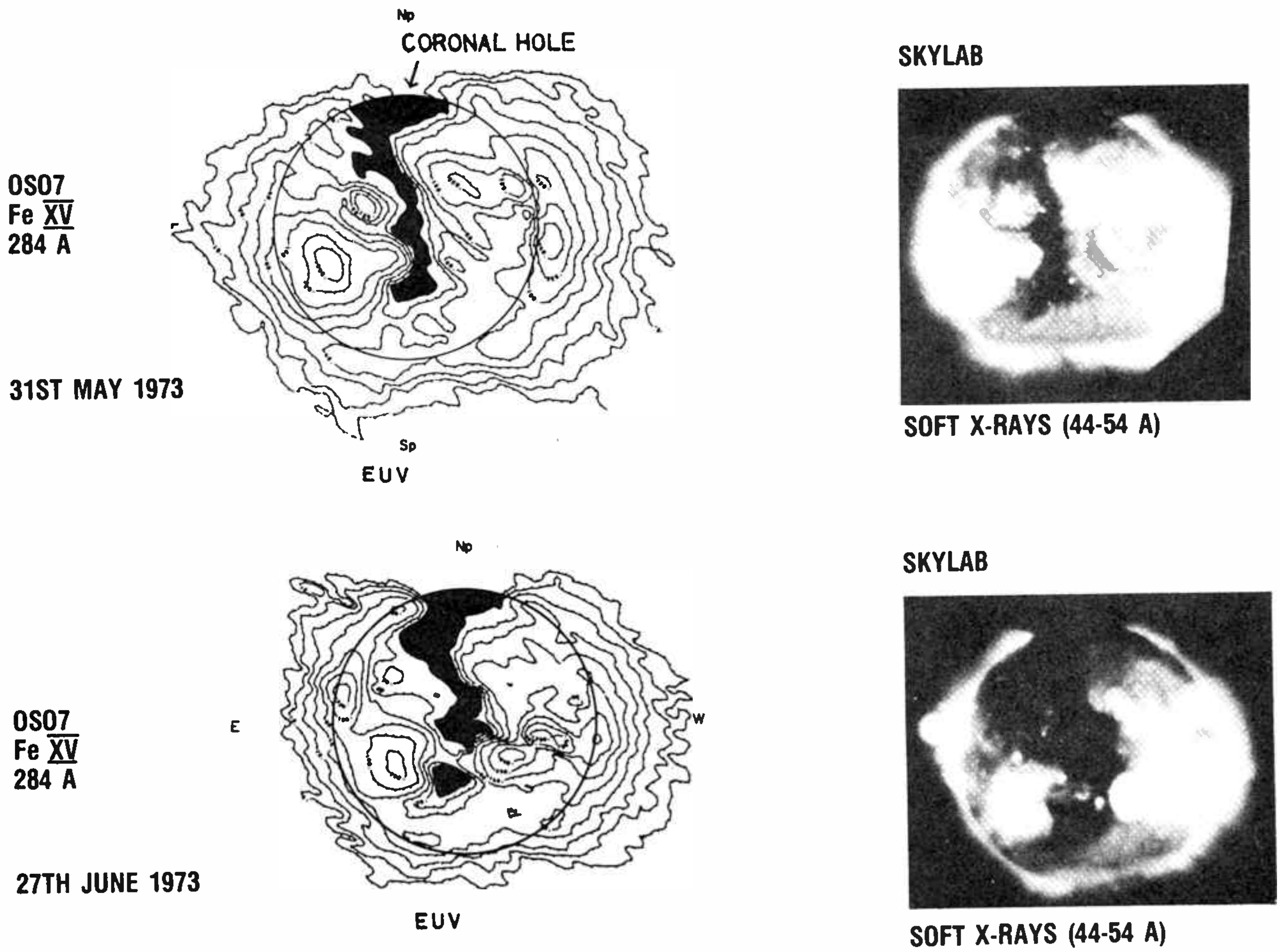
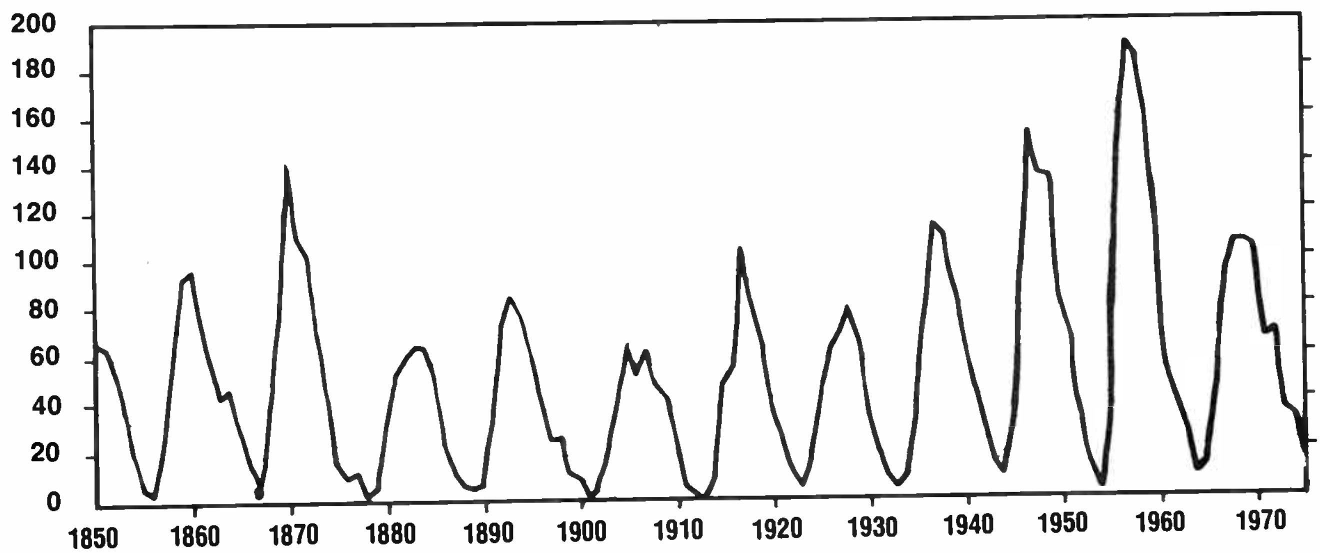


Figure 2.6. The coronal hole observed during the Skylab mission in 1973. The EUV plots (left) are from the satellite OSO7, while the X-ray photographs (right) are from Skylab. The black areas denote areas of low emission at these wavelengths, and correspond to magnetically 'open' regions in the corona which are the sources of high speed solar wind streams.

maxima are not equal. The 1957 maximum was the largest ever recorded. The current cycle (see Fig. 2.8) was the second highest recorded.



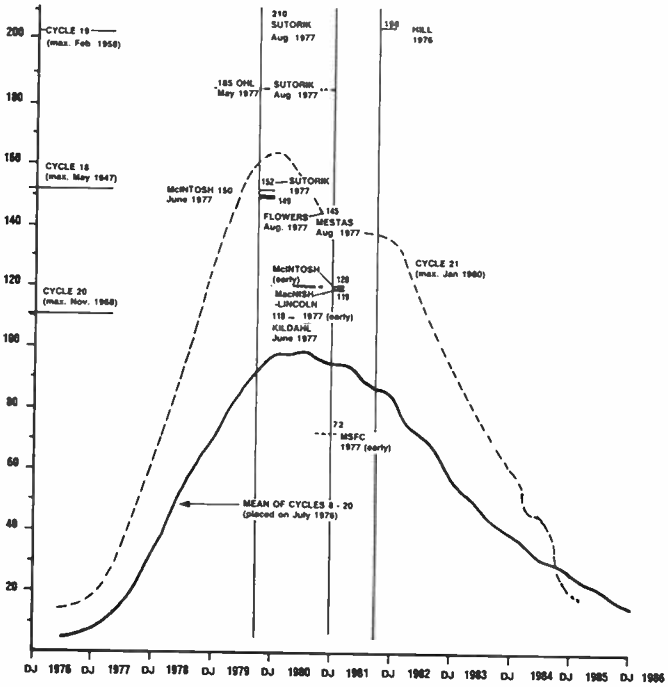


Figure 2.8. The observed sunspot cycle for 1976 to 1984, together with predictions of its maximum value, and the mean cycle averaged over cycles 8 to 20. The predicted values are identified by the name of the person making the prediction, and the time when the prediction was made.

The large discrepancy between the MSFC prediction and the observed value (72 versus 165) was partly responsible for the untimely demise of Skylab. The next maximum (in 1990 or thereabouts) is expected at present to be fairly average, in contrast to the present cycle, cycle 21.

this inconvenient fact which had been ignored for the 200 years after the original observations. Recent work by J.A. Eddy has confirmed the reality of the Maunder minimum, as well as indicating the existence of an earlier minimum of a similar nature between 1460 and 1550. It is quite feasible that we could currently be headed for another such minimum within the next few decades.

Prediction of future solar cycles

At the time of writing (1985), solar activity is decreasing rapidly towards a minimum in around 1986-87, and the question of how large the next maximum will be has already been asked. Why would we want to know now what the size of the 1990/91 maximum will be? The answer is that there are some terrestrial and space programs which will take years to implement and will be expected to last for at least a decade, thus covering a full solar cycle.

A good example of the need to predict the general level of solar activity some years in advance was given rather dramatically by the unplanned, and certainly unwanted, demise of Skylab over Australia in July 1979. One feature of high solar activity is that the higher the activity, the hotter the atmosphere of the earth becomes, and the more it expands out into space. This means that a satellite revolving around the earth encounters more resistance from the atmosphere that it passes through, known as *satellite drag*, and the satellite orbit decays to lower altitudes.

The prediction of the size of cycle 21 (1976-1986?) made by the Marshall Space Flight Center in 1977 was a low value of 72, which would be reached in January 1981. Assuming that this prediction was correct, it followed that NASA had several years of grace to mount a rescue mission for Skylab and boost it into a higher orbit. Unfortunately for NASA, cycle 21 passed through R = 72 in 1979, several years ahead of the predicted time, the rescue mission (using the Shuttle) was not mounted in time, and Skylab came tumbling down.

Figure 2.8 shows the sunspot number recorded during the present (1976-1986?) cycle, the average cycle (averaged over the last 20 cycles), and various predictions of the size and date of the 1979/80 maximum. Some predictions fared well, while others were abysmal failures. The methods which were most successful during the current cycle suggest that the next maximum will be a little above average in size, but we really have to wait for the next minimum in 1986 or thereabouts before we can make a reliable prediction.

LEO McNAMARA

Leo McNamara is currently Head of the Prediction Section and director of research at the Ionospheric Prediction Service (IPS) Radio and Space Services, part of the Australian Government's Department of Science.

Leo obtained a B. Sc. from the University of Queensland in 1961, B. Sc. (Hons) in 1964 and his Ph.D. in 1969. Subsequently, he gained M.Sc. & Soc. from the University of NSW in 1979. Leo's Ph.D. work was on solar physics.

He worked as a post-doctoral research associate at the University of Colorado during 1969-70, in the Joint Institute for Laboratory Astrophysics. From 1970 through 1979, Leo was the Head of the IPS low-latitude (equatorial ionosphere) research section. Roger Harrison worked with him during 1971-73 on transequatorial propagation.

During 1977-78, Leo again worked at the University of Colorado, as Visiting Scientist at the World Data Center for Solar-Terrestrial Physics. Upon his return, in 1979 he was appointed to his present position in IPS. During 1982-83, he worked in America again, this time at the US Air Force Geophysics Laboratory in Boston, Ma.

Leo is known among the international scientific community through his work on various international committees, which includes the International Union of Radio Science (URSI), the International Committee for Space Research (COSPAR) and the International Consultative Committee for Radio (CCIR).

Apart from this series, Leo has some 58 publications to his credit, many appearing in international scientific and engineering journals such as Nature, Australian Journal of Physics, Proceedings of the IREE (Aust.), Radio Science, Journal of Atmospheric and Terrestrial Physics, Advances in Space Research, etc. Aside from his prolific print output, Leo is an accomplished lecturer.

Leo is married with two children. He lists his hobbies as "doing nothing".

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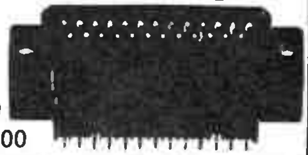

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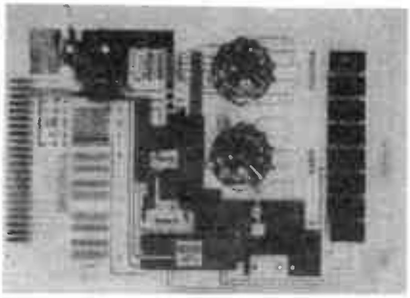

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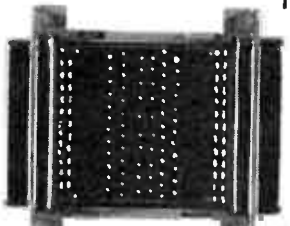

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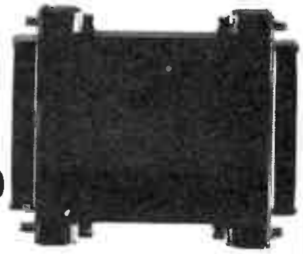

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World Radio History

Toroids to take on traditional trannies

Toroidal power transformers will challenge the existing dominance of traditional laminated types, according to Jack O'Donnell of Altronics, particularly in those applications where bulk and weight matter. Altronics recently commenced marketing a range of imported toroidal transformers.

For the same VA rating as a laminated type, a toroidal power transformer offers: • smaller volume and less weight • substantially reduced external field • lower operating temperature • better regulation, and • simple, single-bolt mounting.

Toroidal power transformers are particularly suited to use in power supplies, sensitive audio equipment, etc.

Altronics stocks a range of 12 British-made ILP toroidal trannies in two ratings — 160 VA and 300 VA. All measure 100 mm diameter, the 160 VA type being 42 mm high, the 300 VA type being 52 mm high. Each has two separate secondaries, and you can select from six standard secondary voltages in each VA class: 12/12 V, 25/25 V and then in 5 V steps to 45/45 V.

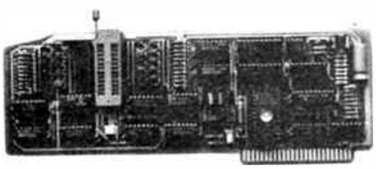
The 160 VA types cost $45 each, the 300 VA types $55 each. Further details available from **Altronics, Box 8280, Stirling St, Perth WA 6000. (008) 99 9007.**

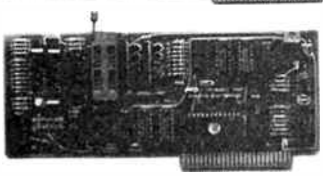
Apple tools

Two new instrumentation add-ons for Apples have been released by Energy control — a logic analyser and a series of PAL programmers.

The logic analyser add-on is from Total Logic Corporation of the USA. Known as the LA100, it is a 16-bit logic analyser for the Apple II and compatible microcomputers.

Low in cost, the LA100 features 16-bit x 1024 words, input





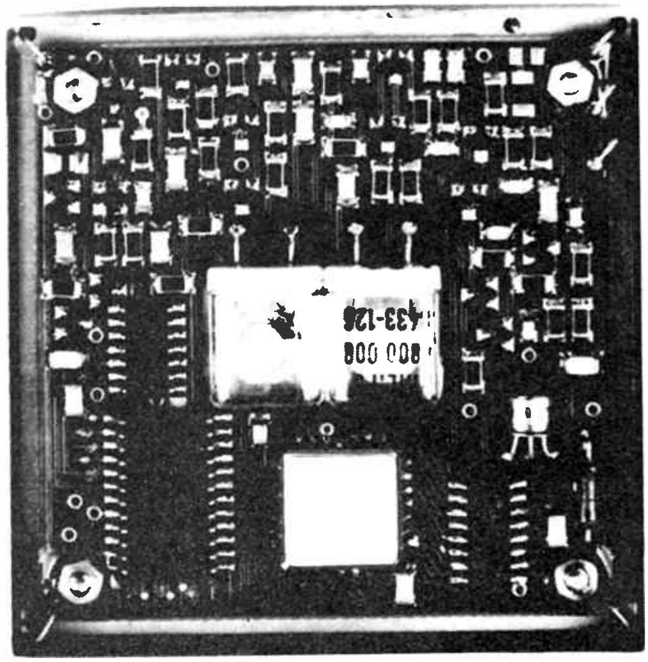
capability, 5 MHz speed, two clock qualifiers and menu-driven software. It plugs into the Apple's slot 5. A 32-bit x 1024 words 15 MHz (LA200) version is available for the IBM-PC.

Also from the US comes the series 700A PAL Development Systems made by Dynatem Electronics Incorporated.

These PAL programmers plug into the Apple II and compatible microcomputer bus. The low cost PALP-701A programs 20-pin MMI, NS and TI PALs and provides complete software support for programming and boolean equation analysis.

The PALP-702A programs both 20- and 24-pin PALs. The PAL Assembler provided is functionally compatible with PALPSM software by Monolithic Memories.

More details from Ken Curry, **Energy Control, PO Box 6502, Goodna, 4300 Queensland. (07)288 2455.**



Compensated crystal oscillator module

Philips has introduced a new crystal oscillator module featuring low power consumption, compact size and a stability of better than a half-part per million over a temperature range of -40 to +85 degrees Celsius.

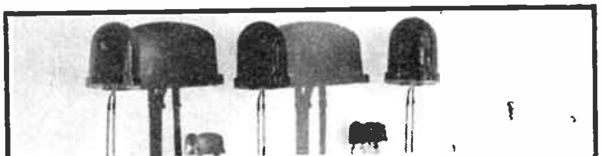
The company says this digital temperature compensated oscillator (DTCXO) has bridged the gap between the analogue temperature compensated oscillators (TCXOs) and ovenised oscillators.

Philips claim their DTCXO's high stability outclasses any standard TCXO of similar dimensions. As no crystal oven is employed, the unit draws only 20 mA supply current.

Light and compact, the DTCXO measures 60 x 60 x 8 mm and is available with frequencies in the range 4.5 MHz to 5 MHz. Applications sinclude: equipment reference oscillator, mobile radio, portable precision navigation equipment, hand-held measuring instruments, personal satellite controlled guidance systems, etc.

The DTCXO's design features are due to the use of a quartz crystal oscillator incorporating temperature sensors and a digital temperature compensation network employing proprietary ICs.

The unit is normally supplied with low power Shottky outputs, but CMOS or TTL-compatible outputs are also available. Details from **Philips Elcoma, 11 Waltham St, Artarmon 2064 NSW. (02) 88 3200.**



Jumbo LEDs

Telefunken Electronics are now shipping a new type of 10mm diameter visible LED, the TLH-400 series. To achieve high brightness in such a large package, Telefunken employ two high efficiency LED chips on a three-lead header.

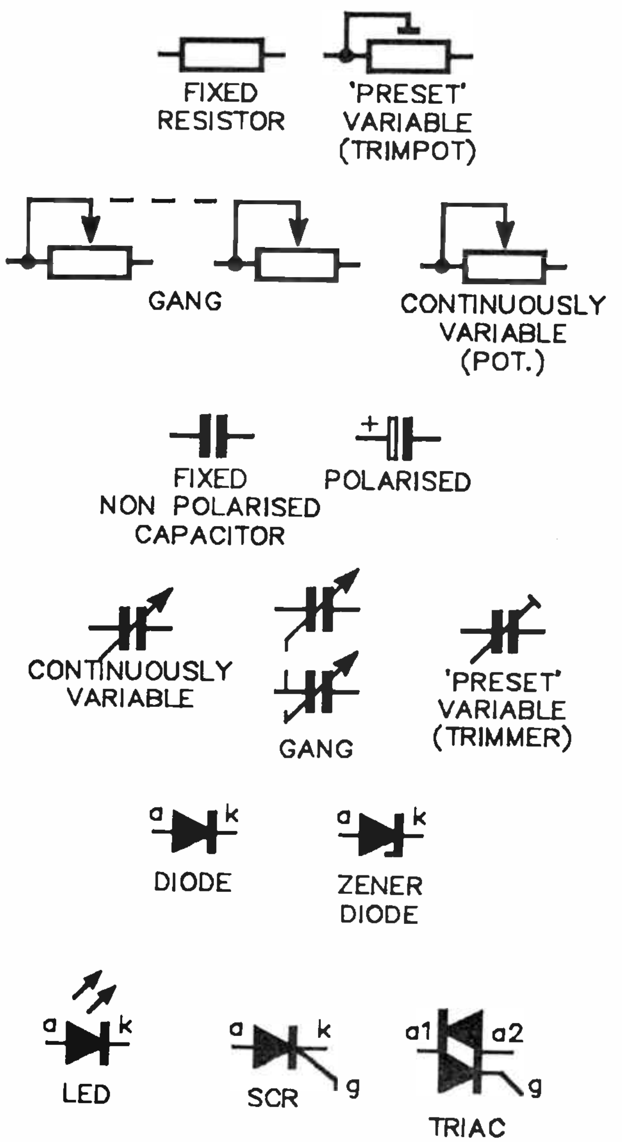
The LEDs are available in red, yellow and green and find use in large indicator panels where high visibility is important.

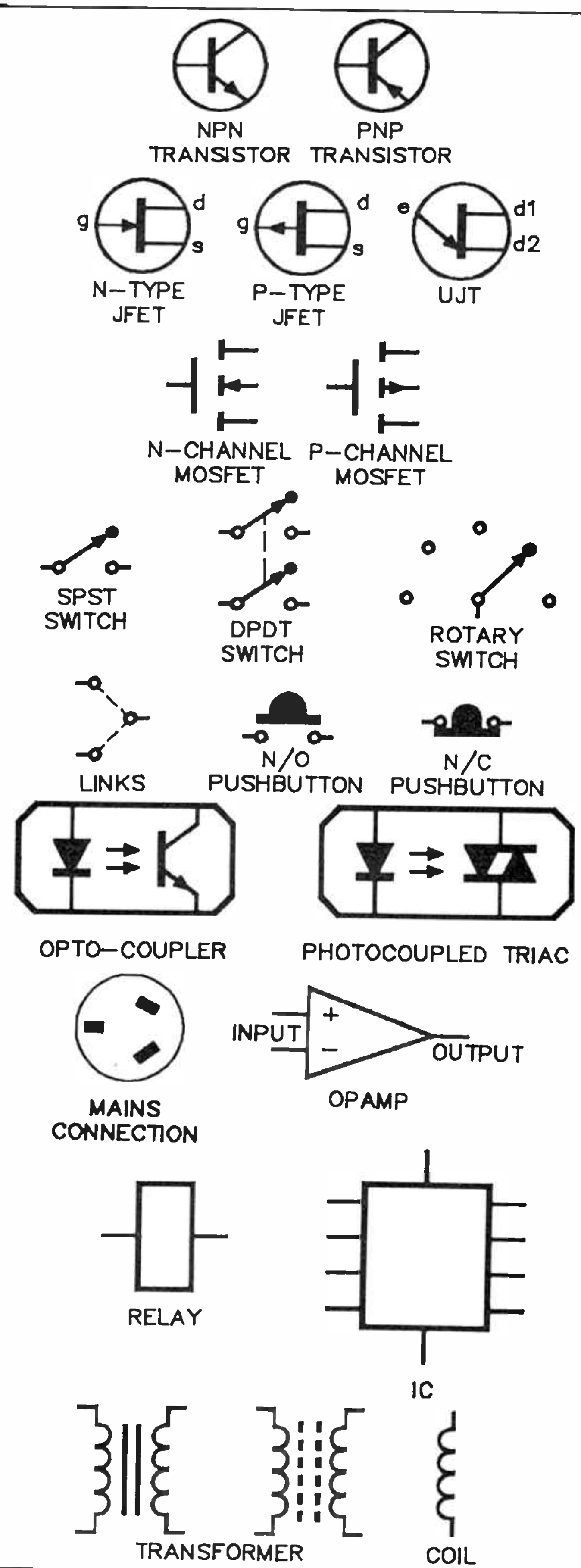
The TLH-400 is ex-stock from **Promark Electronics, PO Box 381, Crows Nest 2065** NSW

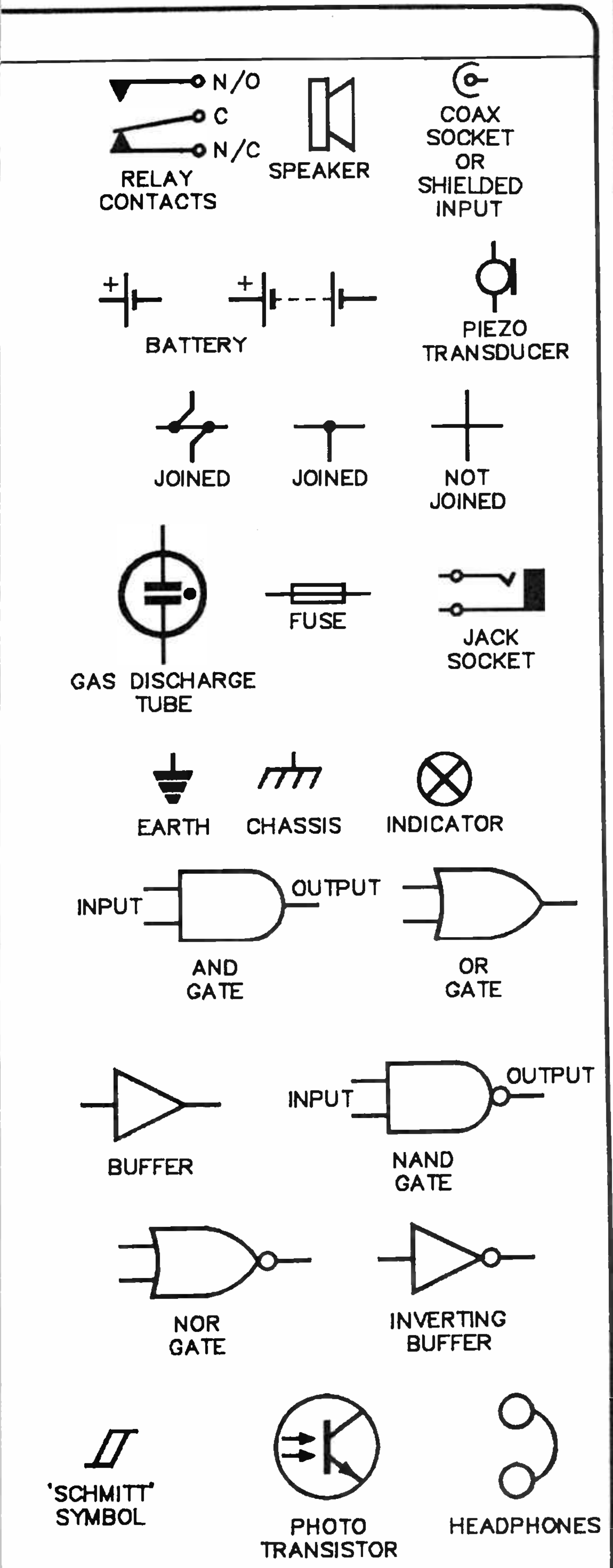
The common component symbols

THE FIRST STEP in being able to read and understand electronic circuits, is to know the common component symbols employed and what they stand for. This article illustrates the common component symbols we employ in our circuit drawings and diagrams to represent the electronic components and devices actually used.

A circuit is nothing more than a diagram which shows the connections between an assembly of components, giving some indication of its working, but not necessarily its physical assembly or construction.



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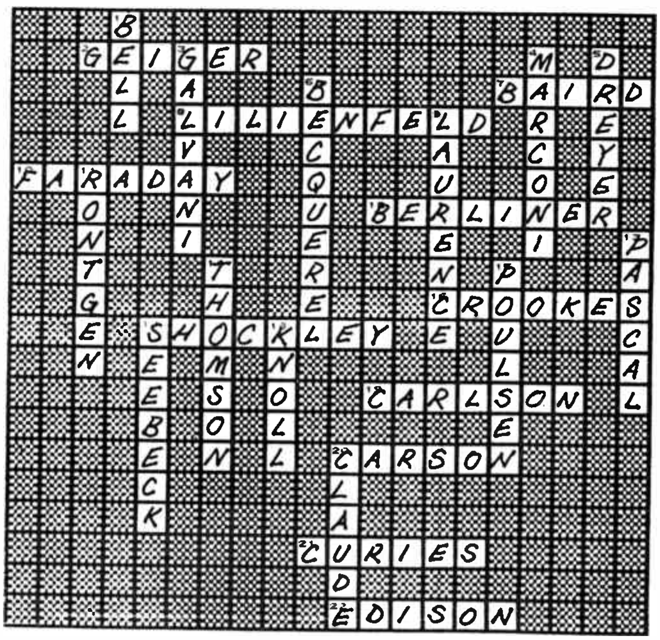

HOBBYIST TOOLKIT — SPECIAL READER OFFER

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The set of tools comes in an attractive and useful carrying case that holds all the pieces. The tools included in the kit comprise the following:

Drill stand, jigsaw, orbital sander, flexible shaft and motor, grinding tool, 3 mm drill, sandpaper, set of 10 spare jigsaw blades, tommy bar for drill, small G-clamp, Allen key, extension dc lead.

The Minitool **drill** has a chuck that will accommodate drill sizes from 0.8 mm diameter (commonly used for drilling component lead holes in printed circuit boards) right up to 6 mm diameter. Chuck speed is approximately 7000 rpm. The Minitool **jigsaw** is able to cut wood down to a depth of 7 mm and is ideal for use on plastic 'jiffy' cases, etc. The blunt saw tip protects against injury. The **orbital sander** is just the thing for 'finishing off' surfaces and edges. It has a sanding face of 65 x 90 mm.

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A look at ultrasonic pest repellers

IT SEEMS electronic pest control employing ultrasonic sound has been around some 20 years or more. Early efforts employed valved equipment drawing many watts from the ac mains and inefficient transducers to deliver, well, not very efficient results. Perhaps disappointing past experience accounts, in part, for a pervading 'suspicion' of electronic pest control devices and a continued reliance on chemical poisons.

However, electronic pest control devices have proliferated in the past half-decade, so something must be working in their favour. It seems a little background research and the general development of electronic componentry has contributed.

Apparently, research into the effects of sound waves on such undesirable creatures as rats, mice and cockroaches has shown that they're all susceptible to high level ultrasonic sound waves in different ways. Whatever these sound waves (above the range of human hearing) do to the creatures, they show a distinct propensity to vacate the vicinity of anything that generates loud ultrasonic noises.

However, a single-pitch sound seems to lose its discouraging effect after a short while, but complex, modulated (especially swept-frequency) ultrasonic sounds do not. This seems to be the basis of circuitry found in modern ultrasonic pest controllers. The different creatures react to ultrasonic sounds at different parts of the spectrum, so generators that sweep over a range of frequencies are employed to 'catch' all the pests in their 'net'.

Common low-cost solid-state devices and efficient piezoelectric transducers make modern repellers 'run rings' around those early behemoths. Both mains and battery — operated models are available, some offering operation from either power source.

Inside a commercial unit

Figure 1 shows the circuit of what you might find inside a commercial ultrasonic pest repeller. Simple, isn't it? The 555 is simply arranged as an astable multivibrator, oscillating at a frequency in the 40 kHz region. Output is taken direct from pin 3 to a small piezo horn tweeter. The voltage control pin (pin 5) is modulated by half-wave pulses coupled-in from the transformer secondary via the series RC circuit (100n capacitor and 4k7 resistor). This sweeps the 555 up and down over a range of ultrasonic frequencies.

The 555 output will provide a few volts peak drive to the small piezo-electric ceramic horn tweeter. (Rather like those found in PA speaker systems). These exhibit a response which extends through to the Ultrasonic frequences, although efficiency falls off.

Heaven knows what 'coverage,' such a unit provides, but the circuitry has the obvious advantages of simplicity and low cost.

The circuit of another commercial unit is illustrated in Figure 2. Yet again, it's pretty simple. The ultrasonic oscillator employs a 4011 quad NAND gate package, with two parallel-connected pairs of gates arranged as a feedback oscillator. It runs at about 40 kHz. The output drives a Darlington amplifier employing a pair of power transistors. This will deliver considerably more output than the circuit of Figure 1.

This sort of oscillator is frequency sensitive to supply voltage variations and this characteristic is exploited here. The

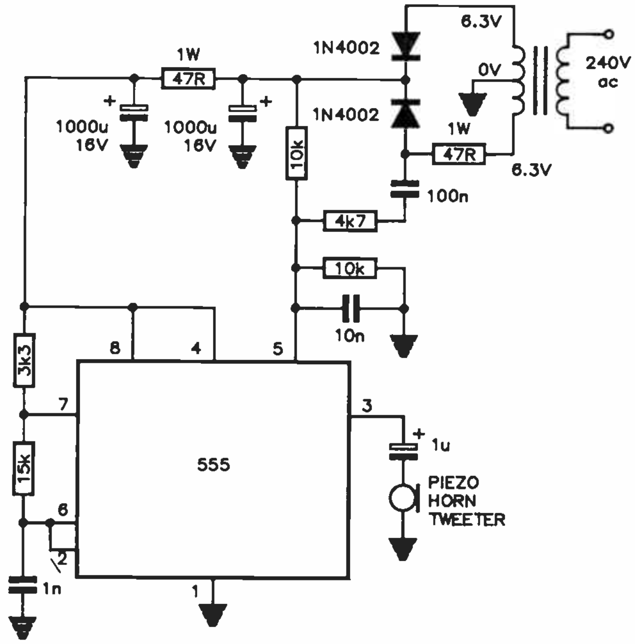

Figure 1.

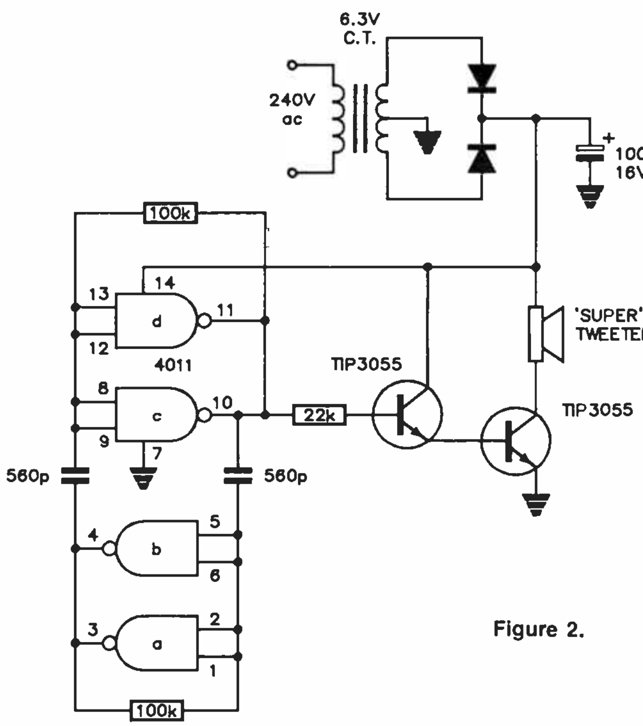

Figure 2.

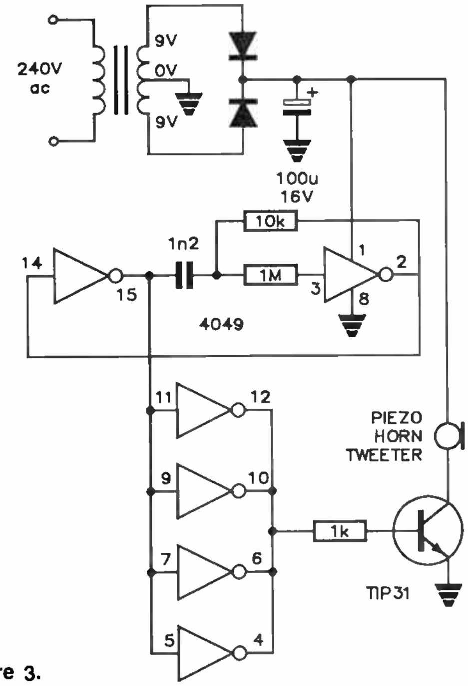

Figure 3.

rectifier output is only partially 'smoothed' by the 100u capacitor, so that the supply rail has a substantial 100 Hz ripple on it, causing the oscillator to sweep over the ultrasonic band. A bit of 100 Hz 'roughness' from supply ripple modulating the output stage just adds to the effect, in all probability.

Output is via a 'super tweeter', originally intended for hi-fi loudspeaker applications. There are some models around that have a response that extends to 40 kHz, particularly the 'ribbon' type tweeters. Such things are not inexpensive, though.

Figure 3 is something we would suggest as a starting point for experimentation. It employs readily available, low-cost components and should deliver substantial output.

Here, a 4049 hex CMOS buffer package is employed. Two buffers are arranged as an ultrasonic feedback oscillator, running at a centre frequency of about 40 kHz, the output being connected to the other four buffers connected in parallel. These provide ample drive to the single transistor output stage, which employs a common medium power device.

Once again, the oscillator is frequency sensitive to power supply variations and an inadequately smoothed rectifier is used to both power and modulate the oscillator.

Before you rush to the workbench to lash-up your electronic rodent ravager, keep in mind that the output level from these devices can be in the region of 100 dB spl or more. While it's well beyond human hearing, creatures other than rats, mice and cockroaches may be able to hear it and might react with some distress.

Practicalities is an occasional column dealing with *practical* electronic circuit and construction techniques. Contributions — short or long — are always welcome. We pay for all items published. Contributors should supply typed manuscripts, double-spaced, with at least a 40 mm margin all round, one side of the paper only please. Diagrams may be hand-drawn, but please draw clearly, preferably on graph paper. Manuscripts should be sent to **'Practicalities'. Australian Electronics Monthly, PO Box 289, Wahroonga NSW 2076.**

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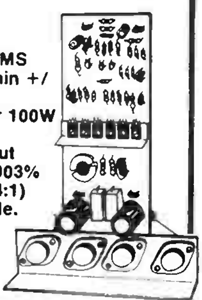
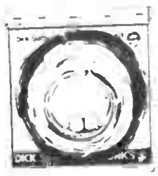
- **Noise: - 100dB below full output**
- **Intermodulation Distortion: 0.003% at 100W (50Hz & 7kHz mixed 4:1)**
- **Stability: Unconditionally stable.**



60 Watt Mosfet Cat K-3441 **$49**
100 Watt Mosfet Cat K-3443 **$69**



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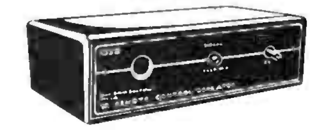

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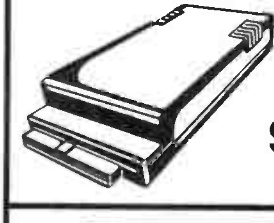

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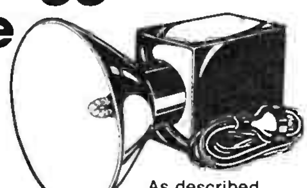

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DICK SMITH® ELECTRONICS

aem data sheet

EXAR XR-2211

FSK Demodulator/Tone Decoder

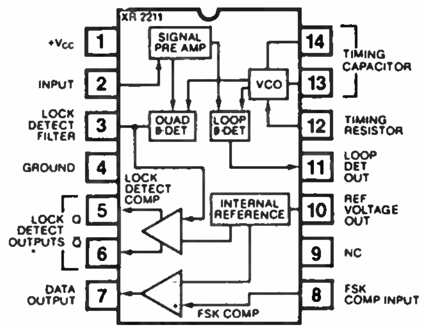
Many thanks to Exar's Australian agent, Tronic Bits, for permission to reproduce this data sheet information. More information on Exar products is obtainable from:
Tronic Bits
PO Box 371
MENTONE 3194 Vic.
(03) 587 2257

GENERAL DESCRIPTION

The XR-2211 is a monolithic phase-locked loop (PLL) system especially designed for data communications. It is particularly well suited for FSK modem applications. It operates over a wide supply voltage range of 4.5 to 20V and a wide frequency range of 0.01 Hz to 300 kHz. It can accommodate analog signals between 2 mV and 3V, and can interface with conventional DTL, TTL, and ECL logic families. The circuit consists of a basic PLL for tracking an input signal within the pass band, a quadrature phase detector which provides carrier detection, and an FSK voltage comparator which provides FSK demodulation. External components are used to independently set center frequency, bandwidth, and output delay. An internal voltage reference proportional to the power supply provides ratio metric operation for low system performance variations with power supply changes.

The XR-2211 is available in 14 pin DTL ceramic or plastic packages specified for commercial or military temperature ranges.

FUNCTIONAL BLOCK DIAGRAM



APPLICATIONS

FSK Demodulation
Data Synchronization
Tone Decoding
FM Detection
Carrier Detection

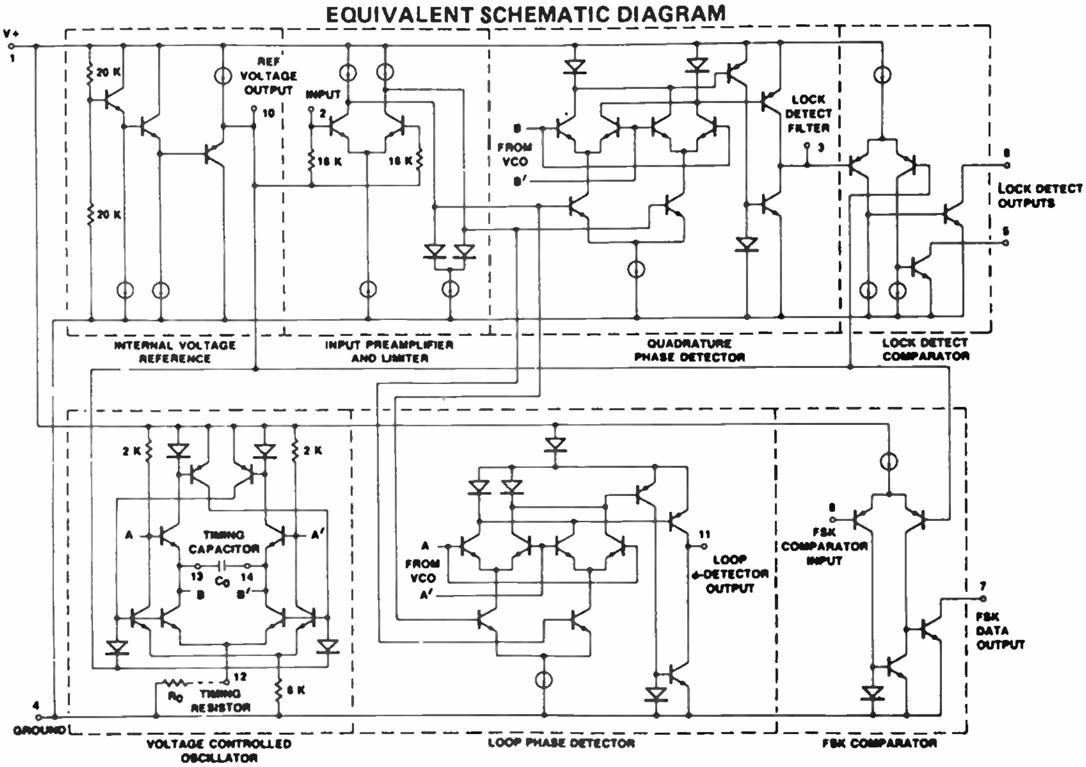
FEATURES

Wide Frequency Range	0.01 Hz to 300 kHz
Wide Supply Voltage Range	4.5V to 20 V
DTL/TTL/ECL Logic Compatibility	
FSK Demodulation, with Carrier Detection	
Wide Dynamic Range	2 mV to 3 V rms
Adjustable Tracking Range (±1% to ±80%)	
Excellent Temp. Stability	20 ppm/°C, typ.

ABSOLUTE MAXIMUM RATINGS

Power Supply	20V
Input Signal Level	3V rms
Power Dissipation	
Ceramic Package	750 mW
Derate Above T_A = +25°C	6 mV/°C
Plastic Package	
Derate Above T_A = +25°C	5.0 mW/°C

EQUIVALENT SCHEMATIC DIAGRAM



XR-2211

Part Number	Package	Operating Temperature
XR-2211CN	Ceramic	0°C to +70°C
XR-2211CP	Plastic	0°C to +70°C
XR-2211P	Plastic	−40°C to +85°C

ELECTRICAL CHARACTERISTICS

Test Conditions: Test Circuit of Figure 1, $V^+ = V^- = 6V$, $T_A = +25°C$, $C = 5000\,pF$, $R_1 = R_2 = R_3 = R_4 = 20\,k\Omega$, $R_L = 4.7\,k\Omega$. Binary Inputs grounded, S_1 and S_2 closed, unless otherwise specified.

PARAMETER	XR-2211/2211M			XR-2211C			UNITS	CONDITIONS
	MIN	TYP	MAX	MIN	TYP	MAX		
GENERAL								
Supply Voltage	4.5		20	4.5		20	V	
Supply Current		4	7		5	9	mA	$R_0 \geq 10\,k\Omega$. See Fig. 4
OSCILLATOR SECTION								
Frequency Accuracy		±1	±3		±1		%	Deviation from $f_0 = 1/R_0C_0$
Frequency Stability								$R_1 = 1/2$
Temperature		±20	±50		±20		ppm/°C	See Fig. 8.
Power Supply		0.05	0.5		0.05		%/V	$V^+ = 12 \pm 1V$. See Fig. 7.
		0.2			0.2		%/V	$V^+ 5 \pm 0.5V$. See Fig. 7.
Upper Frequency Limit	100	300			300		kHz	$R_0 = 8.2\,k\Omega$, $C_0 = 400\,pF$
Lowest Practical Operating Frequency			0.01		0.01		Hz	$R_0 = 2\,M\Omega$, $C_0 = 50\,\mu F$
Timing Resistor, R_0								See Fig. 5.
Operating Range	5		2000	5		2000	kΩ	
Recommended Range	15		100	15		100	kΩ	See Figs. 7 and 8.
LOOP PHASE DETECTOR SECTION								
Peak Output Current	±150	±200	±300	±100	±200	±300	µA	Measured at Pin 11.
Output Offset Current		±1			±2		µA	
Output Impedance		1			1		MΩ	
Maximum Swing	±4	±5		±4	±5		V	Referenced to Pin 10.
QUADRATURE PHASE DETECTOR								Measured at Pin 3.
Peak Output Current	100	150			150		µA	
Output Impedance		1			1		MΩ	
Maximum Swing		11			11		V pp	
INPUT PREAMP SECTION								Measured at Pin 2.
Input Impedance		20			20		kΩ	
Input Signal Voltage Required to Cause Limiting		2	10		2		mV rms	
VOLTAGE COMPARATOR SECTIONS								
Input Impedance		2			2		MΩ	Measured at Pins 3 and 8.
Input Bias Current		100			100		nA	
Voltage Gain	55	70		55	70		dB	$R_L = 5.1\,k\Omega$
Output Voltage Low		300			300		mV	$I_C = 3\,mA$
Output Leakage Current		0.01			0.01		µA	$V_O = 12V$
INTERNAL REFERENCE								
Voltage Level	4.9	5.3	5.7	4.75	5.3	5.85	V	Measured at Pin 10.
Output Impedance		100			100		Ω	

SYSTEM DESCRIPTION

The main PLL within the XR-2211 is constructed from an input preamplifier, analog multiplier used as a phase detector, and a precision voltage controlled oscillator (VCO). The preamplifier is used as a limiter such that input signals above typically 2MV RMS are amplified to a constant high level signal. The multiplying-type phase detector acts as a digital exclusive or gate. Its output (unfiltered) produces sum and difference frequencies of the input and the VCO output, f input + f input (2f input) and f input - f input (0 Hz) when the phase detector output to remove the "sum" frequency component while passing the difference (DC) component to drive the VCO. The VCO is actually a current controlled oscillator with its nominal input current (f_0) set by a resistor (R_0) to ground and its driving current with a resistor (R_1) from the phase detector.

The other sections of the XR-2211 act to: determine if the VCO is driven above or below the center frequency (FSK comparator); produced both active high and active low outputs to indicate when the main PLL is in lock (quadrature phase detector and lock detector comparator).

FSK Data Output (Pin 7): This output is an open collector logic stage which requires a pull-up resistor, R_L, to V+ for proper operation. It can sink 5 mA of load current. When decoding FSK signals, FSK data output is at "high" or "off" state for low input frequency, and at "low" or "on" state for high input frequency. If no input signal is present, the logic state at Pin 7 is indeterminate.

FSK Comparitor Input (Pin 8): This is the high impedance input to the FSK voltage comparator. Normally, an FSK post-detection or data filter is connected between this terminal and the PLL phase detector output (Pin 11). This data filter is formed by R_F and C_F of Figure 2. The threshold voltage of the comparator is set by the internal reference voltage, V_R, available at Pin 10.

PRINCIPLES OF OPERATION

Signal Input (Pin 2): Signal is ac coupled to this terminal. The internal impedance at Pin 2 is 20 KΩ. Recommended input signal level is in the range of 10 mV rms to 3V rms.

Quadrature Phase Detector Output (Pin 3): This is the high impedance output of quadrature phase detector and is internally connected to the input of lock detect voltage comparator. In tone detection applications, Pin 3 is connected to ground through a parallel combination of R_D and C_D (see Figure 2) to eliminate the chatter at lock detect outputs. If the tone detect section is not used, Pin 3 can be left open circuited.

Lock Detect Output, Q (Pin 5): The output at Pin 5 is at "high" state when the PLL is out of lock and goes to "low" or conducting state when the PLL is locked. It is an open collector type output and requires a pull-up resistor, R_L, to V+ for proper operation. At "low" state, it can sink up to 5 mA of load current.

Lock Detect Complement, $\bar{Q}$ (Pin 6): The output at Pin 6 is the logic complement of the lock detect output at Pin 5. This output is also an open collector type stage which can sink 5 mA of load current at low or "on" state.

Reference Voltage, V_R (Pin 10): This pin is internally biased at the reference voltage level, V_R: V_R = V+/2 - 650 mV. The dc voltage level at this pin forms an internal reference for the voltage levels at Pins 5, 8, 11 and 12. Pin 10 *must* be bypassed to ground with a 0.1 μF capacitor for proper operation of the circuit.

Loop Phase Detector Output (Pin 11): This terminal provides a high impedance output for the loop phase detector. The PLL loop filter is formed by R_1 and C_1 connected to Pin 11 (see Figure 2). With no input signal, or with no phase error within the PLL, the dc level at Pin 11 is very nearly equal to V_R. The peak voltage swing available at the phase detector output is equal to $\pm V_R$.

VCO Control Input (Pin 12): VCO free-running frequency is determined by external timing resistor, R_0, connected from this terminal to ground. The VCO free-running frequency, f_0, is:

$$f_0 = \frac{1}{R_0 C_0} \text{Hz}$$

where C_0 is the timing capacitor across Pins 13 and 14. For optimum temperature stability, R_0 must be in the range of 10 KΩ to 100 KΩ see Figure 8).

This terminal is a low impedance point, and is internally biased at a dc level equal to V_R. The maximum timing current drawn from Pin 12 must be limited to ≤3 mA for proper operation of the circuit.

VCO Timing Capacitor (Pins 13 and 14): VCO frequency is inversely proportional to the external timing capacitor, C_0, connected across these terminals (see Figure 5). C_0 must be nonpolar, and in the range of 200 pF to 10 μF.

VCO Frequency Adjustment: VCO can be fine-tuned by connecting a potentiometer, R_X, in series with R_0 at Pin 12 (see Figure 9).

VCO Free-Running Frequency, f_0: XR-2211 does not have a separate VCO output terminal. Instead, the VCO outputs are internally connected to the phase detector sections of the circuit. However, for set-up or adjustment purposes, VCO free-running frequency can be measured at Pin 3 (with C_D disconnected), with no input and with Pin 2 shorted to Pin 10.

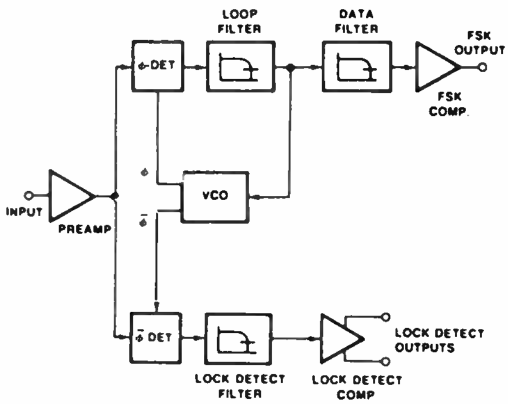


Figure 1. Functional Block Diagram of a Tone and FSK Decoding System Using XR-2211

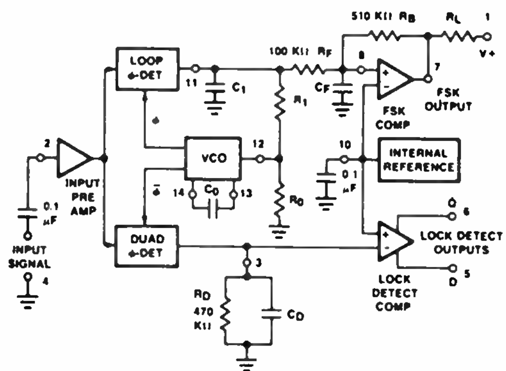


Figure 2. Generalized Circuit Connection for FSK and Tone Detection

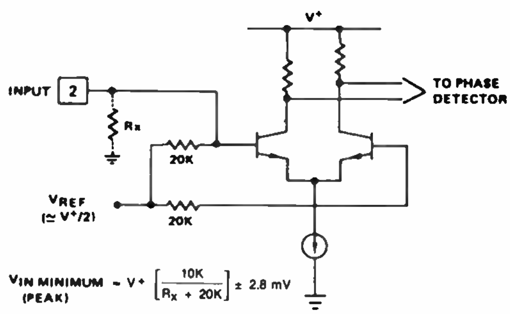


Figure 3. Desensitizing Input Stage

XR-2211

DESIGN EQUATIONS

(See Figure 2 for definition of components.)

1. VCO Center Frequency, f_0:

   $f_0 = 1/R_0C_0$ Hz

2. Internal Reference Voltage, V_R (measured at Pin 10):

   $V_R = V+/2 - 650$ mV

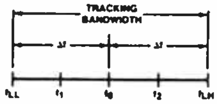
3. Loop Low-Pass Filter Time Constant, τ:

   $\tau = R_1C_1$

4. Loop Damping, ζ:

   $$\zeta = 1/4\sqrt{\frac{C_0}{C_1}}$$

5. Loop Tracking Bandwidth, $\pm\Delta f/f_0$:
   $\Delta f/f_0 = R_0/R_1$



6. FSK Data Filter Time Constant, τF:
   $\tau F = R_FC_F$

7. Loop Phase Detector Conversion Gain, $K\phi$: ($K\phi$ is the differential dc voltage across Pins 10 and 11, per unit of phase error at phase detector input):

   $K\phi = 02V_R/\pi$ volts/radian

8. VCO Conversion gain, K_0: (K_0 is the amount of change in VCO frequency, per unit of dc voltage change at Pin 11):

   $K_0 = -1/V_RC_0R_1$ Hz/volt

9. Total Loop Gain, K_T.

   $K_T = 2\pi K\phi K_0 = 4/C_0R_1$ rad/sec/volt

10. Peak Phase Detector Current I_A:

    $I_A = V_R$ (volts)/25 mA

APPLICATIONS INFORMATION

FSK DECODING:

Figure 9 shows the basic circuit connection for FSK decoding. With reference to Figures 2 and 9, the functions of external components are defined as follows: R_0 and C_0 set the PLL center frequency, R_1 sets the system bandwidth, and C1 sets the loop filter time constant and the loop damping factor. C_F and R_F form a one-pole post-detection filter for the FSK data output. The resistor R_B (= 510 KΩ) from Pin 7 to Pin 8 introduces positive feedback across the FSK comparator to facilitate rapid transition between output logic states.

Recommended component values for some of the most commonly used FSK bands are given in Table 1.

Design Instructions:

The circuit of Figure 9 can be tailored for any FSK decoding application by the choice of five key circuit components: R_0, R_1, C_0, C_1 and C_F. For a given set of FSK mark and space frequencies, f_1 and f_2, these parameters can be calculated as follows:

a) Calculate PLL center frequency, f_0:

$$f_0 = \frac{f_1 + f_2}{2}$$

b) Choose value of timing resistor R_0, to be in the range of 10 KΩ to 100 KΩ. This choice is arbitrary. The recommended value is $R_0 \approx 20$ KΩ. The final value of R_0 is normally fine-tuned with the series potentiometer, R_X.

c) Calculate value of C_0 from design equation (1) or from Figure 6:

   $C_0 = 1/R_0f_0$

d) Calculate R_1 to give a Δf equal to the mark space deviation:

   $R_1 = R_0[f_0/(f_1 = f_2)]$

e) Calculate C_1 to set loop damping. (See design equation No. 4.):

   Normally, $\zeta \approx 1/2$ is recommended.

   Then: $C_1 = C_0/4$ for $\zeta = 1/2$

f) Calculate Data Filter Capacitance, C_F:

   For $R_F = 100$ KΩ, $R_B = 510$ KΩ, the recommended value of C_F is:

   $C_F \approx 3/(\text{Baud Rate})\ \mu F$

Note: All calculated component values except R_0 can be rounded to the nearest standard value, and R_0 can be varied to fine-tune center frequency, through a series potentiometer, R_X. (See Figure 9.)

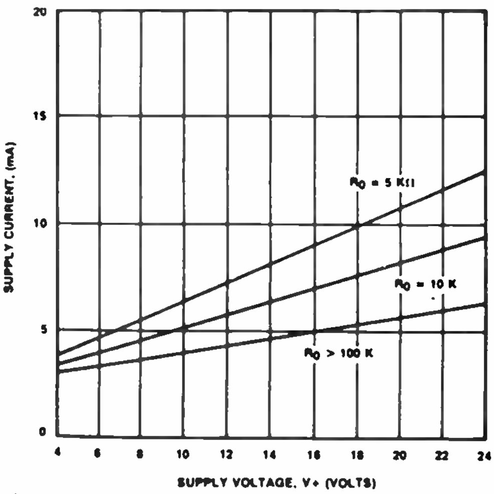


Figure 4. Typical Supply Current vs V+ (Logic Outputs Open Circuited)

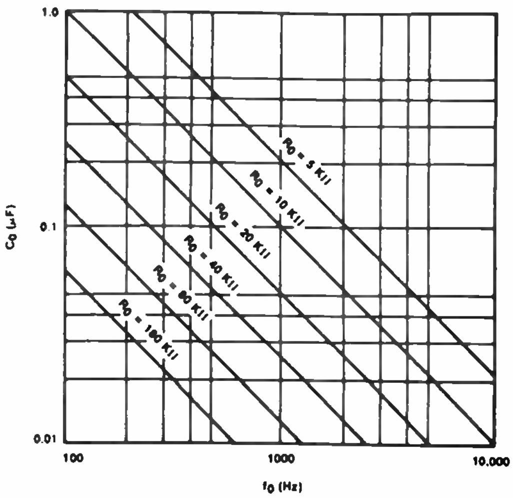


Figure 5. VCO Frequency vs Timing Resistor

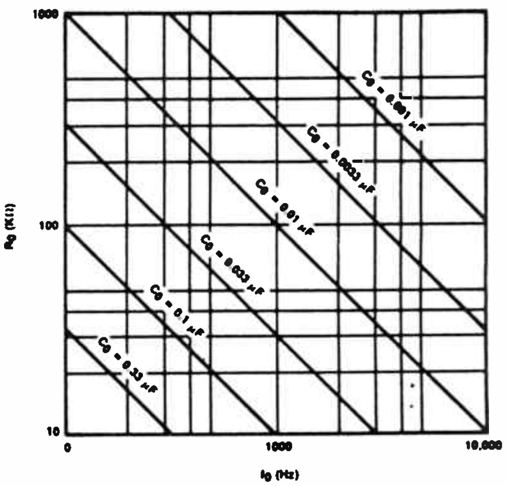


Figure 6. VCO Frequency vs Timing Capacitor

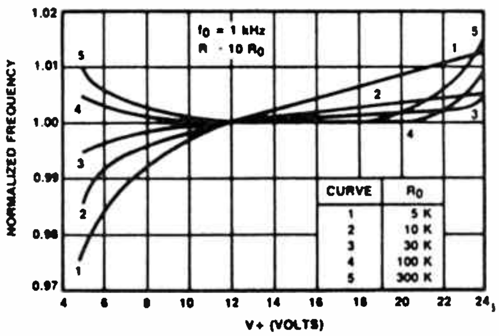


Figure 7. Typical f_0 vs Power Supply Characteristics

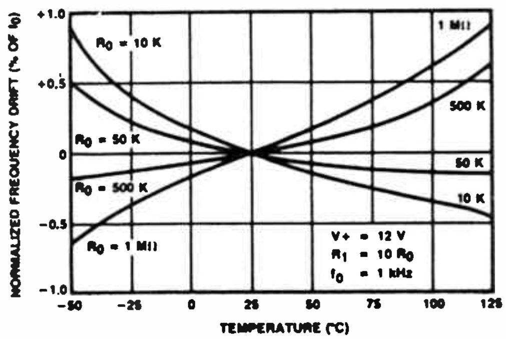


Figure 8. Typical Center Frequency Drift vs Temperature

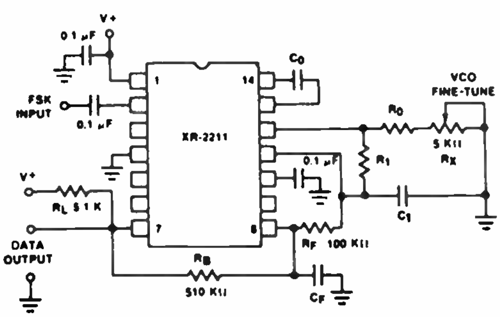


Figure 9. Circuit Connection for FSK Decoding

Design Example:

75 Baud FSK demodulator with mark space frequencies of 1110/1170 Hz:

Step 1: Calculate f_0: f_0 (1110 + 1170) (1/2) = 1140 Hz

Step 2: Choose R_0 - 20 KΩ (18 KΩ fixed resistor in series with 5 KΩ potentiometer)

Step 3: Calculate C_0 from Figure 6: C_0 = 0.044 µF

Step 4: Calculate R_1: R_1 = R_0 (2240/60) = 380 KΩ

Step 5: Calculate C_1: C_1 = C_0/4 = 0.011 µF

Note: All values except R_0 can be rounded to *nearest* standard value.

Table 1. Recommended Component Values for Commonly Used FSK Bands. (See Circuit of Figure 9.)

FSK BAND	COMPONENT VALUES
300 Baud f_1 = 1070 Hz F_2 = 1270 Hz	C_0 = 0.039 µF C_F = 0.005 µF C_1 = 0.01 µF R_0 = 18 KΩ R_1 = 100 KΩ
300 Baud f_1 = 2025 Hz f_2 = 2225 Hz	C_0 = 0.022 µF C_F = 0.005 µF C_1 = 0.0047 µF R_0 = 18 KΩ R_1 = 200 KΩ
1200 Baud f_1 = 1200 Hz f_2 = 2200 Hz	C_0 = 0.027 µF C_F = 0.0022 µF C_1 = 0.01 µF R_0 = 18 KΩ R_1 = 30 KΩ

FSK DECODING WITH CARRIER DETECT:

The lock detect section of XR-2211 can be used as a carrier detect option, for FSK decoding. The recommended circuit connection for this application is shown in Figure 10. The open collector lock detect output, Pin 6, is shorted to data output (Pin 7). Thus, data output will be disabled at "low" state, until there is a carrier within the detection band of the PPL, and the Pin 6 output goes "high," to enable the data output.

The minimum value of the lock detect filter capacitance C_D is inversely proportional to the capture range, $\pm \Delta f_C$. This is the range of incoming frequencies over which the loop can acquire lock and is always less than the tracking range. It is further limited by C_1. For most applications, $\Delta f_C > \Delta f/2$. For R_D = 470 KΩ, the approximate minimum value of C_D can be determined by:

C_D (µF) ≥ 16/capture range in Hz.

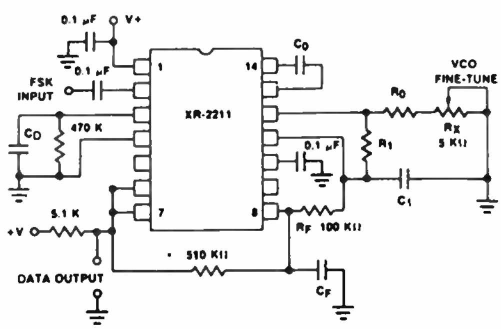


Figure 10. External Connectors for FSK Demodulation with Carrier Detect Capability

Note: Data Output is "Low" When No Carrier is Present.

XR-2211

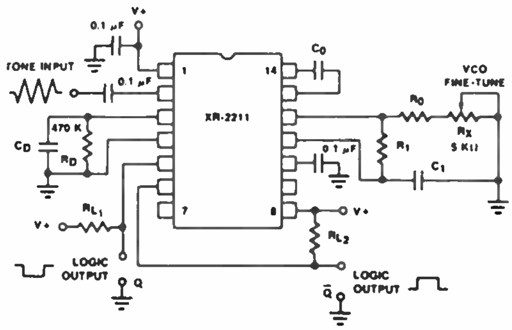


Figure 11. Circuit Connection for Tone Detection

With values of C_D that are too small, chatter can be observed on the lock detect output as an incoming signal frequency approaches the capture bandwidth. Excessively large values of C_D will slow the response time of the lock detect output.

TONE DETECTION:

Figure 11 shows the generalized circuit connection for tone detection. The logic outputs, Q and $\overline{Q}$ at Pins 5 and 6 are normally at "high" and "low" logic states, respectively. When a tone is present within the detection band of the PLL, the logic state at these outputs become reversed for the duration of the input tone. Each logic output can sink 5 mA of load current.

Both logic outputs at Pins 5 and 6 are open collector type stages, and require external pull-up resistors R_{L1} and R_{L2}, as shown in Figure 11.

With reference to Figures 2 and 11, the functions of the external circuit components can be explained as follows: R_0 and C_0 set VCO center frequency; R_1 sets the detection bandwidth; C_1 sets the low pass-loop filter time constant and the loop damping factor. R_{L1} and R_{L2} are the respective pull-up resistors for the Q and $\overline{Q}$ logic outputs.

Design Instructions:

The circuit of Figure 11 can be optimized for any tone detection application by the choice of the 5 key circuit components: R_0, R_1, C_0, C_1 and C_D. For a given input, the tone frequency, f_S, these parameters are calculated as follows:

a) Choose R_0 to be in the range of 15 KΩ to 100 KΩ. This choice is arbitrary.

b) Calculate C_0 to set center frequency, f_0 equal to f_S (see Figure 6): $C_0 = 1/R_0 f_S$

c) Calculate R_1 to set bandwidth $\pm\Delta f$ (see design equation No. 5):

$R_1 = R_0(f_0/\Delta f)$

Note: The total detection bandwidth covers the frequency range of $f_0 \pm \Delta f$.

d) Calculate value of C_1 for a given loop damping factor:

$C_1 = C_0/16\,\zeta^2$

Normally $\zeta \approx 1/2$ is optimum for most tone detector applications, giving $C_1 = 0.25\,C_0$.

Increasing C_1 improves the out-of-band signal rejection, but increases the PLL capture time.

e) Calculate value of filter capacitor C_D. To avoid chatter at the logic output, with $R_D = 470$ KΩ, C_D must be:

$C_D(\mu F) \geq (16/\text{capture range in Hz})$

Increasing C_D slows down the logic output response time.

Design Examples:

Tone detector with a detection band of 1 kHz ± 20 Hz:

a) Choose $R_0 = 20$ KΩ (18 KΩ in series with 5 KΩ potentiometer).

b) Choose C_0 for $f_0 = 1$ kHz (from Figure 6): $C_0 = 0.05\ \mu F$.

c) Calculate R_1: $R_1 = (R_0)(1000/20) = 1$ MΩ.

d) Calculate C_1: for $\zeta = 1/2$, $C_1 = 0.25$, $C_0 = 0.013\ \mu F$.

e) Calculate C_D: $C_D = 16/38 = 0.42\ \mu F$.

f) Fine-tune center frequency with 5 KΩ potentiometer, R_X.

LINEAR FM DETECTION:

XR-2211 can be used as a linear FM detector for a wide range of analog communications and telemetry applications. The recommended circuit connection for this application is shown in Figure 12. The demodulated output is taken from the loop phase detector output (Pin 11), through a post-detection filter made up of R_F and C_F, and an external buffer amplifier. This buffer amplifier is necessary because of the high impedance output at Pin 11. Normally, a non-inverting unity gain op amp can be used as a buffer amplifier, as shown in Figure 12.

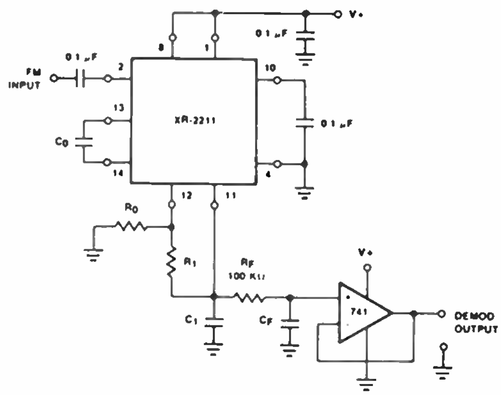


Figure 12. Linear FM Detector Using XR-2211 and an External Op Amp. (See Section on Design Equation for Component Values.)

The FM detector gain, i.e., the output voltage change per unit of FM deviation can be given as:

$V_{out} = R_1\ V_R/100\ R_0$ Volts/% deviation

where V_R is the internal reference voltage ($V_R = V+/2 - 650$ mV). For the choice of external components R_1, R_0, C_D, C_1 and C_F, see section on design equations.

— from page 20.

Courses and careers

personnel in both the electronics and computing fields.

Courses offering training for people wishing to pursue middle level positions in the industry include the Electronics Engineering Certificate, Electrical Engineering Certificate and the Computer Science Technology Certificate courses offered by TAFE. Details of these courses will be discussed later in this article. As these courses do not differ too much between the states only a small sample of the courses will be discussed due to space constraints.

Electronics Engineering Certificate Course (2829)

Introduced in 1980 to replace the Electronics and Communication Certificate, this course is regarded as one of the most versatile courses available. The Electronics Engineering Certificate Course provides training for such "middle level" positions as technical officers, design draftspeople, technical salespeople and engineering assistants in the major field of electronics. Elective subjects are available in the fields of radio, television, communications, industrial electronics, computer hardware, microprocessors and others enabling students to specialise in a wide variety of interests.

The course gives students a sound knowledge of the theory, processes and techniques in their chosen field as well as an understanding of the standards and regulations pertinent to their employment. Communication skills and the preparation and interpretation of technical reports and drawings are also taught. The course is recognised by the Australian Institute of Engineering Associates Ltd. (AIEA) and also the Institution of Radio and Electronics Engineers, Australia (IREE) and successful completion of the course enables the student to become a member of these bodies.

The course is offered on a part or full time basis over four stages. Stages 1 & 2 are common to the Electrical Engineering Certificate and this allows the student extra time in order to decide on his/her career orientation. The final stages (3 & 4) offer a core of compulsory subjects with a larger component of specialisation. Stages 1 & 2 of the course (1st and 2nd semesters-for full time students) cover introductory subjects such as maths, physics, ac & dc circuits, introductory instruments, electronics, electrostatics and magnetism, technical communication and digital electronics. Full time students are expected to spend three hours weekly on workshop technology in order to gain practical training and also to pursue "life orientated" studies which deals with issues arising from working in the modern industrial environment.

Stage 3 introduces a number of electives such as computer systems, antennas and propagation, communications measurements, radio transmitters & receivers, microwave techniques and several elective topics on TV. Several computing options are offered, for example computer communications and digital computers. These options allow the student to specialise in the interesting and lucrative field of computing.

Stage 4 allows even more specialization and students take the core subjects of electronic computations, network analysis, analogue electronics and electrical engineering materials.

Where to study

Part Time: Stages 1-4 are offered at Granville, Newcastle, Nth Sydney, St George and Wollongong TAFEs. Not all the electives are available at all these colleges.

Full Time: Entry to the full time course is more competitive and is offered at Granville, Nth Sydney, Newcastle and Wollongong TAFEs.

Entry Requirements:

The minimum requirement is the School Certificate with Science at grade 4, Maths grade 3; however, year 11 standard at least is recommended for entry into the full time course.

Enrolments:

Enquiries should be made in November/December for the February intake and during May/June for a possible July course. For more information contact the TAFE colleges listed earlier.

Electrical Engineering Certificate (2832)

This course aims to provide training for people seeking employment in middle level positions such as technical officers, technical supervisors etc. It is also open to tradespeople who want to upgrade their qualifications. The Electrical Engineering Certificate is very similar to the Electronics Engineering Certificate as Stages 1 & 2 are the same, although the choice of options is not as wide.

The course covers general engineering subjects such as maths, physics, introductory instruments, introductory electronics, electrostatics & magnetism and technical communications. A number of electives are offered in Stage 3 and these include electronic power control, mining electrical engineering, generation, transmission, distribution and utilisation etc.

Entry requirements, course duration and enrolments are similar to the Electronics Engineering Certificate. The course is also recognised by the Australian Institute of Engineering Associates Ltd. (AIEA) and the Institution of Radio and Electronics Engineers, Australia (IREE).

Where to study:

Part time: Stages 1-4 are available at Lithgow, Newcastle, St George, Sydney and Wollongong.

Stages 1-2 are offered at Bankstown, Granville, Mount Druitt, Muswellbrook, Nth Sydney, St George and Newcastle TAFEs.

Full Time: This is only offered at Sydney Technical College. First year only is offered at Granville, Mount Druitt, St George and Newcastle.

Computer Science Technology Certificate (2837)

Introduced last year, this is a new certificate course offered on a full time basis for two and a half years over five semesters. It caters for the increasing interest in computing and provides students with employment in the computer industry in such positions as customer engineer and computer service technician. Students who are interested in this course are advised to enrol in Stage 1 of the Electronics Engineering Certificate Course and then transfer to this course.

Students who successfully complete the course are eligible for the membership grade of Associate (Engineering) with the Institution of Radio and Electronic Engineers, Australia and are also eligible for membership of the Australian Institute of Engineering Associates Ltd. The course is very similar to the Electronics Certificate and offers specialisation in such subjects as computer principles, computer systems, digital computers, basic engineering, programming and computer communications. This course is offered at Nth Sydney TAFE and a number of metropolitan and country colleges.

Computing Courses

Data Processing Certificate Course

Data processors are concerned with designing, planning, implementing and programming electronic data processing (EDP) systems. The Data Processing Certificate course gives students specific skills in programming systems and understanding related business activities, eg: accounting and marketing. Courses commence in February and July each year and applications need to be made in January and June.

Subjects studied during the course include: data processing concepts, business and commercial systems, communications and various options in computer programming.

Where to study

Part Time: Meadowbank, Gosford, Newcastle, North Sydney, Padstow, Sydney, Seaforth and Wollongong.

Full Time: Newcastle, North Sydney, Padstow, St George and Sydney TAFEs.

Special Computing Courses

Other computing courses are offered at Sydney, Blacktown and North Sydney TAFEs. These include eighteen week courses on such areas as Data Processing Concepts and The Use and Management of Microcomputers. Several courses on programming are also offered and these include Computer Programming in Basic, Cobol, Fortran and RPG11. More information can be obtained from the Head of School, School of Business and Administrative Studies, Sydney Technical College, Mary Ann Street, Ultimo NSW 2007. (02) 217 3400.

More Details on TAFE Colleges

Sydney TAFE

Sydney Technical College is the headquarters of the School of Applied Electricity in NSW. It provides a large number of trades courses including Telecommunications and Electronics and also has a comprehensive range of courses on film and television which are outside the scope of this article. Sydney Tech. offers the full range of electronic courses and several short courses on computing. As can be expected it offers all the electives available for the Electrical Engineering and Power Generation Certificates.

Further details may be obtained from Sydney Technical College, Mary Ann Street, Ultimo NSW 2007. (02) 217 3400.

North Sydney TAFE

The headquarters of the School of Electrical Engineering is located at North Sydney Technical College. North Sydney TAFE offers a wide range of courses in electrical and electronic engineering including the Electrical Engineering, Electronic Engineering and Computer Science Technology Certificate courses. There is also a wide range of post-certificate courses available in electronics, electrical engineering and computer programming.

Further details from The Head, School of Electrical Engineering, North Sydney Technical College, Pacific Highway, Gore Hill NSW 2065, (02) 436 9200.

Newcastle TAFE

Offers a wide range of electronic and electrical engineering courses at both the trade and certificate levels. Most of the options are available at this college and it also offers its unique course on *Computing, a Practical Introduction*. This short course is designed to familiarise students with how computer systems function and give them an understanding of common computer terminology and the social implications of computer technology.

Further details from the Information Officer, Newcastle TAFE, Maitland Road, Tighes Hill NSW 2297. (049) 61 0461.

Box Hill TAFE (Vict)

Box Hill TAFE is a large, well established college offering a wide range of electronics courses at various levels. The Electronics Trade Dept. offers pre-vocational, apprenticeship and post-apprenticeship courses as well as adult electronic courses conducted in the evening. The pre-vocational courses are run through its Vocational Orientation Programme. These courses help students to prepare for further studies in electronics and electrical engineering. Courses are available in the areas of electronic and electrical engineering, science and computer studies.

Students enrolling in the apprenticeship courses must have reached the age of 15 with satisfactory completion of year 10 at high school. Attendance patterns vary, but students need a minimum of 960 hours to gain their certificate of proficiency. A large range of post-apprenticeship courses are offered and these include Communications, Radio Receivers and Digital Receivers.

The Certificate of Technology (General Electronics/Computing)

The Certificate of Technology in either General Electronics or Computing is equivalent to the Electronic Engineering Certificate in NSW. The course is divided into four stages with subjects taken on either a semester or yearly basis depending on full time or part time attendance. Completion of the full time course takes three years with one year being spent on approved work experience. Entry requirements are a minimum of year 11 passes in physics, maths, English or its equivalent.

Computer Operators' Certificate

This course gives students the necessary skills to find employment as trainee computer operators. Subjects offered give an insight into how computers work, how to enter and interpret data ▶

and how to write simple programs. Entrance requirements are a year 11 pass with good results in maths, English and the completion of an aptitude test administered by the college. Duration of the course is one year full time or three years part time.

Computer Users' Certificate
The course is designed for people working in business to assist them to learn to use a computer. It covers the role of the computer in business and how to operate mini and micro computers and is offered over eighteen months part time.

Microprocessor Technology Certificate
Offered by the Electronic Engineering Dept., this course provides specialised training in microprocessors with an emphasis on "hands-on" experience. It is advisable to have completed some form of electronics training before undertaking this course although exemptions are made. Subjects include, digital electronics, microprocessor fundamentals, systems and design.

Enrolments
Enrolments are in December and February for the February and July intakes.

Enquiries
The Head, Electronic Engineering Dept. Box Hill TAFE, PO Box 187, Box Hill Vic 3128. (03) 895 1332.

Swinburne TAFE

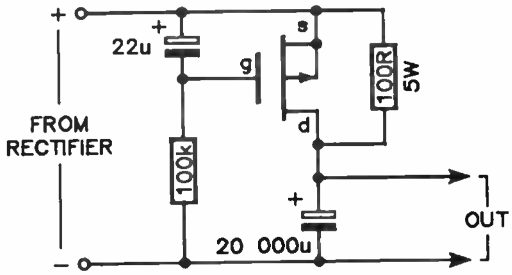
Shares the same grounds as Swinburne Institute of Technology and offers a wide range of electronics courses. Swinburne TAFE offers the Certificate of Technology (Electrical) which provides training for technical officers, technical draftspeople and engineering assistants. The course is run on a full time basis and graduates are eligible to become members of the Australian Institute of Engineering Associates Ltd. Entry requirements are year 11 standard in English, maths and physics. The Certificate of Technology (Electronics) offers more specialised training in the field of electronics and is also available with further specialisation in computers and communications.

Enquiries
The Head, Electronics Dept, Swinburne TAFE, John St, Hawthorn Vic. 3122, (03) 819 8493.

'Soft start' for power supplies

Large value electrolytics used on the rectifier output of a power supply act like a short circuit when the supply is first turned on. The 'in-rush' current can be many, many amps, putting quite a strain on the rectifier diodes and transformer secondary. (This accounts for the 'thump' often heard when turning equipment on.)

This circuit effectively places a resistance in series with the 20 000u supply smoothing capacitor that decreases gradually so that the capacitor is charged slowly. Hence the term, 'soft start'.



The varying resistance is provided by a P-type power MOSFET. When the supply is first turned on, the 22u capacitor will be discharged, effectively shorting the gate and source of the MOSFET, holding it off. Some charging current to the 20 000u smoothing capacitor will 'bleed' through the 100 ohm resistor, providing some initial charge. However, the 22u capacitor will gradually charge via the 100k resistor, forward-biasing the MOSFET gate. The source-drain current will gradually rise as the gate-source bias rises and hence, the charging current to the 20 000u capacitor will rise gradually.

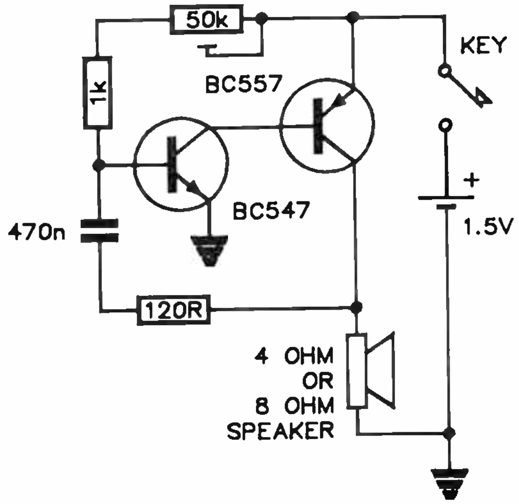
A power MOSFET having a very low on-resistance should be used, and check that the drain-source voltage rating is adequate. The smoothing capacitor value, 20 000u, is used as an example only.

Simple Morse practice oscillator

A transistor complementary-pair is connected here as a non-inverting amplifier in which feedback is provided from output to input via the 470n capacitor and 120 ohm series resistor. This provides positive feedback, thus making an oscillator.

When the key is pressed, the capacitor charges via the 50k trimpot and series 1k resistor, the 120R resistor and the speaker. When it charges to about half a volt, the base of the BC547 will be forward-biased and both transistors will turn on. But the capacitor will then be charged in the opposite direction via the 120 ohm resistor and the base-emitter junction of the BC547. This will reverse-bias the BC547's base, whereupon the two transistors will turn off. The capacitor will then charge, once again, via the 50k trimpot, repeating the whole cycle. The repetitive cycles will be heard as a tone in the speaker.

Most common complementary-pair transistors may be used here — such as the BC548/BC558, BC549/BC559, BC639/BC640 etc.



A 4 ohm speaker gives a louder output than an 8 ohm one. Increasing the battery voltage also improves the output. A 1.5 V battery (single dry cell) gives adequate results, a 6 V battery is positively deafening!

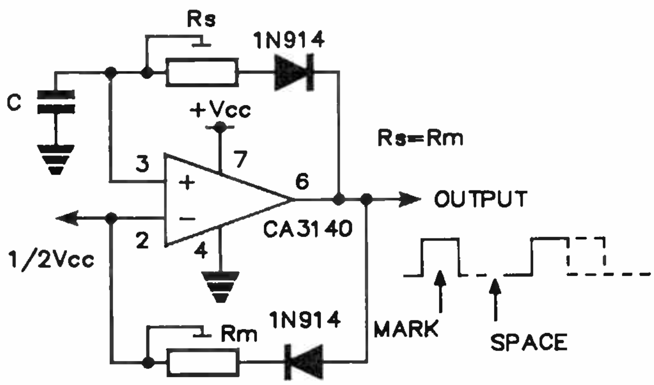
Benchbook is a column for circuit designs and ideas, workshop hints and tips from technical sources of the staff or you — the reader. If you've found a certain circuit useful or devised an interesting circuit, most likely other readers would be interested in knowing about it. If you've got a new technique 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.

Squarewave generator with variable mark and space

An op-amp squarewave oscillator is readily modified to provide independent variation of the mark and space periods.



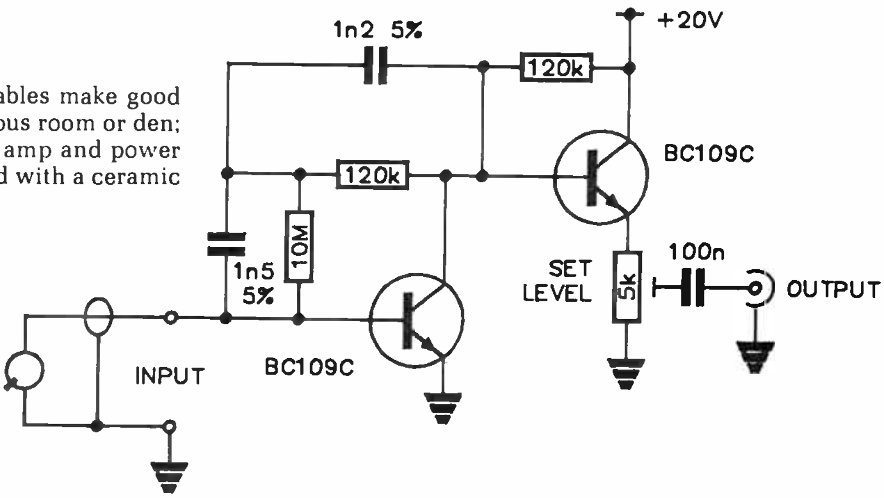
The circuit here has diodes placed in series with the charge and discharge paths of the usual op-amp CR squarewave oscillator. The resistances are made variable, thus providing variation for the capacitor's charge and discharge periods, providing variation of the mark and space periods. Varying either control alone will not affect the oscillator's fundamental period, but varying both trimpots will. The fundamental frequency is determined by the value of Rm and C. The frequency is given by:

$$f = \frac{1}{2.Rm.C}$$

Note that Rs = Rm.

Ceramic cartridge preamp features RIAA equalisation

Those commonly available low-cost turntables make good 'knock-around' record players for the rumpus room or den; just add a preamp and low cost IC power amp and power supply. Problem is, however, they are fitted with a ceramic



cartridge which requires a different style of preamp to that used with magnetic cartridges. This preamp circuit is designed specifically for a ceramic cartridge and provides correct RIAA equalisation accurate to within +/- 2 dB for ceramic cartridges which exhibit between 1000 pF and 10,000 pF (10 nF) of capacitance. (Note that two are required for stereo, naturally, one for each channel).

A pair of cascaded BC109Cs, direct-coupled, are used in an inverting amplifier circuit, output coming from the emitter of the second transistor. Feedback equalisation is applied from collector to base, lowering the input impedance, which allows the circuit to accept a wide range of cartridge capacitances. In addition, this makes the circuit less sensitive to cable capacitance and noise (hum) pickup.

For correct operation, there should be around 8-9 V on the collector of the first transistor. The capacitors should be good quality polyester, polypropelene or mica types. Low noise metal film resistors are recommended. A cermet-type trimpot should be used for the SET LEVEL control. This could be discarded and a 4k7 resistor substituted, the 100n output coupling capacitor then coming directly from the emitter of the second transistor.

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letters

Dear Sir,

Alerted by a note in the June '85 issue of "Technology in Education", I went to our local newsagent and obtained a copy of the first issue of your new journal.

I have now read it from cover to cover and am delighted at its content and presentation. It does definitely fill a gap, left for some time now by other similar publications in Australia, who appear to have drifted off into various esoteric directions, leaving the run-of-the-mill enthusiast like myself wondering.

I like the various levels of your articles, the selection of your projects, well presented and researched, and am convinced that, particularly under the guidance of some familiar names I appear to recognise, AEM is facing a bright future in the domain of popularising radio and electronics in a manner which would make the late Edwin Westwick very proud.

I am delighted to enclose my subscription for your excellent journal and hope to be reading it for many, many years to come.

Theodore L. Baitch
Seven Hills NSW.

Dear Roger,

Congratulations on the birth of a bouncing baby electronics magazine. I've just finished reading issue two and I'm glad free enterprise is alive and well in our ever-growing monopolistic world.

I used to buy both the others but I can see that AEM will cover my needs quite nicely in the future. I mean, well, a new magazine with the names of both Roger Harrison and David Tilbrook inside the front cover is destined for great things!

Keep up the good work and please find enclosed my subscription. It's nice to know that I can still read the last page first.

May your circulation multiply a millionfold.

Bob Toth
Sandy Bay Tasmania.

Dear Editor,

Congratulations on your new magazine. It looks pretty good, for starters. Nice to get a magazine with sensible binding once again.

Then of course there is Mr Tilbrook whose projects generated an excitement that I thought was gone forever. Glad to see he's still around.

You should have a word with your distributors as AEM is rather hard to find at the Newsagents. They have a place for the other electronics magazines etc, but AEM is just shoved anywhere it will fit.

The best of luck to you for the future. Perhaps you'll give us the background on the birth of the new magazine sometime.

A. I. Piggott
Helensburgh NSW.

Thanks for the good wishes. It's nice to know our efforts are appreciated. If you notice the magazine is hard to find in your newsagent, tell the proprietor to give your favourite magazine the best possible display! While our distributors can inform the newsagents of our existence, it's really up to the individual proprietors as to how and where the magazine is displayed in their shop. Readers! — can we enlist your help to have AEM placed in a prominent and appropriate position in your local newsagent? There are probably plenty more enthusiasts out there just thirsting for a charge of electronics excitement and you could help them get it. Don't keep the good news to yourself!

Dear Roger,

It is good to see you back at the reins of an electronics magazine. Please find enclosed my subscription to your new magazine.

One quick question if I may. Can the Scanner antenna in the first issue be used as a transmitting aerial on VHF & UHF?

Peter E. O'Connell VK2JJJ
Oatley, NSW.

Yes, Peter, the Scantenna can be used for both transmitting and receiving across its design frequency range.

Roger Harrison VK2ZTB

Dear Roger,

I've just read the first issue of AEM. Congratulations on a fine start, and welcome. Your timing in launching the magazine is impeccable. Now that both of your competitors belong to the same stable so to speak, there is a real need for some competition from an independent to "keep 'em honest".

I am happy with the contents of the first issue and have no doubt that you'll keep up the standard.

David Leong
Killarney Heights NSW

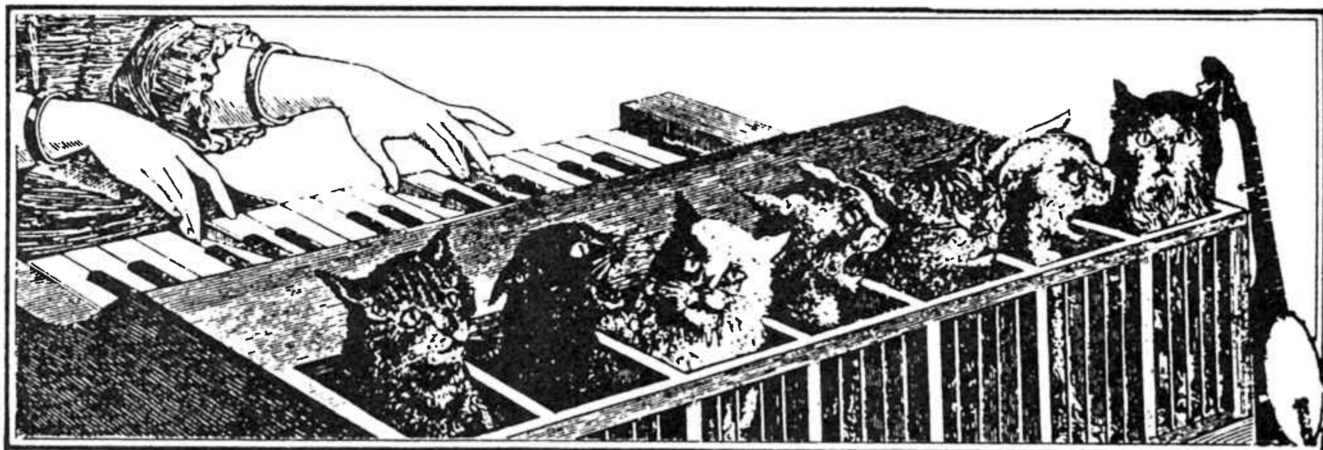
Dear Roger,

I'm very pleased to see you back in harness as an editor. I have enjoyed the first two issues and look forward to a successful future for the magazine. I'm particularly pleased that your sense of humour is as apparent in this publication as it was in your previous position.

Keep up the good work.

Michael Fream
Casterton, Vic.

The Last Laugh



THE CATSKILLS, USA: This is the latest in acoustic synthesizer technology to be released in America. The instrument is claimed to be able to produce the full range of sounds and timbres required by today's "new music" groups.

Thoroughly condemned by the RSPCA, the instrument features a keyboard coupled to the tailpieces of seven sound generator modules by a system of precision analog linkages. The keyboard is said to be "touch sensitive" in that the player can regulate the pitch and volume of the music by applying varying pressures to the individual keys.

Funding for development of the instrument was provided by grants from the American Acoustic Arts Council. The finished product was first demonstrated to the public via a series of Arts Council broadcasts on FM radio. Although similar broadcasts are frequently made in Australia, the new synthesizer is not expected to be heard here until sometime next year, due to quarantine requirements.

Weller-winning ways

Our first Crossword Competition, featured on page 123 of the August issue, drew some pretty imaginative and amusing entries. It seems we have a considerable number of pent-up poetical people reading the magazine. Some 30% of the entries replied in verse to the tie-breaker question "Why I think the Weller WTCPN is the soldering station for me".

Our first winner, Mark Halliday of Carlton NSW, topped the entries with this amusing twist on an ancient and venerable bit of British bosh:

"Whether the Weller be cold,
Whether the Weller be hot,
Whatever the Weller,
It's considerably better
Than the iron I have presently got."

We almost succumbed to the plea form C. J. Carlyon of Toowoomba Qld, who replied:

"Because I'll have to buy one if I don't win it, and you wouldn't want my wife and three kids to go hungry, would you?

Well, C. J., there's always the next issue for you to enter.

It seems both George Mosel, of Springwood Qld, and A. F. Dunn, of Blackett NSW, had sad experiences in the past with attempts at soldering with a blow torch! In reply to the tie-breaker, Dunn wrote:

"Because with the Weller I will be able to solder components without having to break out the blow torch and 1/4lb soldering iron whenever I purchase a kit set."

While George Mosel penned:

"Because my blow torch seems to damage the ICs for some reason!!"

Well, we sympathise fellas. Keep plugging away at the crosswords, you might be able to retire that blow torch yet!

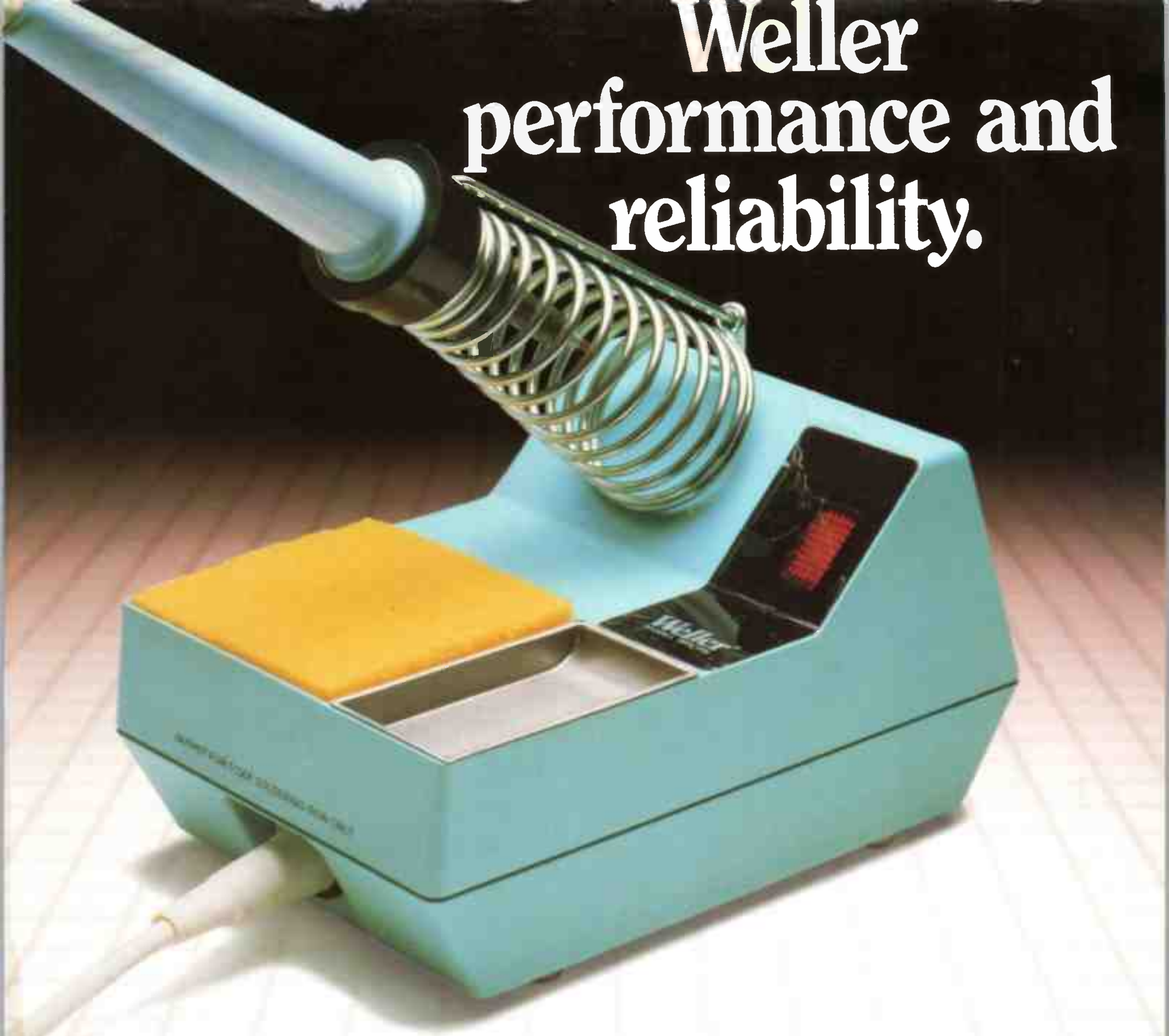
T. J. Threlfall, of Shenton Park W.A., was well to the fore in the running for the prize with his amusing observational rhyme:

"While a soldering iron of red heat
For guttering's found pretty neat,
For boards and resistors
and 'specially transistors,
A Weller would be just the treat!

Naturally, I guess we can expect bucketloads of verse from entrants to future crosswords — but we'd like to point out it doesn't guarantee a better 'hearing'. In addition, we're obviously not making the clues hard enough or maybe you all enjoy a challenge! Just about everyone got the first crossword all out.

In future though, you'll all have to put more effort into the tie-breaker. If you can't complete a crossword, send an entry anyway — it might be that nobody else gets it out either! Well, it's all good fun and you might get a pleasant surprise.

Weller performance and reliability.



Look-alikes aren't that simple.

You could buy a lower priced soldering station that looks very similar to the Weller WTCPN. But it wouldn't perform like it.

By changing the heat sensing tips, the Weller WTCPN automatically controls output and temperature in three stages (315°C, 370°C and 430°C). Once selected, you can be assured of constant, accurate temperature control without dials to turn or settings to watch. To make working with sensitive components that safe and simple, Weller has incorporated state-of-the-art technology into an attractive impact resistance case, that's ideally suited for assembly work.

Don't be fooled by look-alikes.

Check with your Electronics Distributor.

The Weller WTCPN

CooperTools

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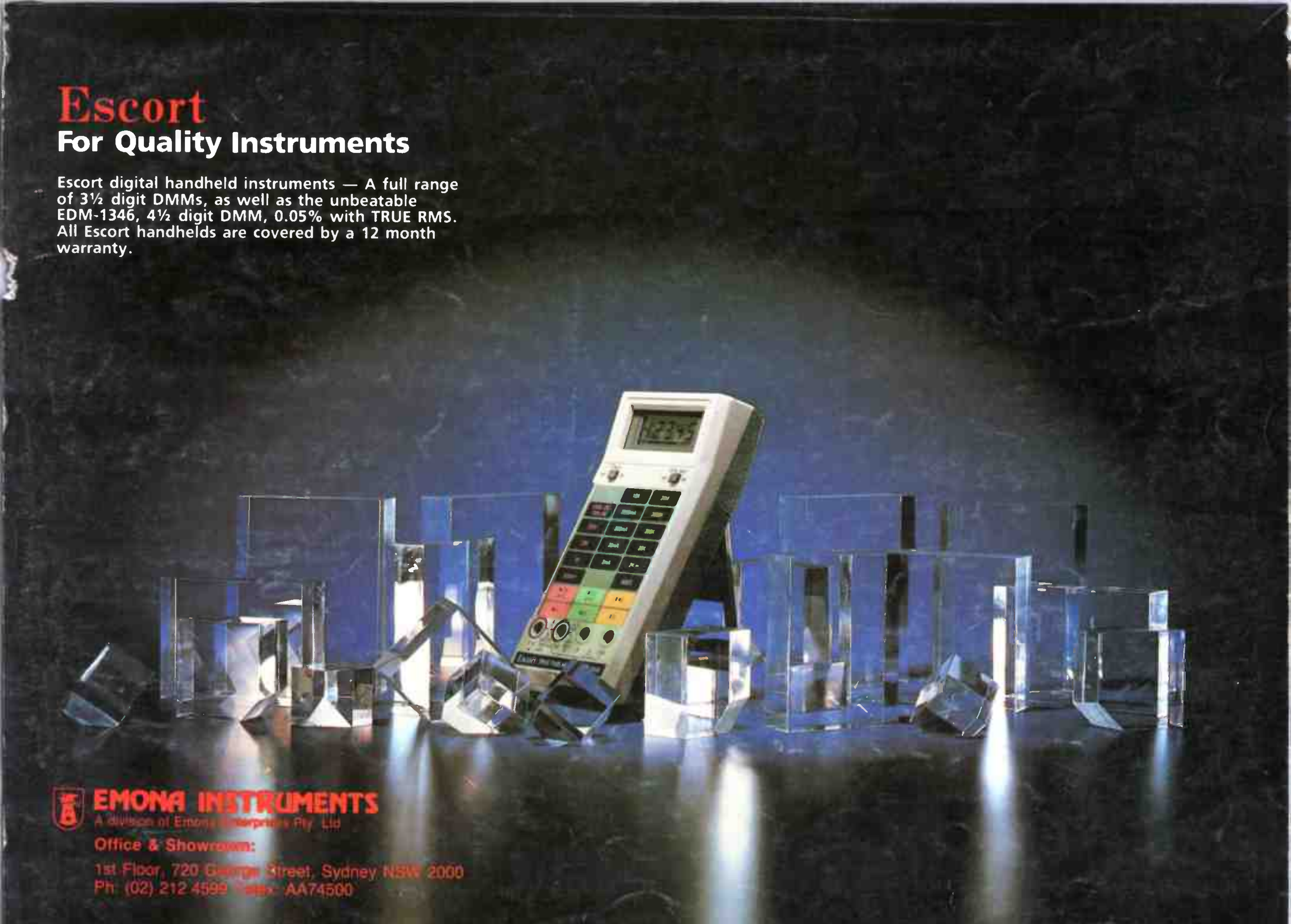
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