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March 1986

The Australian Electronics Monthly

exciting electronics

Feature:

BIOFEEDBACK

Chasing the comet's tail

- Build a signal-operated cassette controller for scanners and shortwave receivers
- Police Radar — Part 2
- Microbee column — ports explained
- Stacking your UHF Yagi antennas
- Will Shuttle disaster affect Australia's fledgling space industry?

Build our low-cost biofeedback project

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C-2101 Stereo Control Amplifier
B-2101* X-Balanced Power Amplifier

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The Australian Electronics Monthly

WE WOULD LIKE TO THANK all the readers who responded to our Reader Survey in the December issue last year. Many of you provided additional constructive comments on the magazine which we have found quite helpful. We are currently in the process of 'digesting' all the information in an effort to learn more about what we're doing well and where we can improve the magazine, as well finding out more about you, the reader.

One surprising result that has been thrown up from the survey is the significant number of readers who indicated they would prefer to pay 10% more for improved quality kits. There's a message there for the electronics retailers — many hobbyists appreciate quality and are prepared to pay for it. To balance that, few constructors who responded to our survey had anything critical or derogatory to say about kit and component quality generally available.

A staggering number of readers had much to say on the subjects of projects, technical articles, communications and computers, among other things. We're extremely encouraged by the many thoughtful and well-considered comments many respondents provided in addition to just answering the survey questionnaire. We will certainly be acting on as many of your worthwhile and practical suggestions as we can feasibly implement, and no doubt you will notice the various changes as they come along. Now that we know more about the sort of features you like in the magazine already, and more about the sort of things you want to see, we can act on it. It saves us flying so much by the seat of our pants!

Roger

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CONTENTS

ADVERTISERS INDEX

COVERS

Vanfi	IFC
Multimeter Offer	IBC
Marist Bros	OBC

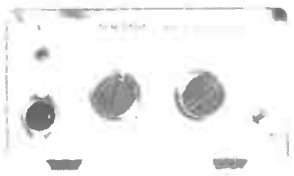
INSIDE

AEM pc boards	101
All Electronic Components	60
Avtek Electronics	27
Bright Star Crystals	45
C&K Electronics	12
Cooper Tools	13
Dick Smith Electronics	11, 28, 36-37, 66, 88
Emona	90
Electromark	52
Electronics World	20
Elmeasco	57, 75, 81
Emtronics	60
Eagle Electronics	8
Electronic Facilities	58-59, 102
Geoff Wood Electronics	53
GFS Electronic Imports	57
Hypec Electronics	76-77
Jaycar	6-7, 46-47
Koloona	27
Microbee Systems	22-23
Philips	75
SCA	91
Scan Audio	20-21, 57

COVER

Relax! — with our biofeedback project, a low-cost electromyogram. Couch courtesy of Artes Studios, Sydney. Model courtesy of Marni Raprager. Photography by Mark Rowland. Design by Marni Raprager.

PROJECTS TO BUILD



AEM5504 Low-cost Electromyogram 42

You can explore biofeedback techniques for yourself with this instrument that measures and indicates muscle activity.

AEM5503 Build this 'Bed-wet-ector' 50

Training young children who suffer from bedwetting can be distressing, but commercially available detectors have proven quite useful in solving this problem. However, the financial burden can also be a problem. This low-cost project reduces that and offers more features than its commercial counterpart.

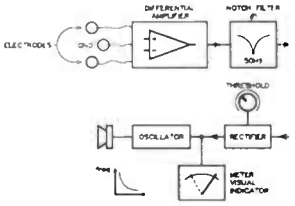
AEM3502 A Signal-Operated Cassette Recorder Controller 54

This useful little project is used in conjunction with a cassette tape recorder and a scanner or shortwave receiver which has a "squelch" facility. When a signal opens the squelch on the selected channel, the project starts the recorder and stops it when the signal goes off.

CIRCUITS & TECHNICAL

Honesty, Fallibility and Police Radar — Part 2 24

Jonathan Scott concludes with an examination of across-the-road radar problems, legal aspects and a brief look at what future technology might hold.



Biofeedback — the technology & techniques 38

Our cover feature delves into the art and science of this fascinating subject, and explains the 'electronic tools' employed.

AEM Data Sheet 92

The LM1830N Fluid Detector, featured in our 'Bedwetector' project.

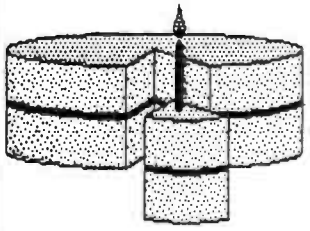
FOR STARTERS: The ins & outs of AND and OR 96

Theo Baitch explains the new standard logic symbols, essential for understanding and reading modern logic circuit diagrams.

Benchbook 103

Our popular monthly column of circuit ideas, hints and tips for the 'true blue' experimenter.

PRACTICAL COMPUTING



AEM Software Review — BeeArtistic 79

A great graphics package that is really a work-a-day tool!

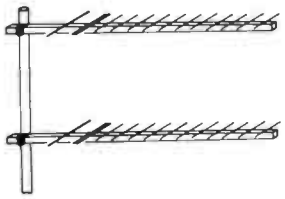
How to save a Marriage by Converting Data from 6809E to Z80 82

Here's how a reader found a practical method of transferring files between a Tandy Co-Co and a Microbee 128K.

BeeBuzz 86

This month Tom Moffat looks at the parallel port — getting data in and putting data out, plus a few extra snippets.

COMMUNICATIONS SCENE



Stacking Your UHF Yagis 62
How to get more gain by 'stacking' a pair of the Dick Smith UHF Yagi antennas, described in the January and February issues.

Radio Communicators Guide to the Ionosphere 65
Continuing with 'variations of the ionosphere'.

CONSUMER ELECTRONICS

Jamo's new CBR 200 Loudspeakers 30
Featuring a non-rectangular cabinet and a specially-formulated front panel, all designed to reduce 'cabinet colouration', reviewing Jamo's newly released CBR 200 proved a hair-raising experience for our reviewer, Bob Fitzell.

NEWS & GENERAL

News Review 9
Will the Shuttle disaster affect our fledgling space industry?

Consumer Electronics 29
Tiny TV boast colour LCD screen.

Retail Roundup 35
The vanishing thermistor.

Project Buyers Guide 35
Where to get kits, boards and components for this month's projects.

Spectrum 61
Icom release 25-1300 MHz scanner.

Bytewide 74
Add-on allows direct input of TV pictures.

New Product News 89
New switchmode supplies.

Admarket 20
Readers' free adverts.

Notes & Errata 105

Weller Crossword 99

Subscriptions 100

Printed Circuit Boards 101

The Last Laugh 106

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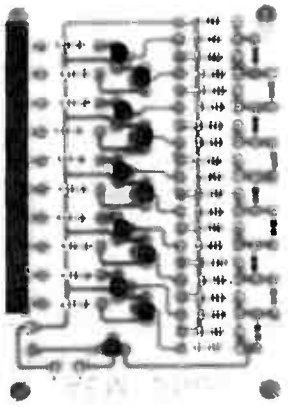
NEXT MONTH!



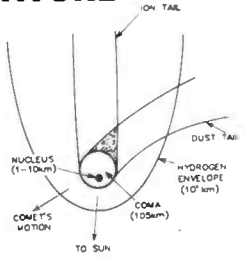
BUILD A PEAK-POWER RF WATTMETER
OK — we give in! Following a barrage of requests to present a pc board for our February issue 'Practicalities' PEP RF Wattmeter circuit, we present next issue a full-blown project.

DABBLING WITH SWITCHMODE
Reader, Gerald Reiter, has been dabbling with some switchmode power supplies. While the circuitry offers much in the way of efficiency and other benefits, there's more to getting them working than first meets the eye. Next month's *Practicalities* gives the low-down.

BUILD OUR 'HASH HARRIER'
This project, just the thing for computer owners, shortwave enthusiasts, radio amateurs and hi-fi buffs, attenuates both differential — and common-mode noise and transients conducted by the 240 V ac mains. It has two dual switched GPO mains sockets and features two-stage filtering. Performance is at least equivalent to the more expensive commercial types but a kit should cost around $60.

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

FEATURE



Chasing the Comet's Tail 14
A number of spacecraft are currently on their way for a rendezvous with Halley's comet. Kerry Upjohn looks at what they hope to achieve.

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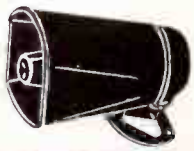

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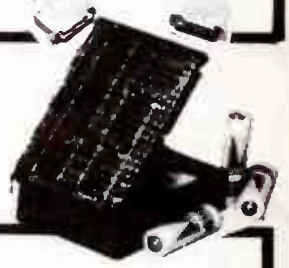

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Voltage at peak power (Vpp)	18V
Current at peak power (Ipp)	380mA
Short circuit current (Isc)	400mA
Open circuit voltage (Voc)	22V

The data on this sheet represents the performance of a typical ZM-9007 module as measured at its output terminals and do not include the effect of such additional equipment as diodes and cabling

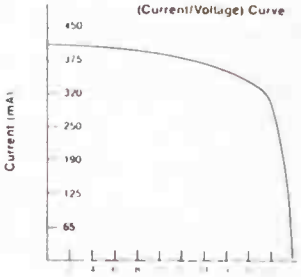
The data is based on measurements made at Standard Test Conditions

- Illumination of 1wK/m² (1 sun) at spectral distribution of AM 1.5 (1½ atmospheres)
- Cell temperature of 25°C +3°C

VARIABLES AFFECTING PERFORMANCE

The performance of a typical ZM-9007 module is described by the I-V (current-voltage) curve and Electrical Characteristics Table Output characteristics of individual modules will vary slightly from typical The module's current and power output are directly proportional to illumination intensity At a given intensity, module operating voltage is determined by output current i.e. as current increases, voltage decreases as demonstrated by the curve

Temperature also affect performance with increase in temperature increasing current but decreasing voltage The ZM-9007 voltage margin ensures excellent performance in hot climates



The ZM-9007 panel measures just .85mm wide and 423mm high and is 8mm thick The cell segments are connected to PCB style Phenolic board, sealed with clear PVC and housed on a sturdy stainless steel frame

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"JUNIOR GALILEO" REFRACTOR D = 60mm

This unit whilst not as sophisticated as the YT-4508, it has some unique features It is supplied with an 840mm wooden tripod and sun observation screen (The only way to observe the sun safely is INDIRECTLY i.e. such as with the equipment supplied with this telescope) Sun filters are supplied with the other telescopes but we strongly recommend that they are not used They are potentially dangerous The Junior Galileo also has a simple spotter scope and 2x Barlow lens, star diagonal prism and all fitting pieces D = 60mm F = 800mm

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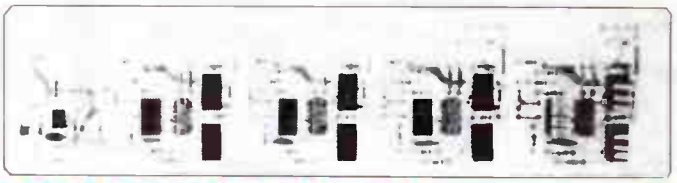

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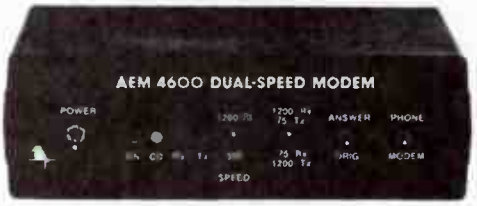

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Shuttle disaster means some setbacks and increased insurance costs for Australian space projects

The disastrous loss of NASA's 25th Space Shuttle launch, while having major repercussions for America's space industry, will only have a minor effect on current Australian space projects but means we'll have to pay significantly more for insurance coverage.

"Australia was lucky", Ken McCracken, head of the CSIRO's Office of Space Science and Applications, told us in an interview the day after the 29th January disaster. "Our first two AUSSATs were Shuttle-launched, but the European Space Agency's Ariane was chosen to launch the third, so the Shuttle disaster will not affect AUSSAT 3", he said.

"Regarding our own space R&D, the disaster will affect us, but not stop us", said McCracken. "Fifty per cent of our current effort is with the Europeans. Our efforts to achieve space qualification for the industry here will not be affected, but our work with NASA will be held up."

Dr Ken McCracken, Head of COSSA.

Ken McCracken said NASA will drop all else to get the Shuttle program back and working. "Nineteen years ago, the Apollo disaster shut the Apollo program down for 18 months. But there was no commercial pressure then," he said. "Now there is considerable commercial pressure. Some 15 Shuttle flights were scheduled in 1986 to launch over 30 satellites, mostly communications satellites", said McCracken. "As these were all paid flights, NASA now faces no return if there are no launches."

McCracken predicted that it would be inevitable that some satellite agencies would transfer their launch programs to the European Space Agency (ESA), a consortium which employs the Ariane launch facility in French Guiana.

However, it seems the way is now open for the Russians to offer commercial launch facilities. McCracken says they have wanted to 'go commercial' for some years. With around 40-50 satellites looking for a flight, the Russians may begin to assume some importance in the commercial satellite market.

Space science research projects will be held up, the advanced Hubble Research Telescope project, among others, being delayed.

Insurance companies involved in covering space projects, already 'jittery' over a spate of expensive satellite failures and the blowing-up of an ESA Ariane rocket just after lift-off last September, are tipped to significantly increase charges and to 'back away' from covering risky periods of launch sequences.

Intec, one of the world's leading underwriters in this area, has already made such moves. Intec now only insures satellites during their launch and their final operation. A recent rash of failures in upper-stage boosters (which puts a satellite in final orbit from a lower orbit), together with plain failure of onboard equipment, brought this on. Over US$200 million was lost in such failures on four US satellites last year. Some US$168 million alone was paid out by insurers on last September's Ariane explosion.

SBS-TV opens Hobart and Perth on 16 March

The Special Broadcasting Service's multicultural television service will begin broadcasting officially in Hobart and Perth on 16 March, 1986, using the UHF allocation.

Originally, the SBS was to begin transmissions in both cities by the end of January 1986. However, due to delays in the delivery of transmitters and the installation of time delay equipment to provide Perth with programs in local time, the opening had to be put back to March.

Test transmissions would begin approximately a fortnight in advance of the official opening of the service, to enable installation of UHF antennas.

THE SHAPE OF KNOWLEDGE

This "electronic book" system could contain the complete text of the Encyclopaedia Britannica on just one compact disc. In a British research project Philips CD ROM technology has been applied to the storage of a vast array of information — 600 Mbytes — containing any combination of text, pictures, graphics, sound or software.

A compact disc player is linked via an interface to a personal computer to provide a whole range of new applications such as the presentation of data from books complete with colour illustrations, animated sequences and even audible responses to give the correct pronunciation of foreign or difficult words.

For example, a good paper dictionary contains around 80 000 entries and consists of 11 Mbytes of text which means that 50 dictionaries could be placed on one disc. The full Oxford English Dictionary contains 230 Mbytes and would only occupy just over a third of a disc.

In one research project carried out at Philips Research Laboratories, Redhill, Surrey, England, some 15 per cent of the entries in an English language dictionary were given an associated colour picture and nearly all entries had the pronunciation of the word as an audible output.

Selected entries also had links to their antonyms, synonyms and semantically related words. Using this presentation and coding system for the sound and pictures it would be possible to create a dictionary of 50 000 entries on one disc, they say.

New Parliament House to boast one of the world's most extensive in-house communications systems

Philips Australia has won contracts worth almost $1 million to supply cabling and ancilliary equipment for the in-house information and communications system for Canberra's new Parliament House, due to be opened in the bicentenary year, 1988.

The monitoring system will be capable of handling 100 TV channels with dual-channel/stereo sound and 100 FM stereo radio channels. Its main task is to link off-air broadcasts and the proceedings of both chambers to Hansard, the press gallery, the parliamentary library, the member's rooms and public areas. The in-house information network will employ a wideband local area network and provide computer communications, electronic mail and general computer services.

The system will require 80 km of 'super shield' coax drop cable, 21 km of low loss coax trunk cable, 600 taps, 1500 splitters and 82 wideband amplifiers.

Of prime importance is the integrity of the system, says Philips. The cabling should not 'leak' signal, nor should it be subject to external interference.

Philips' sales/project engineer responsible for the task said, "For both security and quality considerations, leaks and interference in the system cannot be tolerated, especially where 100 television channels are required to work on adjacent frequencies. To provide this protection we are supplying 55 Philips PM5672 modulators."

The PM5672 television modulator boasts a stereo/dual language capability in conformity with the Australian television standard with adjacent channel operation. The latter feature is possible, Philips claim, through extensive use of surface acoustic wave filters in the IF section as well as sharp cut-off in the RF output.

Philips Australia will benefit from Philips North America's experience in broadband local area networks in gaining the Parliament House contract. Philips North America recently supplied a wideband data network to Wang's Massachusetts head office in the US.

Specifications for the electronics systems in the new Parliament House are determined by the Parliament House Construction Authority and the ABC, acting as its consultant.

It is expected that only 55 stereo TV channels and 10 stereo radio channels will be in use when the building is opened for Australia's bicentennial. Initial commissioning is due in the first half of 1986.

Graham Adams, project engineer responsible for Philips' work on the communication system, outside the Parliament House construction site. As the building has been designed to last 300 years, all facilities are being planned for future needs.

Flying to the defence

Kookaburra, Australia's potential America's Cup defender, fielded by a syndicate headed by the Parry Corp., has taken aboard a new sponsor/supplier, Scientific Electronics, who design and locally manufacture a range of switch-mode power supplies.

Taskforce syndicate instrumentation manager, Chris Todter, praises the company's "innovative designs and proven efficiency" adding that both skills will be put to the test on Kookaburra. Todter describes the working environment on Kookaburra as "horrendous, like being in a salt-water steam bath."

The main job facing Scientific Electronics is co-ordinating a major instrumentation, computing, data and voice communications package so that it's fully operational 12 hours a day. This demands extremely reliable and efficient power handling, from the minimum mass of batteries, Todter says.

"Even though the batteries can be put in a relatively good location in the boat, any added internal weight must come at the expense of keel ballast, so there is real benefit in efficiency of power conversion."

Chris knows the "reliability of every bit of electronics installed on the yacht is absolutely critical" since power supplies are required to convert the battery supplies to all the required standard voltages, e.g. +/-5 V, +/-12 V, 13.8 V and 24 V.

"These boats cannot be sailed to anywhere near their full potential without instrumentation, and a system shutdown during a race could be quite disasterous," Todler said.

Pictures by telephone

Monochrome still pictures can be transmitted worldwide over the normal telephone network, it is claimed, by means of an electronic image-transfer system developed by British Telecom that obviously 'borrows' technology used by radio amateurs for "slow-scan television" over voice bandwidth radio channels.

British Telecom's system has already transmitted brain, chest and lumbar-spine scans live from the UK to Australia for diagnosis during a conference of radiologists.

Applications apply to many fields, say British Telecom. An architect may need to see plans to deal with a problem on a remote building site. An engineering or graphic designer, by seeing a picture, can respond more quickly and accurately to a client's instructions. The system could also be used to transmit pictures from inside an aero engine, by means of a miniature camera, direct to the manufacturer to diagnose faults or pinpoint the cause of a failure.

In its basic form the system consists of two portable units, each in its own carrying case and weighing 5.47 kg.

At the transmitting end, the unit accepts images direct from a video camera or other source and makes them acceptable for transmission over the ordinary telephone network.

At the receiving end, the unit converts the signals back into pictures for display on a monochrome 625-line or 525-line monitor, or suitable TV set.

Three levels of resolution may be selected: 'high' (512 pixels x 256 lines x 64 grey levels), 'normal' (256 pixels x 256 lines x 64 grey levels) and 'low' (128 pixels x 128 lines x 64 grey levels).

In use, it is necessary to dial the person owning a unit and conduct a conversation in the normal way. Then, to send or receive a picture, the appropriate buttons are pressed. The picture can also be recorded on ordinary stereo audiotape, using a standard 5-pin DIN plug to a stereo recorder.

The power supply required is 240 Vac at 40 W, or 110 Vac. Video output is 1 V peak-to-peak video plus sync noninterlaced from 75 ohms. Video input is 1 V p-p video plus sync into 75 ohms with 2:1 interlace, no interlace or random interlace.

The transmission system is vestigial sideband AM with an automatic gain control (agc range of 35 dB quoted).

A range of compatible video equipment is available as an optional extra. Some specialised applications might require other input sources of 625-line or 525-line 1 V p-p video with BNC connection. ▶

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DICK SMITH ELECTRONICS

SEE PAGE 88 FOR ADDRESS DETAILS

B.128/JL

World's largest trade fair

The single largest display of electronics and electrical engineering technology ever held anywhere in the world will be on-show in Hannover, West Germany, over 9-16 April. Featuring nearly 2000 exhibitors from around the world, the organisers claim that nowhere else can experts in the field acquire such a comprehensive overview of innovative products, systems and technologies developed by the electrical and electronic industries.

The Hannover Fair 'Industry', as it is called, has dominated the world trade shows in this area for some years. True to its aim of reflecting the latest technological developments and market trends, the Hannover Fair this year is branching out into a number of new areas.

This year the Fair will have two additional specialised fairs (or sub-fairs) — "New Materials" and "Industrial Automation: Control Systems".

As always, the appeal of Hannover Fair Industry will be enhanced by a programme of events focusing on the more theoretical aspects of the subjects covered at the various individual fairs. International congresses, conferences and symposia will form a part of the daily agenda at the "Fair of Fairs".

Further information and brochures on the Hannover Fair 'Industry' can be obtained from **Brigitte Reichenbach, The German-Australian Chamber of Industry & Commerce, GPO Box 4247, Sydney NSW 2001, or 2nd Floor, 47 York Street, Sydney NSW 2000. (02) 29 3998.**

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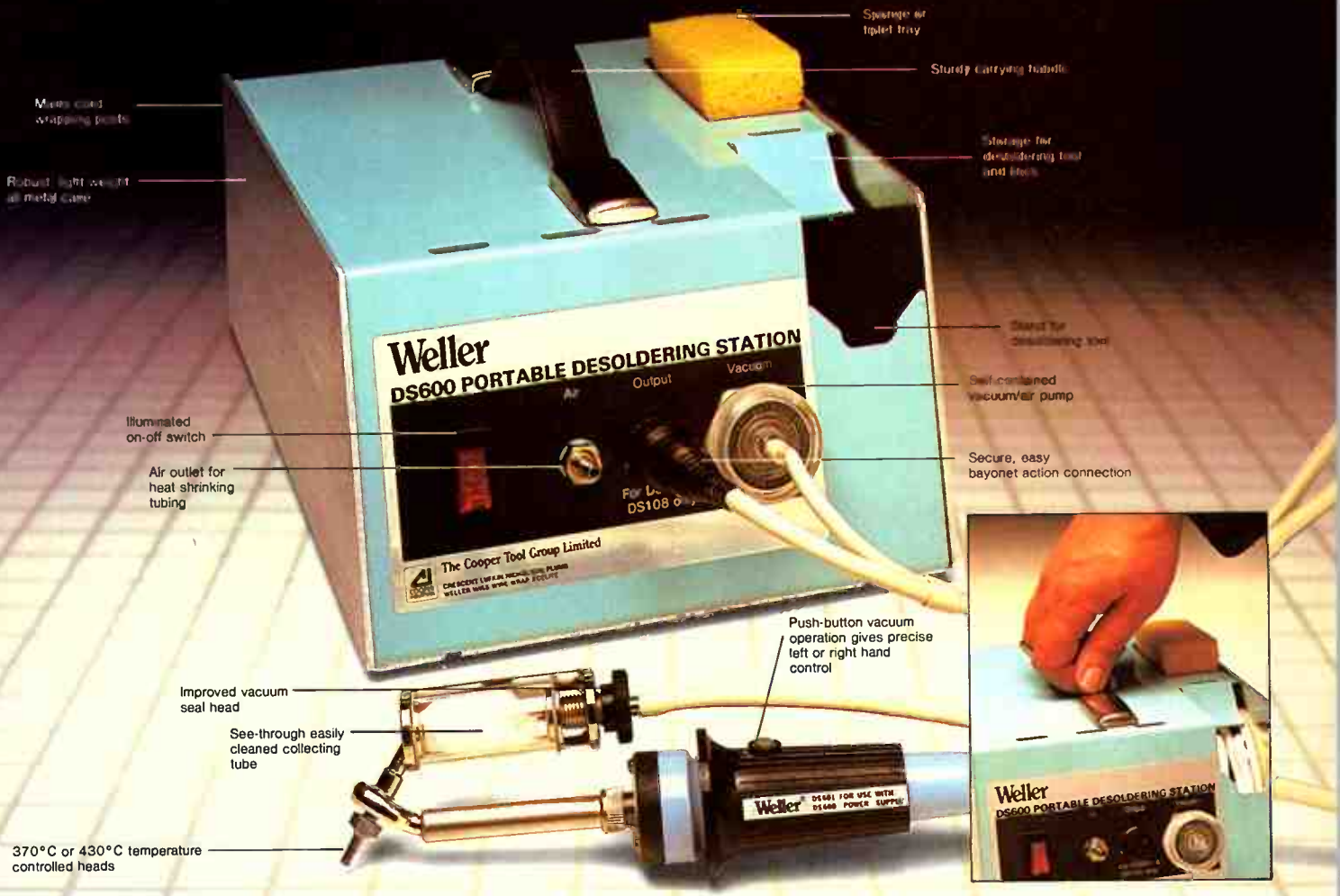

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DS113	2.49	1.14	12
DS114	3.18	1.80	12
DS115	1.52	.64	19
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DS117	2.29	.64	19

Here's the professional desoldering station that has everthing except a fixed place. The low maintenance, self-contained vacuum/air pump in this compact unit now lets the station travel to the job.

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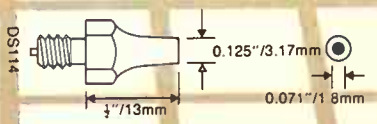

The Weller DS600

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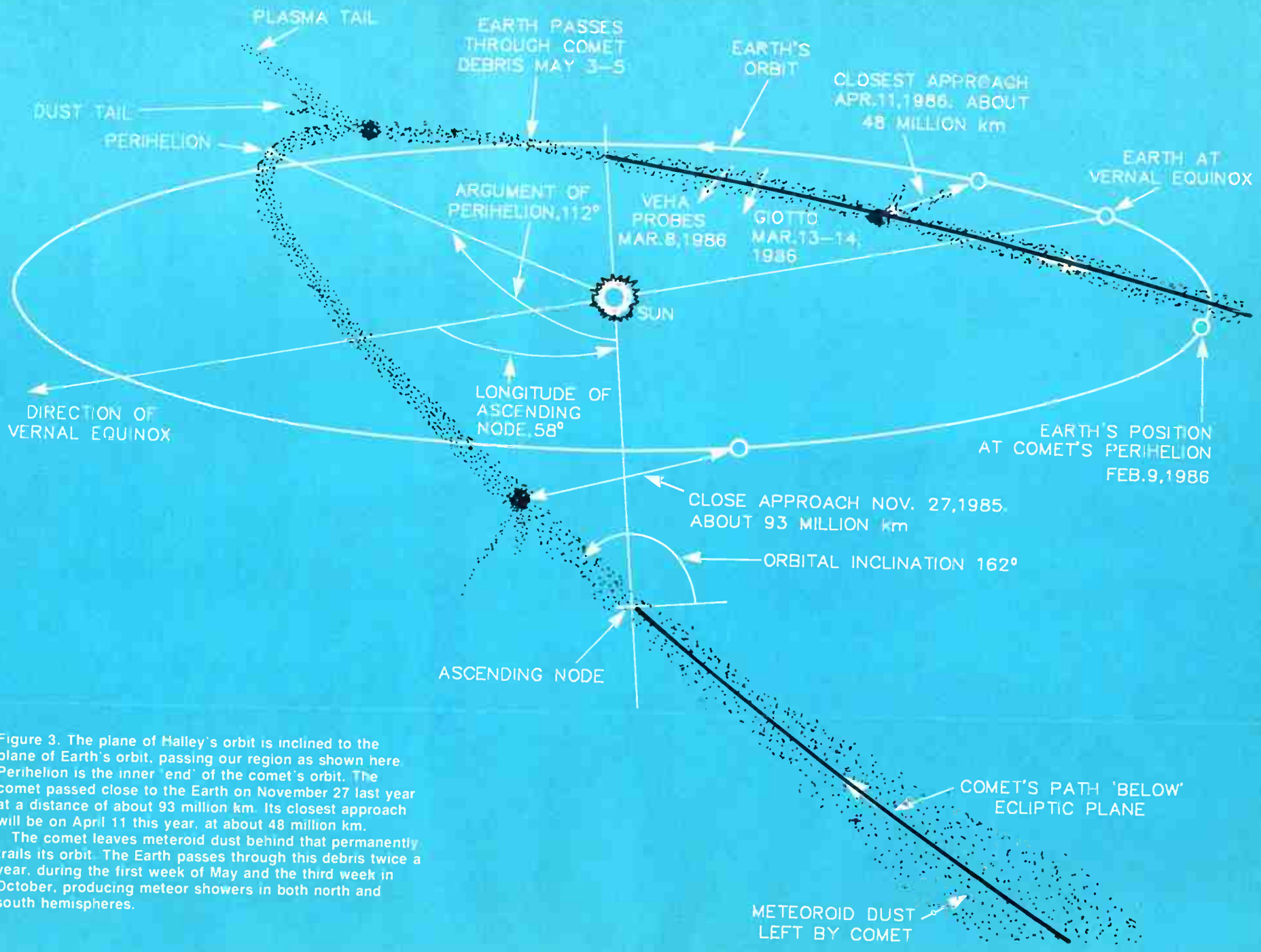


Figure 3. The plane of Halley's orbit is inclined to the plane of Earth's orbit, passing our region as shown here. Perihelion is the inner 'end' of the comet's orbit. The comet passed close to the Earth on November 27 last year at a distance of about 93 million km. Its closest approach will be on April 11 this year, at about 48 million km.

The comet leaves meteroid dust behind that permanently trails its orbit. The Earth passes through this debris twice a year, during the first week of May and the third week in October, producing meteor showers in both north and south hemispheres.

Chasing the comet's tail

Kerry Upjohn

The next two months will probably see the most concentrated attention yet focussed on Halley's comet by people the world over. Popular and scientific interest in Halley's comet has been running at an unprecedented 'high' for the past year. No longer bound to earth-based observations, scientists will get the really first 'close look' at this, the most famous of comets, via some five satellites scheduled for near flybys of the comet. Here's a rundown on two multi-nation space missions to Halley's comet – the European Space Agency's "Giotto" and USSR–co-ordinated VEHA probes.

THE APPEARANCE of Halley's comet in the sky is a "once in a lifetime" event for most people, twice in a lifetime for a lucky few. Several countries are making the most of this historic opportunity. Five spacecraft have been designed to pass close to Halley's comet, two from the Soviet Union and Japan, and one from the Europe *Giotto* spacecraft, launched by the European Space Agency (ESA) is probably the most important as its mission is to intercept the comet and fly through its tail in order to obtain vital information on the characteristics of its nucleus. This information has been impossible to collect in the past as the nucleus can't be detected by instrumentation used by tracking stations on earth. Representatives from ESA have described this as "the most difficult mission yet attempted" and Giotto is also their first space explorer (that is, their first spacecraft to leave Earth orbit).

The ESA spacecraft was named Giotto after the Italian painter who is said to have featured Halley's comet as the star of Bethlehem in his famous fresco "The Adoration of the Magi". The Giotto satellite was designed, built and tested for the European Space Agency by a consortium of 15 companies from ten European countries with British Aerospace as the major partner in the venture. It is hoped that the mission to intercept Halley's comet at a distance of 150, 000 km from earth will help solve the scientific mystery of the composition of the comet and also shed light on the origin and composition of our solar system.

Giotto was launched on an Ariane 1 rocket from French Guiana in August last year and is travelling on an eight months journey of over 150 000 km to ▶

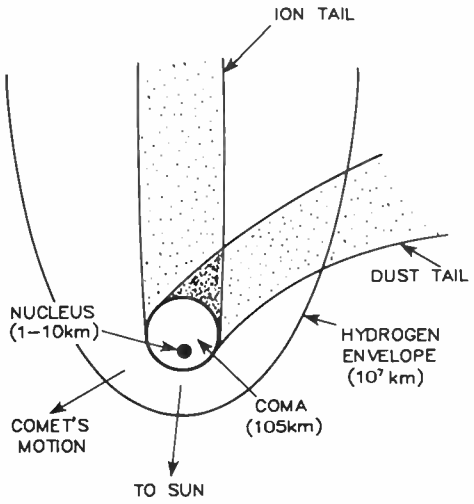


Figure 1. Parts of a typical comet.

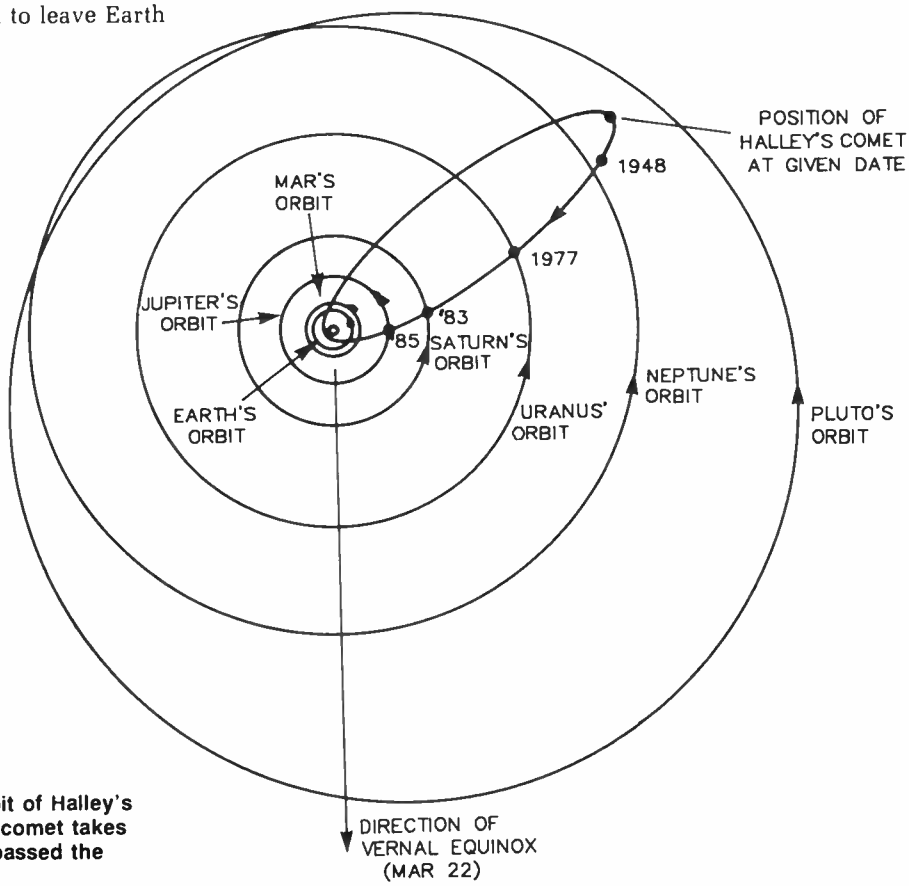


Figure 2. The solar system, showing the orbit of Halley's comet among the orbits of the planets. The comet takes some 76 years to complete an orbit. It last passed the inner planets in 1910.

rendezvous with Halley's comet on the 13-14th of March, 1986. The spacecraft measures 3 m x 1.8 m and it will be travelling at a relative closing speed of 68 km/sec when it is targetted to pass through the comet's tail, within 500 km of the nucleus. Giotto will be the only spacecraft actually passing through the comet and this carries with it the threat of destruction to the craft by the debris likely to be found within the comet's cloud. Although Giotto is fitted with a protective shell to withstand such high speed collisions, a pea-sized speck of cometary dust could destroy the £35m spacecraft before it completes the mission.

The scientific importance of comets

Scientists generally agree that comets are comprised of frozen dust and ice kept from destruction by the sun through their long elliptical orbits. When a comet's orbit approaches the sun, the frozen substances are evaporated to form a halo of gas or *coma* around the nucleus of the comet. As the comet nears the sun (perihelion) these gases are 'blown away' by the solar wind to form the characteristic tails. See Figure 1.

Comets were probably formed at a similar time to our solar system and it is thought that the analysis of their frozen nuclei will reveal some important information about the earth. Their frozen state has preserved them relatively unchanged and it is hoped that investigations and analysis of their characteristics will provide information about the formation of the Sun and solar system.

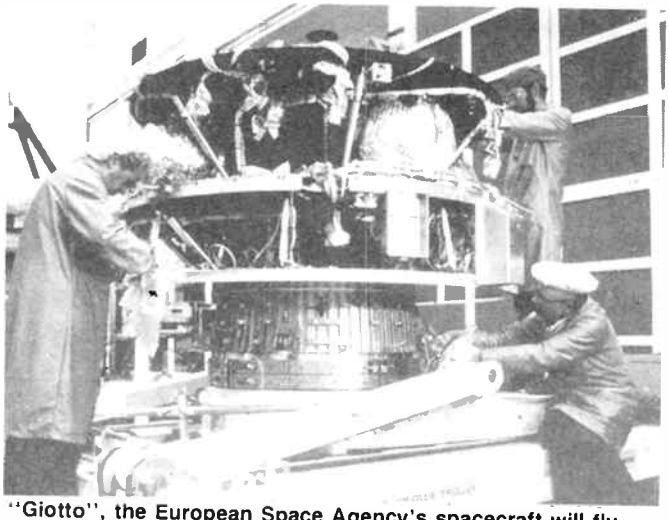
Halley's comet is particularly important for these studies as it can be predicted with reasonable accuracy and is clearly visible. Most comets enter the solar system once and then return to deep space. However, Halley's comet is locked in an orbit within the inner solar system and returns repeatedly, approximately every seventy-six years. The nucleus of Halley's comet is a "dirty snowball" approximately 6.4 km across and is surrounded by an atmosphere or coma 402 000 km deep. The periodic appearance of Halley's comet has been observed since 240 B.C. and its last appearance was in 1910. The core of the comet was originally some 20 kms across. However, each time it passes the sun it loses a two metre thick layer from its surface. As a result the diameter is now halved to 10 km and after another 2500 times around the sun the comet will disappear.

Giotto's mission

The spacecraft will intercept the comet's path and should survive long enough to complete a comprehensive programme of scientific experiments and communicate these results back to the Parkes tracking station in Australia via a radio link. Experiments on board Giotto will measure the chemical composition of both the coma region and surrounding nucleus, and the tail of the comet. Giotto will send back to Earth the first colour photographs of the nucleus and will measure its magnetic field. This will provide scientists with important new information on the nucleus as the comet's coma obscures the nucleus when viewed through telescopes on Earth. As 1986 will be the only opportunity to observe Halley's comet before its next return in 2062 it is hoped that the spacecraft will survive the impact with the comet before it is finally destroyed by dust particles.

Giotto's experimentation & equipment

Giotto will carry out ten scientific experiments in the one and a half hour flight through the comet and transmit these results via a radio link with the Parkes radio telescope in Western New South Wales. This has been made possible through its carbon fibre antenna measuring 1 m in diameter which is one of the largest carbon fibre structures ever made. Cameras will take colour pictures of the comet every four seconds and these photographs should show scientists on Earth how the nucleus sheds gases to form the comet's tail.



"Giotto", the European Space Agency's spacecraft will fly through Halley's tail on 13-14 March, providing scientists with a once-in-a-lifetime opportunity to examine this most-famous of comets at close quarters. Here, workers from the British Aerospace company prepare the final assembly of the 3 m high by 1.8 m diameter spacecraft.

The Giotto mission takes its name from the Italian painter who, having sighted the comet in 1301, depicted it as the Star of Bethlehem in his famous fresco "The Adoration of the Magi". (Photo courtesy of British Consulate).

Two mass spectrometers will analyse the composition of the comet and two plasma analysers will provide data on the behaviour of charged particles within the complex magnetic and electrical field thought to surround the comet. In another experiment initiated by the University of Kent, the body of the spacecraft is used as a 'dust impact protection system' to measure the size and speed of the dust particles in the coma. It is expected to take four hours for Giotto to relay data back to Earth on the encounter.

The danger of destruction

Giotto will pass as closely as possible to the comet's centre and will receive the full impact of the high velocity dust particles in the coma. At its closing speed of 68 kms per second these particles will behave as a high temperature plasma and could burn through the spacecraft. The European Space Agency has minimised this risk by developing new materials to withstand these conditions and creating vigorous testing conditions to simulate the launching and encounter with the comet.

The spacecraft will have three defences to enable it to accomplish its mission.

Giotto is a cylindrical design which will pass through the comet spinning on its axis at fifteen revolutions per second. It is protected by two shields. The first is 1 mm thick and should vaporize dust particles of up to 0.1 g in size. The second shield is 14 mm thick and functions to dissipate the vapour. There is also a sophisticated thermal control system to protect Giotto's instruments from the heat of the Sun.

This thermal system consists of two parts. There is the "passive" system consisting of reflecting surfaces which include strips of gold foil on the antenna and instrument panel. This is coupled with an "active" system of heaters and adjustable reflectors which allow the heat to be evenly dissipated throughout the spacecraft.

Giotto will have little more than an hour to complete its mission and radio information back to Earth. This vital communication with ESA will be through an aerial which will aim for the same location on Earth despite the fact that the craft will spin fifteen times per minute. The bearings on the

aerial and spacecraft will need to work reliably in temperaturs ranging from -55° to -80° Celcius. These bearings will need lubricant in order to move easily and the temperatures rule out the use of oil and grease which could also interfere with the detector's task of analysing organic materials from the comet.

In an attempt to overcome these difficulties, the space laboratory has developed a special lead coating which acts as a lubricant on the spacecraft. Another special lubricant is a polymer which includes fluorine and chlorine and is said to be similar to the material used on non-stick frying pans. Known as polytetrofluorethylene (PTFE), this material has been tested as a bearing coating by being put through 100 million revolutions, around ten times as many needed on the mission.

Significance of the Giotto mission

Dr John Davies of Birmingham University's space research department commented on the historic importance of Giotto's mission. He stated that, although theories of the origin of comets are still disputed, it is widely believed that comets are composed of materials left over from the creation of our solar system. He went on to say that, "If this is so then they have been trapped in deep freeze far beyond the Sun for about 4½ thousand million years." Hopefully, Giotto will enable scientists to analyse and receive pictures of this ancient material. This co-ordinated observation from Earth and space should create a large leap forward in understanding of our planet and solar system.

The VEHA Soviet mission

ccording to the Soviet scientists co-ordinating the two interplanetary probes to fly past Halley's comet, the ESA Giotto mission will complement rather than duplicate the Soviet project. In December 1984, two Soviet interplanetary probes were launched from the Baikonur Space Centre as part of the Venus-Halley project. Known as the VEHA project, these spacecraft will divide into two modules with one of the modules landing on Venus and the other continuing on its flight to the comet. It is expected that the probe will pass at a distance of 10 000 kms from the comet, although Soviet scientists do not rule out the possibility of a collision with the comet because of the complexity of the mission.

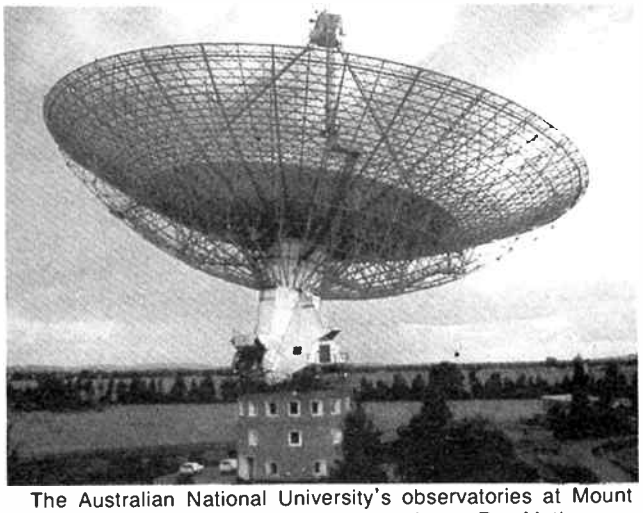
Like the Giotto project, the VEHA programme has been made possible with the co-operation of several countries including Austria, Bulgaria, Poland, Czechoslovakia, Hungary and the G.D.R. (East Germany) with the USSR co-ordinating the programme. Despite their accomplishments in space technology the Soviets, like their European counterparts, know very little about the primordial material which formed the solar system. As mentioned previously, observations from Earth only yield indirect information about the composition of the comet's nucleus. In fact, the molecules detected by means of the refracted spectra from its coma are not the primary material of the comet but a product of the chemical reactions between the comet's original materials escaping from the nucleus at great velocity under the impact of solar radiation. Hopefully, the VEHA project will identify the primary substances in the comet's nucleus and this will be its main goal.

The probe will rendezvous with Halley's comet on 8th March 1986, approximately 270 days after the landing on Venus. During this time the probe will have travelled a distance of approximately 135-170 000 kms. The velocity of the comet about to leave the Sun's zone will be 44 kms per second and the probe will be travelling towards it at a speed of 34 kms per second. This will mean that the relative approach speed will be fairly high, around 78 km per second. Consequently, the VEHA project has encountered similar problems to Giotto with the ever-present risk of damage to or destruction of the spacecraft by dust particles from Halley's comet.

AUSTRALIA TO PLAY KEY ROLE IN INTENSIVE STUDY OF HALLEY'S COMET

Astronomers from all over the world will be using Australian facilities to follow its progress, with a heavy concentration of European Space Agency (ESA) scientists working from the CSIRO radio telescope at Parkes, managed by Dr Andrew Pik of the Radiophysics division.

Parkes will be a major focal point of the Giotto project as the only data-gathering place for the spacecraft's encounter with the comet. As Giotto passes through the head of the comet around 12-13 March, observers will have two hours to collect the transmitted data.



The Australian National University's observatories at Mount Stromlo and Siding Spring, headed by Professor Don Mathewson of ANU, will concentrate their eight optical telescopes and their entire staffs on the comet during the viewing times.

Halley's comet will be the second long-term project for the ANU's 2.3 metre Advanced Technology Telescopy, commissioned by the Prime Minister in May 1984. The telescope will work with a bank of instruments designed and engineered by Australian scientists.

The CSIRO radio telescope facility at Parkes will study and analyze radio waves emitted by the comet.

The comet is losing water as its orbit passes through the inner planets, close to the sun. The water breaks down under the action of solar radiation, one of the products being *hydroxl* (OH). Under solar excitation, the OH molecules emit characteristic radiations at 1665 and 1667 MHz.

The data collected from studies undertaken in Australia will be sent to the International Halley Watch organization's headquarters at the California Institute of Technology, USA.

Experiments conducted by VEHA

The entire programme of research has been divided into three parts. On board the space probe there is an optical system to view the comet which includes two TV cameras with focal lengths of f150 and f1000 respectively. This camera equipment will give pictures of the inner part of the comet's nucleus and coma. The resolution of these instruments enables a clear view of an object with a diameter of 180 m at a distance of 10 000 kms.

VEHA expects to be able to specify the size of the nucleus, its shape, surface characteristics and temperature. Other instruments will study the structure and dynamics of the near-nucleus zone of the coma and its likely emissions throughout the spectrum. Instruments on board will be capable of specifying the composition of dust particles with a mass ranging from 3×10^{-16} to 5×10^{-10} grams. They will also count particles with a mass of one ten-billionth of a gram and less at different distances from the nucleus. ▶

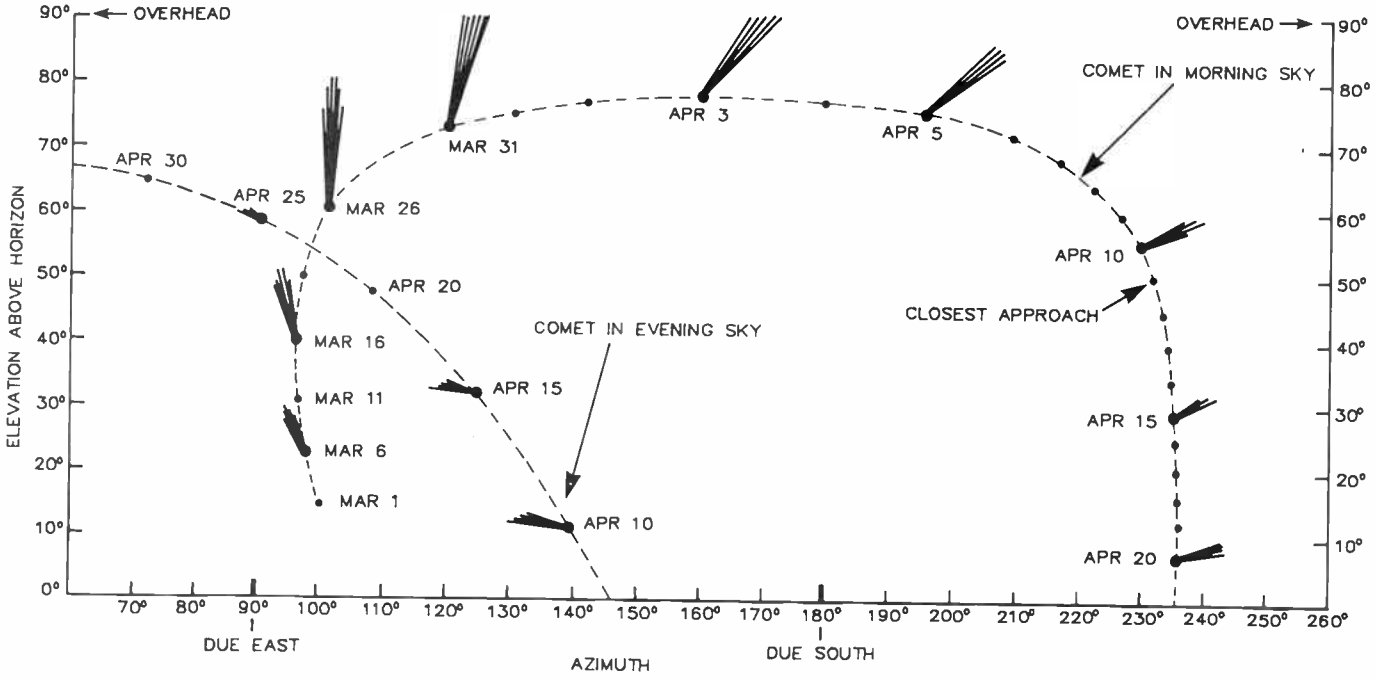


Figure 4. The position of Halley's comet in the morning and evening skies during March and April as seen from latitude 30 degrees south (Coffs Harbour, Narrabri, Bourke in NSW; Kalgoorlie in WA). You may need binoculars and clear, cloudless conditions with no scattered town or city light in order to see it. It will pass from the constellation of Sagittarius in March, then Scorpius and through Centaurus in April.

The third experiment will be analysis of the neutral gas and plasma. Special instruments on board will identify the elements and isotopes contained in the neutral gas and show the flows and spectrums of individual molecules and atoms. Receiver equipment has been designed to register the electromagnetic emissions at various frequencies and the comet's magnetic field (if any).

VEHA will pass through the dust envelope of the comet which will expose it to bombardment by dust particles of speeds up to 80 kms per second. Particles with a mass of a thousandth of a gram could disable on-board instruments and minimize the completion of a successful mission. To combat this danger, the probes have a second and third layer of protective screening to deflect the dust particles. Each layer is placed some distance away from the previous one and as each layer is destroyed the next one will take over.

In the last leg of the flight there will be two programs designed for the on-board scientific instruments and these are known as the duty and principal programs. The duty program will switch the instruments on two to three days before the actual rendezvous with Halley's comet. The information gathered by these instruments will be filed every twenty minutes on a tape recorder with capacity of 5 Mbits. Prior to recording, the information will be processed on individual computers and during regular radio links this data will be relayed back to earth.

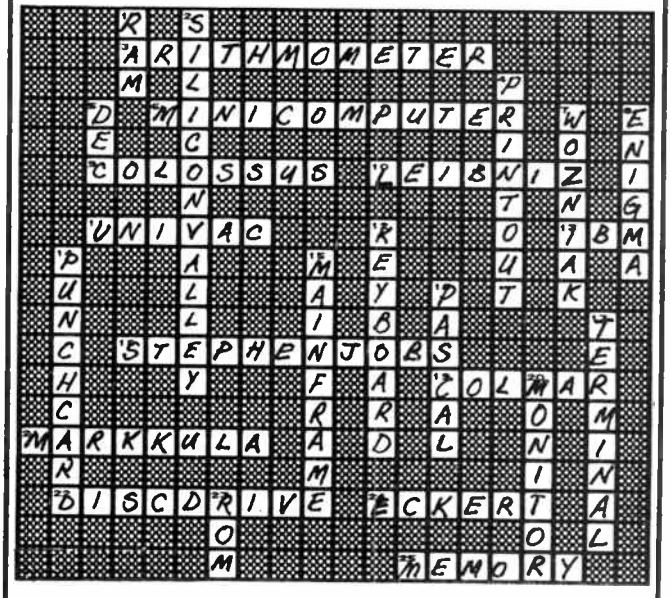
The principal program instruments will activate two hours prior to the rendezvous and will operate for three hours. Information from this program will be transmitted to an Earth-based receiver at a speed of over 65 bits per second (quite slow). During this time the system will operate in the direct transmission mode as information filed in the tape recorder is also transmitted back to Earth at a slower speed along the second radio line.

Finale

Both the Giotto and VEHA missions to intercept and fly past Halley's comet offer the promise of a new understanding of the composition and structure of comets. As well as increased knowledge of the most famous comet, these scientific projects will shed light on the formation of our Sun and solar system. For the first time scientists on earth will receive photographs of Halley's nucleus and find out whether the comet possesses a magnetic field. International co-operation between a number of countries has made these missions a reality and hopefully, more joint space probes will continue.

January 1986

Weller Crossword answers



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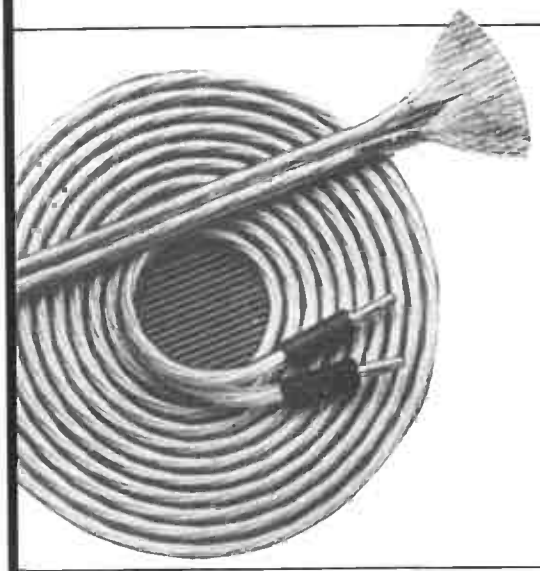

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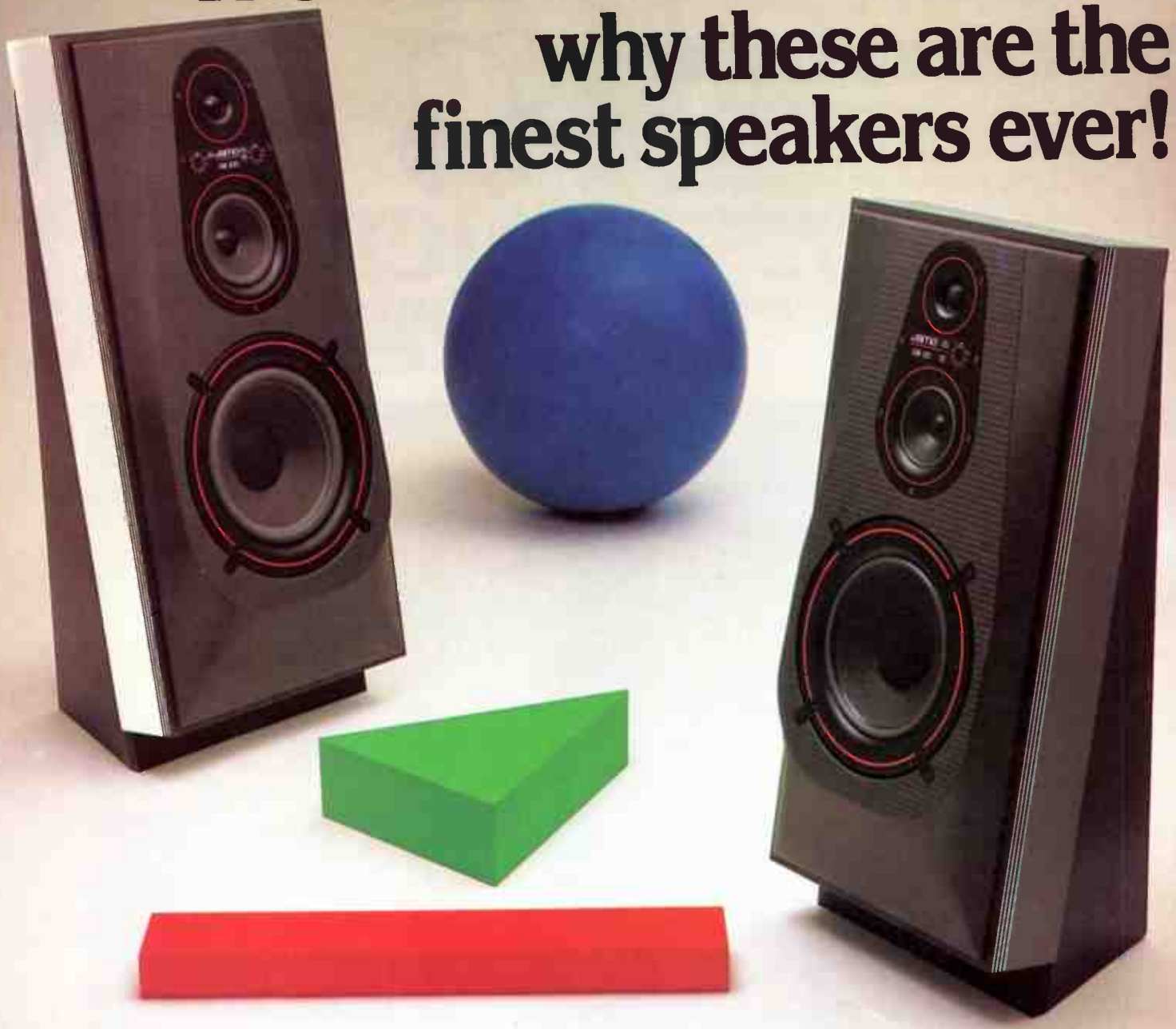

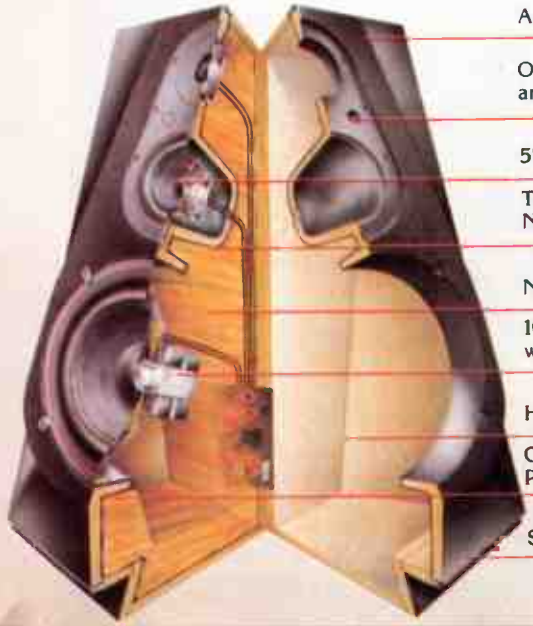

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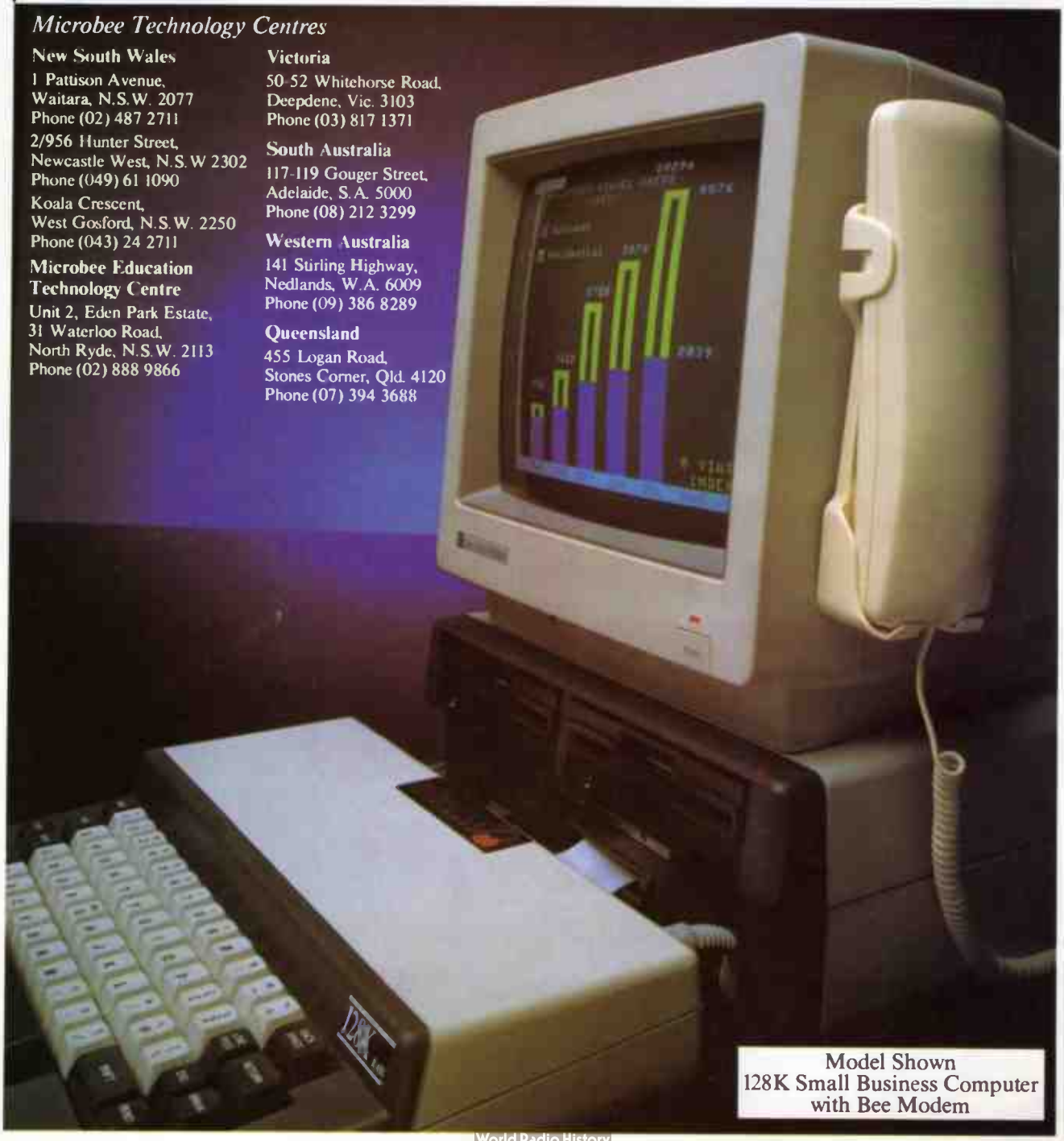

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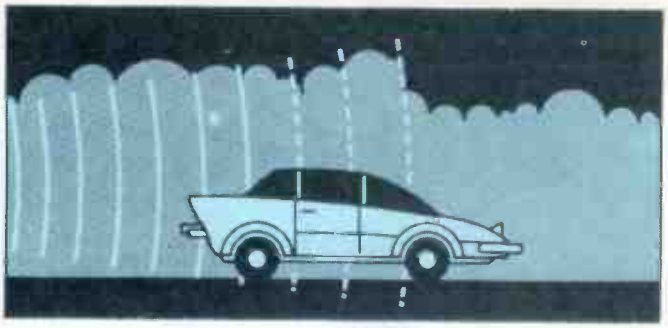


Honesty, fallibility and police radar

Jonathan Scott

Part 2

This part concludes with an examination of across-the-road radars, looks at the human element that's always a factor in current radar operation, covers legal aspects and looks briefly at what hope future technology might hold.

SO FAR, I've covered 'down-the-road' radars that look directly at an approaching or receding vehicle. That's not the only way to determine speed using Doppler radar measurement, though.

The Fairey Instruments 'across-the-road' radar

The Fairey (and other so called "across-the-road" units) seek to effectively put one card on the table, making the choice a very elementary one. They point the beam not down the road, but across it, at some oblique angle. The Fairey unit uses an angle of 22.5°, but almost any angle will do. The idea is that there is only a small bit of road in the main part of the beam, which is made quite narrow, so that only one car 'fits' at any one time. This is a nice idea in principle.

Two problems have arisen with this approach. Firstly, because the machine is allowing for the oblique beam, there is the possibility of an incorrect reading arising if the beam angle is not correct. Secondly, the beam strongly illuminates areas beyond the road it crosses, and if there were targets present there, these could be confused with any in the near field. A most insidious, if rare, situation exemplifying this is shown in Figure 3.

The Fairey machine incorporates a number of design features, such as a very narrow beamwidth in the antenna, and a check for steady signal amplitude to suppress such erroneous responses, but these cannot *completely* eliminate the possibility of confusion. In fact, it can be viewed as detrimental that such mechanisms operate. They reduce the rate of potentially misleading operations to a level where the operator's impression is of reliability. It is all too easy to look a few times at a machine, see that it works well each time, and then implicitly attribute "computer infallibility" to it.

The check for steady amplitude, by the way, is a rather clever means of trying to eliminate cars which are off to the side of the beam. Figure 4 shows a plot of beam strength (brightness) against the angle off-centre. If a vehicle is returning a signal to the Fairey unit, it must be partly approaching the unit, but also partly crossing the beam, because of the oblique angle. This means that its angle off beam centre is changing. Figure 4 tells us that the amplitude of the signal (the B factor in the radar cross section equation, Part 1) will move only slowly as the car is near the centre-line of the unit,

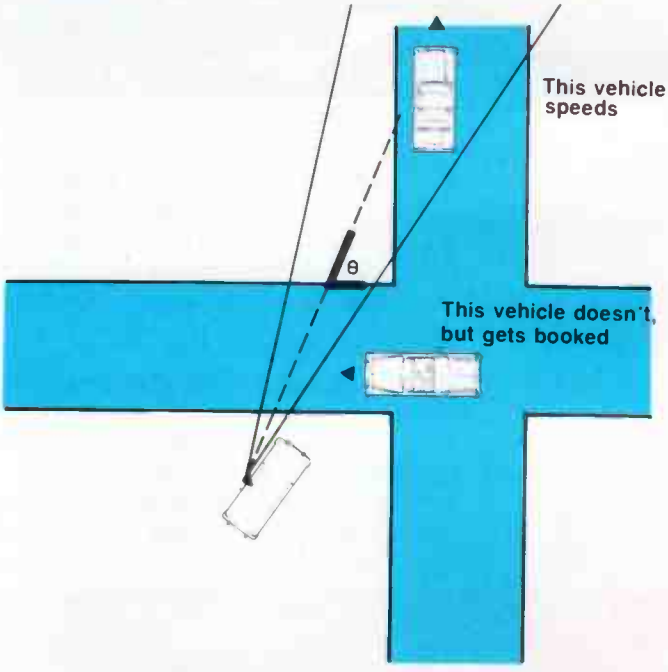


Figure 3. An across-the road radar setup. Little of the road being scanned is effectively illuminated, but another road could be. There is no problem if the operator is paying attention. The Radar 'looks' across the road at an angle of 22.5 degrees, but almost any angle would do, so long as it's taken into account.

but because of the steep slope of the typical beam strength curve, it will change rapidly if the car is off-centre. So a quick change is taken by the unit as an indication that the car detected is not in beam centre. This is supposed to prevent a police operator whose attention has wandered booking a car which comes through a split second before or after the violation is recorded, but which is not the vehicle responsible.

Unfortunately, it is not hard to imagine how the roads in Figure 3 might be changed to force the second, and accidentally illuminated road, to cross the beam more slowly. In addition, that road would then have a cosine error going *against* the motorist. Further, the centre section of the beam is wider on the further road. This means that a car will cross it more slowly, in degrees per second, than if it was close to the radar unit, and is still less likely to be caught out by the check for amplitude consistency, which uses a fixed interval for a given target speed, to make the decision.

The human element

Having now discussed how the radar units work, and what they cannot tell an operator, let us look at what an operator needs to do to be sure "beyond reasonable doubt".

Overall, the operator is required to be sure the correct car, is chosen, the one responsible for the speed on the radar unit display. In the case of the KR-11, where there has never been any doubt that it selects the fastest car from amongst any visible, the problem should be simple. The operator cannot really act unless there is one and only one car "present", or there is one car visibly travelling faster than the others. In addition, that car must of course appear to be doing a speed compatible with the reading.

The case is similar for the Digidar unit. An operator who knows that it is possible for the car nearest not to be the one selected by the radar will be on guard. He must respond to a reading only if there is but one car which could have been responsible. If he is continually alert to the possibility that a receding car could be responsible, or that another car way behind the first might have been responsible, he should be able to sense when the situation is not conclusive.

The first requirement is that the operator be well instructed in the situation. Once upon a time, the operators, even in New South Wales where instruction is relatively comprehensive, were not fully aware of what has been described above. The arguments about how radar units worked were still being bandied about, and the opinions of the wise were still divided. It is not suprising that there was a lot of unrest and wrong bookings when the operator was under the impression that the guilty car was the nearest car, because it sometimes wasn't!

It is possible that there are still police officers who are not familiar with the real situation. It is also possible that retrained officers are still influenced by the past situation. It is easy to make the generalisation that the nearest car is responsible if it *usually* is responsible, especially if you have that common subconscious impression that "machines are infallible". The point again is that these machines are dependent to a great extent upon their operators for their accuracy.

The definition of "present" is the next problem. A car could be practically out of sight, and yet responsible, causing some other car to be blamed. How far away is not present? Well, it seems that ten times farther away is a safe factor. Generally, an operator who is on the ball will twig to the situation if he pulls over one car, and another comes past very soon after. This is especially so if the driver is politely adamant that he was not doing the offending speed. However, if he is tired (by having been on the job for the last few hours of a bleak and boring day, or if he has just done two hours of RBT (which tends to numb the senses), he may not notice. The point here is that *people tire and machines don't*. Since the 'machine' involved includes a radar unit and there may

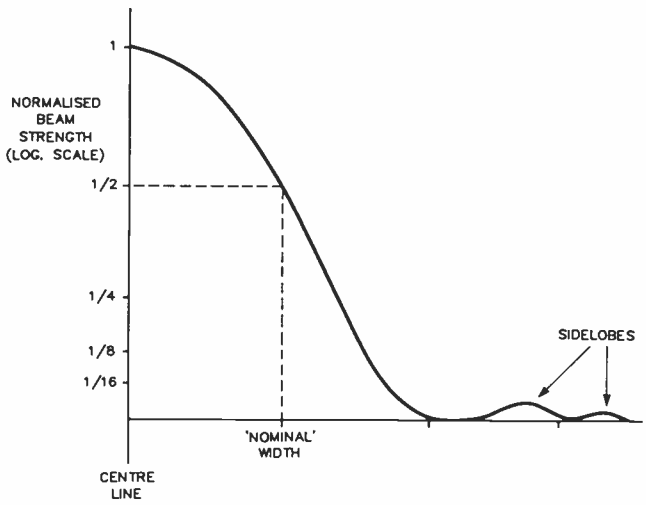


Figure 4. Radar beam strength (vertical axis) versus angle off-centre (horizontal axis). The steep fall-off off-centre is exploited by the Fairly radar to exclude vehicles off to the side of the beam.

be an increased error rate in some circumstances. What is called for is a radar unit which removes the responsibility for detection of other cars from the person and takes over itself.

It is interesting to discuss a "check" against a mistake being made. In New South Wales at least, the officer is instructed to make an estimate of the vehicle speed, and see that it matches that reported by the machine. You can imagine the officer playing a game with himself, using the radar unit to calibrate his estimation skill. Where they agree, he proceeds, but if they do not, he suspects something has gone wrong and either ignores the incident, or proceeds with added care. It is also easy to see that such a game would get boring very quickly.

If you get tired enough to miss second cars or receding cars, you are quite tired enough to have slipped into looking at the radar display and then looking at the car and say "yes, that is about right", which is not much of a check at the point where it is needed most. It only takes one slip-up such as that in a critical situation once a month by some operator somewhere in the state to get the trade a bad name. Considering all the officers on the roads, that does represent more than a minuscule percentage of the total radar bookings.

The situation is rather different with the Fairey unit, but it is as surely dependent upon the operator as with the others. There would seem to be two obvious ways that the unit can mislead. Both mechanisms require but a moment of inattention on the part of the operator, which is easy to accept.

If there is a road in the beam some way behind the road directly in front of the unit, such as depicted in Figure 3, problems can arise. Imagine the following situation. A car travelling at a legal speed passes the operator, who has stopped to scratch or turned to use the radio. A fraction of a second earlier or later a very fast car moves into the beam on the far road. Recall that the beam is quite wide some distance away, so the car can be some degrees off centre-line if need be, and will still cause a valid reading. Imagine that the roads are at right angles and that the radar unit is set up in one of those 25 kph crossing zones which are littered about Adelaide, as radar units sometimes are.

Allowing for the cosine correction of the Fairey unit at 22.5° to the near road, a car travelling at just 60 kph on the far road will seem to the radar the same as a car travelling at 25 kph on the near road. When the radar indicates to the operator that it has detected a car exceeding the speed limit, he returns his attention form that momentary distraction, and sees one car right in front of him. He naturally books it. Even ▶

if he notices (from his tree covered niche where he has hidden from view) that it seemed to be travelling at a reasonable speed he assumes that it has slowed quickly because it has seen him.

The second easy scenario for malfunction arises from the unit's inability to distinguish direction. The same distracting itch or radio call could cause the operator to miss a first car moving the opposite way, off in the direction which takes it behind the trees used for cover. The second car zooms past (legally) before the operator has returned attention sufficiently to do more than get the licence plate and pass it on to his associated patrol car. Again the wrong vehicle will be associated with the speed reading obtained.

The 'Microeye' range of radar detectors, from Perth-based firm Altronics, claim the ability to detect both X- and K-band radar at distances up to 13 km. There are three in the range, all superhet models designed for sun visor mounting. The A 1510 has separate audio alerts for each band and a radar signal discriminator (RSD) switch to ". . . eliminate extraneous signals". The A 1520 has an additional switchable filter to further reduce interference from microwave door openers and burglar alarms, resulting in an extra 3 dB (2x) more sensitivity in 'city' mode, the makers claim. The Vector (A 1530) features gallium arsenide (GaAs) detector diodes, resulting in about 4 dB (2.5x) more sensitivity than the A 1520, it is claimed. All three feature a microprocessor system for discriminating between signal types to allow discrimination between Police Radar and interference, claim the manufacturers. The three units cost, respectively, $399, $449 and $499.

How a court case goes

If you were booked (or arrested) for speeding, and you asked your solicitor to enquire about the possibilities and advise you as to what to do, what would he advise? The truth is that he would be forced to say that you had little chance of proving in court that you were not speeding, even if it was the fact of the matter.

The problem lies in the fact that where it is a matter of one person's word against that of a policeman, the court will normally accept the policeman's description as the truth. Most radar operators know what *should have happened*, which is what probably does happen most of the time. If an operator misses some clue in using the radar unit, he is very unlikely to realise it, and less likely to be convinced later that he made some mistake. When the matter comes to court, some six to eighteen months later, he will recall what his impression of the events were, and the impression is (not surprisingly) likely to be very close to what does happen most of the time. That impression will include the normal checks of satisfactory operation, such as check for other cars, even if his momentary inattention those months ago cancelled the check.

Trying to convince a courtroom that a small inattention could negate the accuracy of the radar is difficult, but trying to also convince it that the policeman had such a small lapse is very difficult. It generally requires that you have an expert witness, and that that witness has briefed your solicitor or barrister carefully beforehand. It also requires a shrewd and capable legal eagle to extract an admission of a moment's possible inattention from a constable who has a carefully rehearsed description of the event and a lot of witness experience. These conditions are very rarely met, and both sides know it.

Cases where there is some independent witness go very differently. A famous (infamous?) case in Sydney involved a motorist behind the victim appearing after the policemen both swore that nothing could have gone wrong. The independent witness was shown never to have seen the victim before that day, and had a description that corroborated the victim's story completely. *Something had gone wrong*, though it was never settled as to exactly what. (The independent witness had a Super Snooper, which told him of the radar unit. There is some suggestion that it was responsible, but the matter did not need to pursued.)

Such witnesses are very hard to come by indeed. Witnesses in you own car do not count, for obvious reasons. The case above involved a good Samaritan, which you are unlikely to have on hand.

JAMMERS

Jamming a radar unit is generally achieved by 'flooding' the environment with a signal which confuses the radar. Such a signal is one which the radar realises is not possibly produced by a steady, valid target, but from which it cannot separate a valid signal if present.

This is most usually done (judging from units I've seen) by frequency modulating an oscillator in the radar band. The oscillator used is just the same as that in a radar unit, except that some circuitry is added to allow frequency modulation. The modulating signal is noise, so that the signal makes no 'sense'. The modulation may be achieved by adding a high Q varactor diode at the appropriate high field strength point in the oscillator cavity, or even more simply by modulating the power supply on the Gunn diode in the oscillator.

This latter method requires neither a second diode, costing a few tens of dollars, nor any mechanical alteration of the commercial module, but is less reliable in confusing radar units. The Digidar, for example, responds to the signal jumping around the band by obtaining unequal readings on its six sequential tries, and so displays 00 and gives up. The KR-11 sees the 'noise floor' of the environment rise, and sees large variation in the amplitude of signal at any single frequency with time because the jammer rushes over that frequency at random. It would be vitally important for the jammer modulation to be truly random, comprising white noise with a bandwith from below 1 Hz, so that the radar unit sees no regular signal which could be recognised as some extraneous signal. This is especially so for the cleverer units such as the KR-11.

'Intelligent' jamming is less simple. *Transponders* operate by receiving the signal sent out by the radar unit. Once they have this information, they can take sensible action. Mostly they transmit a very strong signal corresponding to a vehicle that is travelling slowly, and hope that it swamps out all other signals, which is not too difficult. Again the more intelligent Police radar units require a very much stronger signal to be defeated.

In either case, the mathematics required to calculate the precise requirements is well known from the technical literature, and the hardware required trivial in an electronic sense. A (simple) jammer is readily assembled from locally available parts if you have the know-how. However, like detectors, jammers can be badly designed very easily if you do not know how, and this fact is not often discovered until too late!

WHAT HOPE DOES FUTURE TECHNOLOGY HOLD?

There are problems which hinder the development and use of radar units which can (1) discern between receding and approaching targets, (2) reject readings where there are cars which could confuse the operator and (3) reject spurious signals from other sources, deliberate and accidental. The main problem is that there is no strong incentive from any body to support the development of such machines: the government is happy with the current units. The department that runs the units does not accept that they are significantly fallible, and is going to have to defend the units against crackpots and wealthy people no matter what, so stands to save little in court costs by avoiding genuine errors.

There are ways to implement all the above requirements, albeit at cost. There are newer developments, which are being explored at various research institutions, which may lead to reasonable cost units which do not rely on the operator. It will be some years at the earliest, before such machines are readily accepted into the police system.

What to do if YOU are pulled over

The final piece of useful advice this article offers concerns the best action to be taken if you find yourself wrongly pulled over and accused at the hands of a radar unit.

The very first thing to do is get the licence plate of any car nearby. If you can produce the driver of a car that was there at that very moment, you will have a very strong bargaining point in a court of law. Even if the driver of that car cannot recall your car, or be sure that he passed the trap at the same time, the fact that he was there may contradict other people's descriptions of the incident.

The police officer will address you with a line to the effect that the radar has measured your speed at such-and-such a value. If you do not agree with this, politely say that you do not believe it to be accurate, and suggest that another car was responsible. Many officers will suspect that there may have been an error if you are level headed and seem to know what you are talking about.

If the officer decides to go ahead and book you, ask to see the readout or printout of the radar unit, and take its serial number, and the name and serial number of the officer to whom you are talking. If you carry out these actions calmly and with due respect, the officer is more likely to recall the occasion.

You are permitted to have in front of you in court any notes you take at the time of the incident. This action not only helps you remember what happened, but will also impress a magistrate with your efficiency. Thus, write down anything the officer says which you might think important. You can complete these notes after you have finished your discussions with the officer, just as he may.

Finally, note down the exact location of the radar antenna, e.g. on the road side near window of the (police) car parked outside number 44 something street. You should also have noted if the policeman's view was obstructed by trees, etc, as this may affect what he could have seen of your vehicle. If he could not see your approach, he will not have been able to estimate your speed by eye *before* the unit alerted him to your supposed speed.

Conclusion

The situation with regard to radar equipment is that the instrument is not capable, by itself, of returning any result "beyond reasonable doubt". Because it still depends upon a person, there is room for error. Regrettably, the courts have no way of telling just who made the mistake where there is no independent witness available. Worse, where a member of the police force disagrees with a private individual, the court takes the word of the "trained" officer. While this is a statistically wise decision, it is by no means conclusive, because everybody makes mistakes.

"Pocket Watch" TV boasts colour LCD screen

This pocket/portable TV receiver featuring a 75 mm (3") colour LCD screen will be launched in Japan and North America by the Matsushita Electric Industrial Co. of Osaka, Japan, under the Panasonic brand name this coming May.

Matsushita claim the liquid crystal screen " . . . offers pictures as crisp as those found using conventional cathode ray tubes." The TV's high-clarity picture boasts a resolution of 240 x 372 pixels, made possible by a thin film transistor (TFT) active matrix system. A separate transistor for each pixel (all 89 280 of them!) enables " . . . subtle variations in hue and colour intensity", the company claims.

Matsushita says technological innovations like multi-gap colour filters, triangle colour formation of the red, green and blue pixels, and a black matrix combine to dramatically improve contrast and overall picture quality.

Weighing in at less than half a kilogram, the TV measures just 163 mm high by 90 mm wide and only 22 mm thick, so it will easily slide into a largish pocket or purse.

Matsushita claim the TV provides a brilliant picture even in direct sunlight with a pop-up filter. Indoors, internal backlighting provides viewing under low light conditions. They claim the screen can be viewed over $+/-40^0$ horizontally, $+/-30^0$ vertically.

It can be powered from batteries, ac adaptor or car battery adaptor. It has an audio/video jack and can serve as a colour monitor for video camera or VCR. National Panasonic Australia, Matsushita's Australian operation, say there is no plan to import it here. Never mind, register your enthusiasm/protest with **National Panasonic Australia, 95-99 Epping Rd, North Ryde 2113 NSW. (03) 887 5314.**

Onkyo launch CD player

Onkyo of Japan has released the DX-150 CD player featuring a 'double oversampling' conversion system that is said to preserve the clarity and phase accuracy of digital audio, particularly in the critical high frequency range.

A 16-track memory is only one of the luxury features of the DX-150. This memory play allows one to play tracks in any desired order — even repeating a track number more than once.

The DX-150 also features a forward or backward jump key function, which moves the pick-up directly to the starting point of a track in either direction, reducing time-consuming manual search operation.

Other features include fast forward and fast reverse keys to quickly move the laser pickup to any specific point on the disk; power and play/pause indicators; and optional operation with audio timer.

Onkyo (the Japanese word for 'audio') has specialised in audio and hi-fi technology throughout its 30 years of operations, and chosen not to diversify into other areas like most other companies.

Onkyo products are distributed Australia-wide by Regent Audio, a division of the publicly listed Broadcast and Communications Ltd. For further information, contact: **Margot Bowles, Regent Audio, 16 Suakin St, Pymble 2073 NSW. (02) 449 5666.**

Dick Smith's stereo AM/FM car cassette deck

Dick Smith Electronics has released a $279 stereo AM/FM cassette deck featuring LED digital frequency display, five AM and five FM station memories with auto scanning, plus automatic noise reduction.

The unit, cat. no. A-6020, delivers six watts ouput and the cassette deck comes with Dolby noise reduction. It is designed for in-dash mounting in most cars. Further details from Dick Smith stores and dealers throughout Australia and New Zealand. Viatel subscribers should check with 6743584882.

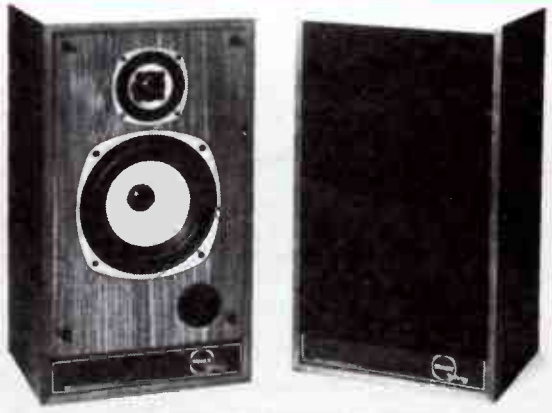
Random playback for Akai CD player

Akai's new CD player, the CD-A30, can play up to 36 tracks from a disc in any order. All you do is press the "skip/music" button until your first track comes up, then press memory; skip to the next track you want, press memory, and then continue until all the tracks you want are entered in the desired order.

There is an MA-MB repeat play, so you can go back to any place on a track and repeat that section as many times as you like. A manual search systems, is included to find your favourite spot in two speeds. To top this off, there is a skip search to go to the end or beginning of the current track at the touch of a button. You can also add-on a 'subcode' jack later to take advantage of the promised video features to become available on compact discs shortly. This provides still pictures on your TV while you listen to the music.

The CD-A30 is attractively style and comes in both black and silver.

See your nearest Akai dealer or stockist for further details.



TANNOY HIT THE HI-FI TRAIL

One of the world's best-known names in loudspeakers, Tannoy, from Britain, has hit the hi-fi trail here once again through the dealership network of Rank Electronics.

Tannoy is well-known for its development of the dual-concentric driver, so successfully exploited in the now-famous Bailey transmission line loudspeaker designs of the early '70s.

Andrew Harrisson, General Manager of Rank Electronics' Audio Division, said the active promotion of Tannoy speakers to the general consumer market was in response to the growing audio sophistication of this sector.

Enquiries to: **Margaret Bowles, Audio Division, Rank Electronics Pty Ltd, 16 Suakin St, Pymble 2073 NSW. (02) 449 5666.**

Jamo's CBR 200 'digital monitors'

Robert Fitzell AAAC

Incorporating some exciting concepts, Jamo's new release – the CBR 'digital monitor' series, of which the CBR 200 is the top model – features a unique box construction employing a front baffle made from a special ('NCC') compound and a non-rectangular enclosure.

SOME YEARS AGO, perhaps even in the early days of 'hi-fi', it became apparent that the components which most strongly influenced audio quality were those at each end of the system. The purely electrical stages have developed to a high level of sophistication, due in no small meausure to the fact that electrical energy is highly controllable. Amplifiers have long been, within reason, very linear. However, since sound energy is a physical quantity obeying physical laws there is required an inevitable conversion process from electrical to mechanical energy — microphones and loudspeakers. Until recently the pressure on the mechanical legs to perform was not so extreme since there were significant 'electro-mechanical' stages in the process — turntables and tape recorders — in which the limitation to quality was also audibly real. The digital era has, however, changed all that. Audio signals can now be processed with almost electrical perfection until reaching that final leg — two or three pieces of cardboard wriggling hopefully in a wooden box and trying to convert the electrical energy into air pressure variations.

Since the arrival of compact discs, although in truth the changes have been occurring since the arrival of digital recording, we have all become familiar with the sight of 'DIGITAL MONITOR' pasted grandly onto most loudspeakers in hi-fi stores. I guess, in truth, the claim is correct — if you listen to digital source material through them you can *monitor* the sound, although I would defy most listeners to assess source *quality* through many of them!

Some manufacturers have, however, sought to do more than just name the box. There have been some crashing successes and some resounding failures. However, until the development work finds the sort of conceptual changes that have revolutionised the signal processing chain, the poor old loudspeakers will still be suffering inferiority complexes. Loudspeakers will never be as accurate as, say, a CD player, since there are simply too many uncontrolled variables involved. But, I for one believe that some aspects of peformance can and will be significantly improved.

REVIEW ITEM:	Loudspeaker
MANUFACTURER:	Jamo
MODEL:	CBR-200
FORMAT:	3-way bass-reflex
PRICE:	$1995 pair RRP.
SUMMARY:	A puzzle with a few missing pieces

No ordinary loudspeaker

One manufacturer who is clearly unafraid of research and development is the Danish firm, Jamo. From first sight it is obvious the Jamo CBR 200 is no ordinary loudspeaker. To me, they looked immediately like a modern day Easter Island statue — large inclined monoliths making no excuses to all the other plumb surfaces which surround them. They actually 'look' digital.

The appearance is not, however, due to any archeaological whim, but due to very real attempt to control some of the aspects so commonly detrimental to loudspeakers.

Design features

The CBR 200 is a three-way bass-reflex loudspeaker incorporating a number of design features common to the model range offered by Jamo. The '200' is a 200 watt capacity loudspeaker, with other models offering 120 watt, 90 watt and 70 watt capacities, respectively. One of my own criteria for deeming a loudspeaker suited to 'digital' sound is power handling capacity, and the CBR-200 is clearly one which complies. Readers are probably becoming bored with my emphasis on power needed for digital source limit but it is, quite simply, essential.

I have never liked the audio industry tendency to jargon. However, I can concede that to do otherwise is sometimes difficult. Jamo has followed the lead of many others in using letter abbreviations to refer to two of the most important design features — CBR means "centre bass reflex" and NCC means "non-colouration-compound". Unfortunately, this tends to distract one from recognising that the loudspeaker

design principles are based in technology and not on marketing. In both these principles physical impedance load on the bass loudspeaker (woofer in jargon: OK, I concede), and an enclosure in which vibration is highly damped and dies away rapidly. A third basic design principles which is utilised is the use of a non-rectangular enclosure.

The benefit of a symmetrical load on the woofer is claimed to be lower distortion and the centre bass reflex principle is one which Jamo has patented, and launched in 1981. In most bass-reflex loudspeaker designs the loudspeaker is mounted in a baffle board with a carefully designed aperture, or port, situated somewhere else in the same baffle board. Since the wavelengths at which the aperture influences the loudspeaker performance are very long, the physical separation between the two components does not cause any phase problem for any listener location. The loudspeaker driver is, however, in a non-uniform pressure field, albeit infinitesimally so, since the aperture is usually to one side of the driver. The Jamo principle is simply that the loudspeaker is mounted within the aperture itself, so that the vent surrounds the driver. Low frequency distortion is claimed to be decreased by 50 to 60 per cent compared to ordinary loudspeakers.

The second major feature is the material used for the baffle board. Quite correctly, Jamo has asserted that the construction material used for loudspeaker enclosures can colour the sound quality. For those who doubt this, remember how much sound comes from a violin or cello, simply from a vibrating wooden enclosure.

From their experimental work, Jamo would have preferred to use concrete for their baffle boards. Since concrete would obviously have limited acceptance domestically, Jamo developed an injection moulded "concrete-like material" sandwiched between formed polystyrene. The polystyrene baffle is textured in a rectangular grid so as to reduce diffraction. The edges of the baffle board are slightly rounded, also to reduce diffraction. Finally, the baffle board is inclined to assist phase alignment of the three drivers by ensuring that the acoustic centres of each driver are in line.

It is known that non-rectangular panels and enclosures tend to resonate at fewer frequencies, and at frequencies which are not harmonically related to one another, than do rectangular ones. Jamo has used a non-rectangular enclosure for the rear half of the box coupled to a rectangular baffle board. The non-rectangular exact angle of which has been determined to assist phasing at crossover points. It is worth remembering at this point that the term 'monitor' has evolved from the recording studio industry, where a recording engineer requires a sound field that is as clear from anomalies as possible but has the advantage of sitting in almost the same position at all times. A true monitor can take advantage of physical design features, such as an inclined baffle board, particularly in relation to phase, which are of little relevance to domestic hi-fi where listeners can be seated anywhere.

Does it make sense?

In summary, yes, although it should also be stated that there is no guarantee at all that non-rectangular enclosures will outperform rectangular ones. In relation to the venting, good low frequency performance is achieved through the use of a properly aligned vent, all that Jamo are doing here is refining the performance. The logic of the use of a damped baffle board is unable to be challenged. What is important, in my own view, is that the entire box be examined and not the baffle board alone.

The decision to use a non-rectangular enclosure format is an important one, the success of which depends on more than the physics of non-rectangular spaces. It is critical for loudspeakers that construction be robust and that panels connect solidly together. Many excellent technical principles have foundered simply because fabrication is either too difficult or too expensive. In my own view it is often worse to implement a good idea badly than implement a mediocre idea very well, particulary where loudspeakers are concerned.

Laboratory performance

Laboratory testing of the CBR 200 has proven more than interesting. Overall, results range from excellent to less than average, and it is clear that the ideas engendered in the design can be taken much further.

Figure 1 shows the frequency response for each driver, measured near-field at 50 mm. The crossover points appear to be nominally 900 Hz and 4 kHz. Overall, the three traces are a lot less exciting than had been expected.

Figure 2 shows frequency response measured free-field on axis at a distance of three metres. The large dip at 100-150 Hz is a ground effect where the wave reflected off the ground has phase cancelled. Whilst this a real effect in a room, the drip would not be there in a Q = 1 anechoic chamber. Not so the dip at 2 kHz, which is much more serious. The microphone position used was one metre above ground, or about at the level of a seated listener.

At first, the dip is very puzzling, since it occurs at about the centre of the mid-range driver performance and well away from the apparent crossover points. Performance at the nominal range point where the near-field traces suggested ▶

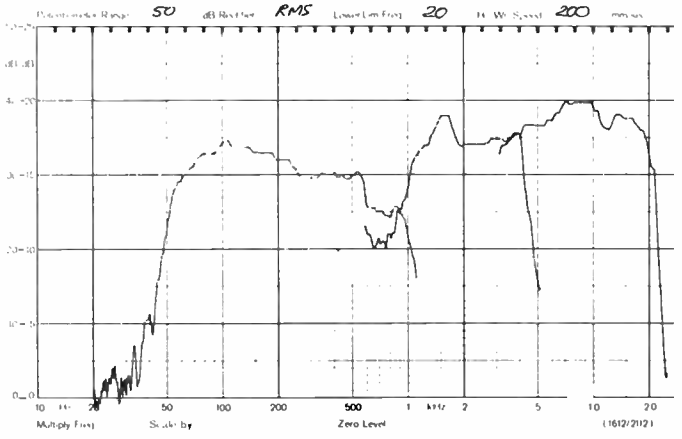


Figure 1. Near-field response of the drivers.

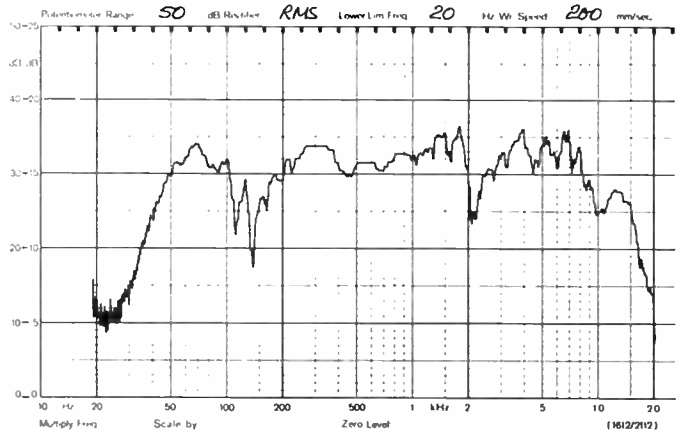


Figure 2. On-axis frequency response of the CBR 200.

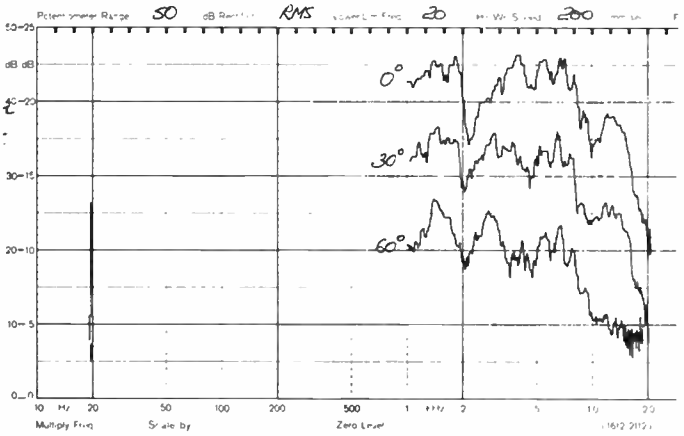


Figure 3. Horizontal off-axis response above 1 kHz, compared to on-axis response (top). The curves are separated by 10 dB for clarity.

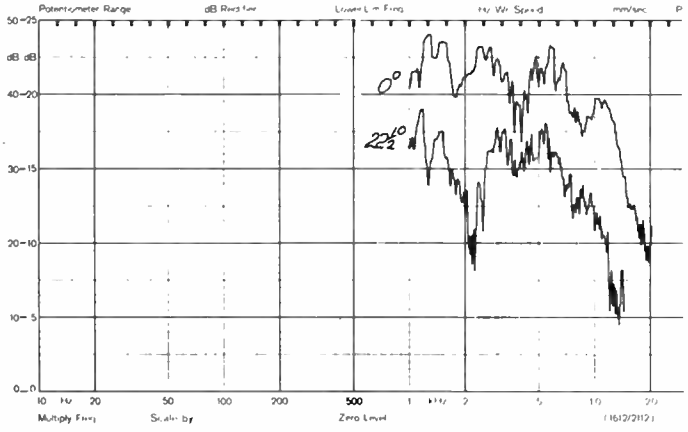


Figure 4. Vertical off-axis response above 1 kHz, taken at 22.5 degrees, compared to on-axis response (top).

performance would more than likely be deficient. However, it appears from Figure 1 that the crossover at 4 kHz uses a very sharp low-pass filter on the mid-range but only a 6 dB/octave slope at best on the high-pass. This appears to be the problem, and signal phase, either electrically or physically, is reversed between the two driver units. This is clearly one of the disadvantages of the sloped baffle, since it much more difficult to identify the cause of a spurious result when it appears.

High frequency roll-off is also a real disappointment, seen in Figure 2. This again is not really expected from the near-field traces, although it is clearly not possible for interaction with the mid-range to be the source of the problem. The roll-off does not sound bad, and many listeners would in fact prefer loudspeakers with a little softening of the highest frequencies. However, if the top end is not there in the first place it will frustrate many.

Gauging by the diffraction treatment on the baffle board I would not have expected the roll-off to result from panel effects, although the dip at 10 kHz is sufficiently discrete to suggest edge diffraction or some other such discrete source. One-quarter wavelength at 10 kHz is 8.5 mm, i.e: virtually at the same point as the tweeter, so if anything the rolled panel surrounding the tweeter may well be the culprit.

Figure 3 shows high frequency horizontal roll-off at 30 and 60 degrees. These results are excellent and really lead to further puzzling at the poor zero degree showing. Figure 4 gives zero degrees again, together with the response at 22.5 degrees above the seating plane. In both Figures 3 and 4, the sensitivity to angle and overall phase deficiencies at 2 kHz are very apparent. Overall, we found the performance at high frequencies to be very sensitive to location, particularly in relation to phase effects.

When compared with other loudspeaker tweeter performances the tweeter response is definitely more lumpy, although the dispersion quite good.

Sensitivity was found to be 92 dB/watt (2.84 V) at one metre for 1 kHz, and the dc resistance 6.74 ohm. Given the power handling capacity at 200 watts, the CBR 200 can produce 115 dB sound pressure level at one metre, well and truly up in the CD player peaks range.

Pulse testing (Figure 5) displays an overall level deficiency centred on 3 kHz. This is nearer the region at which near-field sweeps in Figure 1 might have foreshadowed at deficiency, although it is also clear that there is a lag at 1970 Hz which may be the start of a delayed reversed-phase component. In swept sinewave testing this can occur within the bandwidth of the sinewave and can cause cancellation. Each trace in the impulse response test is 0.8 millisecond apart, so you are looking at about a 12 to 15 millisecond period.

Figure 6 shows an impulse, but over a much wider bandwidth to achieve a short pulse duration. In each trace, time advances 40 microseconds, so you are looking at 1.6 millisecond total time.

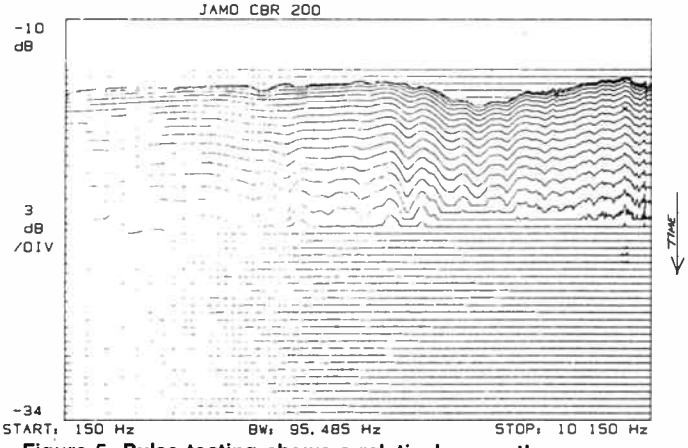


Figure 5. Pulse testing shows a relatively smooth performance over the lower-to-mid-range, but indicates an overall level deficiency around 3 kHz and a 'lag' just below 2 kHz. Frequency (bottom axis) is on a log. scale.

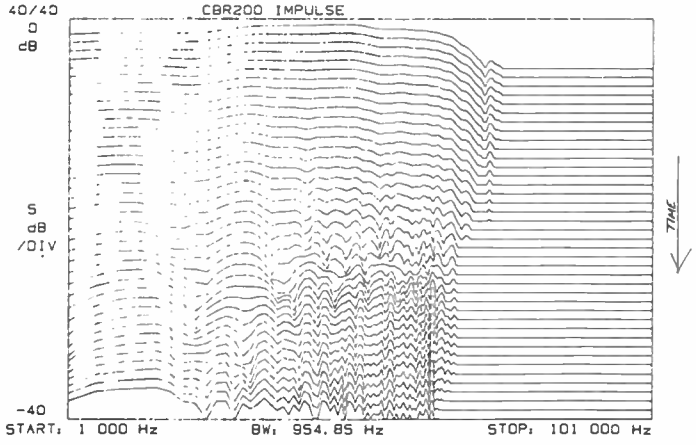


Figure 6. Pulse testing with a short pulse duration with bandwidth extended to cover the top end.

TABLE 1: Total harmonic distortion, dB

Input power, watts	40 Hz	100 Hz	315 Hz	1k Hz	10k Hz
1	n/a	−40	−41	−42	−30
10	−25	−36	−32	−51	−36
100	−10	−18	−34	−43	n/a

Distortion testing is summarised in Figures 7, 8 and 9 along with Table 1. When compared with other loudspeakers, distortion at 1 kHz is very impressive, whilst the values obtained for 10 kHz and 100 Hz are nothing to disappoint, although not stunning. Forty Hertz is not a test frequency that we have used greatly so we cannot draw a fair comparison. At 100 watts and 40 Hz, distortion is certainly starting to rise. Similarly, distortion at 315 Hz cannot easily be compared with our previous tests. In most cases, second and third harmonic distortion were the strongest components, with third harmonic being progressively more significant as frequency lowered.

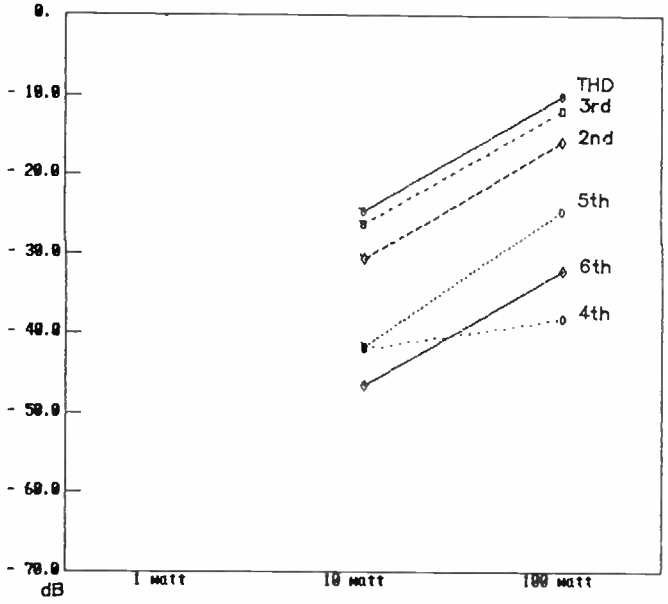


Figure 7. Harmonic distortion at 40 Hz.

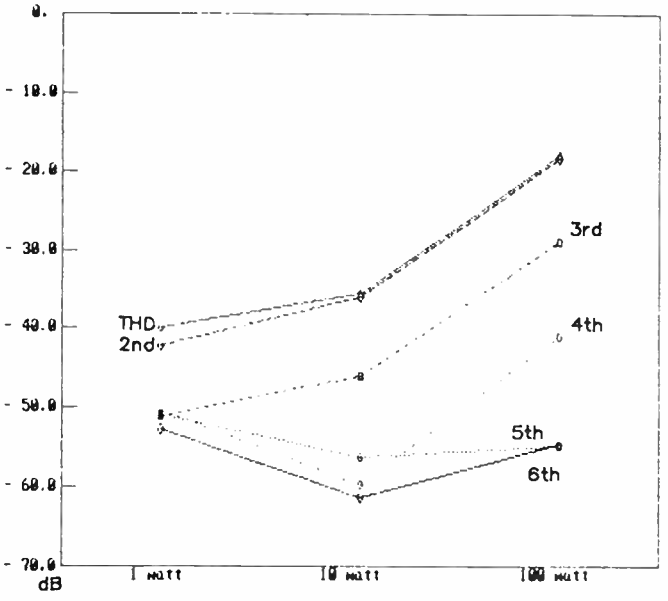


Figure 8. Harmonic distortion at 100 Hz.

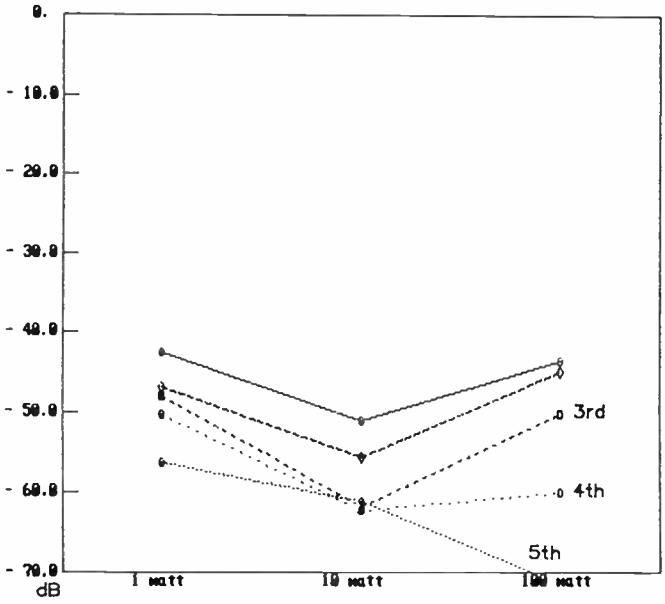


Figure 9. Harmonic distortion at 1 kHz.

TABLE 2: Test results summary CBR 200.

dc Resistance	6.74 Ohm
Sensitivity	92 dB/watt at 1 metre
Frequency Response	40 Hz to 15 kHz +/– 6 dB
Crossover frequencies	900 Hz, 4 kHz
Rated power (not tested)	200 watt
Maximum SPL	115 dB at 1 metre

Panel damping

Having completed most of our usual electro-acoustic tests, we examined the performance of the enclosure, particularly with respect to vibration damping. The results can only be said to be a disappointment.

Two methods were used to assess the effectiveness of the Jamo claims for their panel design — panel excitation using a pulse through the loudspeaker, and impact response using a rubber head mallet (gently!), with vibration being monitored using an accelerometer fixed to various panels.

Figure 10 shows the impulse for an accelerometer on the front baffle panel of the CBR 200, diagonally across from both the mid-range and the woofer, with a pulse through the loudspeaker. Significant panel resonances are evident at 92 Hz, 165 Hz and 238 Hz. Energy at higher frequencies is transmitted from the drivers through the panel, and the important aspect is that energy at higher frequencies decays rapidly. Each trace is 16 millisecond apart, so the time taken for the three panel resonances to decay 60 dB is approximately 400 millisecond! That is, longer than the reverberation time of some studios.

To examine this further we then used the rubber mallet, tapping the front panel at a point opposite the accelerometer on the front panel. This result is shown in Figure 11. The resonances at 92 Hz and 165 Hz are stunningly seen, as are a number of others including the 238 Hz component. This is a more stringent test, and one which is somewhat unrealistic compared with the conditions in use, but one which clearly demonstrates panel resonance.

Whilst tapping the enclosure, prior to any testing at all, it was apparent that the inset baffle plate supporting the mid-range and tweeter is badly resonant. This is both astonishing and disappointing, since I find it hard to reconcile an obvious effort to control baffle board resonance in the main ▶

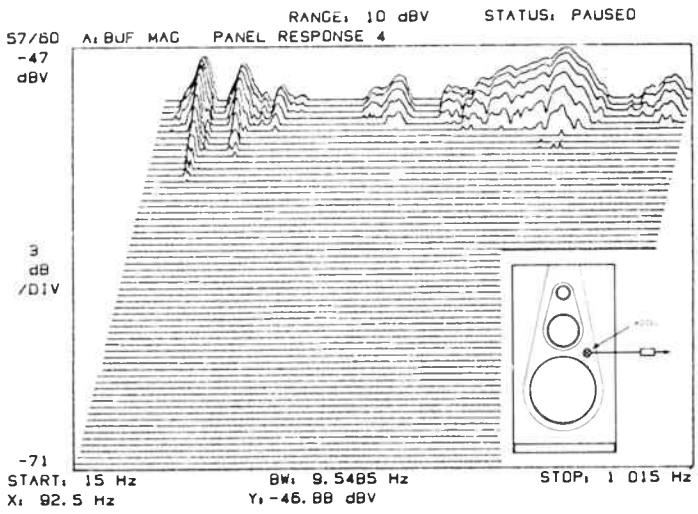


Figure 10. Panel vibration with an impulse signal applied to the loudspeakers. The vibration was measured with an accelerometer placed on the front panel mid-way between the mid-range driver and woofer, and to one side. There are significant resonances around 92 Hz, 165 Hz and 238 Hz. Frequency (horizontal axis) is a linear scale on all figures from this up to Figure 15.

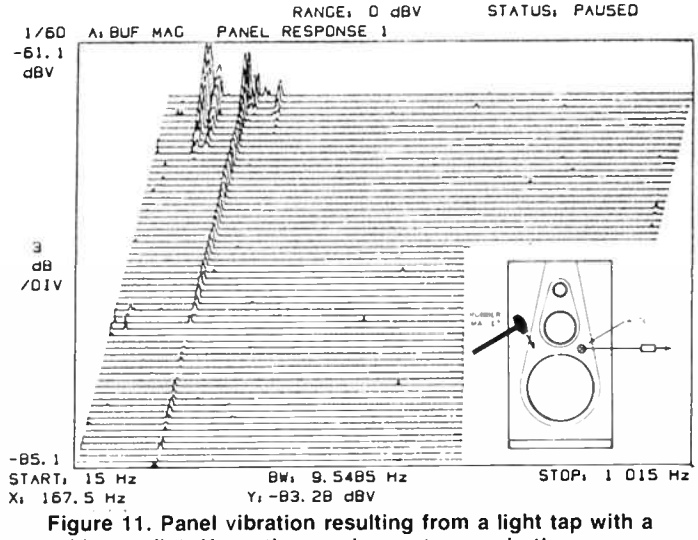


Figure 11. Panel vibration resulting from a light tap with a rubber mallet. Here, the accelerometer was in the same position as in the Figure 10 test, and the mallet was used to strike the panel at a point opposite the accelerometer on the front panel. Major resonances are again seen at around 92 Hz and 165 Hz, the 238 Hz component also showing up.

panel with so simple an oversight with the mid-range baffle board.

Figure 12 shows the panel resonance with a mallet impact on the rear panel of the enclosure. (Not the adjacent front panel, the rear panel!) Resonances a little below and around 90 Hz are again seen, as is a strong resonance at 228 Hz. The 60 dB decay rate for both these resonances is of the order of one second!

Figure 13 show the panel response using a pulse through the loudspeaker. Again there is significant energy, and you should note that the bandwidth of the sample to 1 kHz only is mostly below the output range of the speakers in the board.

Finally, in Figure 14 we show the vibration decay for the rear panel, using the impulse source through the loudspeaker. The resonance at 92 Hz is both sharp and and long, again in the region of 0.8 second for 60 dB decay.

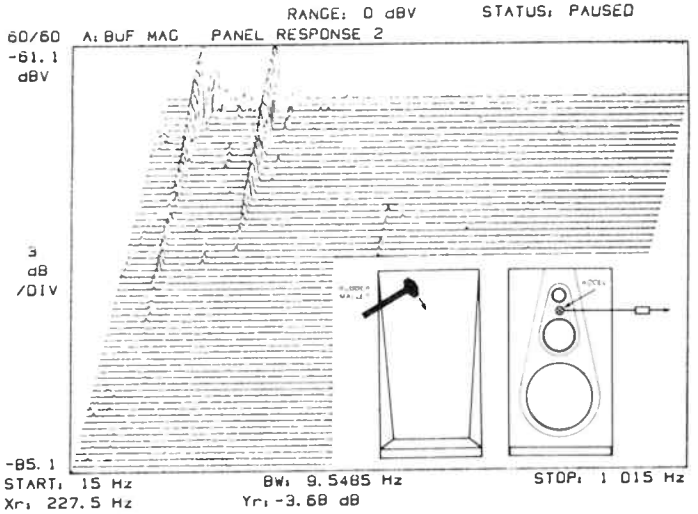


Figure 12. Panel vibration resulting from a light tap with a rubber mallet on the rear panel of the enclosure, accelerometer placed between mid-range driver and tweeter. Resonances around 90 Hz are again seen, as is a strong one at 228 Hz. The decay rate for these resonances to reach –60 dB is of the order of one second.

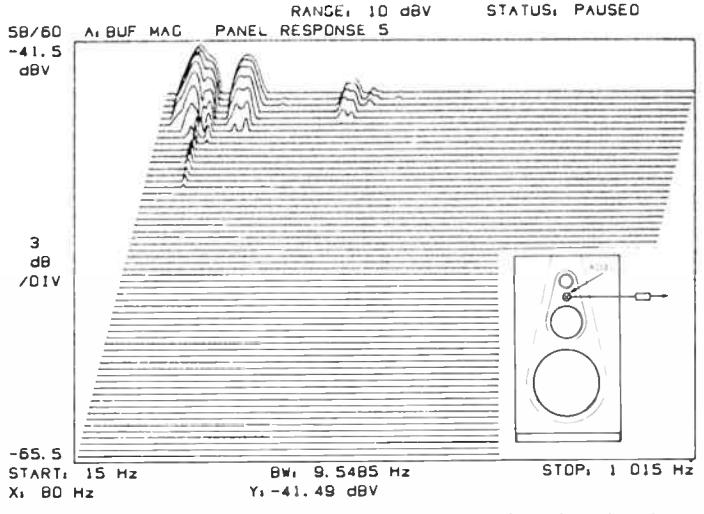


Figure 13. Panel vibration resulting from an impulse signal applied to the loudspeakers, with the accelerometer in the same place as the Figure 12 test. The resonances around 80-90 Hz and 165 Hz are clearly apparent, with minor responses at 370 Hz and 407 Hz.

To make a comparison, I include Figure 15 a vibration decay trace for a simple rectangular particle board construction enclosure. The largest panel dimension, 350 mm by 550 mm, is admittedly smaller than those of the CBR 200, although not unfairly so. An impact with the rubber mallet was used to excite the panels, although it should be said that the response with the impulse source was not greatly different. The panel resonances are clearly greater in number and occur at higher frequencies, but in every other respect I would rather have the simple particle board panel response.

As I said earlier, a disappointment.

Subjective testing

As a rule, I generally prefer to test subjectively before any laboratory testing. In this case I am glad that I did so, since I would have undoubtedly been expecting some poor aspects of performance to appear. I felt that the subjective quality of the speakers was good, with some very pleasant aspects

— to page 100 ▶

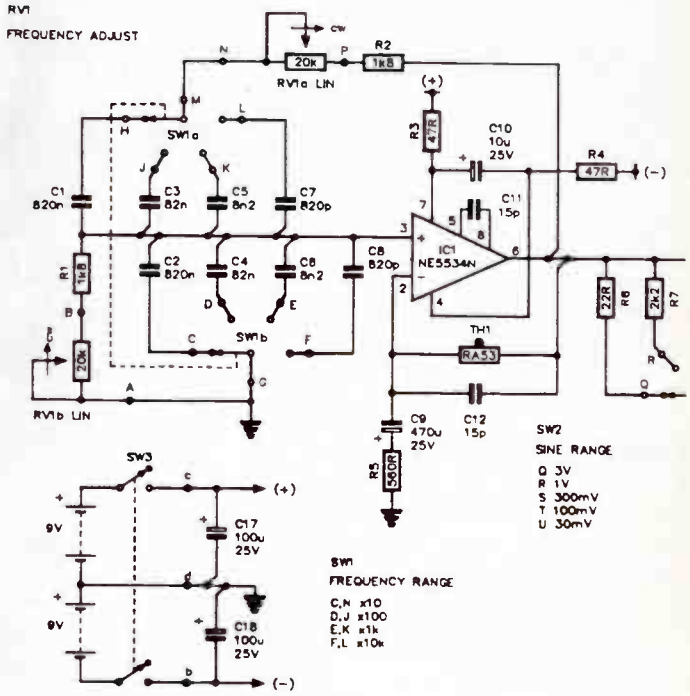
The vanishing thermistor

Readers have reported difficulty in obtaining the ITT RA53 thermistor specified in the AEM2500 Simple Sine/Square Audio Oscillator (December '85 issue). It is imported and distributed here by STC-Cannon. At the time the project was designed, Jaycar were stocking the thermistor, which was listed as catalogue no. RN3400.

We always canvass a number of retailers and kit suppliers before going ahead with any project, especially those which require 'special' components. At the time, a number of firms indicated interest in the proposed AEM2500. However, by the time the project was published, Jaycar no longer stocked the RA53 and the various suppliers who indicated interest had 'gone cold' on it.

In designing the project, we even attempted to replace the RA53 with electronic circuitry, but that complicated the project enormously, did not perform as well, and could not economically replace the RA53 thermistor. We could not find a substitute type from another manufacturer.

So here we are, caught between the devil and the deep blue sea. We'll endeavour to convince a retailer or two that RA53s are worthy of their inventory, or find some other way to have them made available. The RA53 is not a cheap component, but in this application is essential as there's no economic substitute.



Meter bargain

Electronic Facilities currently has on-special some 1 mA meter movements. Now, you can always use a few meters on the shelf or in the 'junk' box, for that rainy day project.

Made by Kyoritsu and dubbed Model KM-48, the meters have a 45 mm wide face with the usual 0 to 1 scale with each 200 uA interval marked. At $6.50 each, they're a bargain! The drawback is — they've got strictly limited stocks.

Rush to **Electronic Facilities, 67 Dickson Ave (PO Box 351), Artarmon 2064 NSW,** or call toll free on **(008) 22 6385.**

Maintenance-free batteries for alarms

If you've built and installed your own electronic burglar alarm system, or are thinking of doing same, then no doubt your thoughts have turned to the question of battery backup in the event of mains failure. Current practice is to employ 'maintenance-free' lead acid batteries for this purpose.

All Electronic Components in Melbourne currently stock the well-regarded Gates sealed lead-acid batteries in 6 V assemblies with two amp-hour ratings of 2.5 Ah and 5 Ah.

The manufacturers claim they can be stored for up to 1200 days and have an eight year life in float-charge service.

According to the literature, the batteries can go through 200 to 2000 charge cycles and can be discharged to as low as 0.8 volts. Built-in relief valves are included to release gas build-up due to charging.

At around $40 each, these Gates batteries are worth close investigation. Contact **All Electronic Components, 118-122 Lonsdale St, Melbourne 3000 Vic. (03) 662 3506.**

Keyboard killing

Dick Smith Electronics seem to have made a 'killing' in the keyboard market. They're offering "Digitran" brand computer keyboards for just $39.95.

We understand these are fully functional keyboards complete with function keys, numeric keypad, plus SHIFT key, an array of control keys, etc. The 56-key QWERTY keyboard is supplemented by an additional 46 keys, 102 total (or thereabouts). Could be some possibilities there!

The Digitran keyboard is listed as cat. no. J-1008. Try your local Dick Smith store or dealer.

Crystals to order

Tandy are offering a service for scanner owners that appears to us to be unique. Through your nearest Tandy store, you can order scanner (and CB) crystals for their Realistic models for whatever frequency you want.

The service costs just $19.95 for each crystal. You fill in a form, giving address and model details etc, and the store will order your crystal(s) which are mailed direct to you. It seems the crystals supplied come in the tiny fixed-pin plug-in package (HC18/U).

See your nearest Tandy store for further information.

PROJECT BUYERS' GUIDE

The AEM5504 Electromyogram may possibly be available as a kit through All Electronic Components in Melbourne and Eagle Electronics in Adelaide. The only 'unusual' components specified are the MKT capacitors, though greencaps or polypropylenes may be readily substituted (though board space will be cramped somewhat). We indicated in this column last month who were the distributors of the various brands. Geoff Wood Electronics in Sydney stocks a range of Roederstein and Wima MKTs. The ICs used in this project are widely stocked by electronics retailers.

The AEM5503 Bedwetector is an unusual project, but most components are widely stocked by electronics retailers. The LM1830N Fluid Detector IC is made by National Semiconductor. Geoff Wood Electronics in Sydney is able to supply this device, but we don't know of any other retailers currently stocking it.

The AEM3502 Signal-Operated Cassette Controller uses parts widely stocked by electronics retailers. The miniature pc-mount relay is stocked by Dick Smith Electronics, cat. no. S7120, as well as by Jaycar, cat. no. SY-4060. Adelaide enthusiasts may be able to obtain this component through Eagle Electronics who happen to be a Jaycar distributor. They also indicated they are considering doing a kit for it.

As always, printed circuit boards for this month's projects will be available through the magazine, or over the counter at Protronics in Adelaide, All Electronic Components in Melbourne and Geoff Wood Electronics in Sydney.

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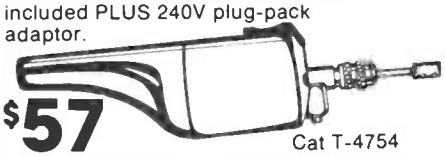

$57 Cat T-4754

Replacement Accessories

Set 4 PCB Drills Cat T-4756	$6.95
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Ink Erasers Cat T-4760	$3.20
Cutting Discs Cat T-4766	$9.95
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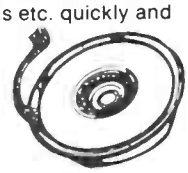

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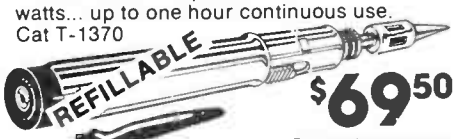

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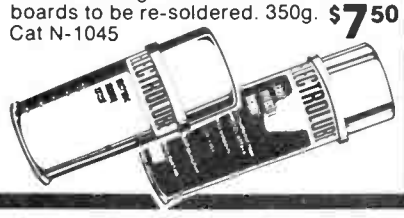

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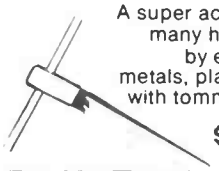

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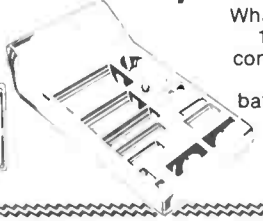

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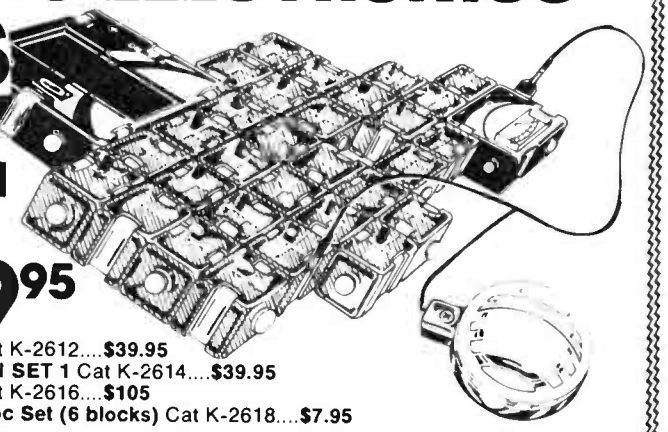

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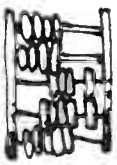

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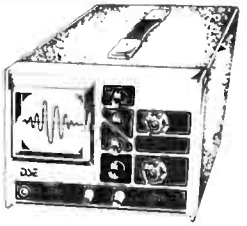

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Z-4908	74LS08	.55	.70
Z-4910	74LS10	.55	.70
Z-4912	74LS11	.55	.70
Z-4914	74LS14	.55	.85
Z-4920	74LS20	.55	.70
Z-4927	74LS27	.55	.70
Z-4930	74LS30	.55	.70
Z-4931	74LS31	1.25	1.65
Z-4973	74LS73	.80	1.20
Z-4974	74LS74	.55	.70
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Z-5011	7401	.50	.80
Z-5023	7413	.55	.85
Z-5085	7485	1.10	1.40
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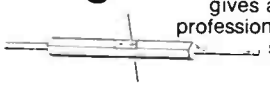

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SEE PAGE 88 FOR ADDRESS DETAILS

Biofeedback — the technology and techniques

Roger Harrison

Electronics has found increasing application in the medical world, particularly in bionics research where 'body parts' can be emulated with electromechanical devices that operate from nerve impulses sent out by the brain, using biofeedback. On a more pragmatic level biofeedback devices have been successfully used for many years in training people to regain the use of damaged or atrophied muscular functions, and widely used in relaxation ('anti-stress') training.

EVERY TIME you type, drive a car, sing, play a musical instrument — almost everything you do — depends on *feedback* of some sort. Whenever you try a new typewriter, or a new computer keyboard, your actions will 'feel' different. You know within fairly broad limits how hard you need to press the keys. But the very first time you strike a key on the new keyboard, a feedback loop comes into operation. The nerves in your fingers will signal your brain that the force the keys exert is less or greater than you anticipated and your brain will then signal your hands and fingers to decrease or increase the force applied as necessary. Within a short time, your response becomes automatic.

Playing a violin involves several feedback loops — aural and physical. You have to place your left hand fingers so as to obtain the correct note when a string is held against the fretboard, and you have to apply the correct force with the right hand and arm so as to produce the required length, loudness and timbre of the note. Both aural and physical feedback is working here.

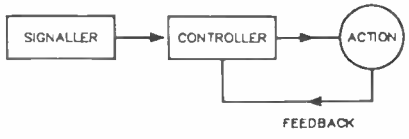


Figure 1. Basic idea of the feedback loop.

What happens when you attempt to open a cupboard door that is stuck? You grasp the handle and apply an amount of force. The door doesn't budge, so you apply more. Feedback tells you that you need more force.

The above describes situations where *external* feedback occurs. However, your body houses a considerable number of automatic internal feedback systems. Together, these systems are termed the *autonomic nervous system*.

Feedback systems in your body — automatic, or controllable?

Whenever you increase exertion — jogging, climbing stairs, your autonomic nervous system increases your respiratory rate. When you walk from your lighted house on a dark night, your pupils automatically expand so as to gather in more light. When you get a fright, a whole host of internal bodily feedback systems come into play; your adrenal glands release copious quantities of adrenalin into your blood, your heart rate increases, your breathing rate increases, your eyes dilate.

Your body has quite an effective feedback temperature control system. Gains and losses in body heat are balanced by a variety of reactions. When you get too hot or too cold, your brain instigates a variety of changes to stabilize your temperature. When you get too hot, the blood vessels in your skin will widen to lose heat (vasodilation) and your skin will sweat. When you get too cold, the blood vessels in your skin will narrow (vasoconstriction), 'goose pimples' appear and your muscles will shiver (which helps to improve blood flow and produce heat). While skin temperature can vary for a wide variety of reasons under a host of external and internal influences, your brain maintains your 'core' temperature at around 36.5-37°C.

Since the turn of this century, various researchers have examined how our physiologic system works and there have been numerous attempts, particularly over the past two decades, at teaching people to control parts of their autonomic nervous system by means of external feedback from sensors or instruments connected to the body. In 1901, J.H. Blair, a psychologist, wanted to shed light on ". . . the nature of the will". He observed how subjects learned to control muscles by mental command. He taught them to wiggle their ears — difficult for most people because the muscles are long-disused. He amplified the tiny muscle movements with a crude mechanical chart recorder, rewarding his subjects' efforts with movement of the pen on a chart. This could probably be classed as the earliest 'biofeedback' experiment.

In the first half of the 1960s, a Dr J. Basmajian looked into the ability of subjects to control the *motor units* which are responsible for muscle contraction. A muscle consists of long, thin cells ('muscle fibres') bundled together. Embedded in each muscle fibre is a motor nerve ending. Each fibre contains interlocking strands of two different proteins — actin and myosin. When an impulse from the brain reaches a fibre, a chemical transmitter is released, releasing energy into the cells, causing the strands of actin and myosin to move closer together. The muscle becomes shorter and fatter — that is, it contracts. Dr Basmajian inserted tiny needle electrodes beneath the skin of his subjects so as to contact a large number of motor units. The contacts were hooked up to an oscilloscope.

The motor unit firings largely resemble noise, but traces of single rythms can be discerned and, with practise, the good doctor's subjects were able to recognise single motor unit firings and to control them at will. This feat represents control over a single body cell in isolation through biofeedback.

This work led to myo-electrically (muscle-electrically) operated prosthetic 'replacement parts' for people who have lost the use of hands or arms, for example, through birth defects or accident. A myo-electrically controlled hand was produced by Dr G. Shannon of Queensland University in 1978. This device was remarkable in that it gave sensory feedback about the strength of grip provided by its electric motor drive. A set of strain gauges attached to its mechanical fingers provided the sense of touch. The sense of applied 'force' was provided by feedback from an electromyogram — a device that amplifies a muscle's electrical nerve activity — and converting it to a control signal for the motor. The muscles in the forearm to which the electromyogram was attached were those previously used for controlling movements of the fingers.

Biofeedback technology

Post World War II, experiments with sensitive measurements of electrical responses of the skin to direct and indirect stimuli showed that skin resistance, temperature and emf all showed reactions. Subsequent research showed that, with feedback from measuring these quantities, subjects could learn to control these parameters.

The skin is a remarkably sensitive organ and quick to react to stress. The layer immediately under the skin's outer surface, the dermis, undergoes quite large and readily measurable changes in electrical resistance, regardless of whether the tension is localised or general or where it may be centred. If you measure the skin resistance on your forearm and tense your neck muscles, a similar reaction may be obtained by tensing your right calf muscle. One simple biofeedback device that grew out of this research was the *Galvanic Skin Response* (GSR) meter.

GSR meters are simply wide range ohmmeters. Two electrodes are taped to either the forearm near the wrist or between two adjacent fingers on one hand. Feedback may be via either an analogue meter (visual feedback) or an audible pulse or tone (aural feedback), or both. Skin resistance rises with decreasing muscular tension but, as one associates a decreasing indication with decreasing activity, the feedback tone or meter reading is arranged to *decrease* with *increasing* skin resistance. A GSR meter is shown in block diagram form in Figure 2. They have been predominantly used in stress relief and tension reduction.

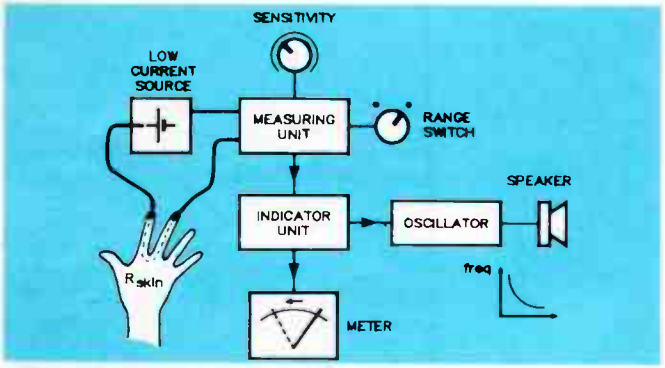


Figure 2. The Galvanic Skin Response (GSR) meter measures skin resistance, variations being indicated by either a meter for visual feedback and/or an audio oscillator for aural feedback.

The range is set to obtain an on-scale reading and the sensitivity adjusted to give the required response. As the indication lowers, the range is adjusted to bring it back on-scale.

GSR meters are easy to use, but the response is never twice the same as a whole host of physical, physiological and psychological influences bring about variations from day to day and hour to hour, so you can't get a 'benchmark'. However, the object during each session of use is to cause a decreasing indication and, with repeated use, you can train yourself so that it takes less and less time to bring about a substantial decrease in the GSR.

Skin Temperature

The skin can be a remarkably sensitive 'barometer' of your mental and physical state. To take an extreme example by way of illustration, your epidermal temperature drops sharply when you receive a fright. This is due to vasoconstriction of the small blood vessels just beneath the skin — giving rise to the familiar expression "white with fright". Conversely, when you flush with embarrassment or exertion, your skin temperature rises due to vasodilation where the small blood vessels expand, pumping blood into the immediate area thus raising the temperature. The most sensitive areas are those richly supplied with small blood vessels, particularly the hand. Skin temperature of the hands can vary by as much as 5°C, or more.

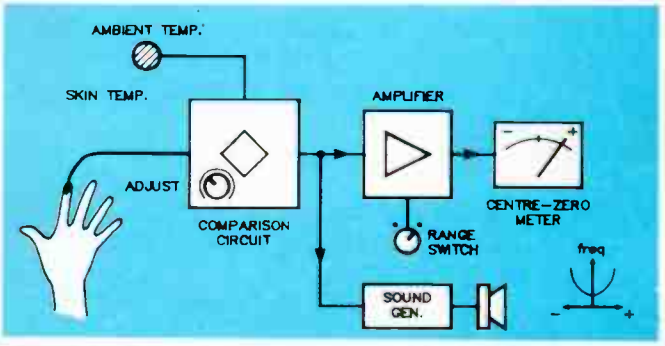


Figure 3. The skin temperature biofeedback instrument measures skin temperature compared to ambient, the meter or aural feedback indicating change compared to 'centre-zero'. In relaxation biofeedback training, the unit is initially set for centre zero reading and the subject attempts to lower body temperature.

When the reading goes off-scale, the unit is once again adjusted for centre zero. After a while, when only small changes can be effected, the range can be switched to give a more sensitive indication.

By measuring skin temperature and providing visual and/or aural feedback, it is possible to train oneself to consciously raise or lower skin temperature with respect to ambient. When you're in a mentally or physically excited state, skin temperature is typically raised with respect to ambient. When relaxed, your skin temperature will approach ambient. Physiologic factors may mean an individual's skin temperature is typically below ambient (sub-average vasocirculation — the 'cold hands/warm heart' syndrome). In addition, both cold stress and heat stress affect skin temperature through the autonomic nervous system.

Skin temperature biofeedback devices measure epidermal temperature compared to ambient, generally over a range of +/– 5°C (coarse) and +/– 1.5°C (fine). One of the problems of skin temperature measurement lies in the reaction time (thermal time constant) of common electronic sensors — usually thermistors. While their response is linear, their reaction time can be longer than that of the body. Another problem arises in that some subjects' reactions are *opposite* to that expected!

Heart rate

As no doubt you're aware, that remarkable four-chambered pump in your chest does a sterling job at keeping you going, almost no matter how you abuse it. It pushes blood through ▶

your lungs where oxygen is exchanged for carbon dioxide, the re-oxygenated blood then being pumped through the rest of the body.

The rate at which your heart beats, the number of times the valves open and close each second, is related to the metabolic requirements of your body. I related earlier how, when you're frightened, your autonomic nervous system increases your heart rate. But, it seems that many physiological and psychological 'triggers' can affect heart rate and that many areas in the brain play some role in determining heart rate at any particular time.

Heart rate requires an *indirect* measurement — counting the number of beats per unit time and converting that to a rate. Increased activity — increased stress or tension — will increase heart rate, while a decrease in these parameters will decrease heart rate. Hence, a benchmark that's true from person to person cannot be readily established.

Heart rate monitors sense the changing blood density, and hence its varying ability to transmit light, that occurs every pulse. It is readily sensed using opto-electronic sensors employing a light source that shines through a convenient area of the skin, picking up the changes in light transmissivity as the pulses of blood course through the small blood vessels. The finger or ear lobe are favourite spots for heart rate sensing using this technique. Figure 4 shows how it's done.

In attempting relaxation training, many researchers working in this field employ heart rate monitoring to train subjects using biofeedback. It is well-known that heart rate slows when bodily tension is reduced. If one can do this at will, tension or stress can be conciously alleviated.

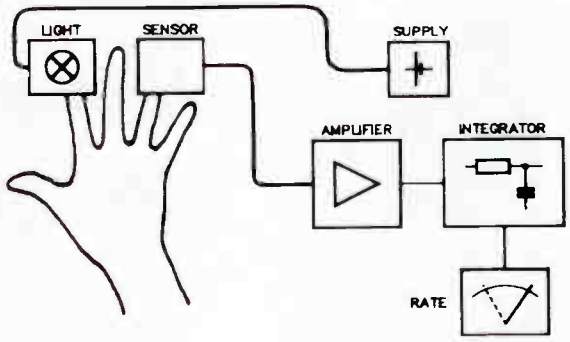


Figure 4. A simple and popular method of measuring heart rate is to shine a light through a convenient area of the skin, usually a finger or ear lobe, and pick up the changes in transmissivity caused by the varying density of the blood as it pulses through the small blood vessels. The pulses are then amplified and integrated to provide a convenient 'rate' indication.

With such an instrument you can monitor your heart rate and see how it responds to efforts to vary it.

ELECTRODERMAL ('SKIN ELECTRIC') RESPONSES

The McGraw-Hill *Concise Encyclopaedia of Science & Technology* has this to say on electrodermal response: "A transient change in certain electrical properties of the skin, associated with the sweat gland activity and elicited by any stimulus that evokes an arousal or orienting response. Originally termed the psychogalvanic reflex, this phenomenon became known as the galvanic skin response. Phasic changes in skin conductance and potential (voltage) are designated as SCRs and SPRs, respectively, and electrodermal response has replaced galvanic skin response as the collective term.

The skin of a relaxed person has a low electrical conductance (high resistance), and the skin surface is some 40 mV negative with respect to interior tissues. Sweat gland activity changes these electrical properties by increasing skin conductance and by changing the balance of positive and negative ions in the secreted fluid.

Tonic skin conductance varies with psychological arousal, rising sharply when the subject awakens and rising further with activity, mental effort, or especially stress. Phasic skin conductance responses are wavelike increases in skin conductance that begin 1-2 seconds after stimulus onset and peak within about 5 seconds. The amplitude of the skin conductance response varies with the subjective impact of the eliciting stimulus, which in turn varies with the intensity of the stimulus, its novelty or unexpectedness for the subject, and its meaning or signal value. Aroused subjects display spontaneous skin conductance responses, generated apparently by mental events or other internal stimuli; their frequency, like the Tonic skin conductance level, increases with the level of arousal."

'Brainwave' monitors

Brain functioning is characterised by a great deal of electrical activity in the cells. While, taken as a whole, brain electrical activity is seen largely as 'noise', the activity can be characterised into four cateogories, or rhythms, according to the frequency ranges seen.

Alpha rhythms range between *8-12 Hz* and are associated with relaxation and feelings of well-being.

Beta rhythms range between *13-30 Hz* and are associated with increased attention and/or anxiety.

Delta rhythms are in the low frequency range, between *0.5 Hz and 4 Hz*. Generally they are found when a subject is experiencing dreamless sleep.

Theta rhythms also occur in the low frequency range, between *4 Hz and 8 Hz*, and are generally associated with meditation (deep relaxation).

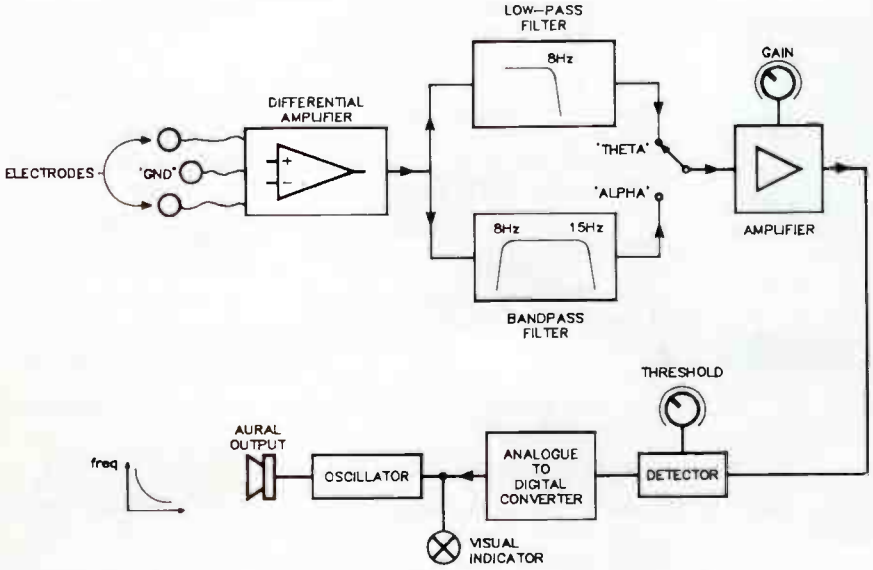


Figure 5. A brain wave monitor employs a pair of electrodes attached to the skin which pick up the tiny ac signals. A low noise differential input stage picks out the microvolt-level brain wave signals from the volts or more of hum induced on the body from house mains wiring. A third electrode provides a 'common' reference for the input to reduce common-mode signal levels. A low-pass filter may also be included to further reduce masking of the required signals by hum or other electrical activity on the skin.

A set of filters is used to select the required rhythms — usually the alpha and/or theta rhythms. The signal is 'digitized' to provide the aural/visual feedback outputs.

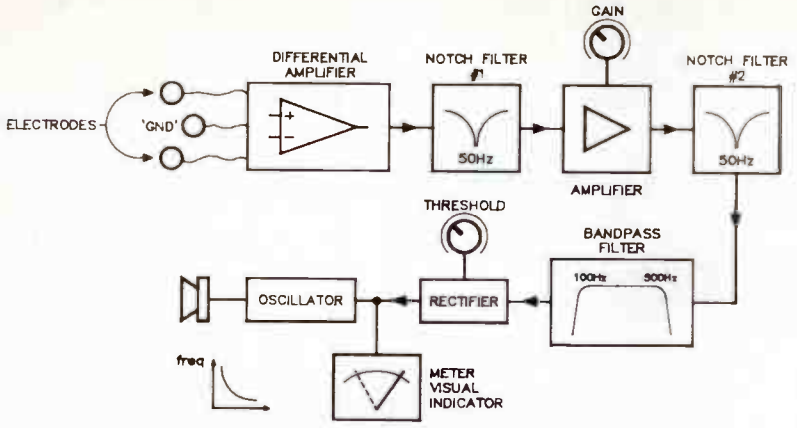


Figure 6. A typical electromyogram (EMG) has a similar input stage to the brain wave monitor, and encounters a similar range of problems. The signal available from motor unit firings is at the microvolt to nanovolt level. A pair of electrodes is employed to pick up the signal which is then amplified by a low noise differential input stage. A third electrode provides a common reference for the input, as in the brain wave monitor, to reduce common-mode signal levels. The input stage is immediately followed by a 50 Hz notch filter to attenuate any hum picked up.

Further amplification and filtering is provided to bring the signal level up to something that can be readily dealt with. Bandpass filtering is also employed to further bring out the motor unit signals in the 100-500 Hz region, where the largest amplitude signals lie. The amplified and filtered signal is then rectified to provide a dc output proportional to muscle activity.

A threshold adjustment is provided so that, as you relax, the threshold can be gradually reduced, giving you a measure of performance from session to session of use. Some integration of the output is usually provided to indicate average activity. Aural and/or visual output provides the feedback signal.

This electrical activity of the brain, though occurring at quite low amplitudes — in the microvolt region — can be readily sensed employing electrodes on the skin and using filters to select the desired 'brain wave' pattern. Figure 5 shows a typical 'brain wave' biofeedback instrument. Through training, it is claimed that subjects can 'teach' themselves to produce the requisite 'brain wave' patterns at will. Mains-induced 50 Hz hum is the biggest 'bug-a-boo' to overcome. Usually, two electrodes sense the differential voltages induced on the skin surface, a third electrode providing a 'ground' reference or common source. Muscle activity can generate pulses within the frequency ranges given, possibly 'masking' the desired signal(s).

Using 'brain wave' biofeedback instruments to induce periods of Alpha wave activity was in vogue through the '70s and early '80s.

Muscle electricity activity — electromyography

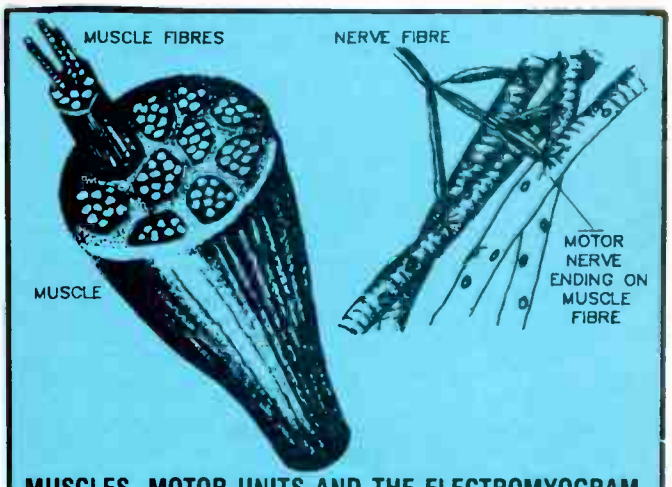
Sensing and displaying the electrical pulses generated by muscle motor unit firings gives a direct indication of muscular activity, whereas GSR, skin temperature and heart rate are secondary indicators of the body's state of tension or relaxation.

Electromyograms (with aural and/or visual feedback) and electromyographs (with chart or graph output) have been in use for some time, as indicated earlier. The electrical signals generated from muscle activity arise from the motor units attached to the muscle fibres. A large number of motor units fire in order to contract a muscle, but their firings are not synchronised. Thus the electrical signal generated resembles amplitude modulated noise extending from below 100 Hz to around 1 kHz or so. Studies of the complex myo-electric signal have shown that it appears to be a weighted sum of the tiny electric potentials produced by the motor units, modulated in amplitude, the signal as a whole being a function of the number of motor units, their rate of activation and how good a contact is made with the skin.

The block diagram of an electromyogram is shown in Figure 6. The signal is picked up as a differential signal by a pair of electrodes placed on the skin, with a third contact to provide a 'ground' reference. the myo-electric output of a relaxed muscle is of the order of a microvolt or so peak-to-eak. The electromyogram has to sort this signal out from all the other electrical activity present on the skin. In addition, hum induced on the body from the 50 Hz ac mains can be *volts* in amplitude which can swamp the instrument's input stage. The problems are much the same as those encountered by brain wave signal biofeedback instruments.

Typically, an electromyogram biofeedback instrument has either an aural output and/or a meter (visual feedback). An integrator may be swtiched in, or permanently wired-in, to average the feedback response. Typical integration times range between 0.5 and five seconds.

Electromyograms are widely used in research for monitoring muscle activity. They are also widely used in medical applications for relaxation ('anti-stress') training and for the relief of migraines. tension-related muscular aches, hypertension etc.



MUSCLES, MOTOR UNITS AND THE ELECTROMYOGRAM

A motor unit within a muscle comprises some 10-500 muscle fibres, each controlled by a motor nerve cell. Contraction of the muscles results from the rhythmical discharge of these motor nerve cells. The more units there are activated, among the hundreds composing a muscle, the greater the intensity of the contraction.

Each nerve impulse in a series generates a brief cycle of contraction in the corresponding muscle fibres. Certain conditons bring about the synchronisation of the rhythms of many units or group the corresponding impulses to produce a tremor (regular bursts).

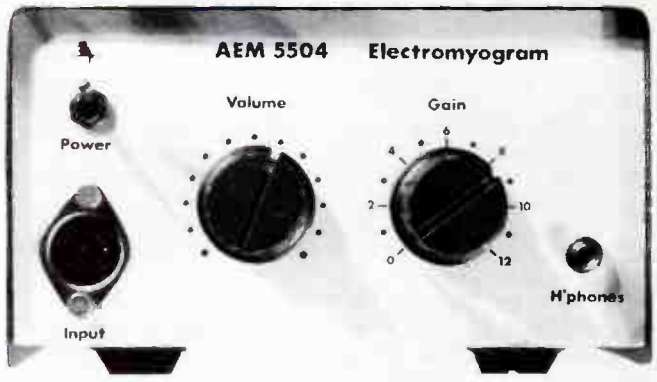
The electromyogram has proved useful in the study of diseases such as poliomyelitis that reduce the number of motor units, or that diminish the number of muscle fibres in a motor unit, as happens with muscular dystrophy and myasthenia, as well as with diseases that abolish the nerve supply leaving isolated muscle fibres to spontaneously twitch, weakly and independently.

NOTE: Biofeedback instruments are *invariably* battery operated as, with any device connected directly to the body, the risk of possible accidental contact with mains potential from ac mains-operated units is very real. And the results can be lethal.

Build this low-cost electromyogram

David Tilbrook

This unit detects small voltages induced on the surface of the skin due to muscle activity. These miniscule voltages are separated from mains hum and other noise sources, and after amplification are used to control a voltage-controlled oscillator which provides an audible indication of muscle activity for biofeedback use.



AN ELECTROMYOGRAM (EMG) is a biofeedback instrument which provides information about the degree of muscle activity associated with a particular muscle or group of muscles. The unit relies for its operation on the fact that when a muscle is used, "motor units" connecting the muscle fibres to nerves are fired causing a signal similar to band-limited noise to appear on the skin adjacent to the particular muscle. The task of the electromyogram is to detect these minute signals, separate them from mains generated hum and other noise sources and use the resulting information to control audible or visual indicators of the amount of muscle activity.

In this project we have elected, mainly for reasons of cost, to provide just the audible indication. This takes the form of a tone, the frequency of which varies proportionally with the amount of muscle activity.

The main difficulties associated with the design of a useful EMG is the task of separating the desired muscle-generated signal voltage from induced 50 Hz mains hum, RF interference and audio frequency noise. In this design, this is achieved using a three-fold approach. Firstly, the input stage employs a differential input. Combined with this is a 50 Hz mains frequency filter and a bandpass filter set to pass the dominant region of muscle activity signals.

The differential input stage

The differential input stage is formed using an instrumentation amplifier. This type of input stage amplifies the difference in voltage between its two inputs. Any signal which is applied equally to both inputs is not amplified. The ratio of the common mode signal to the amplified difference signal is called the common mode rejection ratio (CMRR). Typically, single op-amp based designs have CMRR figures of around 20 dB. In order to improve on this figure, a slightly more complex scheme employing three op-amps is used. These circuits are usually referred to as 'instrumentation amplifiers' and are capable of significantly improved CMRR figures.

The circuit employed in this design is capable of CMRR figures greater than 80 dB, depending on the matching of the resistor values used. In practical EMG applications, CMRR figures greater than 80 dB become academic since large common mode rejection can only be achieved if the common mode signal is applied almost identically to both inputs and this is not possible using the standard contact electrode scheme that must be used. The two input electrodes must have identical contact resistances if high CMRR figures are to be realised, and this is almost impossible.

In order to minimise the effect of different contact resistance between the two input electrodes, the input of the differential amplifier must be provided with as high an input impedance as possible. Another advantage with the type of instrumentation amplifier employed here is that it is capable of providing very high input impedance. We have chosen the TL074 quad op-amp for this project which has a JFET input stage. The input impedance is therefore extremely high and is in fact determined by the two 10 megohm resistors which are used to provide the necessary minute bias current required for the input JFETs.

The hum and bandpass filters

The next measure employed to overcome the effects of hum and noise is the use of a notch filter, set to reject any signal with a frequency at or close to the mains supply frequency of 50 Hz. This is required because, as explained above, a finite amount of 50 Hz signal will be present at the output of the differential input stage. Since the gain of the circuitry after the input stage can be as high as 10 000, depending on the setting of the gain control on the front panel, the presence of significant amounts of hum can easily lead to the amplifiers being driven to their full output, causing clipping. Once this occurs, distortion products are generated that will completely swamp the EMG signal.

As with the differential input stage, the amount of rejection at the notch frequency is dependent on the component matching. This type of notch filter is often referred to as a 'twin-T' filter and in theory is capable of infinite rejection at the notch frequency. In practical circuits, however, the rejection is more likely to be around 30-50 dB. In order to ensure satisfactory performance of the notch filter, one per cent tolerance resistors are specified. Ideally, one per cent tolerance capacitors should also be used but these are very

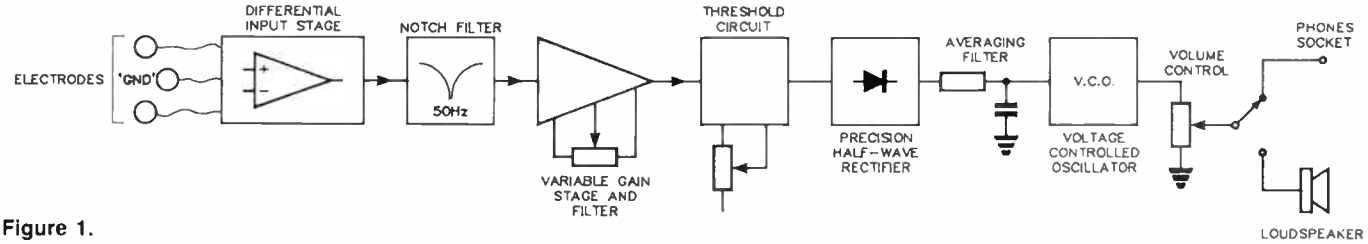


Figure 1.

difficult to obtain and are expensive. With a reasonable match of capacitor values, however, the notch filter is capable of delivering around 30 dB of attenuation at 50 Hz in addition to that provided by the input stage.

The third measure used to optimise the detection of muscle signals as opposed to other noise signals is the use of a bandpass filter which has been set up to pass signals in the 100 Hz to 500 Hz region. The actual mean signal frequency is dependent on the state of tension of the muscle. The frequency region corresonding to the peak output is therefore fairly broad and for this reason the bandpass filter used must have a broad passband. The circuit used here is a 1st-order bandpass filter with only 6 dB/octave slopes outside the passband and is implemented using only a single op-amp which also serves to provide a large proportion of the total gain required for the instrument.

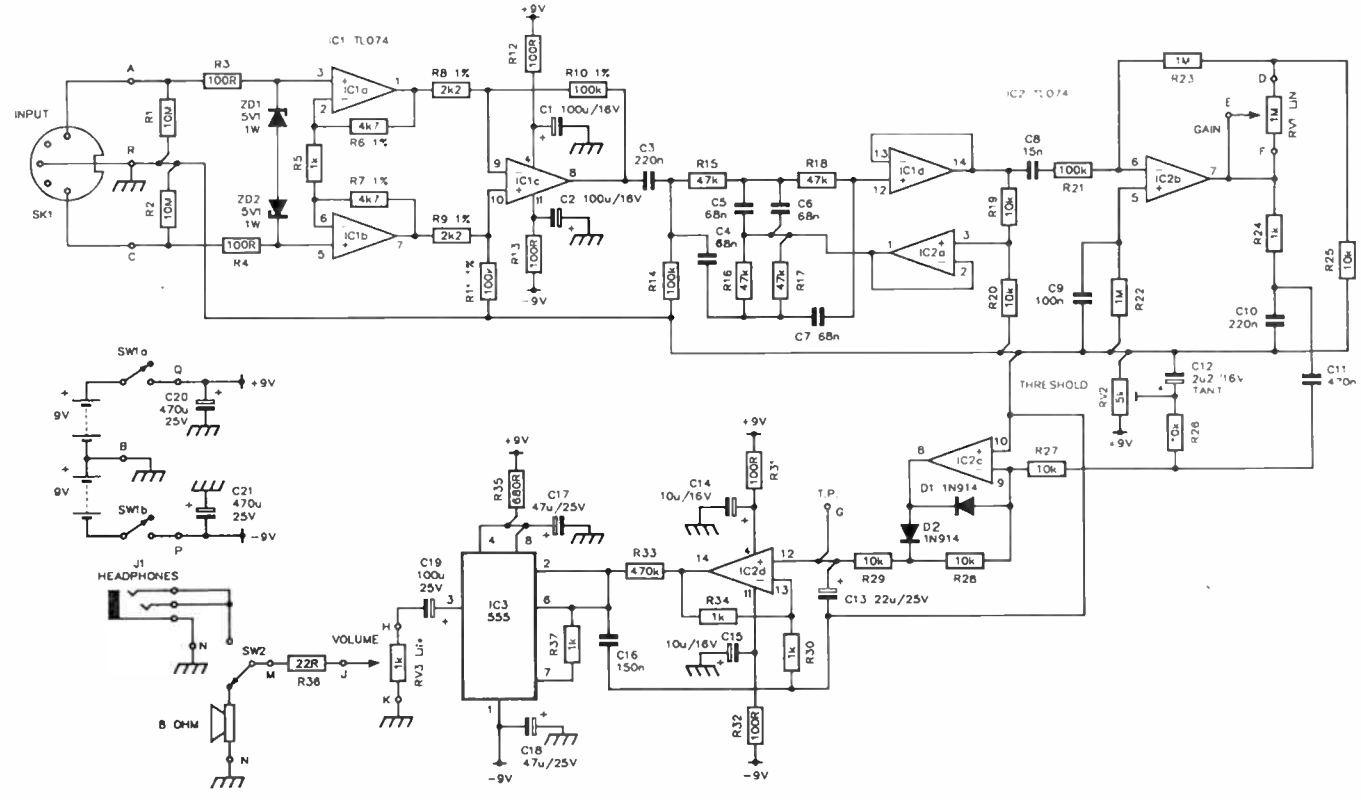
Circuit overview

An overall block diagram of the EMG is shown in Figure 1. As has been discussed above, the input electrodes are connected to the differential input stage. Notice that three electrodes are used for connection to the skin, one of which is an 'earth' connection. This provides an earth reference for the electronics and has the effect of decreasing the hum voltage at the inputs. Another way to look at this is that the earth reference within the EMG 'floats' on top of the hum signal so that the hum voltage developed between the input and the earth is reduced.

Note that the earth reference within the EMG is just the O V line of the battery supply. The unit must remain floating and should be battery powered. DO NOT REPLACE THE BATTERY SUPPLY SHOWN IN THIS PROJECT WITH A MAINS-BASED POWER SUPPLY. This will degrade the unit's performance and more importantly, could also render it very dangerous. It is very important that any unit intended for connection to the human body be extremely well isolated from the mains supply and for build-it-yourself projects, this usually means a battery supply.

The output from the differential input stage is connected via the 50 Hz mains frequency filter to the variable gain stage. This stage can be adjusted by the front panel gain control to have a gain in the range from 10 to 1000. This stage also functions as the bandpass filter described above.

The output of the variable gain stage is connectd to the input of a threshold control circuit. The purpose of this circuit is to decrease the effects of audio frequency noise that remains mixed with the muscle signal. This noise is generated by the active and passive components within the EMG and represents a noise 'floor' which limits the maximum use- ▶



ful gain of which the EMG is possible. The threshold circuit helps to overcome this problem by providing a voltage level below which it will not generate an output signal. If the threshold circuit is adjusted so that the threshold is set to be just greater than the typical noise voltage, then no output will result from the threshold circuit as a result of the noise input. If the muscle signal is then superimposed on the general noise floor, the resulting signal is then greater than the threshold level and an output will result.

The signal from the threshold circuit is rectified by a precision halfwave rectifier circuit and the resulting dc output is averaged by an RC filter, amplified and applied to the voltage controlled oscillator. This is based around the 555 timer which has been configured as an oscillator, the frequency of which can be controlled by the applied dc voltage. This provides a good linearity VCO capable of a very large frequency excursion range and hence an easily recognisable change in pitch as muscle tension varies.

The VCO output is fed via the volume control to an output switch that is located on the rear of the instrument which serves to select between the internal miniature loudspeaker and the 'phones socket.

Construction

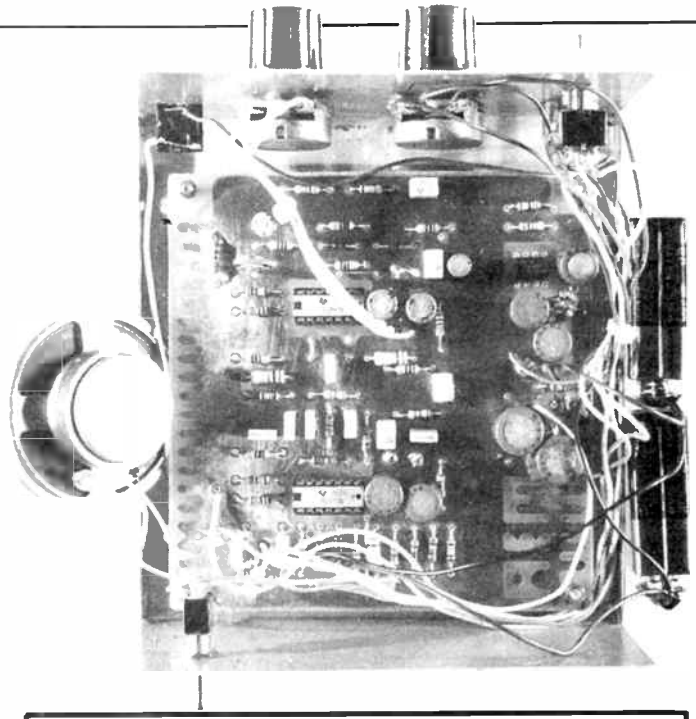
The construction of the EMG is not particularly difficult, provided the AEM5504 pc board is used. The combination of relatively high currents necessary to drive the loudspeaker and very high gain/input impedance is one that usually leads to a host of interaction problems that can seriously degrade the unit's performance. We paid great attention to the development of the pc board for this project and still had to discard several early attempts. Fortunately, the final design works extremely well but necessitated the use of a solid ground plane on the components side of the board. This technique works very well and enables the signal earth and supply decoupling earths to remain isolated from each other and the entire pc board with the exception of a single reference point.

The pc board forms the nucleus for the construction, containing all of the components with the exception of those mounted on the front and rear panels and the loudspeaker. Commence construction by mounting the components to the pc board. start by soldering the resistors in place on the board. These are fairly robust devices and are unlikely to be damaged when soldering other components to the board. Next solder the non-polarised capacitors in place. These are the greencaps or polyester types and, like the resistors, are fairly robust.

After the resistors and capacitors are in place, solder the diodes into position. Note that these are polarised components and mut be positioned on the board with the correct orientation. Be careful not to confuse the zener diodes with the standard diodes.

Finally, solder the remaining components such as the tantalum and aluminium eletrolytic capacitors, again being careful to orientate them correctly. Once these are in place the ICs can be soldered in place. Three ICs are used in the project, two 14-pin dual-in-line packages and one 8-pin dual-in-line package. In order to facilitate removal of these devices in the event of failure at some time, you might think about using the appropriate IC sockets. In this case, the sockets are soldered into place on the pc board and the ICs are plugged into them. Use good quality types.

The pc board must be located in the chassis and wired to the front and rear panel controls using hook-up wire. This wiring can be soldered directly to the pc board or pc pins can be soldered to the board first and the wiring soldered



AEM5504 PARTS LIST

Semiconductors

D1, D2 ..... 1N914
IC1, IC2 ..... TL074
IC3 555
ZD1, ZD2 .... 5V1/1 W zeners

Resistors — all ¼ W, 5% unless noted

R1, R2 ..... 10M
R3, R4 ..... 100R
R5 ..... 1k
R6, R7 ..... 4k7, 1%
R8, R9 ..... 2k2, 1%
R10, R11 ..... 100k, 1%
R12, R13 ..... 100R
R14 ..... 100k
R15-R18 ..... 47k
R19, R20 ..... 10k
R21 ..... 100k
R22, R23 ..... 1M
R24 ..... 1k
R25-R29 ..... 10k
R30 ..... 1k
R31, R32 ..... 100R
R33 ..... 470k
R34 ..... 1k
R35 ..... 680R
R36 ..... 22R

RV1 ..... 1M/A pot.
RV2 ..... 5k vert. trimpot
RV3 ..... 1k/A pot.

Capacitors

C1, C2 . 100u/16 V RB electro.
C3 ..... 220n/63 V MKT
C4-C7 ..... 68n/63 V MKT
C8 ..... 15n/63 V MKT
C9 ..... 100n/63 V MKT
C10 ..... 220n/63 V MKT
C11 ..... 470n/63 V MKT
C12 ..... 2u2/16 V tant.
C13 ..... 22u/25 V RB electro.
C14, C15 10u/16 V RB electro.
C16 ..... 150n/63 V MKT
C17,C18 . 47u/25 V RB electro.
C19 .... 100u/25 V RB electro.
C20,C21 470u/26 V RB electro.

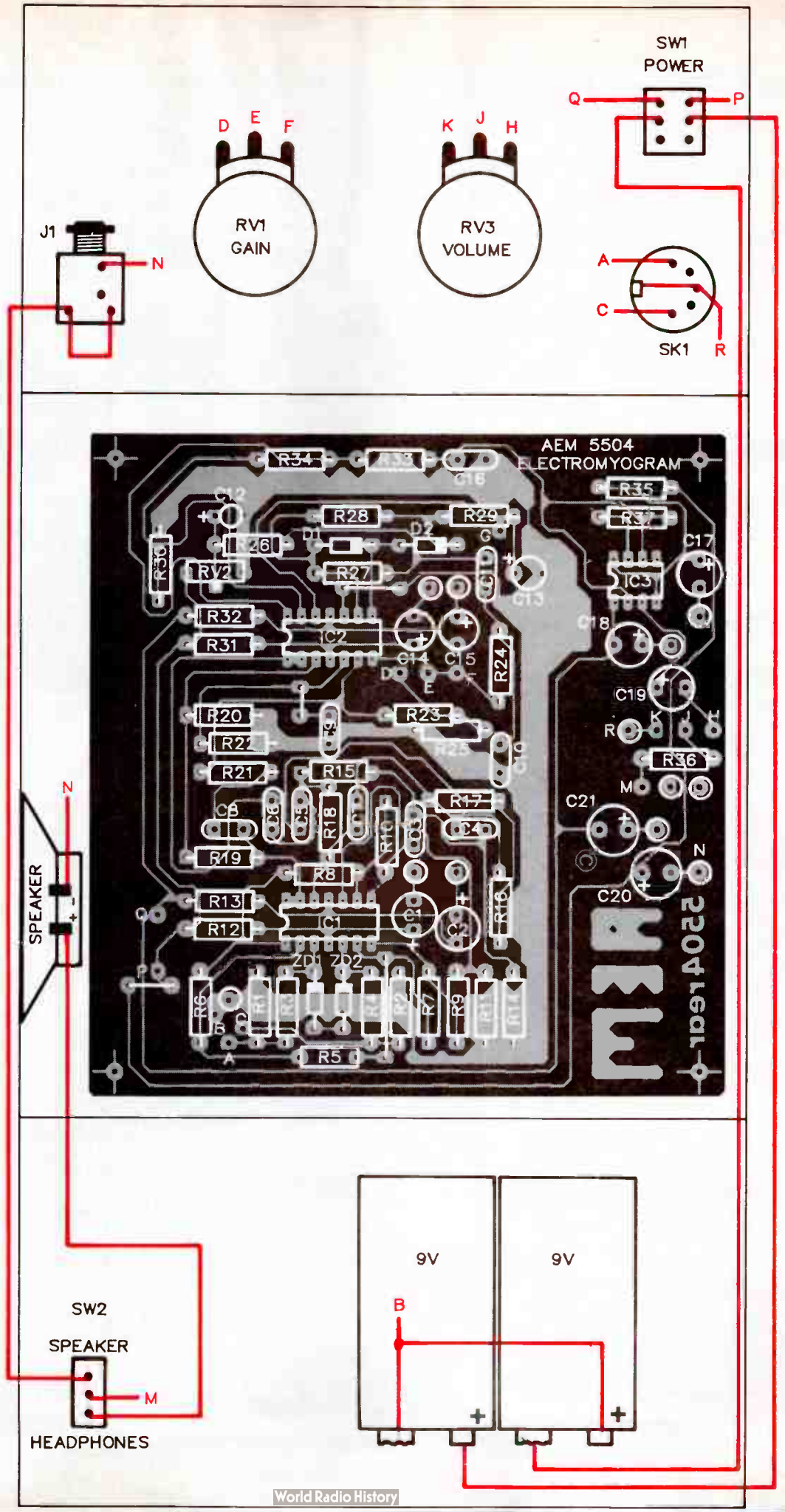
Miscellaneous

J1 ..... 3.5 mm stereo headphones jack
PL1 ..... 5-pin DIN line plug.
SK1 ..... 5-pin DIN socket, chassis-mount type.
SW1 ..... DPDT min. toggle switch.
SW2 ..... SPDT min. toggle switch.

AEM5504 pc board; metal case 150 x 76 x 134 mm (e.g: DSE H-2743 or similar); Scotchal panel; 2 x No. 216 9 V batteries and snap connectors; one 8 ohm 50 mm diameter speaker; three small metal discs; two or three metres of shielded cable (e.g: RG174 coax); hookup wire; nuts, bolts, standoff pillars, etc.

Cost Estimate: $55-$62 depending on quality and type of components supplied.

NOTE: MKT capacitors are metallised polyester types in a radial-lead package with most values up to 470n having 5 mm (0.2") pin spacing. Makes available in Australia include Wima, Roederstein, Thomson-CSF and Siemens. MKTs by Wima are distributed by Crusader Electronics in Sydney, Roederstein by Promark in Sydney and Melbourne, and Siemens through Seimens in Melbourne and Sydney. Geoff Wood Electronics in Sydney stocks a range of Roederstein and Wima MKTs.



WHEN IS A KIT NOT A KIT? A) WHEN IT'S A JAYCAR 'MINIMODULE' KIT!

Following the success of the 30 + 30 amplifier module launched last year Jaycar has vastly increased this lineup for 1986. Featured in the new lineup is a magnificent HIGH POWER integrated amplifier with fantastic control preamp. Also stocked are a universal infra red remote controller, sound switch, LED level meter, super Hi Fi preamp and lots more!

THE BIG NEWS. Jaycar 'Minimodule' kits are strictly not kits by our normal definition. Each module is actually built and tested and guaranteed. You still have to connect them to the outside world of power supplies, signal sources etc ; however they are still kits (and therefore fun to work with) in that respect!

80 + 80 PRE-MAIN AMP

A complete preamp and high power amp - with power supply electronics in the same package! All that you need to connect is a power transformer and signal source!

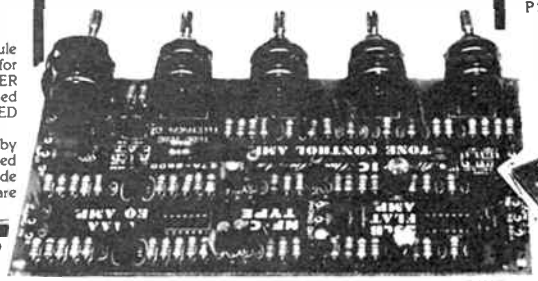
It features TWO huge heatsinks for the power transistors, bass, treble and midrange controls, a MICROPHONE preamp and mixer pot, balance and volume control. There is facility for preamp out (to dub from source to tape) as well as phono out. All in all it's very well thought out.

The main board measures 245(W) x 240(D). The heatsinks 130(W) x 75(D) x 70(H) are connected to the main amp board by about 150mm of wiring.

COMPLETE AMP/PREAMP

Cat. AA-0310

ONLY $149.95



Suitable power transformer 44361 type Cat. MM-2015 $49.95

INFRA RED REMOTE CONTROL SYSTEM

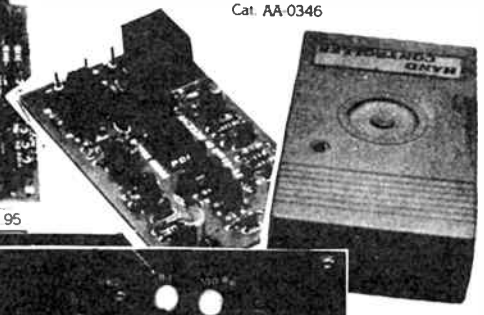
This system comprises two basic components: the hand-held transmitter and the receiver. The hand-held transmitter is supplied in an attractive plastic case and is powered by a 9V battery. It has a range of 10 metres approximately.

The receiver consists of a circuit board measuring 110 long x 55 wide and requires 9-12V DC. Both transmitter and receiver use a proprietary Hitachi encoder/decoder IC set to preclude false triggering by daylight, sparks, flashes etc.

The receiver output is by relay with N.O. or N.C. output. The relay is NOT 240V AC mains rated but will switch considerable DC loads i.e. 5 amp (resistive) at 12 - 24V or up to 100V AC. An on-board switch configures the unit to either operate only while the transmitter switch is held 'on' or alternatively in latch mode i.e. press transmit button and switch 'on', press again to switch 'off'. P.S. It also works as an event counter.

ONLY $42.95

Cat. AA-0346



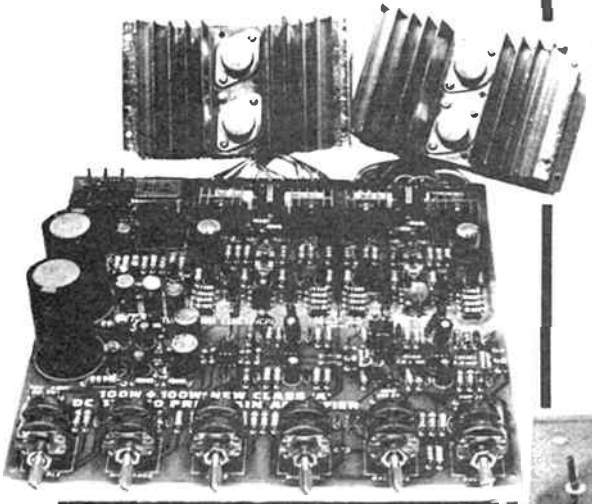
SUPER HI FI BI-FET PREAMP 0.005% Distortion

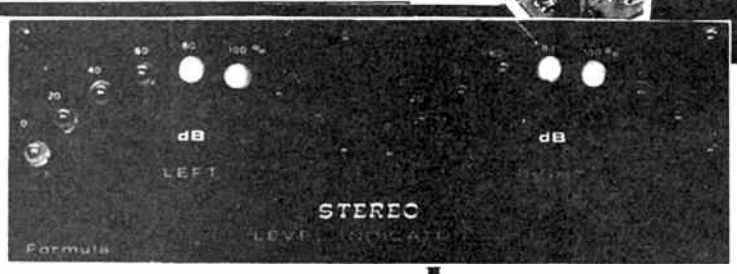
This magnificent preamp measuring 200(W) x 110(D) has many features- Phono in (RIAA equalisation within 0.2dB), phono out (to tape), and aux input (as many as you like). Provision for switching 'loudness' control in or out as well as the provision of a 'tone defeat' switch.

Bass, treble AND midrange controls are provided as well as 40 detent clicks type volume potentiometer. Naturally, frequency response is flat over the audio spectrum and beyond and the S/N figures are outstanding. (Requires ±15V 200mA power supply, a circuit for this is included)

Cat. AA-0315

ONLY $69.95





DUAL LED AUDIO LEVEL METER ASSEMBLY

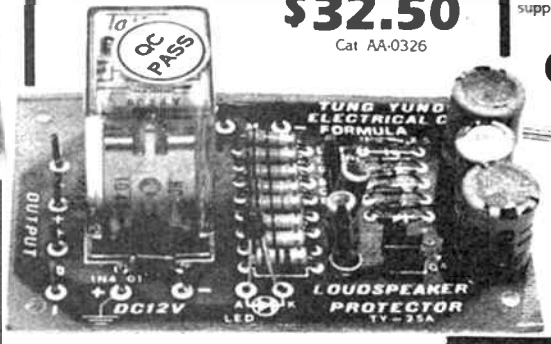
This meter enables you to display power levels from −30dB to +5dB. The meter operates directly from the speaker leads. It does not consume any amplifier power. The level meter is powered by any voltage source between the range 3-20V so it is ideal for 12V auto use.

Ten LEDs are provided for each channel, the first 4 LEDs in each channel are green (−30 to −5dB) the next two are yellow (−1 & 0dB) and the next three are red (+1 to +5dB) a peak LED yellow is also used to indicate an 'overload' condition. The meter can be calibrated to operate on amplifiers from 1 - 200 watts!

A circuit for mains power supply is included

$32.50

Cat. AA-0326



6 WATT 'MICRO' AMPLIFIER (1 CHANNEL)

AMPLIFY YOUR WALKMAN!

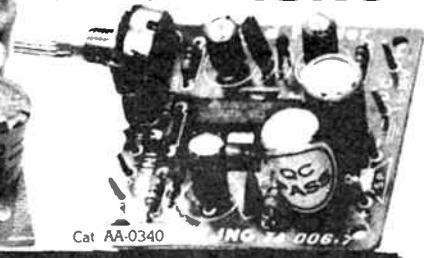
This little amp will provide up to 6Wrms into 4 ohms from a 15V power supply* The mighty midget measures 50mm square and has an on board volume control. Facilities are provided to accept high or low impedance inputs i.e. 'low' headphone output of cassette deck, 'Walkman' type unit, etc., 'high' for standard line level signal sources such as tuners, VCR's etc. (regard as AUX). Output is short circuit protected.

* A copper heatsink fin must be soldered to the top of the IC to achieve this

SPECS: ● Power out 6W (max) into 4 ohms ● Input sensitivity 100mV ● THD 0.3% ● Gain at 6V 38dB ● Power supply 4 - 16V @ 1 - 2A

(2 REQUIRED FOR STEREO)

ONLY $13.95



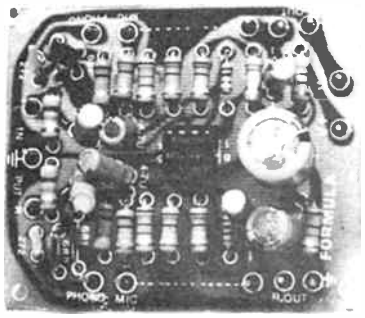
Cat. AA-0340

MINI PHONO & MICROPHONE PREAMP

This unit features a high slew rate Op-amp type gain block 5% RIAA equalisation capacitors and small size (70(W) x 60(D)). It will bring up a magnetic phono cartridge or dynamic micro-phone to line level with very low distortion. Power supply circuit diagrams included

Cat. AA-0324

ONLY $16.95



STEREO LOUDSPEAKER PROTECTOR

An absolute must for all high power amps.

If anything goes wrong with a high power amp that is O.C.L.* (i.e. does not have a large coupling capacitor between the final output stage and the speakers) a very high power source of DC can present itself directly across the voice coils of your expensive speakers destroying them probably before a fuse blows.

This unit measuring 85(W) x 55(D) x 35(H) draws very little current at 12V DC. (A circuit drawing how to connect it inside an existing amp is shown as well as a separate power supply)

The protector has a 3 second de-thump turn on delay and a D.C. fault sense circuit. The protection relay is massive and will not offer any significant voltage drop in even the highest power amps. Cheap insurance!!

* Output capacitor-less. The enormous bulk of Hi Fi & P.A. amps are now built this way.

Cat. AA-0320

ONLY $22.95

SOUND OPERATED SWITCH

This compact 70(L) x 45(W) switch will detect a sharp sound and latch a relay with N.O. and N.C. output. It runs from 9 - 12 volts and has adjustable sound level sensitivity. Cat. AA-0342

ONLY $16.95

LIGHT OPERATED SWITCH

This controller uses a Cadmium Sulphide (CdS) cell to detect an ambient light level. The sensitivity is adjustable. When the level of light reaches a certain value the relay (with N.O. or N.C. outputs) switches on. It remains on until the light level falls below the predetermined value. The relay will switch up to 200W (resistive) but is not mains rated.

The switch is ideal for use as an event counter. Cat. AA-0344

ONLY $8.95

NOT ALL COMPACT DISC PLAYERS ARE THE SAME! NEW

It is becoming increasingly apparent that not all CD players are the same. You get no guarantee of superb sound quality by paying around $1,500. You may get a model that bristles with programming facilities but is in fact no better than a model costing ⅓ as much.
With this is in mind, Jaycar has concluded an exhaustive technical evaluation of models suitable for inclusion in the 1986 Jaycar Catalogue. We feel that the choice of the **ADC Model CD-100X** player will be welcomed by the technical reader of this magazine.

SPECIAL OFFER - We welcome technical scrutiny of this magnificent CD player. To prove this, we can supply a detailed 40 page technical service manual on the ADC CD-100X. This manual (one of the best we've seen out of Japan) covers theory of player operation, circuit operations, test procedures, test print and waveform illustrations, block diagrams, IC description and schematic diagrams and much, much more!
If you wish to review this manual before you buy send $10 (inc. P&P) for a copy. After reading this manual we are certain you will buy. (When you buy the CD-100X we will take $10 off the purchase).

BRIEF TECHNICAL SPECS.

Frequency Response	5 - 20kHz ±0.5dB
T.H.D.	0.004%
Dynamic Range	95dB
Channel Separation	90dB @ 1kHz
Optical Pickup	3 beam laser
D/A Conversion	16 bit linear
Filter	Seventh order passive filter
Error Correction	CIRC dual error system

ONLY $499 plus p&p

Cat AC-0400

FEATURES: • Motor driven horizontal loading (front load) • 3 beam laser (not 2) • Metal chassis for rigidity • Astigmatic beam focus • 16 memory track programming.
The price for this magnificent unit?
The first 50 buyers will receive the magnificent 40 page service manual FREE!

WE'VE GOOFED

We have made a terrific blue and have hundreds, yes hundreds of Avtek Auto Answer Multi-Modems in stock!
We need to move them fast so we've slashed the price by an incredible $100 to help you make a decision.
That's right! You can have an AVTEK Multi-Modem with AUTO ANSWER for only $299!! Save $100!

THE FULL AUTO ANSWER UNIT!!

SAVE $100

HURRY!!!

ONLY $299 SAVE$100

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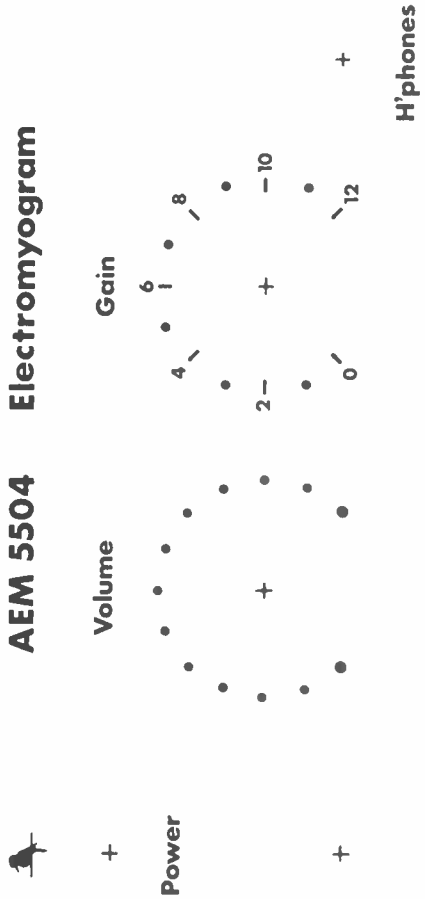


to these. This option has the advantage that the pc board can be located within the chassis before terminating the connecting wiring.

Whichever option is used, the chassis must first be drilled and filed to suit the control potentiometers and switches. We used an inexpensive all-metal box obtainable from Dick Smith stores for the prototype unit. Drilling details have been included with this article which shows the hole positions and sizes.

Once the chassis has been prepared mount the front and rear panel-mounted components and install and wire the pc board. The batteries are wired using special purpose clips which are commonly available. Be very careful when soldering the wires from these to the pc board. It is very important that these be soldered the correct way around. If not, the components could be supplied with inverted supply voltage which will almost certainly cause damage, particularly to the ICs.

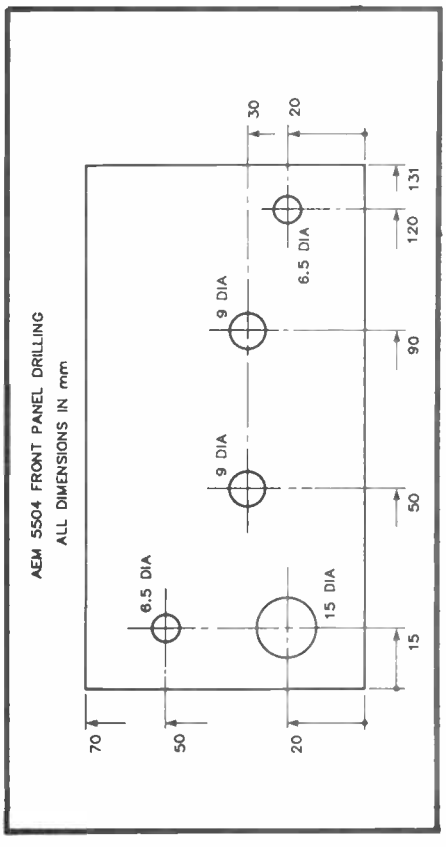
Setting up procedure

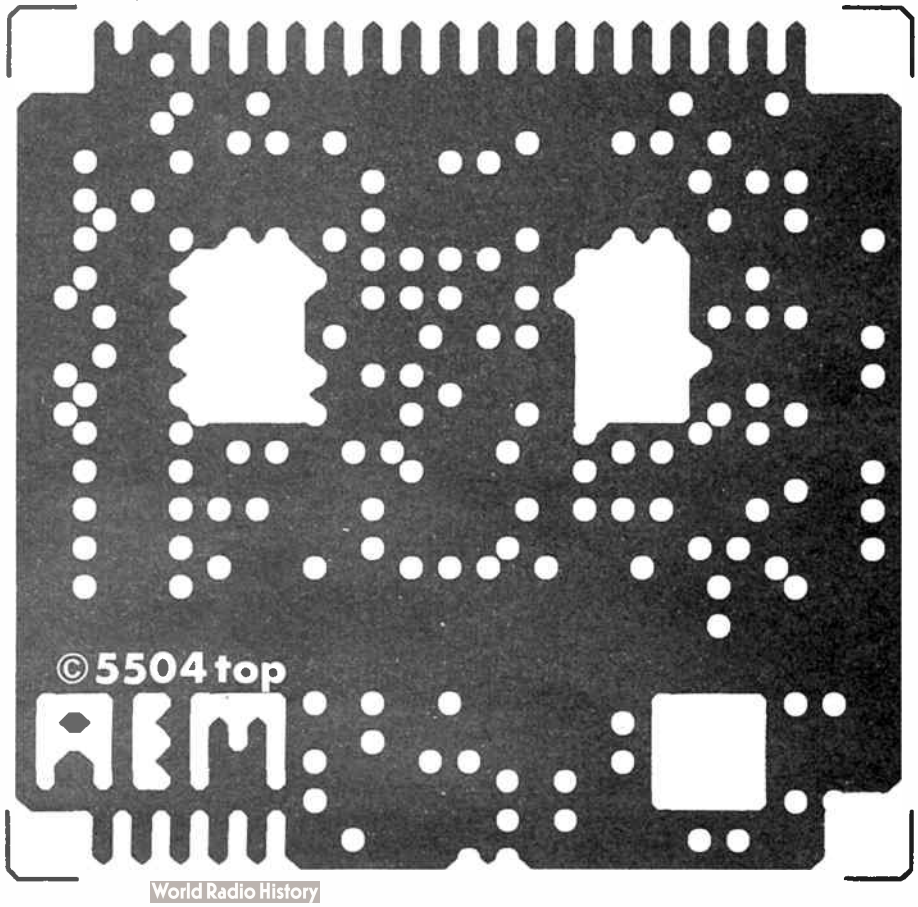
The setting up procedure consists of the adjustment of the threshold preset pot on the pc board. This requires a degree of experimentation and is best set up at the gain setting you prefer to use. One method of alignmnt is achieved by shorting all three electrodes to each other and then increasing the gain potentiometer to the gain setting usually used.

Adjust the threshold so that the frequency of the generated tone is just starting to decrease. Advance the preset a little further so that a noticeable decrease is perceived in pitch. This is the correct setting.

Construction of the electrodes

The electrodes consist simply of a 5-pin DIN plug, three lengths of shielded cable and three metal discs. For con-





venience and light weight, we used light gauge shielded cable (RG174). The two input leads are made by soldering the centre conductor of the shielded wire to a small metal disk approximately the size of a ten cent piece. Use plated or passivated metal disks with a non-reactive plating.

Be careful not to allow the shields of these cables to come into contact with the metal disc. If this does occur, the signal present on the electrode will be shorted out. The best way to prevent this from happening is to insulate the shield using a few turns of insulation tape. In order to prevent the wires breaking free of the metal disks a small quantity of epoxy resin can be applied to the side of the disk to which the solder connection has been made.

The earth reference electrode is built in exactly the same way, except that a slightly larger metal disk should be used to distinguish it from the two signal electrodes.

Using the EMG

Your goal when using an EMG is to identify the subtle feelings or sensations within your body which correspond to minute variations in muscle activity level. Probably one of the widest uses will be in relaxation training where you learn to 'turn off' specific muscles or specific muscle groups. Alternatively, if through illness or accident you have atrophied muscles or impaired muscle usage, the EMG can be used to re-train them, indicating 'strength' in activity as you progress.

The electrodes are taped to the skin over the area of the muscle or muscle group. Velcro strip works well in taping the electrodes in place when using them on a limb. Surgical plaster tape, or Bandaids, are also convenient to use. Tape the ground electrode either between the main pair or slightly off to one side, but not too far away. To achieve best contact with the skin, you can use a small amount of 'electrode paste,' available from distributing chemists and a few medical suppliers. Moistening the electrodes works quite well in lieu of the paste.

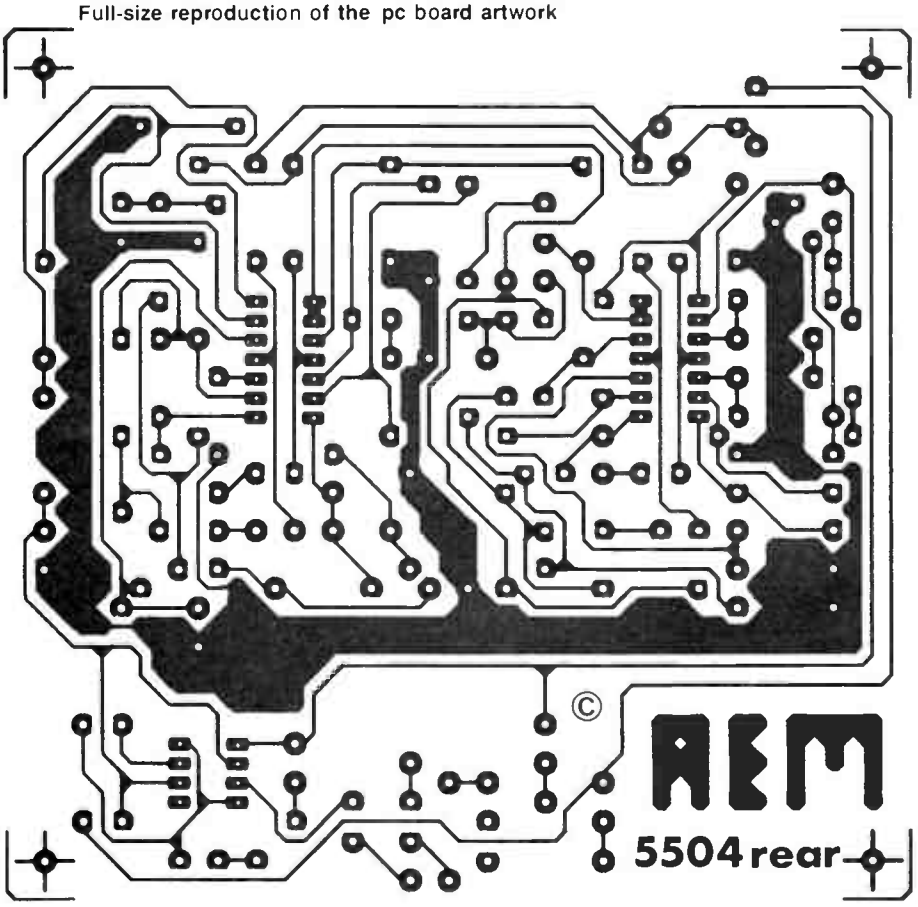
To try out the instrument, tape the electrodes to one of your forearms. Commence with the gain and threshold controls at minimum and switch on. Listen to the output while slowly advancing the gain. Try tensing your arm and see if it produces a rise in pitch and mask some of the noise which affects the audio output. Try tensing your muscles again to see that you haven't set the threshold too high.

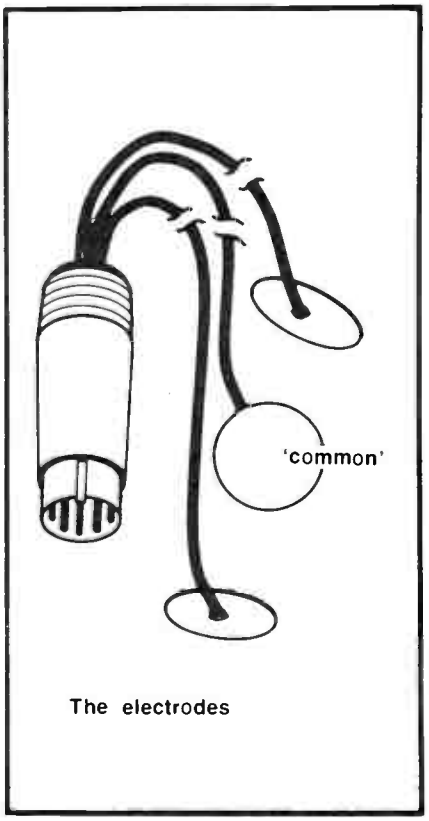
Try various combinations, different electrode placements etc, to get the 'feel' of the EMG. Eventually, you should be able to set the gain quite high and the threshold such that you can readily detect a change in muscle activity that is imperceptible to anybody else observing the area being measured.

When using the EMG attached to your forearm, let your arm lay on an arm rest or across your lap. Note what happens when you make fine movements with your fingers. You can relax your arm quite effectively by picking it up at the wrist and letting it flop into your lap. Learn how to make the arm feel numb and heavy.

Use of the EMG on your neck can be very effective in all sorts of circumstances. Lie down in a comfortable position face-down with your forehead on the back of your hands or resting on a rolled-up towel or small cushion. You should also sit up in a comfortable chair with your back well supported. Attach the main electrodes either side of the base of your neck or even up under the rear of the skull. — to page 100 ▶

Full-size reproduction of the pc board artwork





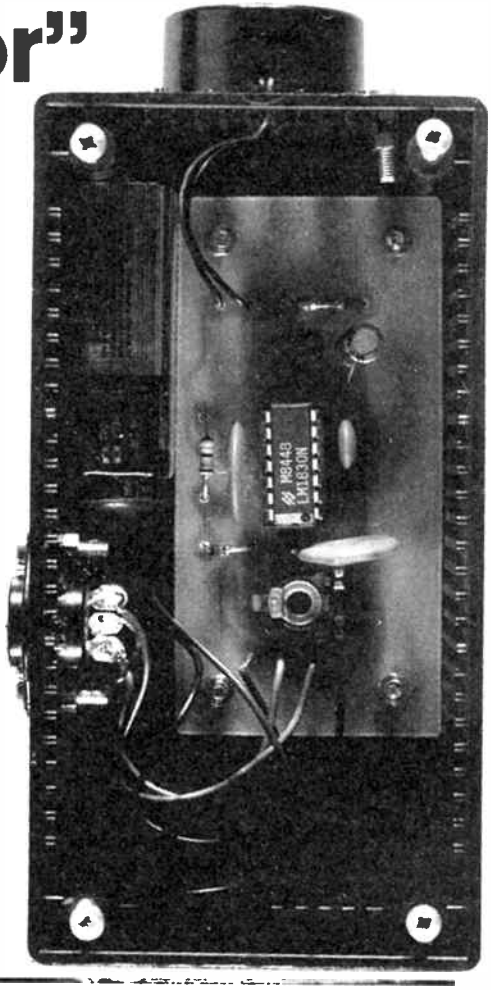
The electrodes

aem project 5503

The "Bed-wet-ector"

Tony Curtis

Using readily obtainable parts, this do-it-yourself project provides an alternative solution in training young children out of bed-wetting at a fraction of the hire cost of similar commercial devices.



LEVEL

We expect that hobbyists who are

BEGINNERS

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

BY THREE YEARS OF AGE the majority of children have 'learnt' not to bed-wet. For those not in this majority, several solutions to training them out of the problem exist, after medical diagnosis that the problem is not physiological in nature. One solution is the purchase of a rubber-mat sensor for use in conjunction with the monthly hire of an electronic detector box. Such systems are available from reputable chemists. But the whole system ends up quite an expensive exercise, I found. So, I applied a little electronic know-how to circumvent at least part of the cost.

The theory — what makes it 'work'?

In sleep, the child is unaware of bedwetting and does not awaken at its onset, but after the event (sometimes, not even then). Therefore, if the child is awakened at the instant the inner 'decision' to urinate occurs, unconscious association of these decisions will be impressed on the child's mind, thus 'training' them to awaken in future to relieve both bladder and the discomfort of a wet bed.

Such associative training techniques are invariably successful.

The project

What I needed was a simple, low cost, reliable fluid detector to drive some form of audible alarm. National Semiconductor had just the thing — an IC known as the LM1830. This is a fluid detector with integral alarm circuitry and a Data Sheet is published elsewhere in this issue. I have incorporated a 'sensitivity' adjustment to allow the unit to be adapted to individual circumstances.

For obvious reasons, I dubbed the project the 'Bedwetector'.

The adjustable nature of the 'Bedwetector' is unavailable in the hired devices. Here, the adjustment allows detection from 'summer-sweats' to a bedwetting 'pool'.

While there few components in the project, it is recommended that you use the printed circuit board design shown here to avoid wiring errors and for reliability (ready-made boards are available through the magazine and some electronics retailers).

The unit is housed in a common, low-cost plastic 'zippy' box. The alarm unit is a commonly available (and cheap!) piezoelectric alarm. The project is powered from a single 9 V battery. Do NOT attempt to power it from a plugpack or any other form of mains supply for there is a remote, but nonetheless real, risk of accidental contact with mains potential. The result could be tragic.

The sensor mat comes from the *Mediclean* Enuresis Co., *Unit 1/54 Jersey St, Jolimont, Perth W.A. (09) 387 5011.* You can order one direct from them, at a cost of $65, or through a chemist store, though not all chemists will do that. Larger 'chain' chemists, such as Amcal and Soul Pattinson indicate they would be happy to oblige.

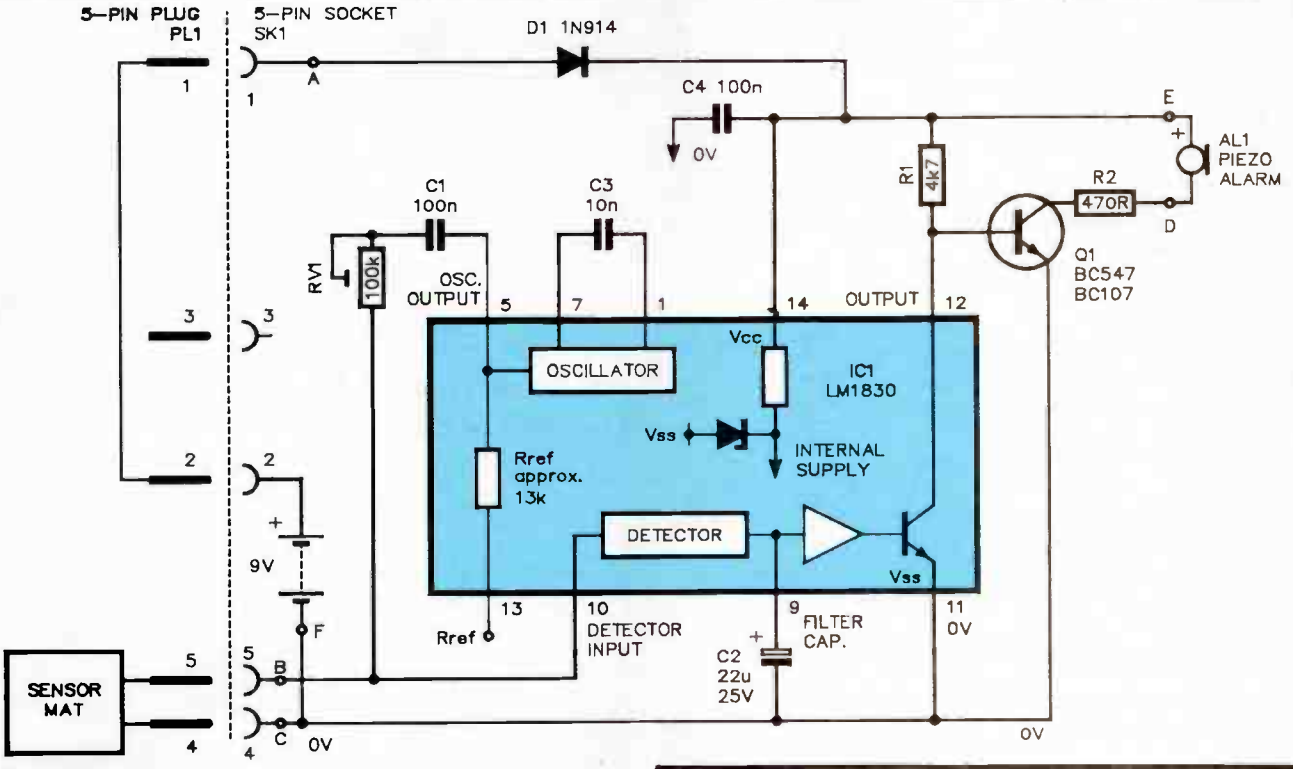
Construction

Assembly of the Bedwetector is straightforward. Using the blank pc board as a template, position it with the silk-screen side (the white writing on the board) uppermost on the outer side of the zippy box lid, leaving room for the alarm alongside (see Figure 2). Mark holes A, B and C. Place the piezo alarm alongside and mark its fixing holes. Drill the five holes, opening out hole 'B' to 6 mm. Drill a 15 mm hole at one end of the box and, using the 5-pin chassis-plug as a template, mark and drill its fixing holes.

Assemble the alarm to the inside of the lid. Assembly the components onto the pc board leaving off the LM1830. Ensure each component is pushed down flush with the board.

Capacitor C2 is polarised. That is, it will go 'bang' when power is applied if its incorrectly oriented, so ensure that its positive lead connects through the hole marked '+'. When you hold C2 with its writing facing you, the '+' lead is the one to your right.

Next, wire up the 5-pin chassis connector to the battery connector and pc board so that the 5-pin connector can be screwed to the box leaving wires long enough to lift the board over the box edge.



CIRCUIT OPERATION

Figure 1 shows how National Semiconductor's LM1830 fluid detector gives the low-cost solution The LM1830 produces a signal from its internal oscillator which is sent to both the sensor-mat and a detector within the integrated circuit. The sensor-mat is placed under the child in a position to get wet should bedwetting occur.

The internal reference resistor, Rref, is pre-set such that, when the resistance between the sensor-mat wires, normally open-circuited, drops to one-third of Rref, the signal fed to the detector is reduced to a level which sets off the alarm.

Thus, urine being highly conductive, bedwetting operates the alarm.

AEM5503 PARTS LIST

Semiconductors
D1 ..... 1N914, 1N4148
IC1 ..... LM1830N
Q1 ..... BC547, BC107

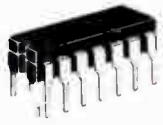
Resistors all ¼W, 5%
R1 ..... 4k7
R2 ..... 470R
RV1 ..... 100k vert. trimpot.

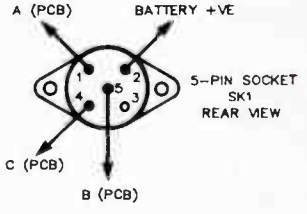
Capacitors
C1 ..... 100n greencap
C2 ..... 22u/16 V RB electro.
C3 ..... 10n greencap
C4 ..... 100n greencap

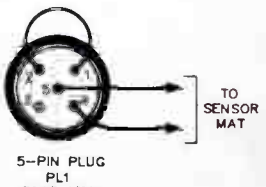
Miscellaneous
AL1 ..... Murata slim piezo alarm, e.g: DSE L-7204 or similar.
PL1 ..... 5-pin plug, e.g: DSE P-3125 with P-3140 cover, or similar.
SK1 ..... 5-pin socket, e.g: DSE P3135, chassis mount, or similar.

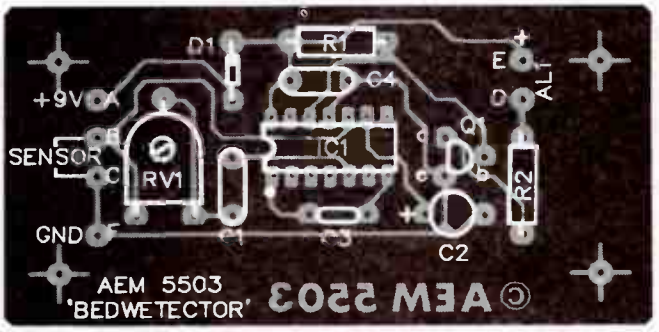
AEM5503 pc board; zippy box to suit; No. 216 9 V battery and connector clip; two M3 screws 15 mm long; four M3 screws 10 mm long; ten M3 nuts; hookup wire; sensor mat (see text).

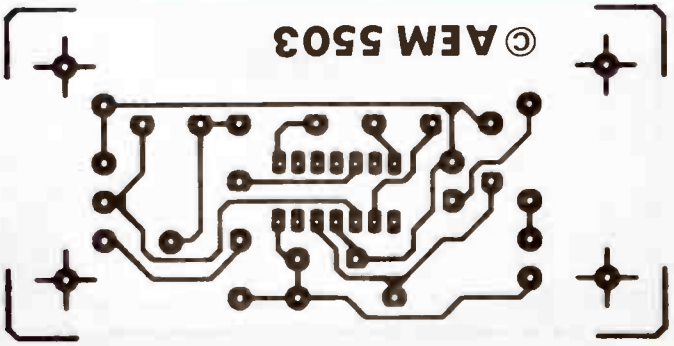
Cost Estimate: $25-$30
(plus sensor mat)











Make up two pillars using screws and six nuts, by mounting the screws through the lid with three nuts to each screw. Carefully solder in the LM1830, the CORRECT way round, connect the alarm wires to the board and mount the board with the components to the lid, alongside the alarm on the two nut-pillars.

Assemble the 5-pin chassis socket into the box, connect the battery to its connector, secure it inside the box (double-sided sticky pads work great) and assemble the lid back onto the box.

Remove the two-pin connector from the sensor mat wires and wire these to the 5-pin plug. Connect the wire link which serves as an on-off switch for the unit.

You are now set to test the Bedwetector.

Testing

Lay the sensor-mat on a table and open it out flat. Carefully connect it to the assembled Bedwetector, remembering that connecting it will apply the power. Using an insulated-blade screwdriver, rotate RV1 from end to end and set it about half-way between the ends. The alarm should not sound.

Using a teaspoonful of ordinary tap-water — not pure rainwater — pour a 'bubble' over the wires embedded in the sensor mat so as to cover them. The alarm should sound.

If it doesn't, the water resistance is high, probably greater than about 15k, and RV1 should be *slowly* rotated anticlockwise to cause the alarm to commence.

Once the alarm sounds, wipe dry the sensor-mat and it will stop.

Try different liquids to get a 'feel' of their resistivity. If your sample of 'calibration' water is of reasonable conductivity, using pure rainwater will not set off the alarm. In fact, by using the setting of RV1, the device can be set to detect anything from dilute battery acid to minutely sugared rainwater.

The Bedwetector is now ready to do its job.

Using the Bedwetector

Place the sensor-mat beneath the sheet of the bed where the child sleeps, in a suitable position to get wet when bedwetting occurs. It is essential to ensure that the mat does not fold or crinkle up and short the sensor-wires together, so use sticky-tape or packing tape to eliminate this. Leave the connector wires in a suitable position to connect to the Bedwetector.

At bedtime, explain the 'game' you want the child to help with so that the alarm sounding doesn't shock too much. Plug-in the sensor-mat. You might arrange a prior demonstration.

After it goes off, the alarm can be cancelled by unplugging the sensor-mat or wiping it dry.

Hints on getting the best from your Bedwetector

The device must detect bedwetting at its onset for best results. If it is too sensitive it will detect sweat and if too insensitive, only sound the alert when bedwetting has ceased.

In order to get the best results, the sensitivity adjustment, RV1, should be experimented with until the first drops of 'wet' are sensed. Thus the whole episode can be turned into an experimental, co-operative dialogue with the child playing a part. This helps in removing the problem.

The battery will last about one month depending on the alarm rate, so long as you remember to DISCONNECT the sensor-mat each morning.

UNDER NO CIRCUMSTANCES REPLACE THE BATTERY BY A MAINS POWER-SUPPLY!

WHEN GEOFF DOES A KIT HE DOES IT PROPERLY

Geoff's policy is to do a few kits and do them well. Rather than bundle up bits and pieces for everything under the sun, Geoff takes a lot of trouble to get all the RIGHT parts for just a few projects. As a result you can be assured that there are no dubious substitutions and that all parts are prime spec.

Also the projects are checked out before the kit is even considered. Both of this month's projects had mistakes in the original articles - in both cases the PCB layout was incorrect - and Geoff was the one who spotted the errors.

AEM4600 DUAL SPEED MODEM

Geoff can't put this kit together fast enough. The queue started to form the moment the magazine came out.

Features both 300/300 baud full duplex and 1200/75 baud half duplex operation so it's ideal for Viatel. All functions are selected with quality C&K toggle switches with four LEDs to indicate correct functioning. Interfacing is standard RS232 using a minimum of signal lines for "universal" interfacing.

Geoff's kit comes complete with punched front panel (looks like a bought one!) and is just

$159.00

ETI 169 LOW DISTORTION OSCILLATOR

If you're checking out Hi Fi systems then an audio oscillator is a must. The trouble is that the average el-cheapo probably has a higher level of distortion than a $10 transistor radio. So with this kit there can be NO compromises. The distortion just has to be better than 0.001%. Covers the frequency range to 100kHz. Geoff has checked the whole thing through with Ian Thomas (including pointing out the track error on the pcb).

Kit again includes a posh front panel and the top quality AB pot (available separately at $9.00).

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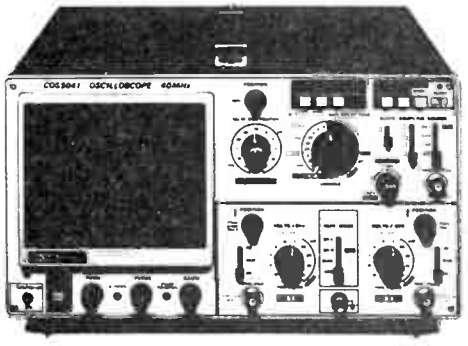

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Accuracy	• 200mV - 1000V ± (0.05%rdg + 3dgt)

AC Voltage: (True RMS, AC coupled 10% to 100% of range)

Range	• 200mV, 2V, 20V, 200V, 750V
Resolution	• 10uV, 100uV, 1mV, 10mV, 100mV
Accuracy	• 200mV - 200V @45Hz 1KHz ± (0.5%rdg + 20dgt) @1KHz - 2KHz ± (1.2%rdg + 30dgt) @2KHz - 5KHz ± (5.0%rdg + 40dgt) (200V @2KHz - 5KHz not specified) 750V @45Hz - 1KHz ± (1.0%rdg + 20dgt)

DC Current

Range	• 2mA, 20mA, 200mA, 2A, 10A
Resolution	• 100nA, 1uA, 10uA, 100uA, 1mA
Accuracy	• 2mA - 200mA ± (0.3%rdg + 3dgt) 2A 10A ± (0.75%rdg + 3dgt)

AC Current: (True RMS, AC coupled 10% to 100% of range)

Range	• 2mA, 20mA, 200mA, 2A, 10A
Resolution	• 100nA, 1uA, 10uA, 100uA, 1mA
Accuracy	• 2mA @45Hz - 400Hz ± (2.5%rdg + 20dgt) 20mA - 200mA @45Hz 400Hz ± (0.75%rdg + 20dgt) @400Hz - 1KHz ± (0.75%rdg + 30dgt) 2A 10A @45Hz - 500Hz ± (1.2%rdg + 20dgt)

Resistance

Range	• 200Ω, 2KΩ, 20KΩ, 200KΩ, 2MΩ, 20MΩ
Resolution	• 0.01Ω, 0.1Ω, 1Ω, 10Ω, 100Ω - 1KΩ
Accuracy	• 200Ω ± (0.2%rdg - 5dgt + 0.04Ω) 2KΩ - 200KΩ ± (0.1%rdg + 3dgt) 2MΩ ± (0.15%rdg + 3dgt) 20MΩ ± (0.5%rdg + 3dgt)

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A signal-operated cassette recorder controller for scanners and shortwave receivers

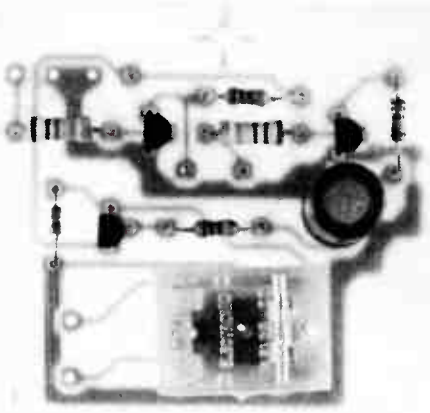
Tom Moffat VK7TM

Here's a handy little project to use with your scanner or shortwave receiver to record tranmissions, turning your cassette recorder on at the start of the transmission and off when it finishes. It does the job autoamtically, so you don't have to be in attendance.

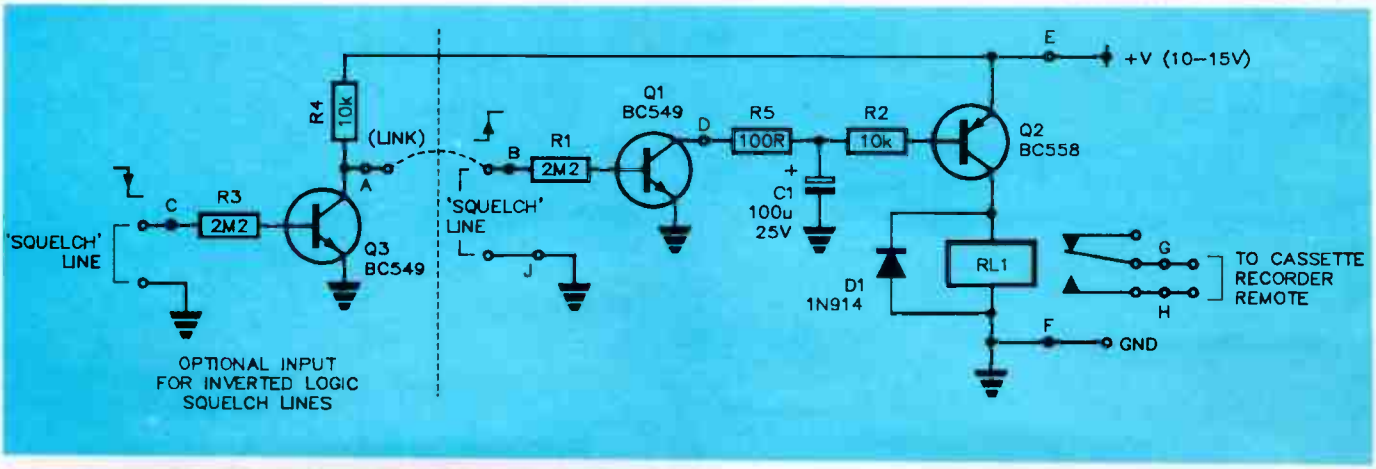
THIS MAY WELL be one of the smallest projects ever to be published in AEM. The basic version consists of two transistors, three resistors, one capacitor, a diode and a relay. But, if you're into scanning or shortwave listening, you'll find it one of the most useful devices you can own.

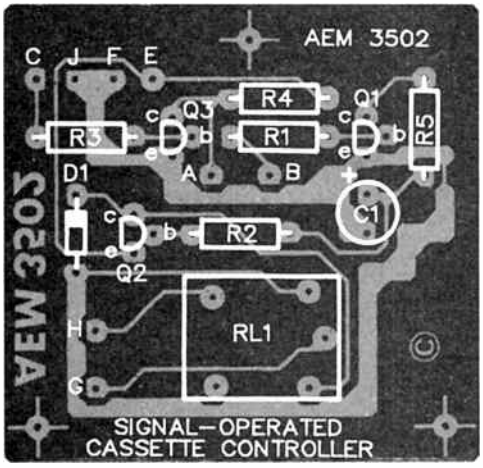
The project, when connected to a receiver which has its "squelch" line brought out to a rear panel connector, will switch a cassette recorder on when a signal appears on the frequency to which the receiver is tuned. When the transmission ends, the cassette recorder keeps running for a few seconds, and then stops . It's *very handy* for logging a full day's activity on a frequency that isn't used very much, such as some of the military or diplomatic channels on the HF bands. (You too can be a spy!)

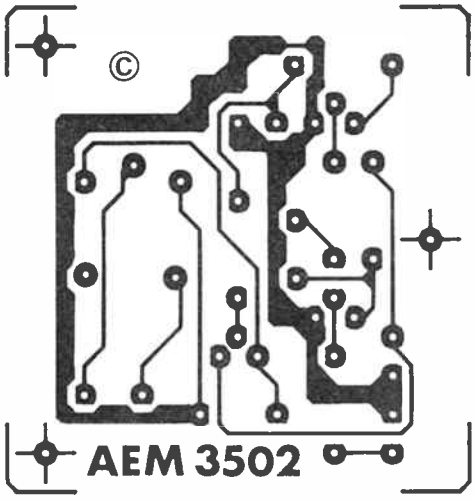
The AEM3502 has been designed for use with receivers which have a "squelch" or "muting" control that you can set to shut down the receiver's audio when no signal is present,



The finished unit. We've left housing of the project up to you as individual requirements will vary widely. The pc board will readily fit in a small plastic jiffy box. Alternatively, it could be housed in your receiver and a connector for linking the relay contacts to the cassette recorder 'remote' jack fitted to the rear panel.







Full-size reproduction of the pc board artwork

AEM3502 PARTS LIST

Semiconductors
Q1 . . . . . BC549, BC109
Q2 . . . . BC558, BC559, BC179
Q3 . . . . . BC549, BC109

Resistors all ¼W, 5%
R1 . . . . . 2M2
R2 . . . . . 10k
R3 . . . . . 2M2
R4 . . . . . 10k
R5 . . . . . 100R

Capacitors
C1 . . . . . 100u/25 V RB electro.

Miscellaneous
RL1 . . . . . miniature pc-mount relay with 12 volt/200-250 ohm coil SPDT contacts (e.g: DSE S7120, Jaycar SY-4060 or similar).

AEM3502 pc board; jack plug to suit cassette recorder's remote jack; zippy box (if needed); hookup wire, nuts, bolts, etc.

Cost Estimate: $9-$11

thus eliminating the background noise. On most receivers having this facility, a control line is also brought out to a connector on the back of the receiver, the voltage level on this line indicating whether or not the squelch circuit is operated. This control line is employed to activate the cassette recorder motor via the AEM3502 project.

Construction

It hardly seems necessary to use a pc board for the project as it could be readily constructed on matrix board, Veroboard or even a lashed-up "rat's nest." However, for convenience, confidence and appearance, we present a pc board.

Components should present few problems. The relay used is a common, low-cost pc-mount type having a nominal coil resistance around 200-250 ohms. These work quite happily ▶

LEVEL

We expect that hobbyists who are

BEGINNERS

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

CIRCUIT OPERATION

The project was designed with the concept of using the absolute minimum technology . . . getting the most use out of the least amount of hardware. There are two ways the squelch line can work in a receiver: it can start at a 'high' voltage with the squelch 'closed' (no signal present), and go to a 'low' voltage (usually 0 V) when the squelch 'opens' on reception of a signal; or, it can be low when closed and high when open. Hence, the project has provision for either case.

Shall we take the case where the squelch is low when no signal is present? The squelch line in this case is connected to point B. Your cassette recorder will be lying in wait to capture some transmission. As the squelch line is at zero, there is no current fed into the base of Q1 so it is off. The collector of Q1 is floating so there is no base current for Q2, and it is also off. This means there is no current for the relay, so it too is switched off. But, C1 will be charged because, when you first applied power it will have charged via R1 and the base-emitter junction of Q2. The relay operates for some seconds initially until C1 charges to within 0.5 V of the supply, when Q2 will turn off, leaving the circuit prepared.

Now, along comes a signal. The squelch line goes high, feeding a tiny amount of current into the base of Q1. Most receivers can't supply a lot of current from the squelch line; that's why R1 is such a high value. With some base current, Q1 switches on, and its collector goes low. This discharges C1, although not instantaneously, the rate being limited by R5 which also limits the discharge current throughout Q1.

As Q1's collector goes low, it pulls current through R2, allowing base current to flow in Q2, which then conducts and switches on the relay, starting the recorder. Everything is now stable as long as the signal remains.

When the signal disappears, the squelch line goes low again, switching off Q1. But Q2 can't switch off until C1 charges again to within 0.5 V of the supply. This takes several seconds. When C1's voltage rises high enough for Q2 to switch off, the relay opens, and the cassette recorder stops.

The delays in the circuit's operation are quite intentional. The short turn-on delay prevents the cassette recorder from starting every time there is a "sput" or "plop" from the receiver, caused by static or whatever. The signal must be properly established before the recorder switches on. This may sometimes chop off the first words of fast talkers, but it's better than having the cassette run with every burst of noise. The long turn-off delay waits for a possible reply to a message before turning off the recorder. In fact, if you record the constant barrage of traffic on some busy repeater, the recorder may seldom switch off at all!

The delays may be varied by varying C1 and R5.

If your're using a receiver which has an 'inverted' squelch line, such as the Icom R-71, you'll need the optional part of the circuit, Q3, R3 and R4. This is a simple inverter to turn the squelch signal upside-down. The squelch line connects to point C, and point A is linked to point B.

Some receivers, such as the popular J.I.L. SX-200, have an open-collector NPN transistor in the squelch line output. In such cases a sensitive relay with a high impedance coil may be used, connected between the collector and a suitable supply. A suitable type may not be readily available; in which case, discard Q1, Q3 and associated components and connect the collector output line to point D (and common to chassis).

over a voltage range from 8-14 V. Jaycar stock them as catalogue no. SY-4060 and Dick Smith stock them as cat. No. S-7120.

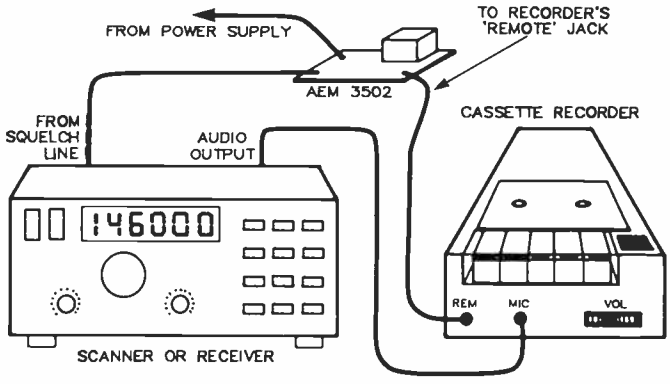
Assembly is quite straightforward. Leave the relay till last. The resistors and capacitor can go on first, but watch the orientation of the capacitor. Then, solder the transistors in taking care you orientate them correctly also. After mounting the relay, you can attach the leads that go to the receiver and cassette recorder.

Hooking it up

To connect the relay to your cassette recorder you will most likely need a 2.5 mm sub-mini jack plug. The connector you need to interface to your receiver will be dictated by the plug or socket the manufacturer provides on the rear panel (see your manual). The squelch signal line on the Yaesu receivers mentioned earlier is brought out to pin 6 of their CAT ('computer aided transceiver') connector. On the Icom R71, the signal is on pin 1 of the accessory connector.

In Yaesu receivers such as the FRG-9600 scanner and FRG-8800 shortwave receiver, the control line goes to around +4 or +5 volts when the signal disappears (don't believe what you read in the FRG-8800 operating manual it has it the other way around!). In the case of the Icom R71, the control line is the other way around, with +8 V on the line when a signal is present, and zero volts when the signal disappears (assuming the literature is correct). Check your equipment's manual and confirm with a multimeter. This project has been used for many hours on both the Yaesu FRG-8800 and FRG-9600 receivers. With those receivers having a squelch line that operates opposite to the Yaesu's, the extra transistor inverter circuit is necessary.

The "output" end of the circuit, the relay contacts, connect to the remote socket that is on just about every cassette recorder ever made. Of course, there must also be a connection between the receiver's audio output ("record" connector) and the cassette recorder's audio input ("mic" or "aux" jack). Be sure your cassette recorder can record your receiver all right on its own before using this project.



General block diagram of how the project is hooked up between a receiver and cassette recorder.

Power for the project may be 'pinched' from the receiver it's being used with. Otherwise, it may be run from a dc plug pack or small power supply. It seems to work OK on everything from +8 to +14 volts. You can get +11 volts from the Yaesu FRG-8800 from pin 4 of the accessory plug, and ground is on pin 1. The FRG-9600 has a +8 volt supply on an RCA jack on the back of the unit. The Icom R71 has +13.8 volts on pin 2 of its accessory connector, and ground on pin 8.

The general hookup is shown in the accompanying block diagram.

If, once it's going you feel the time delays are too long or too short, you can change them by changing the value of C1. A smaller value will speed things up.

Finale

Sneak preview time: Shortly, we are going to publish a project for receiving facsimile (FAX) pictures from weather satellites with a home computer. You'll find the AEM 3502 handy for automatically recording the transmissions from these satellites as they pass overhead. So if you want to try satellite pix, you'd better get cracking on this project!

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74LS192	.80
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74LS368A	.80
74LS373	1.45
74LS374	1.45
74LS377	1.45
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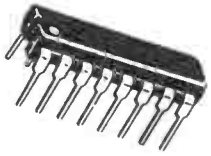

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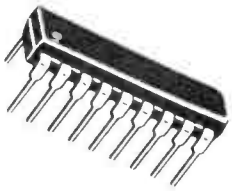
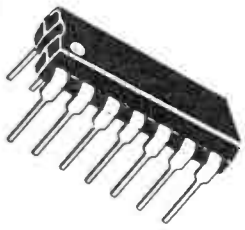
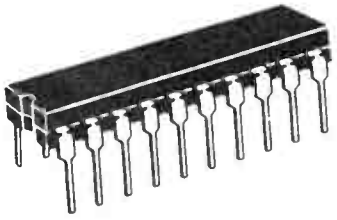
4081B	.50
4085B	.50
4093B	.50
40160B	1.65
40174B	.90
4503B	.65
4510B	1.60
4512B	1.60







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Icom releases all-mode scanner with coverage from 25 MHz to 1.3 GHz

Featuring advanced technology to achieve continuous coverage from 25 MHz to 1300 MHz, Icom's new IC-R7000 scanning receiver complements their now-famous HF receiver, the IC-R71A.

A prominent front panel rotary tuning knob drives an optical incremental tuning mechanism that provides a minimum 100 Hz steps over the entire tuning range. This is enhanced, Icom say, by a direct-entry keyboard on which you can punch-up known frequencies. You can select dial step increments of 100 Hz, 1 kHz, 5 kHz, 10 kHz, 12.5 kHz and 25 kHz.

The dial indicator employs a 7-digit, dual-colour fluorescent readout that always displays frequency along with the mode selected.

Icom's R7000 uses multi-conversion techniques for reception of FM (both narrow and wide band), AM and SSB (upper and lower). Ninety-nine memories are available, each capable of recording mode and frequency. Further, the memory can record active frequencies while in the scan mode without disabling the scan. Later, the memory may be interrogated for active frequencies. Scanning may be done by mode, programmed scan, full scan, selected scan, memory channel scan, auto-write programmed scan and priority scan.

An optional infra-red remote control, model RC-12, will control all the functions of the R7000. This will be available shortly.

Icom claim outstanding performance of the R7000 places the radio in the professional class. The spurious and image rejection performance they claim is better than 60 dB and sensitivity typically better than 0.5 uV for 12 dB SINAD.

The radio is powered from either 13.8 Vdc or a mains supply. The compact size of the R7000 allows mobile use.

Further details are available from **Icom (Australia) Pty Ltd, 7 Duke St, Windsor 3181 Vic. 2284. (03) 529 7582.**

New through-line power meter

Vicom has announced details of a new range of RF thru-line power meters from Fujisoku Electric Company of Tokyo, Japan. Fujisoku is a leader in RF test instruments with many years experience in precision power meters.

The new series TLP-52X is capable of directly reading forward and reflected power together with unique "cross-needle" reading of SWR.

Frequency coverage is 1.8 to 1000 MHz with various power ranges. Quoted accuracy is ±10% of full scale. The unit also provides for "RF sampling" with an isolated output for monitoring with a spectrum analyser. Fukisoku also offer models with a built-in frequency counter.

Further details can be obtained from the Australasian distributor, **Vicom Australia Pty Ltd, phone Melbourne: (03) 62 6931; Sydney (02) 957 2766 or Brisbane on (07) 229 9278.**

Townsville amateurs look forward to an active 1986

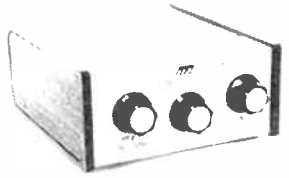
The Townsville Amateur Radio Club looks forward to a healthy 1986 following elections late last year which saw 31 of 32 available positions filled. Outgoing 1985 President, Bob Mann VK4WJ, welcomed 1986 President Harry Verner VK4BBC.

It seems 1985 was another successful year for the club. Their amateur television (ATV) repeater was successfully commissioned during the year, which saw quite a bit of club ATV activity.

Your Editor notes some familiar names (old acquaintences) among 1986 club officer bearers: Peter Renton VK4PV, Anne Renton VK4MUM (since when?), and Bill Sebbens VK4XZ, amongst others. If you live in the 'deep north', the Townsville ARC can be contacted via **PO Box 964, Townsville 4810 Qld.**

Versatile antenna tuner covers 1.8 to 30 MHz

A continuous frequency coverage antenna tuner for use over the 1.8 to 30 MHz frequency range has been released by GFS Electronic Imports.



Manufactured by MFJ Enterprises in the USA and known as the Model MFJ-900 Econo Tuner it is designed to match virtually any HF transmitter to almost any antenna, MFJ claim.

The unit's wide matching range comes about through MFJ's use of a large air-cored inductor with taps at 12 locations varied via a front panel mounted 12-position switch.

It is ideally suited to use on dipoles, inverted-vees, random wires, verticals, beams, mobile whips and other antennas fed with coaxial cable or single wire.

The MFJ-900's small size, being 135 x 60 x 190 mm (w/h/d), makes it easily adaptable for both marine and land mobile use. If you would like further information, contact **GFS Electronic Imports, 17 McKeon Road, Mitcham, 3132 Vic. (03) 873 3777.**

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The Electronic Instrumentation Division of Eaton Corp has appointed Elmeasco Instruments as the exclusive distributor for its products in Australia.

Eaton's Electronic Instrument Division is based in Los Angeles, California and is a leading supplier of high performance RF and microwave test and measurement equipment.

The product range includes spectrum analysers, noise-gain analysers, noise figure indicators and noise generators, linear broadband amplifiers, frequency synthesisers, manual and computer-aided EMI measurement systems for all common specification measurement capability, phase angle voltmeters and synchro/resolver ratio instrumentation.

Elmeasco are headquartered at **15 McDonald St, Mortlake 2137 NSW. (02) 736 2888.**

'Stacking' your UHF Yagis for more gain

Roger Harrison VK2ZTB

Have you built, or are you contemplating building, the 'Star Project' 13-element UHF Yagis from Dick Smith Electronics (AEM January and February 1985)? Well, you can improve the performance of a single Yagi by 'stacking' a pair and connecting their feedlines via the 'phasing harness' described here, available as a precut assembly through Dick Smith stores.

THERE IS a 'rule of thumb' about antennas — "the more metal you've got in the air, the better"! 'Stacking' antennas — that is, mounting them such that they are physically separated by a certain amount and feeding them in-phase to achieve a gain increase — is a popular method of increasing gain to improve station system performance. It's often cheaper than buying or building an RF power amplifier which will deliver as much power as a pair of stacked antennas.

Stacking a pair of antennas is a mechanically simple operation and will yield around a 2.5-3 dB gain increase. Another advantage of employing stacked antennas is that the pair will have a smaller turning circle diameter for a single (longer) Yagi of the same gain. To feed the pair, all you need do is 'split' the feedline and feed each in-phase, ensuring you correctly match the two antennas to the feedline. The 'phasing harness' described here does both jobs at once. Dick Smith electronics supplies phasing harnesses to suit their UHF CB antenna (cat. no. K6298) and 70 cm amateur band antenna (cat. no. K6299). They are precut to the correct length with the 'Y' termination sealed with hot-melt glue and the joint covered in heatshrink tubing, all to keep the weather out. They cost just $9.95.

Stacking techniques

There are two ways you can go about stacking a pair of Yagis — whether for vertical polarization or horizontal polarization. You can stack them with the elements in the same plane, or with the elements in *parallel* planes. Figure 1 illustrates the two methods for vertically polarized Yagis. Figure 2 shows the alternatives for horizontally polarized Yagis.

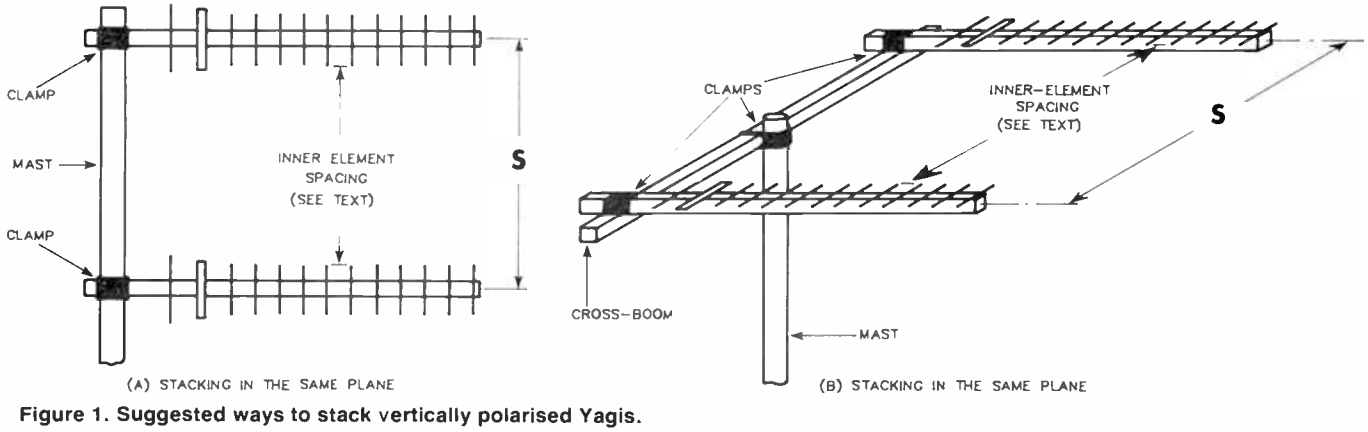


Figure 1. Suggested ways to stack vertically polarised Yagis.

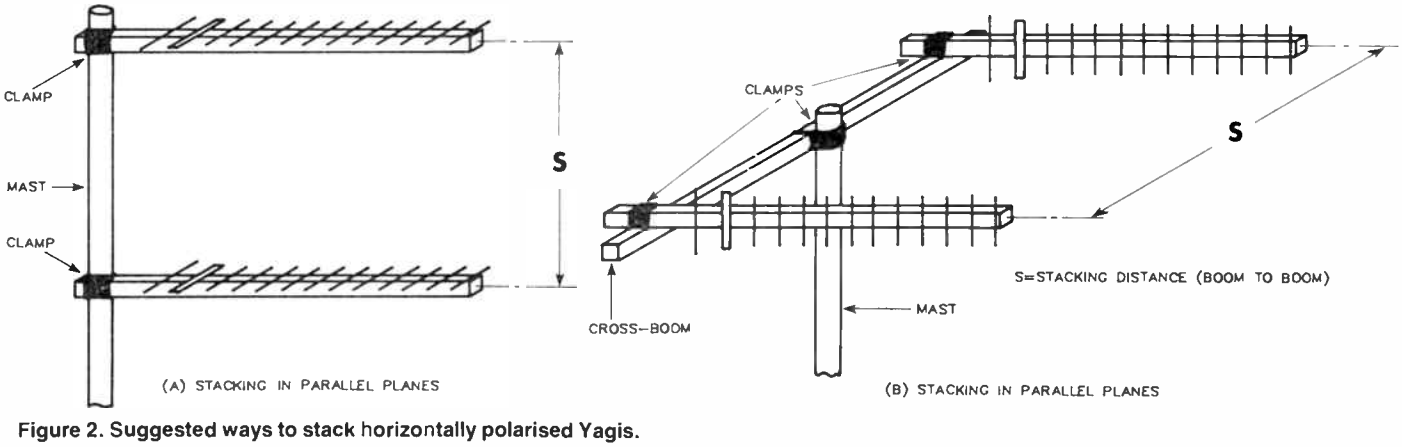


Figure 2. Suggested ways to stack horizontally polarised Yagis.

The stacking distance, 'S', is open to debate, depending on what result you want. However, the debate reduces to the following: for a 'cleaner' radiation pattern (fewer sidelobes, sidelobes well attenuated with respect to the main lobe), closer stacking is preferred. This incurrs a slight gain penalty, but it's generally less than 1 dB; for maximum gain, wider spacing should be used, but the penalty is greater amplitude sidelobes. The latter pick up more noise, which is definitely a penalty where you have a low noise receiver front end. It also means greater potential for interference to or from other stations, particularly on fixed path, point-to-point services. The choice is yours.

In stacking the two antennas with the plane of the elements parallel, the stacking distance can be anything suitable from ⅝ to 1½ wavelengths (measured boom-to-boom). There is no significant increase in gain spacing them further than that.

When stacking them in the same plane, the ends of the inner elements (between directors) should be no greater than ⅝ wavelength apart, which puts the boom-to-boom spacing at virtually 1¼ wavelengths. However, a minimum boom-to-boom spacing of ⅝ wavelength could be used.

Tables 1 and 2 tabulate the relevant stacking distances.

TABLE 1: Stacking distances for 438 MHz Yagis

S(λ)	Boom-to-boom spacing, S
⅝	428 mm
¾	514 mm
1	685 mm
1¼	770 mm*
1½	1027 mm

TABLE 2: Stacking distances for 477 MHz Yagis

S(λ)	Boom-to-boom spacing, S
⅝	393 mm
¾	472 mm
1	629 mm
1¼	708 mm*
1½	944 mm

** Maximum recommending spacing for Yagis mounted with elements in the **same** plane.*

Phasing and matching

The general arrangement of the phasing harness is shown in Figure 3. It has been designed so that the two transmission lines from each antenna to the main coaxial feedline termination are identical electrical lengths. This ensures each antenna is driven in the correct phase. In addition, each 'leg' of the phasing harness acts as an impedance matching transformer.

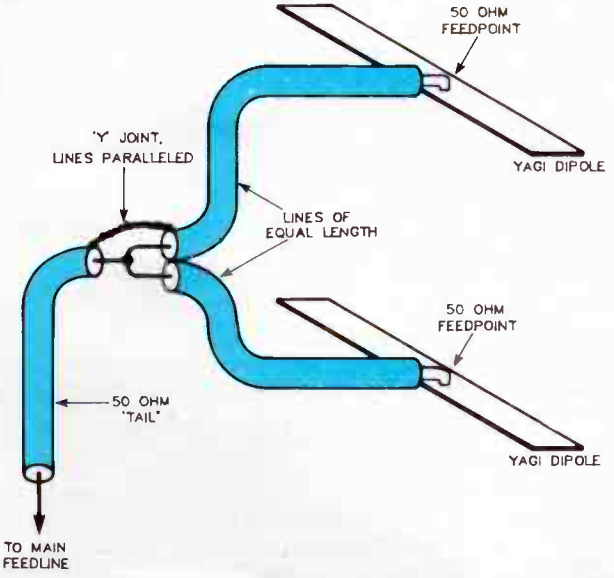


Figure 3. General arrangement of the phasing harness.

Obviously, if we paralleled two 50 ohm antenna feedpoints via 50 ohm transmission lines, we would end up with a 25 ohm load impedance at the join. This would result in an impedance mismatch of 2:1 were we to connect that to a 50 ohm transmission line. As 25 ohm transmission lines are as rare as the proverbial, we need to transform the two feedpoint impedances to 100 ohms each before paralleling them in order to end up with a 50 ohm load impedance.

We can make a 'transmission line transformer' to do this for each antenna feedpoint. This employs the impedance-transforming properties of a quarter wavelength, or an odd multiple thereof, of transmission line.

The input impedance of a quarterwave transmission line terminated in a resistive impedance is given by:

$$Z_S = \frac{Z^2_Q}{Z_L}$$

(see Figure 4)

where: Z_Q is the characteristic impedance of the 'transformer'
Z_L is the load impedance
Z_S is the source impedance

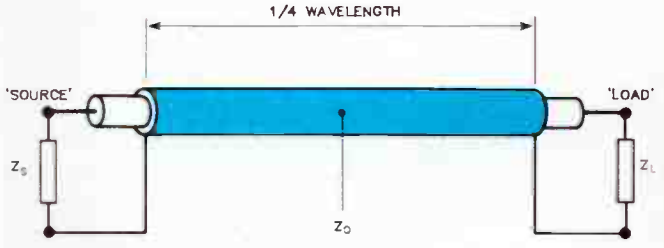


Figure 4. A quarterwave length of transmission line can act as an impedance transformer, the impedance of the line (Z_Q) providing a match between the source (Z_S) and the load (Z_L).

As we know the load impedance (the antenna feedpoint) is 50 ohms, and we know the source impedance required is 100 ohms, we want to know what impedance the quarterwave 'transformer' line needs to be. Rearranging the above equation, we get:

$$Z_Q = \sqrt{Z_L Z_S}$$
$$Z_Q = \sqrt{50 \times 100}$$
$$= \sqrt{5000}$$
$$= 70.7 \text{ ohms}$$

So we need a piece of 70 ohm transmission line a quarterwave long, or a convenient odd multiple of that length.

In practice, 75 ohm RG59 cable is the closest commercially available equivalent (widely used in TV and video systems). This results in only a small mismatch of 1.125 at worst, which is hardly worth losing sleep over in this application.

It is necessary to correct for the velocity factor of the cable used, which is dependent principally on the dielectric employed, for each transformer in the harness. The RF energy travels through the coaxial cable at a speed of about two-thirds (0.66) its 'free-space' velocity (i.e.: the velocity of light). Hence, an 'electrical' wavelength of cable will be shorter than a wavelength in free space.

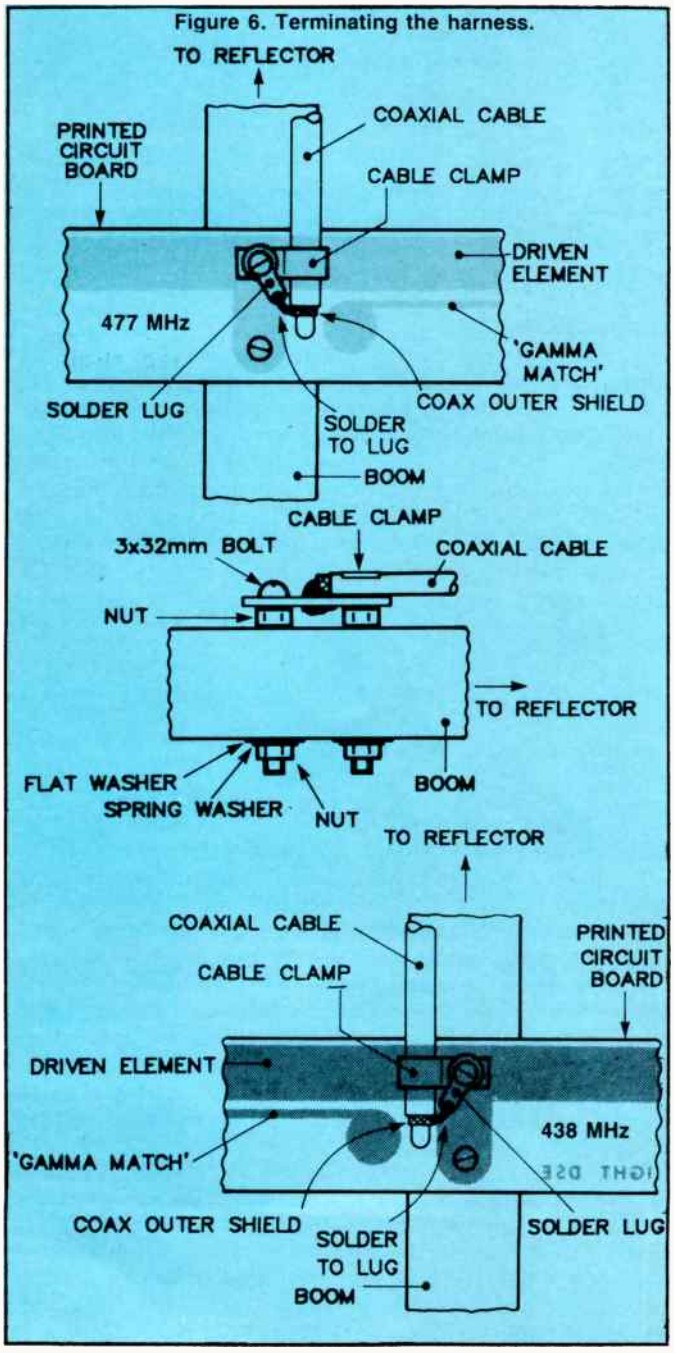
Manufacturing tolerances mean that individual batches of cable vary slightly and, with the physically short lengths necessary at these frequencies (438 and 477 MHz), each piece of the phasing harness has been cut accurately to the required *electrical* length using a 'vector voltmeter' which permits measurement of voltage amplitude and phase of a signal sent down a length of cable.

Now, a free-space quarter wavelength at 438 MHz is about 171 mm, at 477 MHz, it's about 157 mm. To allow stacking a pair of Yagis the maximum recommended distance of 1½ wavelength between booms — that's 1027 mm at 438 MHz and 943 mm at 477 MHz — the two phasing/matching lines need to add up to something longer than this. Quarterwave lines would be clearly too short, so 7/4-wavelength lines have been employed.

The configuration of the phasing harness supplied is shown in Figure 5. The two phasing/matching lines have been accurately precut to the required length and the feedpoint ends prepared for attachment to the dipoles. *These must not be shortened.* However, the short length of 50 ohm coax 'tail' can be trimmed if necessary.

Assembly

The harness may be attached either before or after mounting the antennas, whichever is the most convenient. Carefully attach each end of the phasing/matching lines to each dipole as illustrated in Figure 6. *Do not cut or trim these short-*



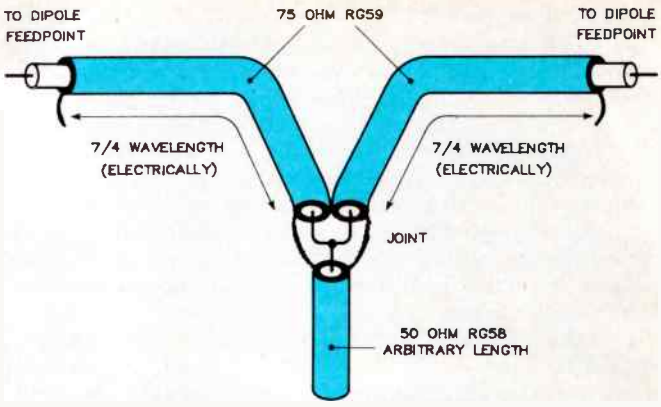


Figure 5. Configuration of the DSE phasing harness for their UHF antenna kits.

er. Seal the dipole terminations with a generous application of silicone sealant, such as Selley's 'Silastic'. Once the antennas are mounted in their final positions, secure the harness to each boom and the mast, using all-weather tape or zip-up cable ties, in one of the various manners suggested in Figure 7.

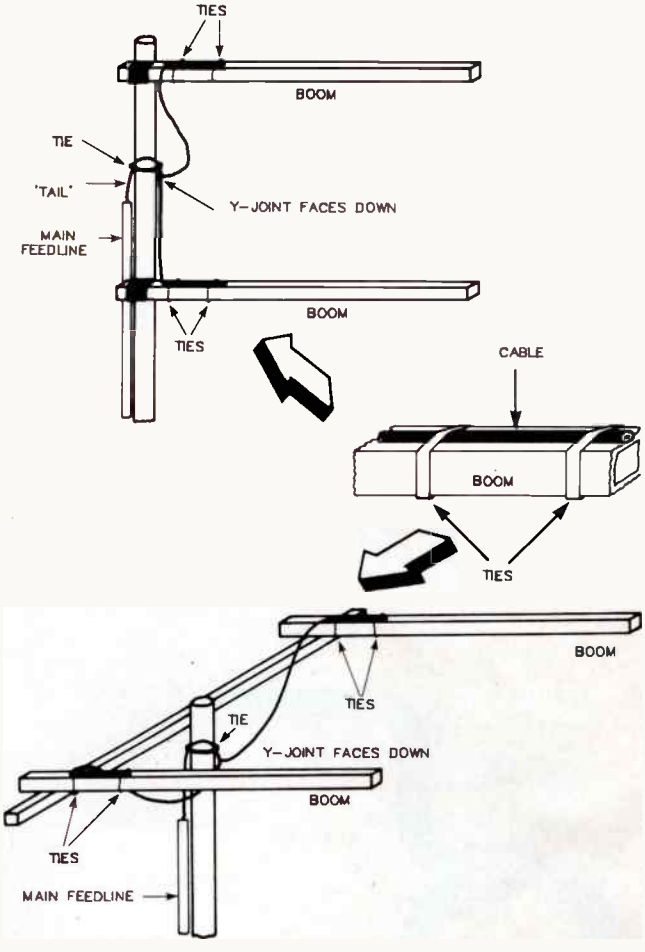


Figure 7. Securing the harness. The Y-joint should face downwards to avoid water possibly getting into the joint which would markedly degrade performance. Only the Yagi dipoles have been shown for clarity.

The 50 ohm 'tail' should be terminated in a suitable connector (BNC is recommended) to couple to the main transmission line. Seal this coupling with suitable all-weather tape to keep moisture out which can seriously degrade the performance of your antenna system.

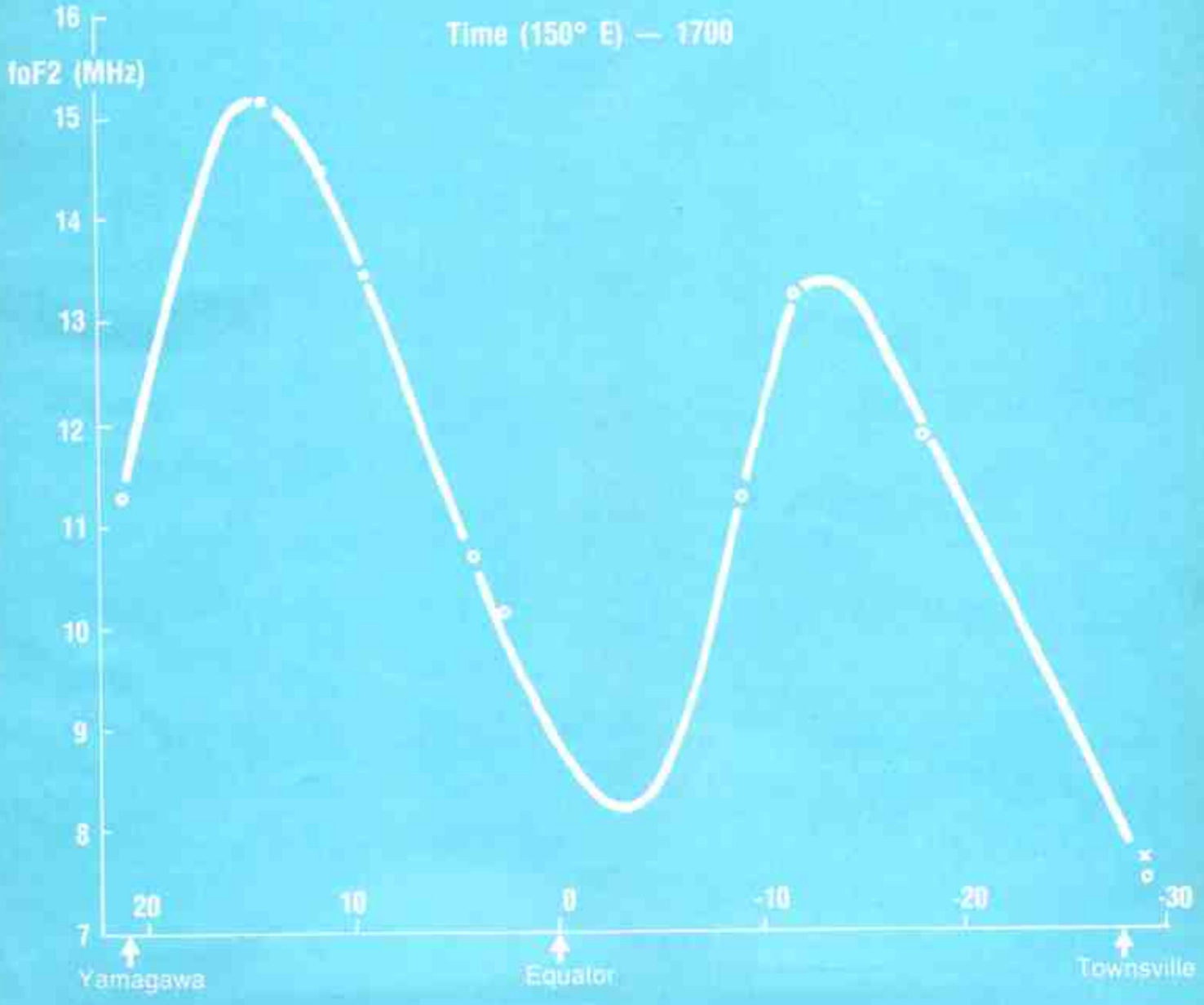
The best of DX to you!

Radio Communicators guide to the ionosphere

Part 4b

Leo McNamara and Roger Harrison

Variations of the ionosphere



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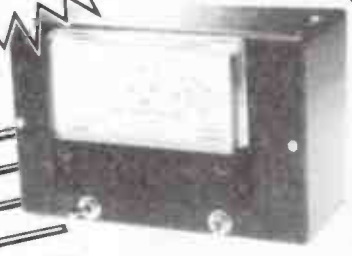

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Variations with solar activity

As with the day-to-day variations, we are not really able to describe in detail how the ionosphere varies with changes in solar activity, because there are still too many unknown things going on. However, we can be fairly successful if we just use some simple *indicators* of what the sun is doing. The sunspot number, which we met in Part 2, is one of the parameters most widely used to describe the behaviour of the sun as it affects the ionosphere. It is found that the monthly median values of the critical frequencies of the ionosphere for a particular month are linearly related to the monthly average value of the sunspot number, smoothed over 12 months. In other words, if we draw a graph of foF2, say, against sunspot number, R, the points will lie close to a straight line.

Figure 4.7 shows the 35 values of the monthly median foF2 for noon in December (winter) and June (summer) at Washington, D.C., from 1934 to 1968 versus the sunspot number for each of the 35 months. The straight lines are the ones which best fit the data points. It can be seen that the lines are very good fits, except for very high values of sunspot number. Diagrams such as Figure 4.7 can be drawn up for all stations for which data are available (about 150), for each month (12) and for each hour (24). This gives a total of about 40 000 graphs!

Each of these figures can be thought of as a *calibration curve* relating what the sun does to how the ionosphere responds. For example, if the smoothed monthly sunspot number is expected to be 50 in some December in the future, Figure 4.7 tells us that at noon in December at Washington the observed value of foF2 will be 8.6 MHz, with a little uncertainty because the data points do not all lie exactly on the straight line.

One advantage of a straight line is that it is completely defined by specifying two points which lie on it. [It is only a rumour that ionospheric physicists use just one point to define a straight line]. It is therefore common practice to represent each of the calibration curves by the two points R = 0 (sunspot minimum) and R = 100 (a fairly high sunspot number and level of solar activity). We can therefore fully describe the solar-cycle variation of the ionosphere at any location, month and hour by just two data points and the straight line joining them.

It may seem strange at first sight to find that the behaviour of the ionosphere is so closely related to the sunspot number. After all, as we saw in Part 2, sunspots are relatively cool areas of the sun, and it is hardly likely that they would do any more to the ionosphere than the hotter areas. What is *actually* important are the plage regions surrounding the sunspots in the active regions, since these are sources of increased UV radiation which causes increased ionization of the earth's atmosphere. The special value of the sunspots is that they are much easier to observe than plage regions, while at the same time being very good indicators of how much of the sun is covered by plage areas. They have also been observed on a systematic basis for over 300 years, giving us some idea of what to expect in the future.

We can in practice do better than the sunspot number when drawing the calibration curves. In many cases, straight lines do not fit the data very well, especially for very high levels of solar activity. In general, it is better to replace the sunspot number, which is a measure of what some vaguely relevant feature of the sun is doing, by an *ionospheric index*, which is a measure of what the ionosphere itself is doing. After all, it is the ionosphere in which we are interested. This is done by averaging the behaviour of the ionosphere over a group of stations, cancelling out any variations which occur at only individual stations, and leaving the variations which are common to all the stations.

We will not pursue this point further because the description of the procedures for calculating an ionospheric index is very long-winded. Suffice it to say that virtually *any* ionospheric index, no matter what goes into making it, is a better indicator than the sunspot number of what the ionosphere is doing or will be doing. However, the differences are not world-shattering and we can often get along quite nicely by using the sunspot number.

The effects of different levels of solar activity on the ionosphere can be seen from the difference between the upper and lower panels of Figures 4.4 and 4.5. As a general rule, the critical frequencies of all ionospheric layers will be greater at higher levels of solar activity. The exceptions to this rule will be described in a later part, which describes disturbed conditions. The higher critical frequencies arise because of higher UV flux levels which occur because there are more active regions on the surface of the sun at high levels of solar activity. This, after all, is the definition of high solar activity. ▶

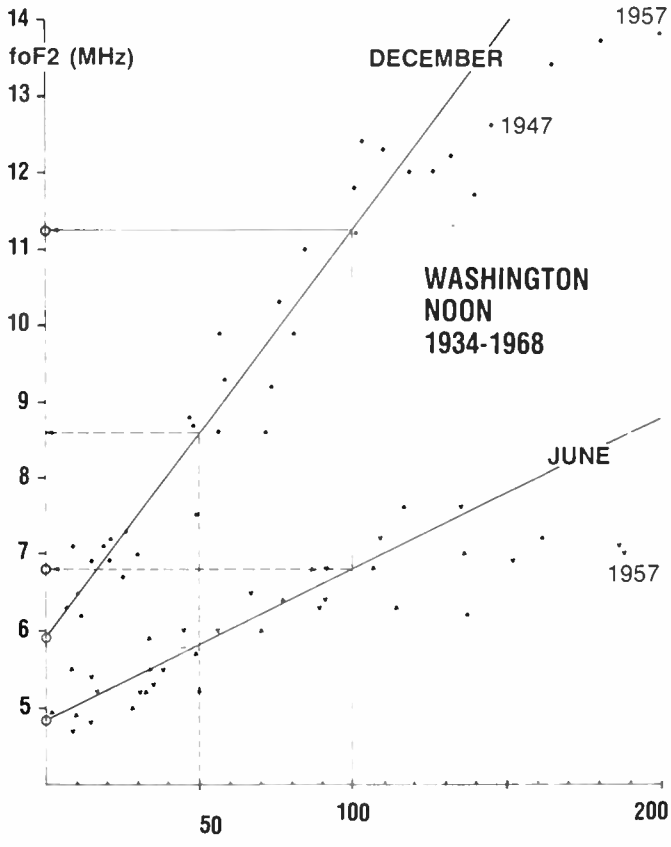


Figure 4.7. The calibration graph of monthly median values of foF2 versus the monthly sunspot number smoothed over twelve months, R_{12}, for Washington, D.C., for noon in December (winter) and June (summer). There are 35 data points, one for each December or June since the station opened in 1934, up until 1968. The straight lines are the best-fit straight lines. The values of foF2 at R = 0 (4.8 and 5.9 MHz in this case) and R = 100 (6.8 and 11.2 MHz) are used to describe the variations of foF2 with solar activity for noon in June and December respectively, at Washington.

Sporadic E

We shall encounter sporadic E many times in this series, both as a friend and as an enemy. As its name implies, sporadic E is a reflecting layer in the ionosphere which comes and goes sporadically at E-region heights. At mid-latitudes, sporadic E (Es for short) layers are a few kilometres thick (or less), up to a few hundred kilometres across, and occur at altitudes between approximately 90 and 130 km. To a radio wave, they look like rather good quality mirrors.

The most important aspects of Es as far as HF communications are concerned appear to be the maximum electron density or critical frequency, foEs, and how this varies with time of day and season. Attempts to predict these features of Es have to date been unsuccessful, but we are able to make general statements which are useful under some conditions. The occurrence properties of Es at different latitudes, described in terms of the probability of foEs exceeding 5 MHz, are summarized in Figure 4.8.

Mid-latitude Es is essentially a daytime summer phenomenon, occurring most often at these times and with the highest critical frequencies. Midday values of foEs during the summer typically reach about 10 MHz. At least some mid-latitude Es is thought to be caused by high altitude winds blowing in opposite directions and compressing the very fine debris of meteors into a narrow sheet. There are still many unanswered questions about midlatitude Es.

Low-latitude Es is essentially a daytime phenomenon, with little seasonal variation, and the critical frequencies are higher than at mid-latitudes. Near the geomagnetic equator (see Figure 4.11 later) the critical frequency foEs exceeds 5 MHz for 90% of the time during daylight hours. Equatorial Es is very patchy and transparent, and vertically incident signals are little affected by it. However, it does seem to be a useful reflector on long circuits.

High-latitude Es also has little seasonal variation, but it occurs most often at night. Critical frequencies greater than 5 MHz are observed for more than 50% of the time prior to midnight, and somewhat less often from midnight to dawn.

The different diurnal and seasonal variations at different latitudes tells us that Es is caused by different things at different latitudes. Simple deductions like these can save years of misguided effort since in this case, for example, we know not to try to explain *all* Es by the one grand theory.

The equatorial ionosphere

At first thought, we might expect the equatorial F region to be more or less the same as the mid-latitude F region, with perhaps higher critical frequencies because the sun is more directly overhead, and not much difference between winter and summer. However, there are some basic differences between the mid-latitude and low-latitude ionospheres, the main one being the *fountain effect* which redistributes electrons at low latitudes, moving electrons from over the equator down to latitudes of 10-20 degrees.

We do not really need to understand how the fountain effect works, but it is fairly easy to get a good idea of what it is all about and it explains so well the observed equatorial ionosphere.

We start off with a background ionosphere which is more or less what we would have expected to see. To this we add an eastward electric field and the north-south magnetic field of the earth, both of which are horizontal, or nearly so, in the equatorial regions. Then we start creating large numbers of electrons at the equator by photoionization due to the sun.

The combined effect of the electric and magnetic fields on the electrons is to cause them to rise (or *drift*) upwards, as illustrated in Figure 4.9. As they rise, they encounter horizontal lines of force of the earth's magnetic field. The electrons move (or *diffuse*) down these field lines and re-enter the main

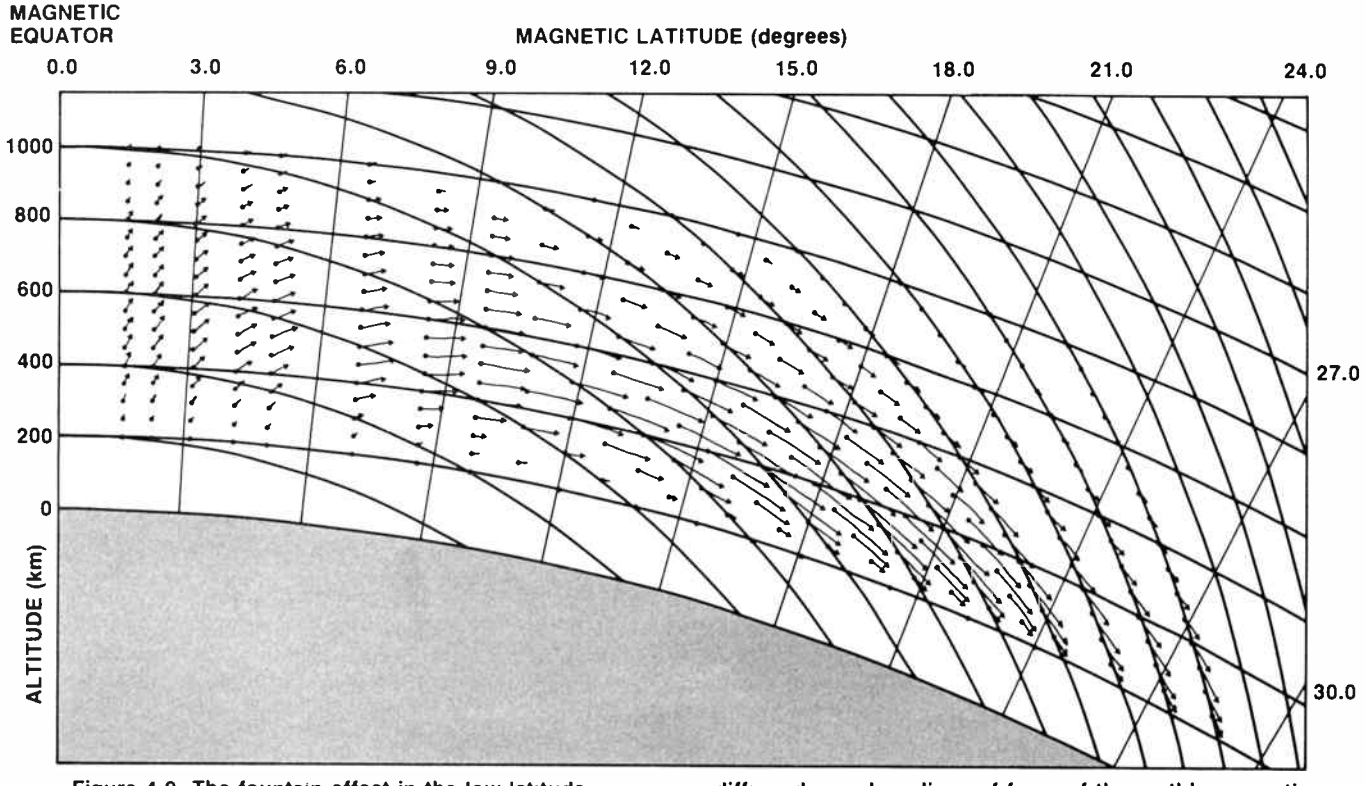


Figure 4.9. The fountain effect in the low latitude ionosphere. Electrons produced near the equator by photoionization drift upwards under the combined influence of horizontal electric and magnetic fields, then diffuse down along lines of force of the earth's magnetic field towards lower altitudes and higher latitudes. Large numbers of electrons produced near the equator thus end up in the crests of the equatorial anomaly.

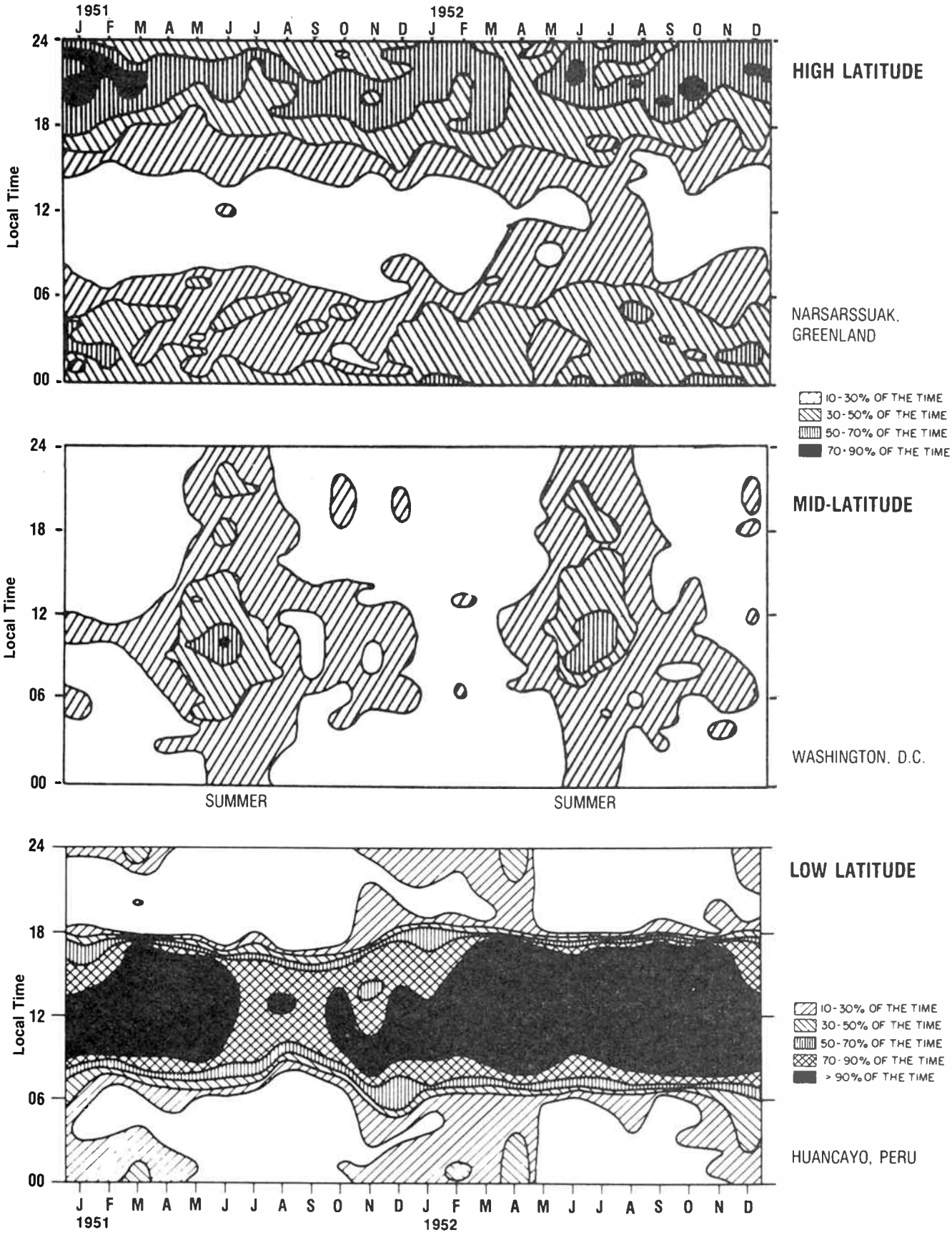


Figure 4.8. Contour plots of the time for which the critical frequencies of the sporadic E layer, foEs, exceeds 5 MHz. In the equatorial zone, foEs exceeds 5 MHz over 90% of the time during daylight hours. Mid-latitude Es, on the other hand, has its highest critical frequencies during the day in summer. At high latitudes, high values of foEs occur mainly at night and do not depend very much on season of the year. Note that Washington and Narsassuak are northern hemisphere stations, for which summer occurs in June/July. After E. K. Smith, 1957, "Worldwide occurrence of Sporadic E, NBS (USA) Circular 582.

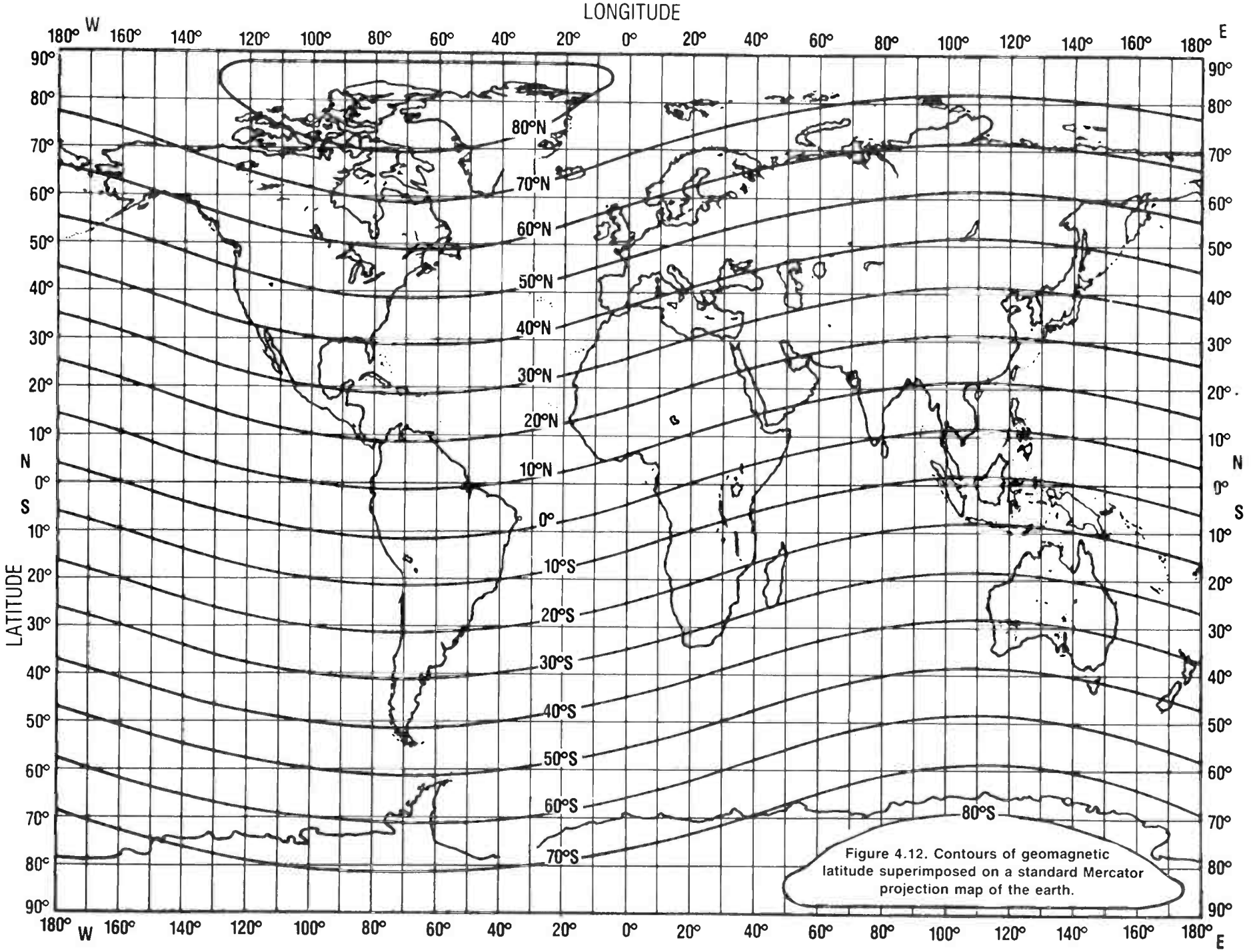


Figure 4.12. Contours of geomagnetic latitude superimposed on a standard Mercator projection map of the earth.

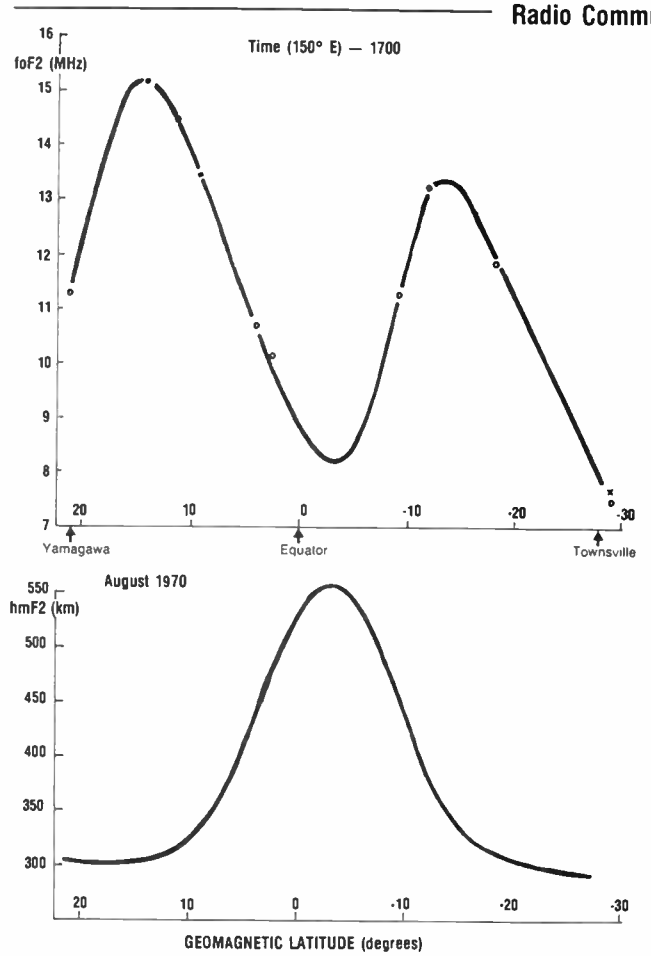


Figure 4.10. The late afternoon variation of foF2 and hmF2 (the height at which the maximum electron density occurs in the F2 layer) along a circuit from Yamagawa in southern Japan to Townsville in northern Australia, for August 1970. The regions of high critical frequency occurring on either side of the geomagnetic equator are called the crests of the equatorial anomaly. The hmF2 reaches a maximum value (of about 550 km) over the geomagnetic equator, where foF2 has its lowest value.

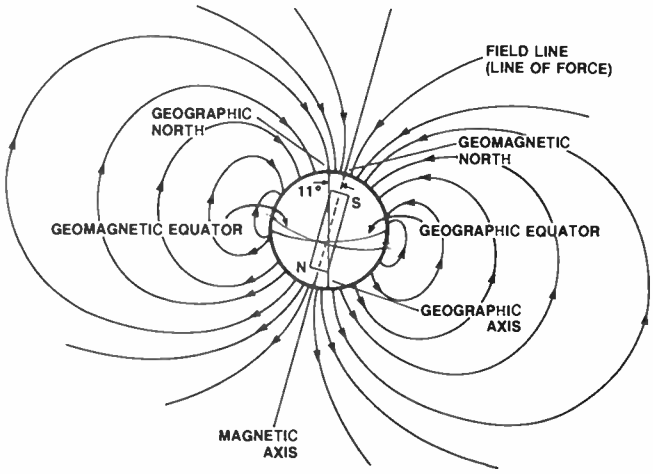


Figure 4.11. Simple model of the earth's magnetic field, in which it is assumed that the field is caused by a large bar magnet tilted 11 degrees from the geographic axis of rotation. The plane to which the bar magnet is perpendicular cuts the surface of the earth in a great circle called the geomagnetic equator. Note that the southern end of the equivalent bar magnet is actually a *north* magnetic pole, which attracts the *south* pole of a compass needle.

body of the ionosphere where the field lines cut through the F region, giving rise to large clumps of electrons at latitudes 10 to 20 degrees from the equator and on both sides of it. These clumps are called the *peaks* or *crests* of the *equatorial anomaly*. Of course, since we know what causes the crest, the equatorial anomaly is not really an anomaly any more.

The crests of the equatorial anomaly are most developed in the late afternoon and early evening, during the equinoxes, and at solar maximum. The critical frequencies associated with them often exceed 15 MHz at the equator. The height at which the maximum electron density occurs, **hmF2**, is less at the crests than it is at the equator. Figure 4.10 illustrates how foF2 and hmF2 varied with latitude during the late afternoon on an Australia-to-Japan circuit on selected days in August 1970. The significant changes with latitude of foF2 and hmF2 make it a little harder to determine the effects of the equatorial ionosphere on HF propagation at any time, and also lead to some interesting propagation modes, as we shall see in a later part of this series.

The variations of the ionosphere at low latitudes are influenced by the earth's magnetic field, to such a large extent that, instead of looking at how the ionosphere varies with the normal geographic latitude, it is more fruitful to consider how it varies with geomagnetic latitude or with the dip angle of the earth's magnetic field described shortly.

The polar ionosphere

The ionosphere over the north and south poles, alternatively called the polar or high-latitude ionosphere, is exceedingly complicated and discussion of it is best left until later. HF communications are not easy at high latitudes.

The earth's magnetic field

The earth's magnetic field, or *geomagnetic field*, is not very strong compared to magnets in everyday use, but it has important effects on both the ionosphere and HF propagation. To a good approximation, the geomagnetic field is the same as that of a large bar magnet tilted at an angle to the geographic north-south axis of rotation of the earth. This is illustrated in Figure 4.11. The southern end or *pole* of the magnet, is at approximately 79S, 110E, while the northern end is 79N, 70W. The plane at right angles to the axis of the magnet cuts the surface of the earth in a ring known as the *geomagnetic equator*, which is analogous to the more familiar geographic equator. The two equators do not coincide because the axis of the magnet is tilted (at an angle of 90-79 = 11 degrees) with respect to the geographic axis of the earth.

Geomagnetic latitude and *longitude* are measured in the same way as geographic latitude and longitude, but using the geomagnetic poles and equator. Figure 4.12 illustrates how these geomagnetic coordinates vary over the surface of the earth when it is drawn in the common Mercator geographic projection.

The strength of the geomagnetic field is conveniently measured in terms of the *electron gyro-frequency*. Charged particles such as electrons cannot move across a magnetic field line but are forced to spiral or rotate around them. The rate at which they rotate is called the gyro-frequency and depends on how heavy they are, their electric charge, and the strength of the magnetic field. The lighter the particle and the stronger the field, the faster the particles rotate around the lines of force.

For electrons in the geomagnetic field, the gyro-frequency is around 1 MHz and varies with latitude and longitude over the surface of the earth. See Figure 4.13. It is least near the equator (about 1 MHz) and greatest near the poles (about 1.6 MHz). An interesting feature of the geomagnetic field is the low values of the gyro-frequency in the South Atlantic. This is known as the South Atlantic anomaly, and leads to ▶

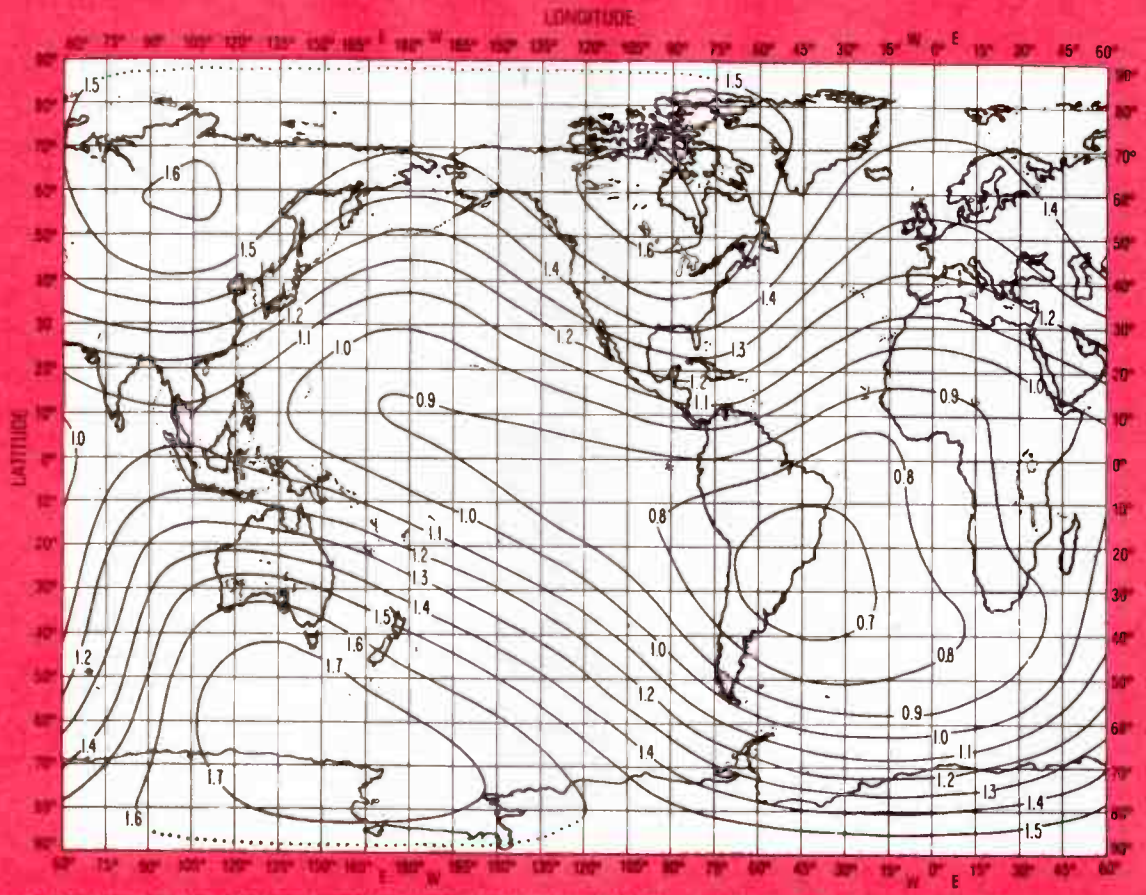
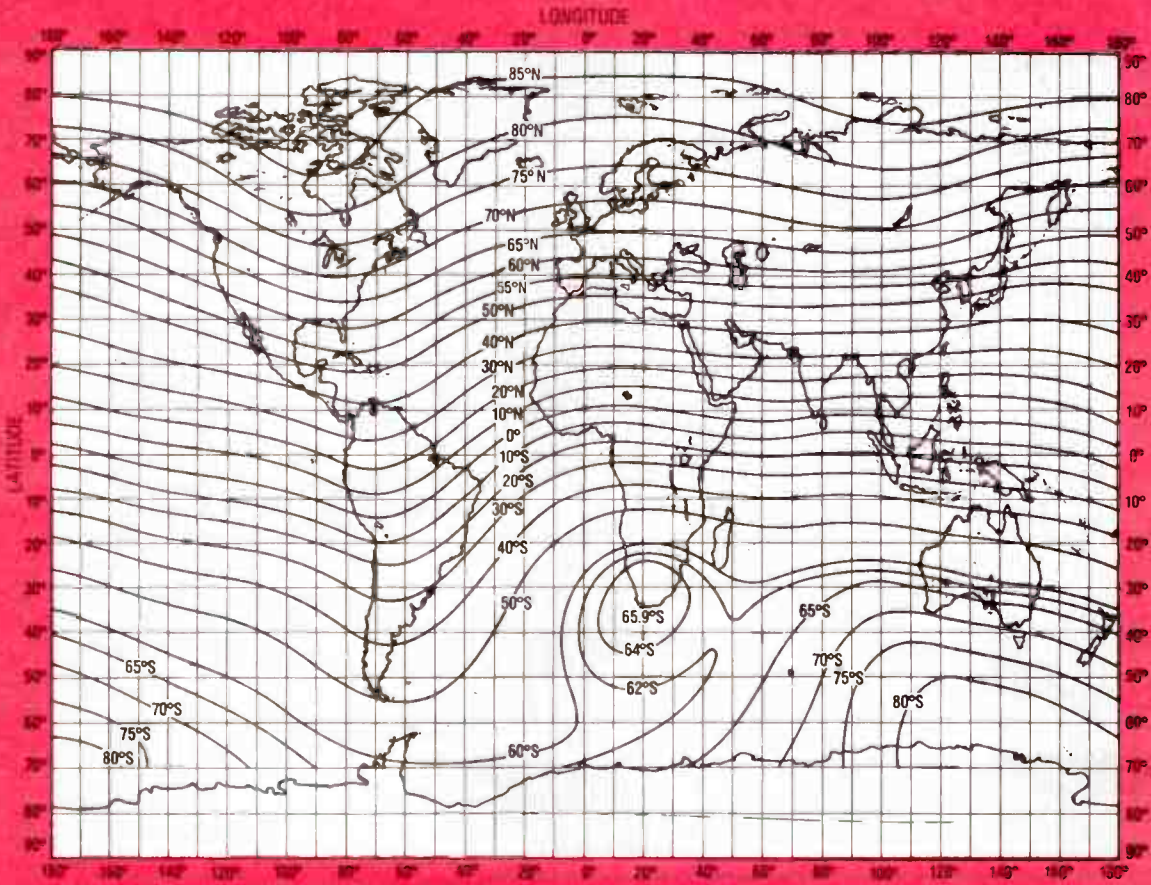


Figure 4.13. Contours of the electron gyro-frequency (at 100 km altitude) superimposed on a standard Mercator projection map of the earth.



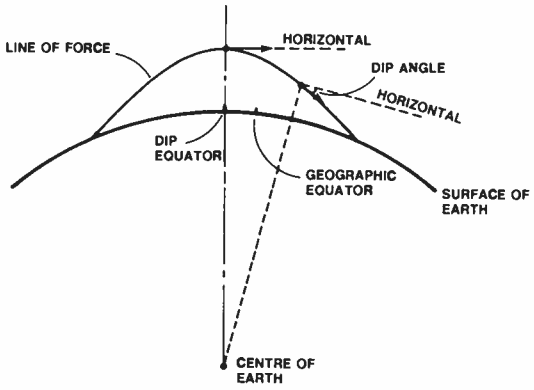


Figure 4.14. Sketch of one line of force of the earth's magnetic field, illustrating how the dip angle varies along the line of force, and thus over the surface of the earth. At the dip equator, the dip angle is zero and a suspended bar magnet would remain horizontal.

corresponding anomalies in the behaviour of the ionosphere and of HF propagation.

Another interesting feature of the geomagnetic field is the *dip angle* of the field. The field is horizontal only along a great circle around the Earth called the *dip equator*. At all other positions on the surface of the earth, a suspended bar magnet free to move in any direction will point downwards, as illustrated in Figure 4.14. The needles of magnetic compasses are usually weighted at one end so that they stay horizontal, since they are mostly used to see how the field varies in a *horizontal* direction. Figure 4.15 shows how the dip angle varies over the surface of the earth. The dip equator. which is where the dip angle is zero, does not coincide with the geomagnetic equator because the real geomagnetic field is not exactly the same as that of a simple bar magnet as assumed earlier. The dip angle reaches 90 degrees at the poles, where a compass needle would stand up vertically if allowed to do so.

The behaviour of the ionosphere at low latitudes depends to a large extent on the dip angle. For example, the crests of the equatorial anomaly discussed earlier lie at positions with dip angles of approximately 15 degrees, independently of what the geographic latitude happens to be. At mid-latitudes there are significant differences between the ionosphere at points in the northern and southern hemispheres simply because the geomagnetic field is different at the two points. Equatorial Es also illustrates the dominance of the magnetic field at low latitudes — this type of the equatorial anomoly discussed earlier lie at positions and *centred on the dip equator.*

Irregularities in the F region

As though the F region were not complicated enough, Nature has conspired to make it even more complicated at night by sometimes causing the ionization to break up into small bunches of electrons, rather than stay in a uniform, homogeneous, sea of electrons. These bunches of electrons are know as *irregularities*, because when they exist the distribution of ionization in the F region is no longer a regular phenomenon. The processes which cause the nighttime F region to break up into irregularities are also the enemy in the fight to develop a reliable system of controlled thermonuclear fusion.

◀ **Figure 4.15. Contours of the observed dip angle of the earth's magnetic field, superimposed on a normal Mercator projection of the earth's surface. The contour labels are given in the middle of the diagram. Note that the dip equator does not coincide with the geomagnetic equator. This is because the magnetic field of the earth is only roughly similar to that of the bar magnet used to define the geomagnetic equator.**

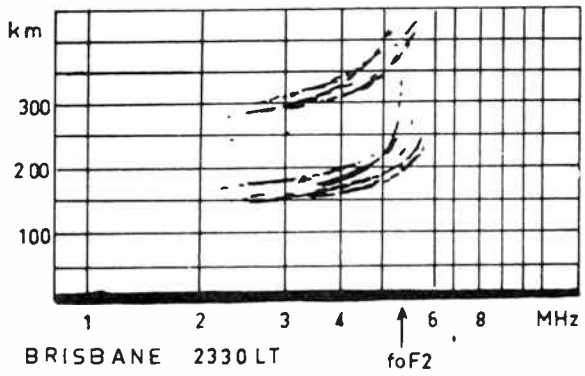


Figure 4.16. Vertical incidence ionospheric sounding (ionogram) showing "range-spreading" of the echoes far from the critical frequency (foF2).

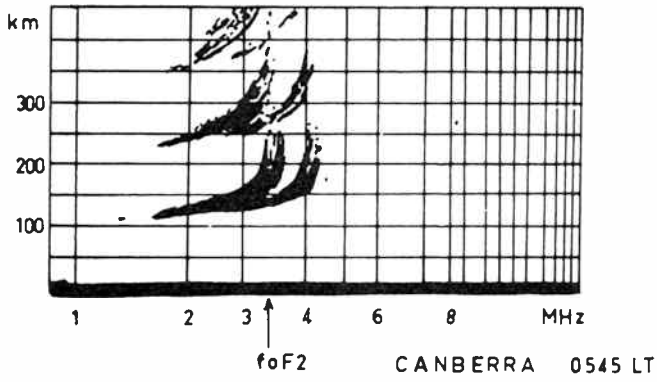


Figure 4.17. Vertical incidence ionogram showing "frequency-spreading" of the echoes close to the critical frequency (also called "spread F").

Since electrons are free to move at will up and down along lines of force of the earth's magnetic field, but not across them, the irregularities become stretched along the lines of force soon after they are created. We therefore talk about *field-aligned irregularities*, or FAI, in the F region. When the FAI are present, a single pulse reflected from the ionosphere will be 'spread' or stretched in time, echoes arriving with time delays significantly longer than those normally observed. We call such echoes from the F region *spread F echoes* and speak rather loosely of the irregularities as *Spread F*, although this term strictly applies only to the echoes.

Spread F irregularities can lead to echoes which are stretched in range (which is equivalent to stretching in time), in which case they are described as *range-spread. See Figure 4.16.* There is also the case in which the irregularities cause spreading at the critical frequency, which is no longer a simple frequency but instead covers a band of frequencies. The echoes in this case are called *frequency-spread. See Figure 4.17.*

In general, spread F at low and mid-latitudes occurs only at night, whereas at high latitudes it can also occur during the day. Range spreading and frequency spreading of echoes seem to have different causes because they have different variations with location on the earth, level of solar activity, season and time of day.

Spread F will usually have detrimental effects on HF communications, and also on ground-satellite links, but under some circumstances spread F is *necessary* for communications on particular circuits, as we shall see later.

Computer add-on allows direct input of TV pictures

Colour or black & white pictures from a standard 625-line (PAL) TV camera or VCR can be fed directly into a computer by means of an input module developed by a British company called Primagraphics Ltd.

Described as suitable for use in inspection systems, medical imaging applications and robotics control, the VV17 provides facilities for pictures enhancement and freeze-frame effects.

Incoming signals are fed via an analogue multiplexer to a 7-bit analogue/digital converter which samples at 15 MHz. The resulting data are stored in a temporary buffer and then sent in the form of 16-bit words to a software-defined memory area.

The module may be used in conjunction with the company's recently introduced video frame store to allow a sustained data-transfer rate of 15 Mbyte/s, so that a complete 625-line frame can be input in 40 milliseconds. With colour signals, the red, green and blue frames are written in sequence over a period of 120 ms.

Details from **C. Childs, Primagraphics Ltd, Melbourn Science Park, Melbourn, Royston, Hertfordshire, England SG86EJ.**

'Insatiable lust' for under-$200 Viatel modem

Avtek's Minimodem II, priced at $199, has proved a 'boomer' product for them, according to the proprietor, Phil Gleeson. "We just can't make

enough to satisfy the cravings of the market at the moment", he said.

Gleeson claims he increased production over 500% in the last quarter of 1985, but was still unable to satisfy the demand. Commodore, Apple and IBM owners make up most of the market, he says.

Avtek place great store in modem reliability, claiming the use of digital filters in the Minimodem II makes it ultra reliable, even on bad lines. This is becoming very important with the increasing use of Viatel for banking transactions. "After all, you wouldn't want to wipe out your bank balance with a crummy modem, would you" said Phil, jokingly.

Minimodem supports both 300/300 and 1200/75 baud rates, catering for database and Viatel use, at the flick of a switch.

Avtek can also supply a Viatel software package to complement the Minimodem. Indeed, you can get a Minimodem and Viatel software for the Microbee for $249.00 complete.

Avtek are currently supporting Viatel software for Microbee, Commodore, Apple and most MS-DOS machines.

For further information contact: **Avtek Electronics on (02) 427 6688.**

How about a 'nice modem'?

A Western Australian company, The Nice Computer Company of Australia, has released a modem based on the AMD7910 'world chip'. Called 'The First Nice Modem' it boasts Bell 300 baud answer/originate, Bell 1200/5, 5/1200 baud (with/without equalization), and CCITT 600/75, 75/600 baud. Conforming to the Bell 103, 202 and CCITT V.21, V.23 standards.

The 300 baud modes are used mainly for the various bulletin boards and databases around the country. The 1200/75 baud mode would be used mainly for videotex services (such as Telecom's Viatel), although there are databases and bulletin boards appearing which are taking advantage of this mode.

A useful facility which has been included is the reverse videotex (75/1200 baud) mode.

Two versions of 'The First Nice Modem' are available — an RS232 version which plugs into any computer, and one that plugs directly into the Commodore 64's user port.

You don't need to use different cables for the 300 baud, videotex and reverse videotex modes. It has it's own telephone and power supply.

The Commodore 64 version includes free terminal, file transfer (including 1200 baud file transfer), and videotex software.

The modem also has auto-answer capability (under software control), is fully Telecom approved and plugs into any standard Telecom telephone wall socket.

Two options are a hardware auto-answer and a baud rate converter for computers and terminals that do not have split baud rate capabilities.

The modem comes complete with a full 12 month warranty and is priced at $299 for the Commodore 64 version and $279 for the RS232 version.

Details from **The Nice Computer Company of Australia Pty Ltd, 36 Parliament Place, West Perth, 6005 WA. (09) 321 6636**

Visionhire goes 'computerhire'

Visionhire Business Systems recently opened its first outlet at **293 Church Street, Parramatta**, with the Mayor of Parramatta, Alderman Paul Elliott, officiating at the opening ceremonies.

The Parramatta Business Centre is the first of what will be a nationwide network of Visionhire Business Systems outletss, in keeping with the company's expansion into the business communications sector.

Visionhire Business Systems claim they will be one of the first companies to offer computers for rent, particularly on short term. Popular personal and microcomputers will be available for rent on a weekly, daily or even hourly basis — a concept which should prove attractive to small businesses, as well as university students in the area.

Promac-2 programmer expanded

The PROMAC-2 programmer, has been upgraded to program the new high density 27512s and 27513s and its buffer has been increased to 64K bytes to accommodate the larger devices.

New devices supported include: Intel 27916, 27512, 27513; Fujitsu MBM27C512; AMD AM27512, and new EEPROMs from Xicor, SEEQ, INTEL and NCR.

PROCOM, the program that interfaces the P2 to an IBM/PC or compatible, is also being upgraded to include these new devices and the 512 capability.

An added feature of the upgrade is the battery-backed retention of the interface settings and other select functions making it unnecessary to re-initialise the P2 at power-on. **Details from Current Solutions, PO Box 20, Canterbury, Vic 3126. (03) 836 9220.**

Low-cost word processing on the C64

Tasman Software, known for their Taswords word processor for Amstrad and Sinclair Spectrum computers, has released Tasword 64 for the popular Commodore 64.

The program provides the same features that made Taswords such a success: 80 words per line on-screen, what you see on the screen you get on the printout, auto word-wrap and right justification, block move and copy, insert, margin setting, paragraph reform, several scroll modes, two help pages, an in-built tutor etc, etc. It costs $55.90 on cassette, $65.90 on disk.

Tasman Software is distributed in Australia through **Dolphin Computers Pty Ltd, Unit 2/7 Waltham St, Artarmon 2064 NSW. (02) 438 4933.**

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NULL MODEM

Replaces two modems when connecting two DTE or two DCE devices together over short distances. The unit operates within EIA RS-232C specification. Install directly to equipment ports or insert in between two cables.

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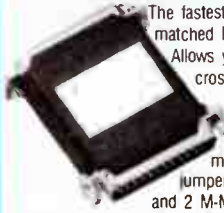

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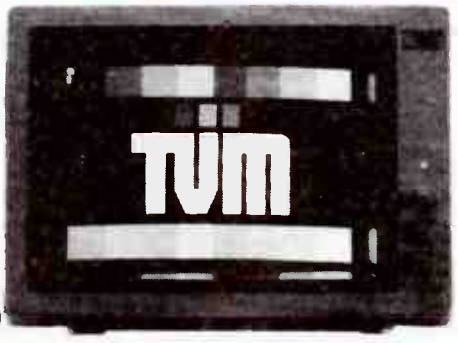

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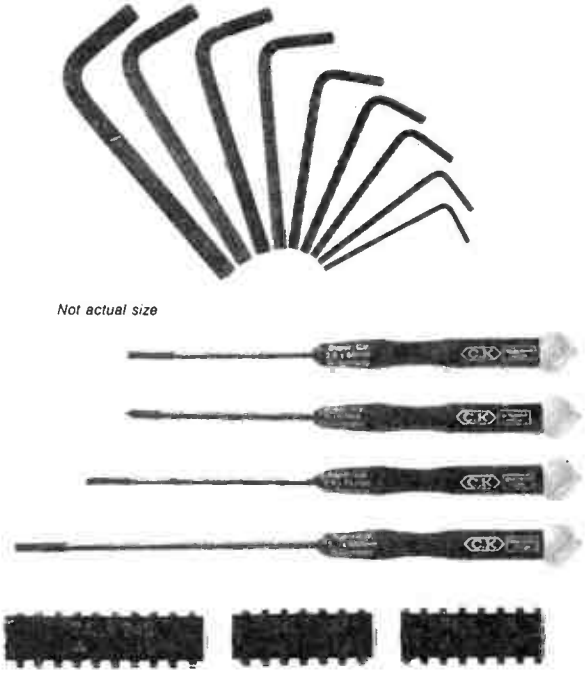

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Jamye Harrison

With this clever, well-priced software package, Microbee owners can join the world of computer graphics artists. BeeArtistic is not just for 'doodling,' but can readily be used as an everyday 'tool.'

IT HAS BEEN a while since we have seen any good, third-party software houses producing programs for the Microbee, let alone anything with even half-way decent graphics. Well, from the early part of 1985 a number of software firms have cropped up, and it looks like they're here to stay. Unfortunately, many concentrate on producing games programs. This is disappointing because many of us have now had our computers for quite a while and want to do our own things, not merely play around.

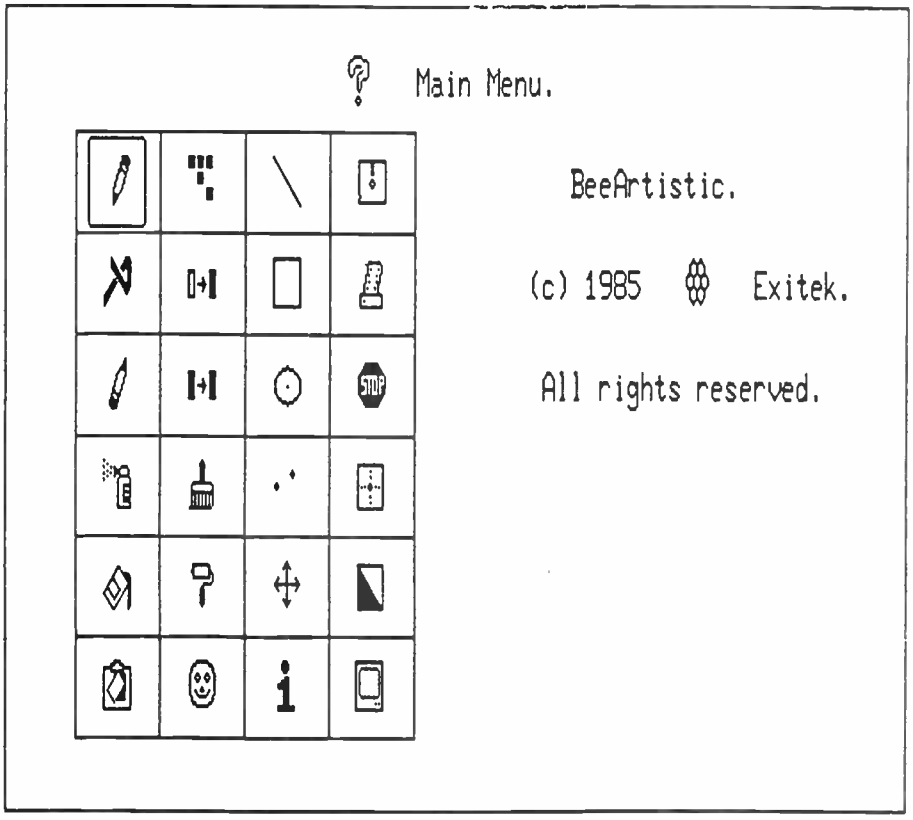
Also games, up till now, have been about the only things people wished to incorporate graphics into. Now Exitek, a Melbourne-based company, has produced a graphics utility for the Microbee computer called, cutely, "BeeArtistic" allowing the user to design, edit, save and print out high quality, high-resolution graphics at a very low price for the facilities it offers ($49.95).

BeeArtistic eliminates the need for laboriously calculating your own PCG character values or screen co-ordinates when making your own graphics. The package itself consists of a command file, BA.COM, the actual program, a number of overlay files, BEESLIDE — a 'slide show' utility allowing a sequential, timed display of your pictures, plus a few demonstration pictures. For any of those familar with the MacPaint program on the Apple MacIntosh, BeeArtistic is somewhat reminiscent of this.

To run BeeArtistic, as a minimum requirement you need a Microbee with at least 32K of memory, one or more disk drives, the CP/M operating system and a monitor. This pretty well means you need at least a Computer-in-a-book, Vol. 1. Exitek say an Epson (or compatible) printer and Microbee joystick are optional, although I'd say that, without the printer, you're only halfway there.

Tools

When first booted, the program displays a graphics screen of a Microbee and monitor, then a copyright notice followed by the "canvas," the actual drawing space. This consists of *the whole screen area* allowing some quite complex drawings to be generated.



At this point, you may now start drawing, but first you may need to select the appropriate *tool*. The tools are a series of drawing implements allowing for a number of different effects to be generated. You can select from the following:

- The **pencil.** This is the default tool. If you start drawing straight away, you're using the pencil. The pencil draws high-res *thin* (single pixel) lines and points. It is selected by the **D** key.

- The **eraser.** As you'd expect, this is on the end of the pencil. It allows you to erase of parts of a picture and is aptly selected by the **DEL** key.

- The **brush** is used for generating broad strokes and you can 'paint' using a pattern selected from a small 'menu,' or you can generate your own (explained further later). The brush is engaged using the **]** key.

- The **spray-can** paints using the brush pattern but only in a random spray instead of a solid pattern. The **:** key is used to select this tool.

- The **fill can** is used to fill large areas of canvas with a particular pattern. This tool is selected, appropriately, with the **F** key.

The tools are all controlled — moved over the screen canvas — with keyboard entry using the normal Wordstar control characters.

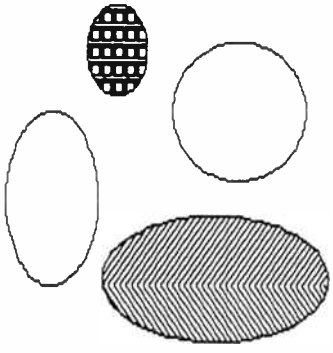
Alternatively, you can use a standard Microbee joystick to control the tools. The space bar or the joystick fire button is used to start drawing with the tool (i.e: putting it on the canvas) and to stop it drawing (taking it off the canvas).

You may control the rate at which the tool moves by pressing the 1 to 0 keys, 1 being the smallest amount (one pixel) and 0 being a fairly large space.

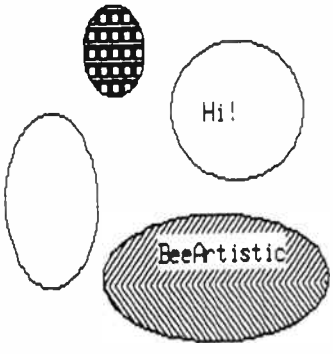
As mentioned previously, the brush, eraser, spray-and fill-cans require you to specify a pattern with which to draw. BeeArtistic comes with 32 brush patterns (also applicable to the eraser and spray-can) and 32 fill-can patterns. You may edit these and save them to disk if required. ▶

Shapes, effects, text and printout

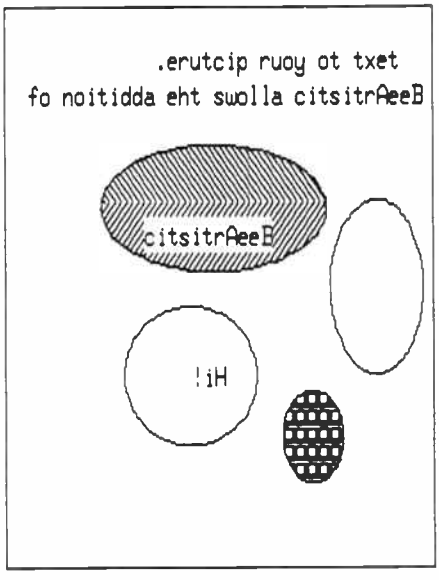
A variety of shapes can be 'called up' by BeeArtistic, including such useful ones as circles and ellipses:



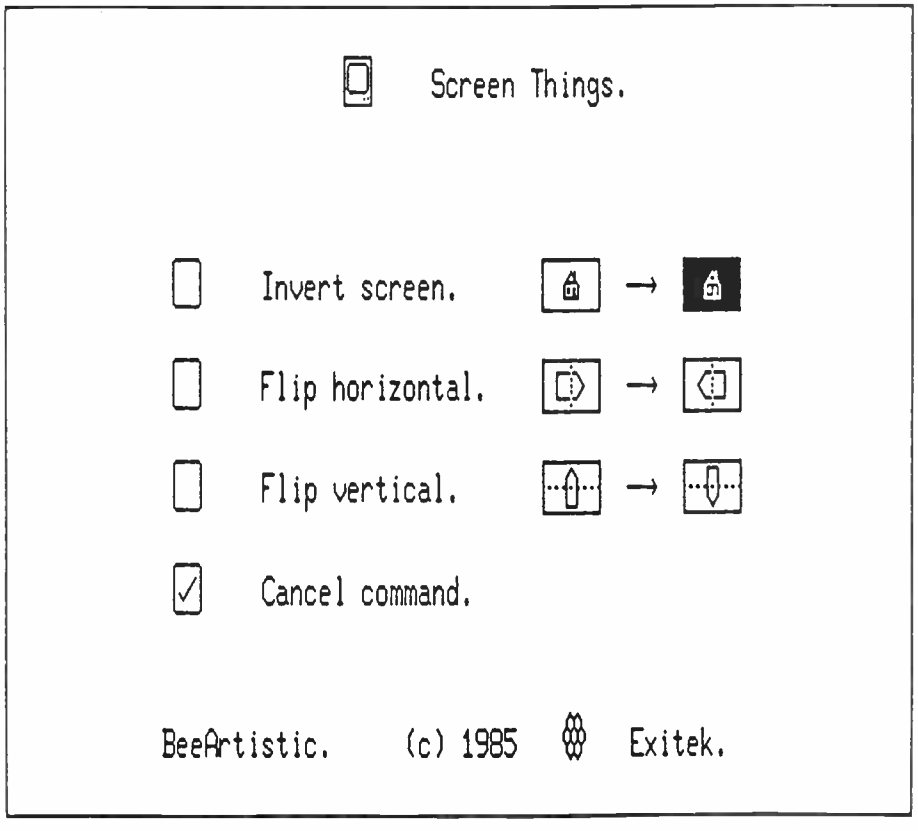
Text may also be added to pictures by simply pressing the **T** key (TEXT) and typing away. When you're finished, you just press ESC.



To provide positioning flexibility the whole picture may be moved around on the screen or only small pieces, if desired. By pressing the **H** key BeeArtistic presents the user with a selection of *special* effects such as:

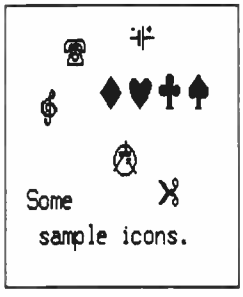


BeeArtistic lets you flip the screen horizontally or vertically or even both, like here.



Pictures, including those with text, can be printed out to an Epson (or Epson work-alike) printer in two modes, *draft* or *final copy*. Draft provides you with a small, quick idea of what your masterpiece will be like. The final mode presents a darker, larger copy.

Icons can be selected to produce small, easily repeatable *picture-lets* on your main picture, such as:



All BeeArtistic functions are able to be selected from a main menu, eliminating the need to remember each command, or keep a copy nearby. The main menu is selected by pressing the '?' key.

Finally, BeeArtistic lets you edit your work in fine detail by zooming-in in on a small area and blowing it up to almost full screen size.

One more interesting feature is that BeeArtistic saves your pictures as COMMAND files, i.e: you can boot them from CP/M just by specifying the extension as ".COM".

Applications

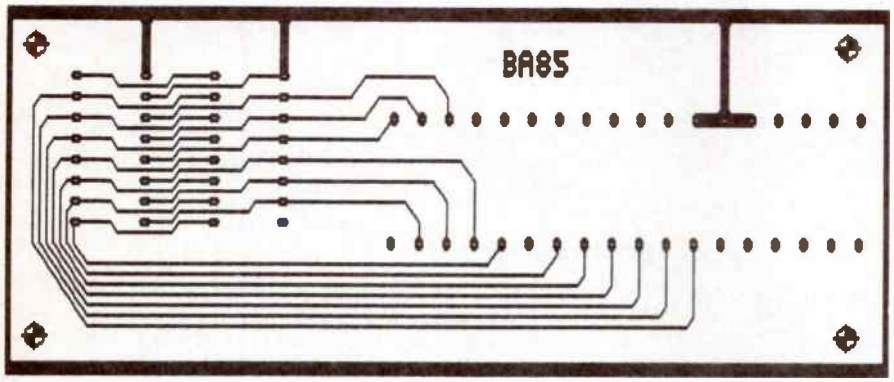
BeeArtistic has some very effective and useful applications. After a quick look at the Icon Menu, one was immediately obvious; that of printed circuit board layout.

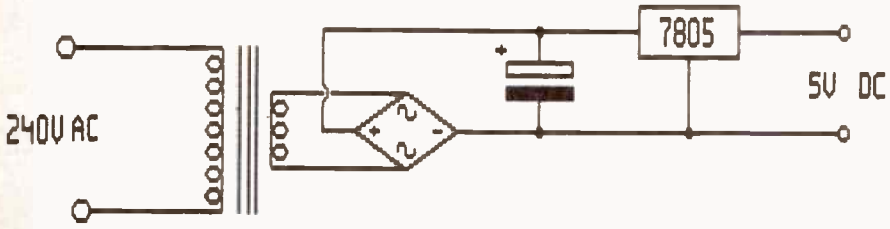
You can layout the major components, draw in the tracks, and edit or modify as you go along. This is where the two print modes (draft and final) come in handy. Your first hardcopy can be a draft to see the design on paper, for checking etc. Your final copy can be done when everything is correct. Surprisingly, despite the output being a dot matrix print, perfectly usable Scotchcal board negatives are readily made and workable pc boards result.

The only problem here is a mechanical one — matching the printout to required mechanical dimensions, particularly with IC pinouts. It's not an insurmountable problem, as you can terminate tracks in the approximate position and use the Bishop Graphics or Chartpack stick-downs. You can line it all up on a draft, then edit as necessary for a final copy. Sure beats tape and pads, and is *streets* ahead of those dinky resist pens, when you want a quick board layout for your latest brain flash project.

The Icon Menu, note, also includes common electronic circuit symbols so you can draught circuits with relative ease with quite acceptable results.

Naturally, mechanical- or architectural-type draughting can be accomplished, too. Mind you, BeeArtistic should not be compared to the performance and features of 'professional' CAD (computer-aided draughting/design) packages, but they *start* at around 20 times





BeeArtistic's price and go through the roof at *300 times* its price. One should always keep in mind "horses for courses."

For computer clubs, amateur radio clubs and other hobby organizations, BeeArtistic is a cheap, convenient alternative to producing diagrams and pictures for your club newsletters and circulars. What's more, unless you h ave a 'tame' draughtsman on-tap, the result is streets ahead in legibility, judging from many of the newsletters I've seen.

WordStar or WordBee may be used for the written content. After both graphics and text are printed, you just cut and paste in the time-honoured way. (It is a pity that neither WordStar or WordBee are able to 'take-in' BeeArtistic files with the text. One software package I've seen advertised in Microbee's *Online* magazine, BEETEX, claims this can be done on their wordprocessor.) Here's a crude example of a newsletter banner you might make with BeeArtistic.

BeeArtistic is also suited to students who wish to produce diagrams for assignments and projects (subject to teacher approval. There's nothing you can do about Luddite-brained educationists who disapprove because they believe "... the computer does it all for you"!) Teachers can design maps and diagrams for lessons and use BeeSlide to display them.

For those into creating their own games and programs requiring graphics, you can create designs on BeeArtistic and either disassemble the file or include the code in REM or DATA statements in BASIC programs.

It occurs to me that it would be possible to produce posters and advertisements using BeeArtistic — or at least "design roughs", enabling quick, easy and cheap production.

Then there's the field of cartooning! And with the Beeslide facility . . . the mind toggles (computer hackers' pun on 'the mind boggles').

Documentation

A comprehensive 84-page manual comes standard with your package. This doubles as a reference and a tutorial manual and is set out in a clear manner with examples throughout.

Summary

All in all, the BeeArtistic package enables a much broader range of applications with the

— to page 98▶

How to save a marriage by converting data from 6809E to Z80

Bruce Bathols VK3UV

Here's how a reader found a practical method of transferring files between vastly-differing computers, from a Tandy Co-Co to a Microbee 128K.

THE HEADING for this article is probably a bit of a misnomer, as in reality this is the story of five years of being a user of personal computers, but does describe how we converted our complete data base text file from a Tandy Color Computer, onto a Microbee 128K disk system and DBase II.

I certainly don't consider myself as a "computer freak" or "hacker", I just enjoy "messing about" with electronics. There is an apt description for people such as me, it is "cranky".

Some history

Five or so years ago, I became interested in computers as a hobby adjunct to amateur radio, in which I have been licensed for 14 years, and to investigate and experiment in radioteletype (RTTY).

At the time, the only real desktop computer a person of my meagre means could support was a used (Tandy) Radio Shack TRS80 Model 1, level 2, 16K tape-based system, using an old black and white TV as the monitor.

After studying the manual and tinkering around, I expanded the 16K to 48K with the help of some pretty nifty hardware modifications from ASP Microcomputers in Caulfield, Victoria (are they still around?).

Some terrible BASIC programs were written by me. (I could never really hack machine code then), but with persistance I managed to drum out a reasonable Morse code and RTTY program for the amateur radio side of my hobby interests.

The Model 1 gave excellent performance, but I soon learnt to realise that a tape system was awfully slow and limited. Besides, I had acquired sufficient knowledge to want to expand the computer hobby interests further.

I had to go to a disk-based system.

Selling the Model 1, I purchased Tandy's then latest seller, the 16K TRS80C Colour Computer (Co-Co), which had been given some rave reviews by overseas and local magazines. I also bought secondhand a single disk drive and controller.

Being a complete ignoramous, and not yet fully appreciating CP/M or other operating systems for business purposes, I began to develop the Co-Co for my hobby purposes.

The first thing changed was that awful toy-like keyboard (the later versions have a more semi-professional keyboard), and this was replaced by the HJL full travel, you-beaut, everything matching, professional keyboard from Paris Radio, in Sydney.

Next, I upgraded the 16K to 64K from a kit supplied by a local Co-Co users group (in Geelong).

Software acquired (actually we imported it from the USA from distributors listed in the Australian Co-Co magazine) was the VIP library, which included VIP Writer, VIP Calc, and VIP Database, also Spectaculator, some excellent utilities, plus a host of rather crummy BASIC programs of games (the latter for the kids, of course!).

Branching out

The system suited my purpose admirably, until we decided to branch out into a small secretarial business.

My wife, Gwen, is an 80 wpm touch-typist (me about 30 wpm, two fingers), with two years previous Wordstar experience at a local hospital. Together with her typing capabilities, and my technical(?) background, we launched our secretarial business. We borrowed money from the bank, bought a new Lingo PX 120 dot matrix printer with RS232 interface (I think it still is the best value around, and is currently marketed under various brand names), plus an Adler electronic daisywheel typewriter, also with an RS232 interface, and awaited our first customers (that is another story by itself).

It was not long before we discovered a serious drawback.

The main criteria for a successful typing business, is operator compatibility with the wordprocessing software.

After spending considerable time with Wordstar on a CP/M system at her previous employment, Gwen was rather astonished to discover the Co-Co and VIP Writer wordprocessing resembled nothing to what she had been used to (first mistake!).

No full-screen editing, no page breaks on-screen, and a fairly cumbersome editing and formatting process, meant she had to learn a complete new system (second mistake!).

The VIP Writer manual, in Gwen's opinion, was too technical — heck!, it only took ME three weeks to fully get used to it, and for nearly 18 months I had received much delight with VIP Writer, and also VIP Calc and VIP Database.

Well, dear reader, have you ever tried to convince your partner to walk three miles to the shops to buy the weekly supplies, when they had previously been able to drive the car in comfort?

This is virtually the analogy I was expecting (third and final mistake!), and one does not have to require much forsight to anticipate the end result. That's right, complete disaster!

Our first customers came along; then we obtained our first mailmerge mailing list/database job. Luckily it was only 100 names and addresses. Yes, VIP Database and VIP Writer complement each other for mail merging, and we managed to struggle through the job.

The cup runneth over

After three months operating, our database/mailing list had grown to over 2000 names and addresses, and I was beginning to realise our requirements for the VIP system was getting beyond its capabilities.

We had nine separate database disks, crammed full with names and addresses, and as each disk only held about 180K of disk storage, we certainly needed a disk system with greater storage capacity.

By this time, I had purchased a new disk drive, a double-sided Chinon, (from Daneve in Sandringham, Vic.) and with some tricky tinkering from some friends (thanks to Ron Cook VK3AFW, and Bill Roper VK3ARZ), we were able to make it work as two single-sided disk drives on the Co-Co. The Co-

Co can access up to four single-sided drives. So we had a complete and expensive range of hardware, the colour computer, disk controller, Tandy single drive (drive 0), the Chinon double-sided drive (drives 1 and 3), two printers, plus a photocopier and telephone answering machine to boot.

We had everything going for us, but the operator was still thinking in Wordstar instead of VIP writer.

A steady flow of work was coming in, and with several student's theses, which in some cases ran to over 100 pages of A4 typing, we were starting to slow down our output. This was due solely to operator incompatibility with the VIP software.

There was only one decision we had to make, and that was to purchase Wordstar itself, but regretably, Wordstar is not written for the TRS80 Colour Computer. We contemplated a software purchase to allow the Co-Co perform as a CP/M system, but this too was only available in the USA.

We had no knowledge of any locals using it, so we didn't really want to be the pioneers of such an adventure, as it was relatively expensive, around US$400 for a system not yet proven in Australia.

This meant we had to look around for a complete new computer system, within our limited budget and which included the Wordstar/Mailmerge package.

Here we go again!

Initial enquiries were *frightening*. The IBM Apricot was $5200 with software included at a small discount. This was entirely out of the question for our small but developing business. Wordstar itself was quoted at $750 (cripes, I only paid $150 for VIP Writer and thought that was a real touch!)

Over a period of several weeks in January 1984, I called on every computer distributor in Melbourne.

Yes, Tandy had a suitable business system, but their prices were on a par with IBM and Apple's Lisa. Medfly had a sophisticated and suitable system for around $3000, but software was an extra $1200.

Several of my amateur friends were experimenting with 32K Microbees, and after listening to them extolling the virtues of the Microbee "cheapie", I noticed an advertisement for the new CP/M Microbee 128K dual-disk system.

This has a full software package which *included* Wordstar/Mailmerge, and many other programs and utilities for around $2000. I could not believe my eyes! Surely there was something amiss, and after having been thoroughly disillusioned with the other big computer manufacturers' prices, here was a *locally* made computer with all the purported bells and whistles of the big names, for less than half the price.

We had to check it out, was this just another "cheapie" computer?

Far from it, as from the moment we had our first demonstration, I knew it was the computer which we had been looking for and which best suited our pocket and purpose.

Sure the keyboard is not the IBM type, but it has standard QWERTY full-travel keys, and the usual array of control keys. Now in reflection, by comparison, the extra keys on the larger keyboards would not have served our purpose any better than the Microbee.

Wordstar was the software my wife was used to, even after six months or more of battling with VIP Writer (I said earlier I was ignorant, but I had to be sure!), and within minutes of our Microbee demonstration, she had a complete screen of typing, properly and automatically formatted, and printed on the shop's printer.

The sales manager was most impressed, and offered her a job there and then as a Wordstar demonstrator (she was quite tempted at the offer actually!).

We purchased the Microbee with dual 386K (formatted) disk drives, and a high quality amber monitor, and put it to work immediately on the word processing side of the business.

We noticed an immediate improvement in our output of work with Wordstar, Gwen was able to work at her full capacity, and our relations began to soothe. All because she was now "at-home" with a software package she was able to understand.

Now came the difficult part, what to do with the now huge data base we had built up on the Co-Co. Should we persevere with VIP Database, or start again with a new database system on the Microbee?

We decided the best thing would be to go the whole way, and use the Microbee and CP/M exclusively, so that all of our work would be compatible with the one system and particularly Wordstar/Mailmerge.

After reading Les Bell's excellent article series on DBase II in *Your Computer* magazine, we decided DBase II seemed to offer all the facilities we required. So we purchased DBase II, and then contemplated the mammoth task of transferring the data file from one system to the other.

The next problem

Of course the Co-Co's 6809E and Microbee's Z80 processors and operating systems were not compatible, and neither are the disk drives. So, I decided to try, at first, to utilise the TELCOM package on the Microbee to retrieve data from the Co-Co. In broad terms it worked and this is how it was achieved.

For those unfamiliar with TELCOM, it is a terminal-type program used mainly with a modem, or for communicating directly with other computers.

The Microbee receives data via its RS232 port, and via TELCOM it then dumps the data, in a maximum lump of only 30K, to the storage buffer. Therefore, we had to break up the incoming data into something less than 30K so that the buffer could be dumped onto disk, and then cleared to accept the next lot of 30K.

SOME COMMENTS ABOUT THE INDUSTRY ITSELF

In these past five years or so, I have discovered that there are still a lot of "get rich quick merchants" in the personal computer industry, in particular the business software. I won't go into specific detail, suffice to say that there is a dearth of **Australian**-oriented CP/M full-bodied accounting software available, at what I might consider a "reasonable" cost (under $500).

Computer technology is going ahead in large leaps and bounds, 16- and 32-bit systems, MSDOS and PCDOS seem to be becoming the industry standards; every man and his dog are producing IBM and APPLE look-alikes at give-away prices, but with all this new technology, I still believe there are "horses for courses". I do not accept the argument from many writers and reviewers that 8-bit and CP/M systems are on the way out, or have gone out. My personal experiences have proven that. No doubt many will howl me down as being non-progressive and resistant to change.

Quite the contrary actually, I recognize that 16/32-bit high capacity RAM (256K+) is a necessity for medium-sized businesses, engineering and scientific work, and large businesses go for minis and main frames.

However, there are may thousands of hobbyists, hackers and one man businesses like ours who really *don't* need, nor can afford, expensive hardware and software.

One of the main criteria for the small businessman and his computer system must surely be backup and service. An old friend often says to me, "If you pay peanuts, you get monkeys!!"

I have discovered many monkeys out there in the computer industry, and plenty of gorillas on the sales side. I am astounded at the lack of technical knowledge from most computer sales personnel who really know little of the product they are selling. If you know nothing about computers and are looking to purchase a small business systems, go to an established trader who deals in *recognised* brands and don't be tempted by slick advertising and cheap prices.

Shop around, it is the only way to learn.

The solution

Each file on the Co-Co VIP Database contained 17 fields, and our file lengths were 497 bytes, but as the VIP Database system allocates 512 bytes minimum per file, we designed each file to maximise the space available instead of wasting it.

I wrote a small BASIC program for the Co-Co, based on the examples shown in the Co-Co disk manual. This took text from the Co-Co's disks in 512 bytes and put it into the "FILES" buffer in exact proportions of each field in the 512 byte file. The disk manual is not very specific with this, so here is a description of the program.

The program is fairly simple and straightforward, and no doubt a "real" programmer could drive a truck through the holes in it, but at least it works extremely well in its raw state.

Lines 1-6 print a screen message as to which disk file number is to be printed, and is an indicator to the operator as to the next group of 50 files to be sent to the buffer.

Lines 9 and 10 set up the buffer storage area, and calls the data file from the disk.

Line 12 allocates the buffer into the data base fields and specific characters.

Lines 14 and 15 are the operator file number input as determined by what is displayed on the screen as a result of lines 1-6.

Lines 30-50 directs buffer output to either the screen (line 45), or the printer (line 50). Edit these lines as appropriate by placing a REM indicator at the start of the line you don't want.

As the No. 2 computer (the Microbee in my case) substitutes for the printer, the output data will go straight into the No. 2 computer's input buffer, as discussed elsewhere in this article.

Lines 64-75 determine how many files are to be sent to the buffer.

Lines 78-100, as the number of files as specified are reached, the program prints the next file NUMBER to be copied at the top of the screen, clears the buffer, and re-runs the program which awaits operator input.

During this pause, the operator can check the accuracy of the data received on No. 2 computer. If any transfer errors are detected, that buffer can be cleared, and the same data sent again from No. 1 computer.

Once a satisfactory transfer of a group of files has been obtained on No. 2, they are then saved under a separate filename on No. 2's disks. The buffer is cleared, then the process starts over again for the next batch of 50 files from No. 1 computer.

When the last file on the disk is encountered on No. 1, an "IE" error occurs. I should have cleaned up the program so that the computer would reset properly, but no harm is done. I didn't worry about closing the "D" buffer, and just ran the program again for each new disk (in our case there were nine data disks).

The entire process was quite time consuming in designing the program to work efficiently, but it was very reward-

FIGURE 1

```
1 PRINT"       INPUT THE NUMBER OF THE        FIRST FILE TO BE
COPIED,         AS DISPLAYED IN THE TOP          left hand corner"
2 INPUT Z$
3 Z=VAL(Z$)
4 Y=Z+49
5 ' Z=OPENING FILE, Y=CLOSING
6 CLS:PRINT" FIRST FILE NOW BEING COPIED IS "Z:PRINT "AND THE
                                                          ALSO,
LAST FILE WILL BE "Y:PRINT"
NOW ENTER THE NUMBER DISPLAYED IN THE TOP right hand corner"
9 FILES 1,512
10 OPEN "D",#1,"FILENAME.DAT",512
12 FIELD #1,6 AS A$,40 AS B$,51 AS C$,51 AS D$,48 AS E$,20 AS
F$,19 AS G$,8 AS H$,27 AS I$,17 AS J$,12 AS K$,17 AS L$,28 AS
M$,54 AS N$,54 AS O$,24 AS P$,21 AS Q$
14 INPUT R$
15 R=VAL(R$)
30 GET#1,R
45 'PRINT A$ R,A$;B$;C$;D$;E$;F$;G$;H$;I$;J$;K$;L$;M$;N$;O$;P$;
Q$
50 PRINT #-2,A$;B$;C$;D$;E$;F$;G$;H$;I$;J$;K$;L$;M$;N$;O$;P$;Q$
64 IF R=50 THEN 90
65 IF R=100 THEN 90
66 IF R=150 THEN 90
67 IF R=200 THEN 90
68 IF R=250 THEN 90
69 IF R=300 THEN 90
70 IF R=350 THEN 90
71 IF R=400 THEN 90
72 IF R=450 THEN 90
73 IF R=500 THEN 90
74 IF R=550 THEN 90
75 IF R=600 THEN 90
78 R=R+1
90 CLS:PRINT R+1:CLOSE#1
100 RUN
```

ing and one learns a lot from this type of experimentation.

I wrote the program so that only 50 files at a time would be transferred to the Co-Co's RAM, and then pause for the next instruction. Instead of driving the printer, I constructed a patch cable from the Co-Co to the Microbee, with the ASCII data output from the Co-Co going to the REC DATA terminal on the Microbee's RS232 port, pin 3, with system ground on pin 7 (saved myself about $50 for about half an hour's work for the connecting cable alone).

This used 25.6K of memory in the Microbee's TELCOM buffer, well within the 30K buffer limit. I could have sent 58 files to the buffer, but it was easier to keep track of with multiples of 50.

The data transfer worked, although cumbersome and time consuming, the entire 3000 data base files from the Co-Co VIP Database were transferred onto the Microbee in ASCII format, and then dumped to the Microbee's disks in individual 50-file segments.

I found that 2400 baud and slower was the best transfer rate, as 4800 and 9600 baud missed one or two bytes and messed up the data collection. At 2400 baud, we were 100 per cent successful.

DBasing it

The next problem was to get the data received by TELCOM and saved on the disks, onto DBase II. This was quite intricate. I configured the DBase II fields into exactly the same number of fields and characters as we had on the original VIP Database and appended to the new DBase II filename using the Microbee's "logical" drive (drive "L") in system data format (SDF). It took a couple of hours to complete the job, but we were again 100 per cent successful.

We discovered how really versatile DBase II and the 128K Microbee are, as we were also able to convert the new DBase II files into a smaller file length of 252 characters instead of a minimum of 512 on the Co-Co-s VIP Database. We were also able to copy the DBase II file into Mailmerge format which can be directly read by Wordstar in the non-document mode for personalising circular letters etc.

So there you have it!, a complete new system incompatible with the previous, but now containing all of the fruits of our labours with VIP Database, without having to re-type the entire list.

Observations

I have now taken a critical look at both systems, and for my specific purposes have decided CP/M is the only way to go, especially the disk-based Microbee, and for any small business with the range of packaged software available, it is hard to beat and at much reduced cost to the bigger names.

After several months of operation with the Microbee, we have found it operates perfectly for at least eight hours per day, and up to seven days a week. We are now looking around for a 10-20M hard disk drive to complement the system.

Wouldn't you know it, Microbee has just released a 10 Megabyte hard disk drive for about $1200 installed! I don't know how they do it, but it has certainly paid me to buy "Australian Made".

Well done Microbee!, but by the way, if Tandy's prices were a litle more "realistic" by comparison, we would have stayed with the brand which had already given us faithful service previously, and probably never discovered the real benefits of computing with the Microbee. The TRS80 Co-Co has now been sold.

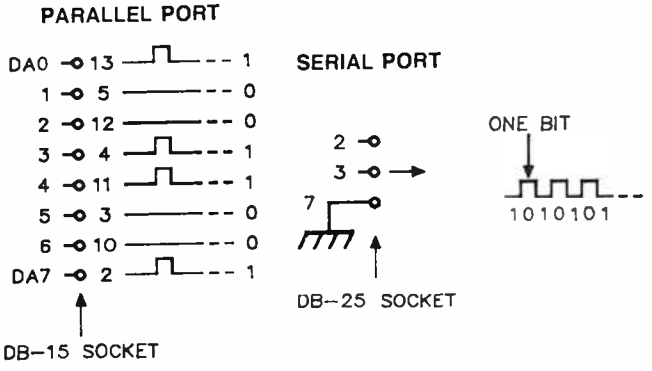
Our secretarial work has grown steadily over the last few months, so much so that we purchased a second Microbee and printer as a back-up unit to the first. Also I needed a computer for the amateur radio side of things, didn't I?

Ports: getting it in and putting it out

A COMPUTER ISN'T GOOD FOR MUCH if you can't put it to a practical use to do some work for you. You can make nice things happen on the screen of course, as seen in games, but you couldn't really call that work! For practical purposes, you've got to be able to get information in and out of the computer, and send it to devices such as printers, plotters, or other computers at the end of a telephone line. The part of the computer where information flows out and in, is called a PORT.

Ports are usually of two different types: *serial* and *parallel*. The serial port sends and receives 8-bit data bytes by handling each bit in turn, one at a time. This is done at some pre-arranged rate of bits-per-second, or *baud rate*. Serial printers usually run at 1200 bauds, or bits per second. A remote computer that you access through the telephone network usually transfers data at 300 bauds, although the popular Viatel system uses two rates . . . 1200 bauds for receiving information from the system, and 75 bauds for sending information into the system.

Parallel ports send and receive all eight bits at a time through eight wires running side by side, or "*parallel*". There are usually a couple of control lines as well . . . one tells the receiving device that a *data byte* is being sent, and the other is for the receiving device to *acknowledge receipt* of the data.



The Microbee has one serial port and one parallel port, although physically they are two halves of one parallel port integrated circuit. The 'Bee uses software techniques to send serial bits out of one of the eight data lines, and it uses others in the same half of the chip for serial port control lines. The cassette interface, and even the speaker, are connected to this same half of the chip. The other half of the same chip is brought out to a 15-pin connector on the back. You can hook a parallel printer to it, or use it for anything you desire. Other computers, such as Apples, don't usually have built-in ports. You can get the type of port you need, serial or parallel, on a card which you plug into a slot within the computer.

The Microbee's parallel port is a most useful device, and just about every project I've designed for the 'Bee has used the parallel port in some way. The easiest way to make use of the parallel port is through BASIC, using the inbuilt instructions "IN" and "OUT". Here's how you can try it for yourself:

If you've got a joystick, plug it in (yes, yet another use for the parallel port). Now, from Microworld BASIC, type "PRINT IN(0)" and then hit RETURN. The computer should respond with "255". BASIC treats the state of a port as a variable, and we have specified the one at address 0, which is the parallel port.

Now, type "PRINT IN(0)" again, but before you hit RETURN, press the FIRE button on the joystick. This time the computer should respond with "127". If you press the joystick forward and try again, the computer should print "254". Moving the joystick in other directions should produce different numbers.

When the joystick is connected, all the data lines are pulled to *logical high* (+5 volts) by some resistors within the joystick, or maybe within its plug. When you move the joystick or press the fire button, the switches short the selected line to ground. The fire button is tied to the "DATA BIT 7" (DB7) line, the highest-numbered one. So when it's pulled low, the resulting number from the port changes from 255 to 127. In the case of the "forward" switch, it is tied to DATA BIT 0 (DB0), the lowest one. So when you press the joystick forward, the number changes from 255 to 254.

The other BASIC command, "OUT", lets you send a specified number out to a port at a particular address. The syntax is something like "OUT 0,255" to send the number 255 to port 0. This would set all its eight data lines high. If there were little lights hooked up to the lines, all eight would light up. To do this practically, though, you would need to use a driver chip or some transistors. The port doesn't have the "guts" to drive lights directly, or anything else for that matter. It just supplies information and external electronics must do all the dirty work.

'Shifting gears' in the PIO

There is obviously some software in BASIC that "shifts the gears" within the port chip, changing it from an input or an output as required. But if we want to use the port chip without the help of BASIC, we must "shift its gears" ourselves. This will usually be done from a machine code program. We won't delve too deeply into it, but here's a brief outline of how you use the chip for your own purposes.

In a Microbee, with a Z-80 microprocessor, the chip is called a "Z-80 PIO" for "parallel input/output" controller. It's a big 40-pin chip that looks exactly like the microprocessor itself. Considering all the functions it performs, it's a fairly inexpensive chip, which is fortunate. If you're like me, you'll likely blow a few of them up with your experiments.

The chip contains two, more or less identical, sections with each consisting of eight data lines and two control lines. The section brought out to the rear plug on the Microbee is known as *Section A* of the chip. *Section B* handles the serial port, the cassette, the speaker, and even the on-screen clock counter in some ROM-based 'Bees.

The Z-80 sets aside 255 special memory areas, apart from its normal memory addresses, for use by in/out chips. These are accessed by the machine code instructions "IN" and "OUT" (surprise, surprise!). The PIO in the Microbee is at address 0, as we found in the BASIC experiment. Any INs and OUTs involving address 0 will affect whatever is plugged into the 15-pin plug on the back of the 'Bee.

Associated with each in/out section of the PIO is a "control register", through which you send the commands to tell the PIO things like whether it is to be an input or output. Each control register has an address which is one higher than the port it controls. So the control register for port 0 is at address 1. At address 2 is the B section of the PIO, the part with all the serial goodies hooked up to it. And section B's control register is at address 3.

With this in mind, we can now make the parallel port do our bidding. If we want it to be an output, we send the hexidecimal number "0F" into the control register at address 1. We first put the "0F" into the A register and then use the assembly language command "OUT" (1),A". with that done we can now send whatever we want out the port with commands like "OUT (0),A" where the A register has the number we want to send.

To make the port an input, we first put the number "4F" into the A register and then send "OUT (1),A" to the control register. We can then read the state of the port's data bits with the command "IN A,(0)". The A register would then contain the number collected from the port.

Another mode of operation is "*bidirectional*". This makes use of all four control lines from both halves of the chip. Since those from Section B are not brought out on the Microbee, this mode is of little use. In fact, in these early examples, we haven't taken any note of these "handshake" lines. If they don't get the response they expect from some external device, they may cause the whole computer to "hang up". To prevent this, you can trick the PIO by tying the control lines together so they just talk to each other!

```
ADDR    CODE     LINE    LABEL  MNEM    OPERAND

                 00100 ;Listening Post === Combined RTTY, Morse, and Fax
                 00110 ;receiving program. Tom Moffat, April 29, 1985.
                 00120
0400             00130          DEFR    16
0A00             00140          DRG     0A00
                 00150
                 00160 ;Initialize clock and PIO and select receive mode.
                 00170
0A00 3A43A8      00180          LD      A,(0A843)
0A03 FEB4        00190          CP      0B4      ;CHECK IF 2 OR 3.375 MHZ CLOCK
0A05 2005        00200          JR      NZ,$+7
0A07 3E51        00210          LD      A,51     ;FOR 2 MHZ CLOCK
0A09 32E80B      00220          LD      (CLOCK),A
0A0C 3ECF        00230          LD      A,0CFH   ;SET PIO FOR CONTROL MODE
0A0E D301        00240          OUT     (1),A
0A10 3EFF        00250          LD      A,0FFH   ;SET ALL LINES AS INPUTS
0A12 D301        00260          OUT     (1),A
0A14 21180C      00270          LD      HL,MESS  ;DISPLAY SIGN-ON MESSAGE
0A17 7E          00280 OPEN     LD      A,(HL)
0A18 23          00290          INC     HL
0A19 CD4200      00300          CALL    0042     ;VDU
0A1C FE3F        00310          CP      '?'      ;END OF MESSAGE?
0A1E 20F7        00320          JR      NZ,OPEN
0A20 CDF40B      00330 CHOOSE   CALL    JMPKEY   ;LOOP UNTIL A KEY IS PRESSED
0A23 18F8        00340          JR      CHOOSE
                 00350
```

Here's a practical example: the first 20 lines or so of the Listening Post program contains the setup conditions for the PIO.

A fourth mode of PIO operation is called "CONTROL". This is the one you will find most useful for experimenting, since you can make the port be an input and an output at the same time. If, for instance, you want lines 0, 1 and 2 to be inputs, and 3-4-5-6-7 to be outputs, you first set up the control mode by sending "CF" to port address 1. You must then prepare a binary number to tell the PIO which lines are to be inputs and which are to be outputs. Any "1" in the number makes that data bit an input, and a "0" makes it an output. Just remember that 1 looks like I, and 0 looks like O, and you'll remember which is which.

To set up data bits 7-6-5-4-3-2-1-0 as described above, the required binary number would be "00000111", or in hexidecimal, "07". Now send this to port address 1, following the "CF". You now have five outputs and three inputs at port 0.

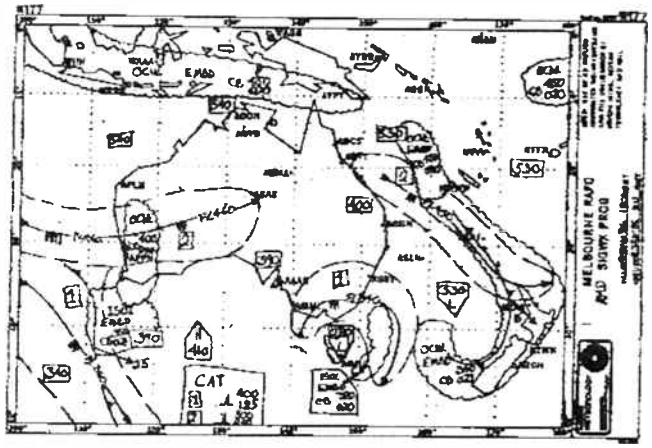
This information only scratches the surface of the PIO. The device is capable of all kinds of magic things, like triggering off interrupts when some input line changes. If you'd like to become really proficient in PIO-ology, get a copy of the book *Z-80 Assembly Language Programming* by Lance Leventhall.

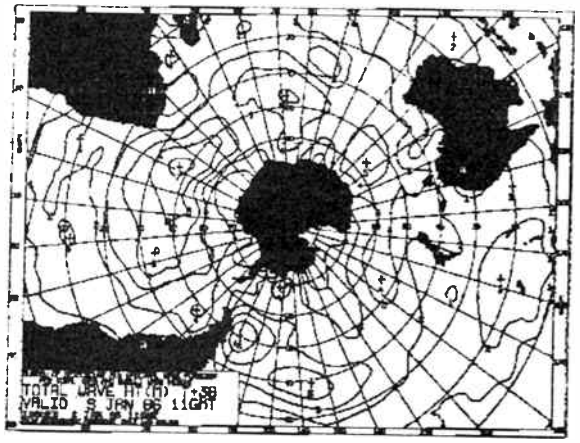
Listening Post update (again)

A couple of new happenings on the Listening Post front: First, I'd like to welcome back with open arms some decent radio propogation conditions. We've been on a long dry spell for many months, with all the normal daytime radio frequencies dead. The only daytime reception has been on the usual nighttime frequencies, such as 5 MHz. And FAX pictures have been pretty scruffy. As of just before Christmas, things improved dramatically, and now we're getting beautiful, clear FAX pictures though on 13 MHz and above, from both AXM and overseas stations.

And from mid-December, AXM has had a major change of program. They've deleted most of their teletype and gone almost all FAX. (There's still plenty of RTTY about from other sources.) The format of the pictures have been changed in some cases, and new types of charts have been added. A couple of their latest charts are reproduced here.

Some recent Listening Post FAX printouts from station AXM. Decent reception has returned!





(**Prescience:** Your editor tells me my New Year Speculation in the January issue was spot on! Microbee's new baby is called "the gamma", just one of a family, due for release this year.)

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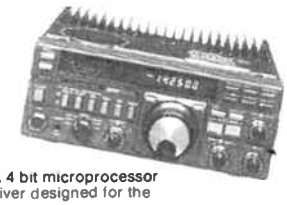

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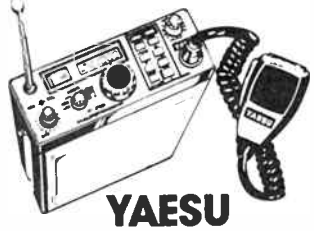

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B.132/RB

New range of switchmode supplies

Amtex Electronics has released a new range of five Boschert switchmode supplies each featuring four outputs comprising special dual +12 V outputs along with +5 V and −12 V outputs.

The dual output is especially designed for computer applications to enable independent powering of the disc drive and monitor with no interference between the two. The +5 V supply is for general logic and the −12 V is for the RS232 port.

There are five models rated from 60 W (XL 50) to 160 W (XL 160) continuous output. They include input surge protection, short circuit protection and 110 Vac/220 Vac selectable input.

Details from **Amtex Electronics, 36 Lisbon St, Fairfield, NSW. (02) 728 2121.**

Pocket calculator sized DMM

Measuring a mere 108 mm tall by 56 mm wide by 10 mm slim, and weighing just 80 grams (inc. batteries!), Dick Smith Electronics' new Q-1555 digital multimeter slips easily in

the pocket, yet features a 3,5-digit LCD readout and 13 measurement ranges.

On dc and ac volts, it boasts four ranges each, up to 400 V. On resistance it has five ranges from 200 ohms full-scale to 2M. Basic dc accuracy is given as 2%.

Better yet, it has autoranging plus an audible continuity test and permanently attached probe leads. At $49.95, you should check it out at your nearest Dick Smith store or dealer.

Allen-Bradley acquire Relco Singapore

Allen-Bradley, the US-based electronics components manufacturer and supplier, has acquired majority ownership of Relco Industries Private Ltd of Singapore.

Relco makes cermet thick film resistor networks and chip resistors widely employed in electronics equipment from test gear to telephones, computers and communications equipment.

Rodney Salzwedel, V-P of Allen-Bradley's International Division, says the move will directly benefit their Australian customers. Allen-Bradley is a Rockwell International company. Further details from **Allen-Bradley Pty Ltd, 37 Chapman St, Blackburn 3130 Vic. (03) 899 0335.**

RF video modulator

Announced recently by GFS Electronic Imports was MFJ Enterprises' new RF video modulator, Model MFJ-1431A.

The RF modulator converts video and audio signals to Australian VHF channels 1 or 3. These video/audio signals from units which do not have a built-in RF modulator, such as computers, video cameras, VCRs, image enhancers or distribution amplifiers, can then be monitored on a standard PAL colour TV set.

The MFJ-1431 is set up to accept standard level video and audio signals, although internal level controls are provided to cater for the situation where non-standard levels are presented to the modulator.

Input and output impedances of 75 ohms or 300 ohms may be achieved by using a balun/switch, which is supplied. All the necessary cabling is provided. Operation is from 12 volts dc or from an optional 12 V, 300 mA ac adapter.

GFS advise that the price of the RF Modulator is $215 plus $7 P&P. Contact **GFS Electronic Imports, 17 McKeon Road, Mitcham 3132 Vic. (03) 873 3777.**

Get the facts, man!

Fairchild's Advanced CMOS Technology, known as 'FACT', is based on their two micron CMOS process, said to be the fastest in the business.

Fairchild claim it sits in a leading edge position and removes any customer need to use:

74ALS
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in that order of priority in any new project from now on.

Being CMOS, it is easily interfaced with CMOS microprocessors and memory devices for operating frequencies under 65 MHz, or can perform very well as stand-alone logic.

It is made of the same two micron process used for their gate-array CMOS family for the just-introduced 32-bit microprocessor denominated 'clipper'.

For further information, contact: **Mr Robert Ross, Applications Engineer, Fairchild Australia, PO Box 19, Nunawading Vic.**

French frequency

A new signal generator manufactured by the French instrument firm, Adret Electronique, has been released by Vicom Australia. Dubbed Model 742A, it covers the frequency range of 100 kHz to 2.4 GHz with a resolution of 10 Hz to 1.2 GHz and 20 Hz to 2.4 GHz the company claims.

The 742A is based on the successful 740A and has resulted from customer needs and applications in the 1-2 GHz spectrum. Its spectral purity close to the carrier, the quality of its modulation and its very low residual FM make the 742A an excellent signal generator for research and development, production and servicing applications, Adret say.

The 742A will be available from April 1986 and all enquiries should be directed to Vicom in **Melbourne (03) 62 6931, Sydney (02) 957 2766 or Brisbane (07) 229 0278.**

Zeners cut the crap

Transient absorptive zeners for absorbing power supply transients are claimed to be superior to metal oxide varistors in this application as they do not suffer long term degradation, according to the manufacturers.

Thomson semiconductors manufacture a wide range of transient absorptive zeners, called 'transil', in mono and bi-

directional types in rated operating voltages from 5 to 500 volts and featuring picosecond response times. A wide range of package styles is available.

A new version, called 'trisil', goes to a short when overloaded, providing a solid state equivalent of the gas-filled transient arrestor. These devices have application on telephone and data communications lines.

The transil and trisil devices are distributed by **Promark Electronics, PO Box 381, Crows Nest 2065 NSW. (02) 439 6477.**

Unique construction for miniature trimmer capacitor

Murata Mfr has evolved, through long experience in the ceramic capacitor field, a new compact range of trimmer capacitors less than 5 mm in height.

The new TZ Series Trimcap features unique construction without a centre axle which used to be indispensable with any conventional ceramic trimmer capacitor.

The axle-less contraction of the Murata TZ Series Trimcap offers many advantages over conventional trimmers, says the makers: excellent linear TC and capacitance drift; special care for chips and cracks is unnecessary. unlike conventional ceramic trimmer capacitors; a flame retardant plastic case; one-piece construction of the case makes the Murata TZ Series ideal for dust and flux-proof requirements; mounting height is 4.8 mm.

Nine different capacitance ranges are available, each physically the same dimensions (6.0 x 4.8 mm) with a 5 mm lead spacing. IRH Components stock all nine values in the top adjust style: single ceramic plate type, 100 Vdc — 2.0-7.0 pF, 3.0-11 pF, 4.2 pF-20 pF, 5.2-30 pF, 6.8-45 pF, 9.8 pF-60 pF. In monolithic ceramic plate type, 50 Vdc — 6.0-50 pF 9.0-90 pF, 10 pF-120 pF.

Further capacitance values will be released from production in the near future. **IRH Components, PO Box 14, Lidcombe 2141 NSW (02) 648 5455.**

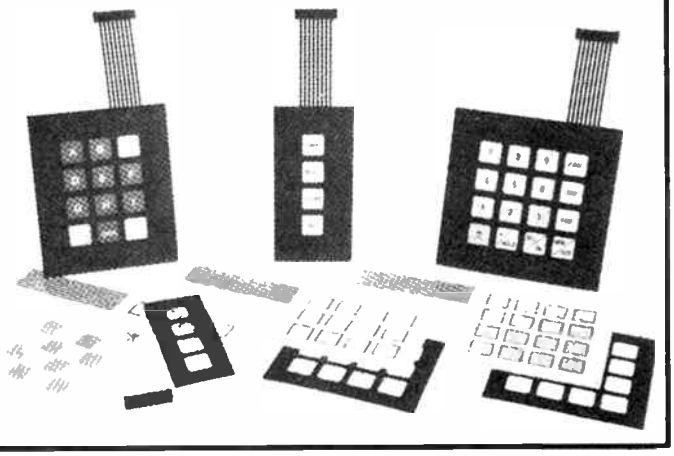
SWITCH SOLUTIONS WITH MEMBRANES

Koloona Industries can offer solutions to special switch problems, particularly where customised keyboards are required. They distribute the DMC range of membrane switches which comprise stock prototype keyboard kits, modifiable stock switches and custom design switches.

The stock prototype keyboard kit may be assembled in minutes according to the literature. They are available in 4-key, 12-key, 40-key, 80-key and 102-key versions. You can choose your own key colours and lettering.

With the modifiable stock switches, you add your own overlay to any combination of stock keyboard switches to achieve a custom design look at a very low cost, making them ideal for prototypes or small production runs.

Alternatively, you may order a membrane switch panel to your own design. Contact **Koloona Industries Pty Ltd, PO Box 297, Riverwood 2210 NSW. (02) 533 2588.**



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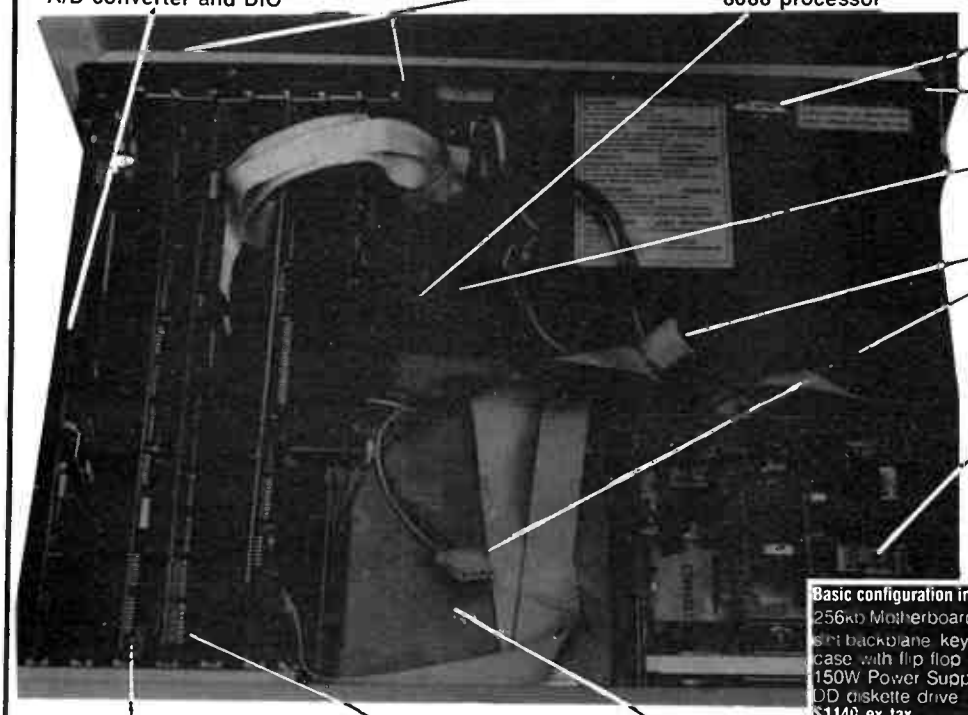

Basic configuration includes
256Kb Motherboard with 8 slot backplane, keyboard case with flip top lid, 150W Power Supply, 1 DD diskette drive
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GUARANTEE
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aem data sheet

LM1830 Fluid Detector

National Semiconductor

General Description

The LM1830 is a monolithic bipolar integrated circuit designed for use in fluid detection systems. The circuit is ideal for detecting the presence, absence, or level of water, or other polar liquids. An ac signal is passed through two probes within the fluid. A detector determines the presence or absence of the fluid by comparing the resistance of the fluid between the probes with the resistance internal to the integrated circuit. An ac signal is used to overcome plating problems incurred by using a dc source. A pin is available for connecting an external resistance in cases where the fluid impedance is of a different magnitude than that of the internal resistor. When the probe resistance increases above the preset value, the oscillator signal is coupled to the base of the open-collector output transistor. In a typical application, the output could be used to drive a LED, loud speaker or a low current relay.

Features

- Low external parts count
- Wide supply operating range
- One side of probe input can be grounded
- ac coupling to probe to prevent plating
- Internally regulated supply
- ac or dc output

Applications

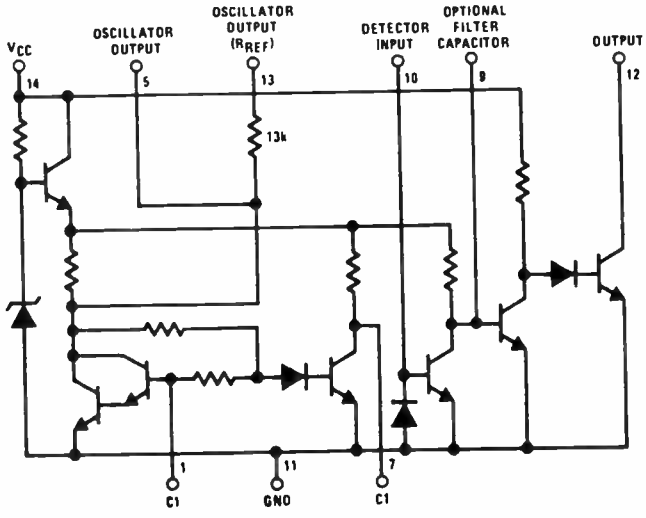
- Beverage dispensers
- Water softeners
- Irrigation
- Sump pumps
- Aquaria
- Radiators
- Washing machines
- Reservoirs
- Boilers

Electrical Characteristics ($V^+ = 16V$, $T_A = 25°C$ unless otherwise specified)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Current			5.5	10	mA
Oscillator Output Voltage					
Low			1.1		V
High			4.2		V
Internal Reference Resistor		8	13	25	kΩ
Detector Threshold Voltage			680		mV
Detector Threshold Resistance		5	10	15	kΩ
Output Saturation Voltage	$I_O = 10$ mA		0.5	2.0	V
Output Leakage	$V_{PIN\ 12} = 16V$			10	μA
Oscillator Frequency	C1 = 0.001μF	4	7	12	kHz

Note 1: The maximum junction temperature rating of the LM1830N is 150°C. For operation at elevated temperatures, devices in the dual-in-line plastic package must be derated based on a thermal resistance of 175°C/W.

Schematic Diagram

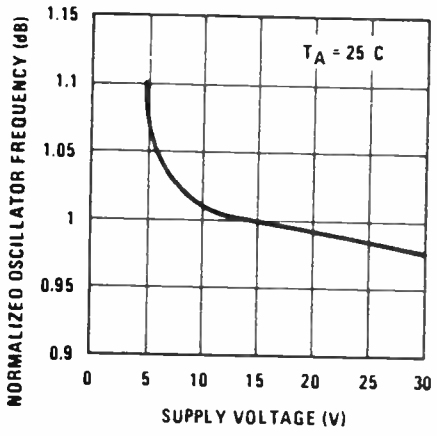


Absolute Maximum Ratings

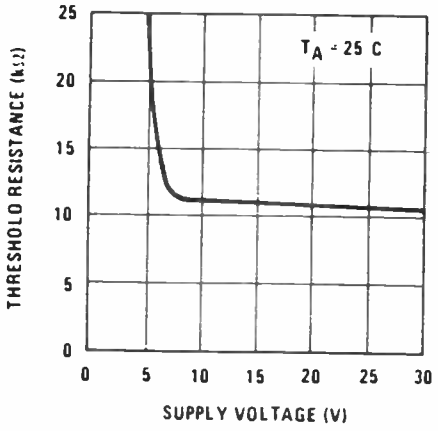
Supply Voltage	28V
Power Dissipation (Note 1)	300 mW
Output Sink Current	20 mA
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−40°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Typical Performance Characteristics

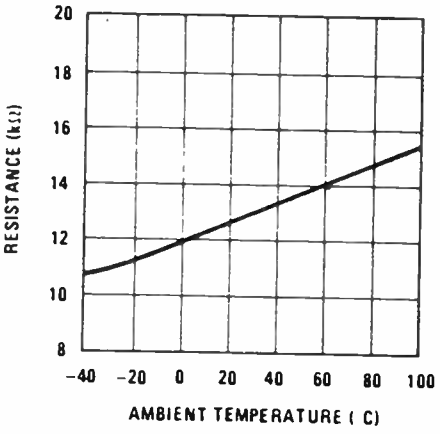
Normalized Oscillator Frequency vs Supply Voltage



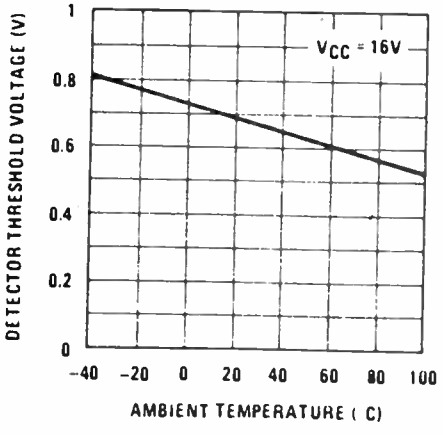
Threshold Resistance vs Supply Voltage



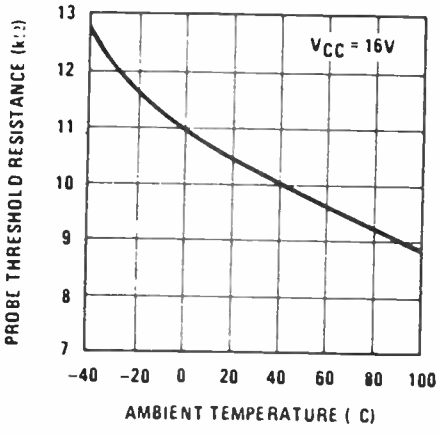
Reference Resistor vs Ambient Temperature



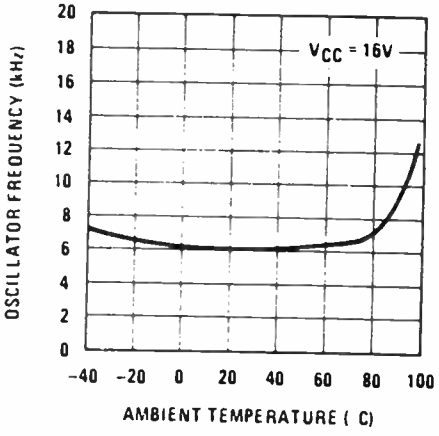
Detector Threshold Voltage vs Temperature



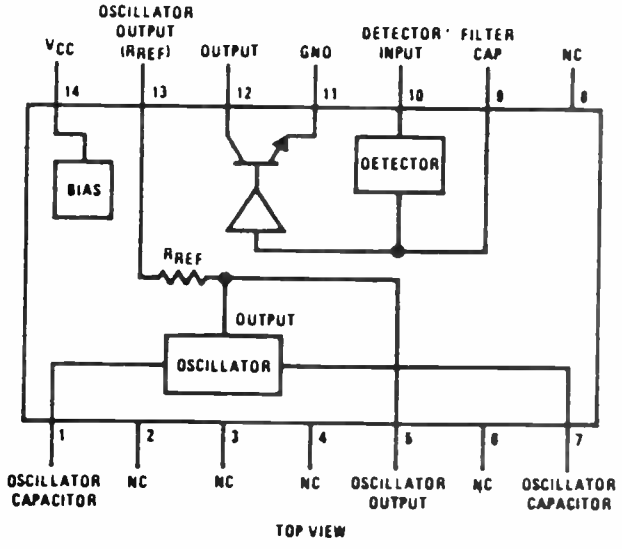
Probe Threshold Resistance vs Temperature



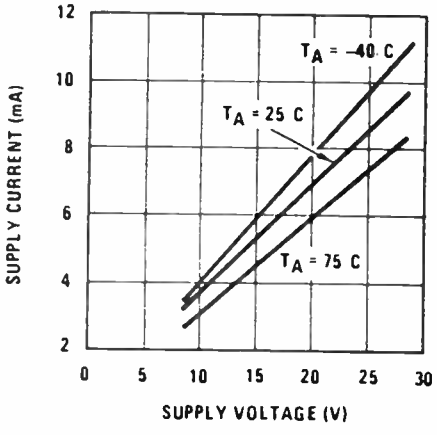
Oscillator Frequency vs Ambient Temperature



Dual-In-Line Package



Power Supply Current vs Supply Voltage



LM1830

Application Hints

The LM1830 requires only an external capacitor to complete the oscillator circuit. The frequency of oscillation is inversely proportional to the external capacitor value. Using 0.001μF capacitor, the output frequency is approximately 6 kHz. The output from the oscillator is available at pin 5. In normal applications, the output is taken from pin 13 so that the internal 13k resistor can be used to compare with the probe resistance. Pin13 is coupled to the probe by a blocking capacitor so that there is no net dc on the probe.

Since the output amplitude from the oscillator is approximately 4 V_{BE}, the detector (which is an emitter base junction) will be turned "ON" when the probe resistance to ground is equal to the internal 13 kΩ resistor. An internal diode across the detector emitter base junction provides symmetrical limiting of the detector input signal so that the probe is excited with ± 2 V_{BE} from a 13 kΩ source. In cases where the 13 kΩ resistor is not compatible with the probe resistance range, an external resistor may be added by coupling the probe to pin 5 through the external resistor as shown in *Figure 2*. The collector of the detecting transistor is brought out to pin 9 enabling a filter capacitor to be connected so that the output will switch "ON" or "OFF" depending on the probe resistance. If this capacitor is omitted, the output will be switched at approximately 50% duty cycle when the probe resistance exceeds the reference resistance. This can be useful when an audio output is required and the output transistor can be used to directly drive a loud speaker. In addition, LED indicators do not require dc excitation. Therefore, the cost of a capacitor for filtering can be saved.

In the case of inductive loads or incandescent lamp loads, it is recommended that a filter capacitor be employed.

In a typical application where the device is employed for sensing low water level in a tank, a simple steel probe may be inserted in the top of the tank with the tank grounded. Then when the water level drops below the tip of the probe, the resistance will rise between the probe and the tank and the alarm will be operated. This is illustrated in *Figure 3*. In situations where a non-conductive container is used, the probe may be designed in a number of ways. In some cases a simple phono plug can be employed. Other probe designs include conductive parallel strips on printed circuit boards.

It is possible to calculate the resistance of any aqueous solution of an electrolyte for different concentrations, provided the dimensions of the electrodes and their spacing is known.

The resistance of a simple parallel plate probe is given by:

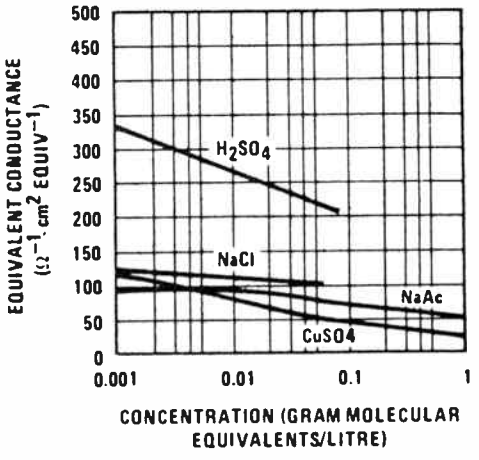
$$R = \frac{1000}{c.p} \cdot \frac{d}{A} \quad \Omega$$

where A = area of plates (cm^2)
d = separation of plates (cm)
c = concentration (gm. mol. equivalent/litre)
p = equivalent conductance
(Ω^{-1} cm^2 equiv.$^{-1}$)

(An equivalent is the number of moles of a substance that gives one mole of positive charge and one mole of negative charge. For example, one mole of NaCl gives $Na^+ + Cl^-$ so the equivalent is 1. One mole of $CaCl_2$ gives $Ca^{++} + 2Cl^-$ so the equivalent is 1/2.)

Usually the probe dimensions are not measured physically, but the ratio d/A is determined by measuring the resistance of a cell of known concentration c and equivalent conductance of 1. A graph of common solutions and their equivalent conductances is shown for reference. The data was derived from D.A. MacInnes, "The Principles of Electrochemistry," Reinhold Publishing Corp., New York., 1939.

Equivalent Resistance vs Concentration of Several Solutions



In automotive and other applications where the power source is known to contain significant transient voltages, the internal regulator on the LM1830 allows protection to be provided by the simple means of using a series resistor in the power supply line as illustrated in *Figure 4*.

If the output load is required to be returned directly to the power supply because of the high current required, it will be necessary to provide protection for the output

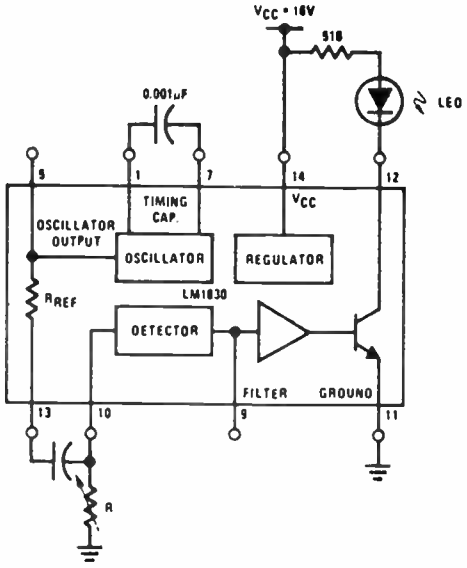


FIGURE 1. Test Circuit

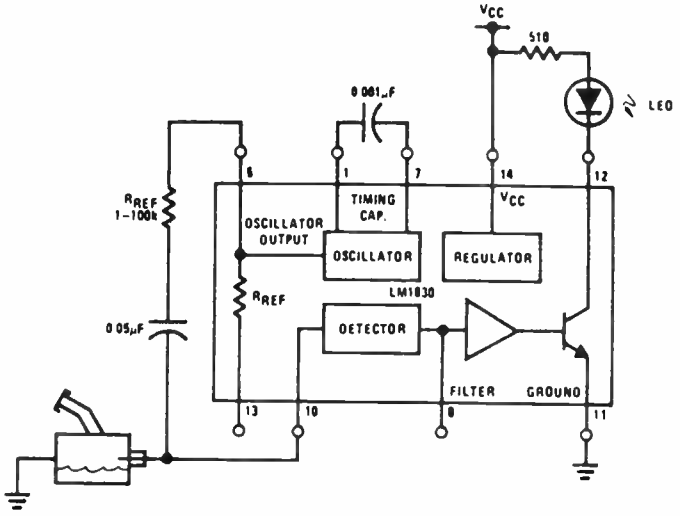


FIGURE 2. Application Using External Reference Resistor

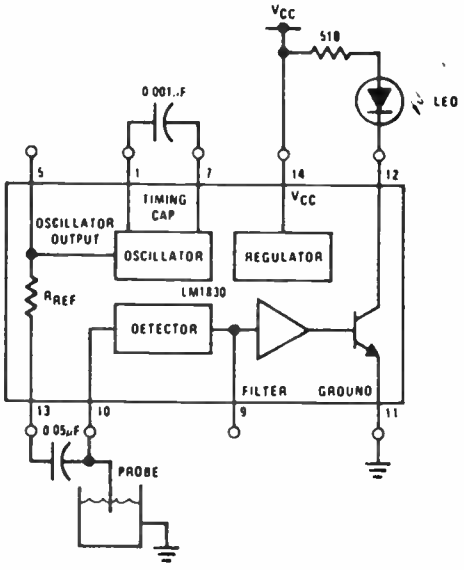
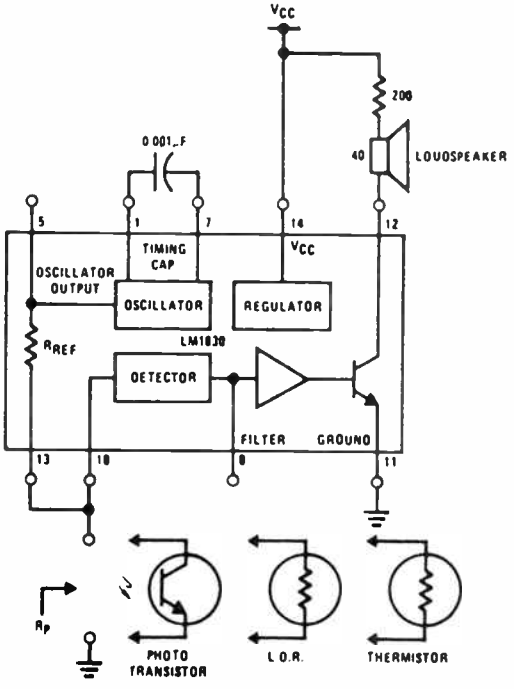


FIGURE 3. Basic Low Level Warning Device with LED Indication



Output is activated when $R_p \gtrsim 1/3\ R_{REF}$

FIGURE 4. Direct Coupled Applications

transistor if the voltages are expected to exceed the data sheet limits.

Although the LM1830 is designed primarily for use in sensing conductive fluids, it can be used with any variable resistance device, such as light dependent resistor or thermistor or resistive position transducer.

The following table lists some common fluids which may and may not be detected by resistive probe techniques.

Conductive Fluids	Non-Conductive Fluids
City water	Pure water
Sea water	Gasoline
Copper sulphate solution	Oil
Weak acid	Brake fluid
Weak base	Alcohol
Household ammonia	Ethylene glycol
Water and glycol mixture	Paraffin
Wet soil	Dry soil
Coffee	Whisky

The "in and out" of "AND and OR"

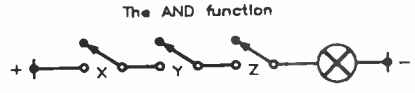
explained by **Theo Baitch**

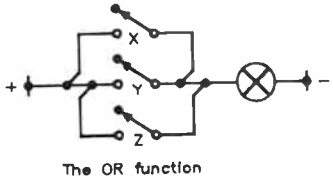
Modern electronics, particularly digital electronics, intimately connected with computers, robots and other more mundane things, such as the operation of courtesy lights in motor cars, would be unthinkable without the use of logic elements.

LOGIC ELEMENTS have emerged from developing computer technology in the immediate post-war years. They were representing fundamentally the following two basic types:

- the AND function, expressed electrically as a number of switches (e.g: X, Y, Z) connected in series, so that X *and* Y *and* Z must be closed to complete a circuit;
- the OR function, expressed electrically as a number of switches (e.g: X, Y, Z) connected in *parallel*, so that either X or Y or Z (or any combination of them) must be closed to complete a circuit.

These functions were called logic functions (or "yes-no" functions) not only because of their decision making ability, but also because they could be manipulated using a special "Boolean" type of logic mathematics. This is a type of algebra, named after the English logician and mathematician George Boole (1815-1864), in which the elements are of two kinds only, and in which the basic operations are the logical AND and OR operations, which are normally symbolised as multiplication (×) and addition (+) respectively. The main applications of this type of mathematics are the design of switching networks and mathematical logic.





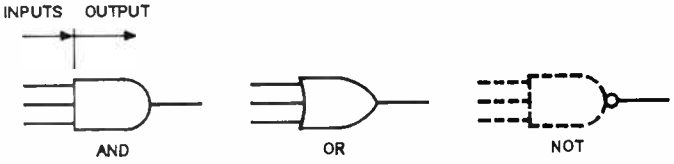
Logic symbols

In time, each of these logic functions was represented in so-called logic diagrams (which tied them together) by logic symbols. These were "dedicated" or "distinctive" symbols of a specific shape for each of the logic functions.

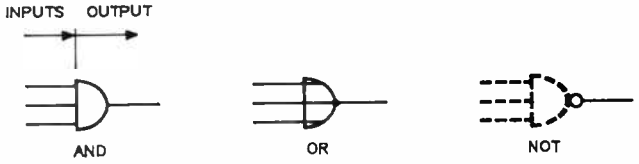
Each major firm developing and building its own computer model or logic control system tended to independently invent its own symbols. By the mid-'50s, there were up to a dozen logic symbol systems in use throughout the USA, the US and continental Europe, leading to chaotic conditions.

In time, two logic symbol systems emerged out of that confusion and were generally accepted world-wide from the late '60s onwards:

- the originally USA system based on a "curvilinear" rectangle;
- the originally European (incl. US) system based on a semicircle.



The now obsolete, originally USA and Australian logic symbols.



The now obsolete, originally Continental and UK logic symbols.

The two systems agreed in that all conductors entering the symbol from the left side were "inputs", while the conductor emerging at the right of the symbol is the "output". Also, that a small circle astride a conductor indicated a "NOT" function (inversion, or 180° phase reversal).

From relay to silicon chip

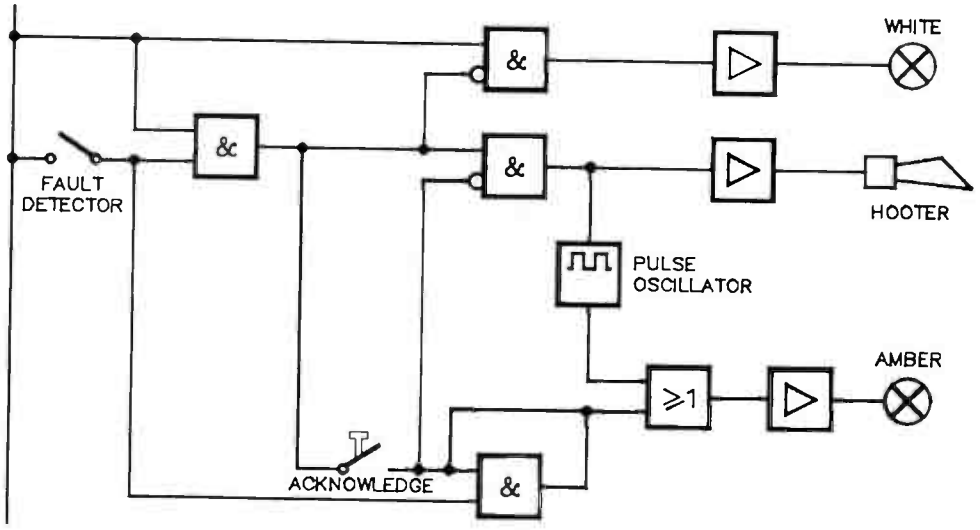
Originally, computers and logic control circuits were based on the then available technology of the day. This consisted of electro-mechanical (i.e: electromagnetic) relays and vacuum (radio) valves and their switching operations were shown by logic symbols.

The advent of the transistor, semiconductor and integrated circuit technology has now made logic symbols not only to represent its conventional logic switching function, but also to become synonymous with complex electronic circuitry, an integrated circuit perhaps on a silicon chip, incorporating hundreds of transistors and other devices. Also, the types of logic (control) devices increased rapidly from the simple AND, OR and NOT function to any conceivable alternative.

The new square or rectangular IEC logic symbols

There obviously was a limit to human ingenuity towards inventing novel distinctive shapes for new logic functions. Also, they became ever more complicated to draw.

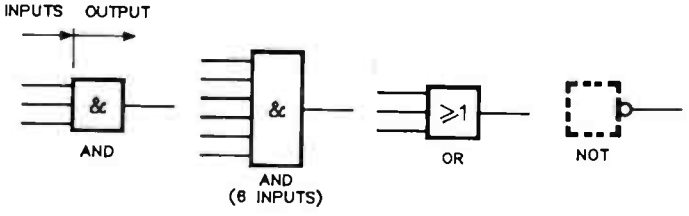
The International Electrotechnical Commission (IEC), as



A typical industrial fault alarm logic diagram.

the world-wide international standards body (and of which Australia is a member nation) resolved the problem of proliferating, complex, distinctive logic symbols in the late '70s by a simple and radical method. It created a new family of logic symbols, all based on a square, traditionally drawn with 12 mm side length. These squares can be stacked vertically, if need be, to form rectangles.

The function performed by each of these logic symbols is designated in a simple manner by an appropriate, universally understood mathematical symbol or expression written inside the square. Thus the symbol for all logic functions is now a square or a vertical rectangle, which are both clearly understood and easy to draw both manually and by computers. It supersedes, world-wide, all previously existing systems based on distinctive or dedicated symbols.



The new Australian and International IEC logic symbols

Introduction of IEC's square logic symbols

The Standards Association of Australia (SAA) was quick to recognise the significance and merits of the novel block- (i.e: square) shaped logic symbols. These were recognised already in the 1979 Edition of the SAA Drawing Standard for Logic Symbols (AS 1102, Part 9) as the preferred system for Australia. In view of the wide acceptance, however, at the time in Australia of the USA-type distinctive symbols, these were permitted (quasi "tolerated") until further notice.

During the subsequent years, the IEC and thus all the world's nations agreed to abandon "distinctive" logic symbols and to universally adopt the simpler "square shaped" (rectangular) logic symbols. It was interesting to note that the USA, whose distinctive (curvilinear) logic symbols were used most widely, spearheaded the campaign in favour of the new logic symbols which have found surprisingly rapid acceptance there. The IEC has now published its appropriate world-wide standard for the new logic symbols.

Only block-shaped logic symbols for Australia

The IEC's block-shaped (square) logic symbols have now become mandatory throughout the world. Distinctive logic symbols have become obsolete and will gradually disappear, as people become aware of the simpler, square symbols.

Implementation of the new symbols will entail their introduction into the "menu" of any CAD (computer aided drawing) system and into drawing stencils, a minor operation.

In Australia, the square symbols have been recommended by the SAA since 1979 as the preferred alternative. In line with world-wide practice, they have now become the only recognised ones, since the latest revision of the Australian Logic Symbol Drawing Standard (AS 1102, Part 9 — 1986) now completely omits distinctive symbols altogther.

A great advantage of the new symbols is that, with complex, multi-logic ICs, their operation can be deduced from their symbol, something which is impossible from the earlier symbols.

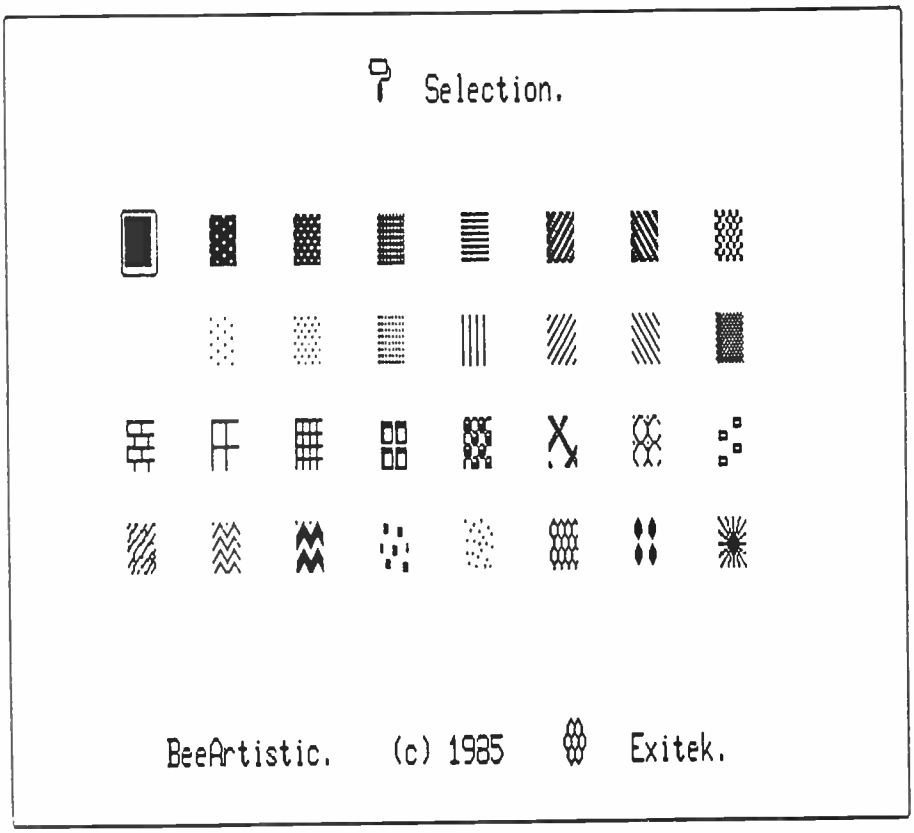
Logic diagram

Logic diagrams are simplified circuit or block diagrams drawn using the logic elements or symbols mentioned earlier. They provide quite detailed information about the operation of the circuit through the use of logic symbols, which are considered to be the smallest building block (consisting usually of an integrated [IC] circuit), representing electrical switching operations.

Logic diagrams follow the rules of conventional diagrams. These are, basically, that events take place in sequence progressively from left to right and/or top to bottom, that is, that the "logic sequence" flows the same way.

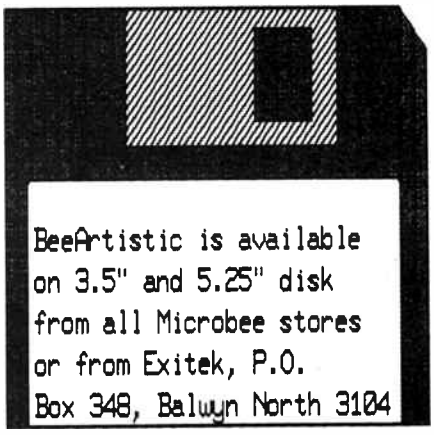
— from page 81

aem software review



Microbee computer at a price that is almost ridiculous. What is nice to see is that small Australian companies are prepared to produce easy to use, powerful software at cheap prices. Many people criticise the Microbee's graphics capabilities, but utilities like BeeArtistic just go to show that ingenuity sees few barriers and all it took to exploit the Microbee's hidden talents was some creative application.

The review package was kindly supplied by **Exitek, PO Box 348, Balwyn North 3104 Vic (02) 842 6139.**



BASIC & BEEARTISTIC

Those users who wish to use their BeeArtistic screens from BASIC will need to remove the first 128 bytes before 'GRLOAD'ing them. Presented here is a machine code program to REMOVE these 128 bytes. Here's how to use it:

After following the instruction in REMOVE, jump into MicroWorld BASIC and load and RUN GRMAKER through your file.

Here are the listings and instructions for REMOVE.COM and the BASIC listing of GRMAKER.MWB.

MONITOR CONTROL KEYS

A LEFT
Z DOWN
S RIGHT
W UP

After entering code, type z from monitor or Control-C from DDT then type:

```
A>SAVE 1 REMOVE.COM
```

Entering code in DDT

To enter code in DDT type S100, then type the code. To enter in monitor hit [reset M] and type A 100 then type in the following:

```
0100:   11 AD 01 0E 09 CD 05 00 3A 5D 00 FE 20 CA 9A 01
0110:   11 5C 00 CD 95 01 3C C2 1D 01 C3 9A 01 AF 32 7C
0120:   00 11 80 00 21 00 40 E5 54 5D CD CB 01 11 5C 00
0130:   CD 90 01 E1 B7 C2 3F 01 11 80 00 19 C3 27 01 11
0140:   62 01 0E 09 CD 05 00 11 01 40 21 00 40 01 7F 00
0150:   36 00 ED B0 21 D0 01 11 A0 00 01 0E 00 ED B0 C3
0160:   A0 00 54 6F 20 73 61 76 65 20 3A 0D 0A 20 20 20
0170:   20 20 20 20 20 20 20 41 3E 53 41 56 45 20 31 33
0180:   20 46 49 4C 45 4E 41 4D 45 2E 45 58 54 0D 0A 24
0190:   0E 14 C3 05 00 0E 0F C3 05 00 0E 09 11 A5 01 CD
01A0:   05 00 C3 00 00 4E 6F 20 46 69 6C 65 24 52 45 4D
01B0:   4F 56 45 20 2D 20 42 79 20 48 61 79 64 65 6E 20
01C0:   42 72 6F 74 63 68 69 65 0D 0A 24 0E 1A C3 05 00
01D0:   11 00 01 21 00 40 01 00 20 ED B0 C3 00 00 00 00
```

Now for GRMAKER.MWB:

```
100 CLOSE 6
110 ON ERROR GOTO 180
120 PRINT "Graphic Maker - by Hayden Brotchie"
130 INPUT "Enter filename: ";F1$
140 OPEN "i",6,F1$
150 ON ERROR GOTO 190
160 GRLOAD 6
170 CLS:PRINT "FILE O.K.":RUN
180 PRINT "FILE NOT ON DISK":PLAY 0,7:RUN
190 CLOSE 6:OPEN "O",6,F1$
200 GRSAVE 6
210 CLOSE 6
```

Many thanks to ***Hayden Brotchie*** for the programs

WELLER CROSS WORD COMPETITION NO. 7

SEND IN YOUR ENTRY BY LAST MAIL MARCH 18

Our seventh crossword is for the computer buff, but it's pretty easy. The prize to the lucky winner is again a magnificent Weller WTCPN Controlled Output Soldering Station. Post us your answers even if you've missed one or two (so might everyone else) by no later than March 18. Our crosswords are prepared using 'Crossword Magic' supplied by and available from Edsoft Pty Ltd, 20 Blackburn Rd, Blackburn, Victoria.

The winner of our December crossword was H. Wood, Craigie W.A.

The answers to last month's crossword are on page 18.

We will accept entries postmarked no later than March 19.

CooperTools

THE PRIZE

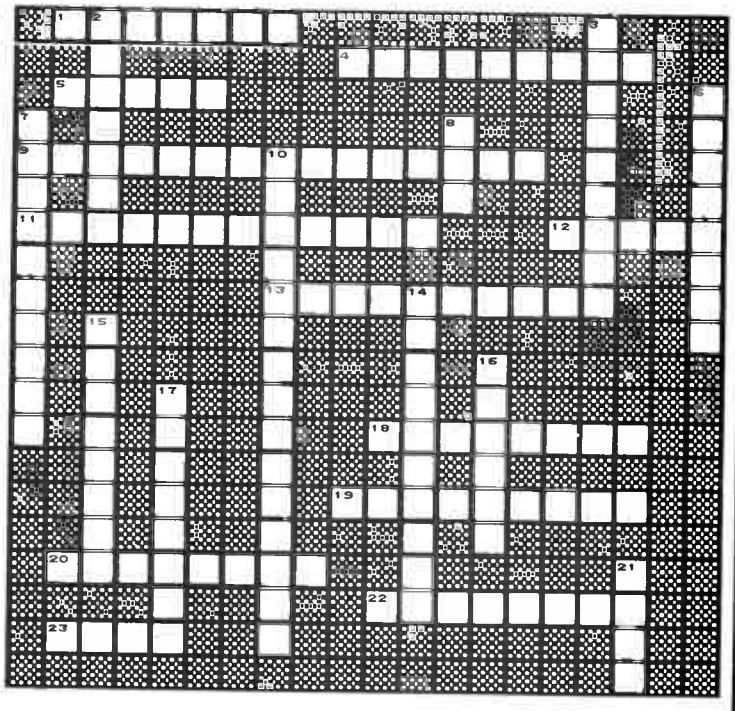
A transformer powered soldering station complete with a low voltage temperature controlled soldering pencil. The special Weller closed loop method of controlling maximum tip temperature is employed thereby protecting temperature sensitive components while the grounded tip and non inductive heater protects voltage and current sensitive components. The soldering pencil features stainless steel heater construction, a non-burning silicon rubber cord and a large selection of iron plated tips in sizes from 8 mm diameter to 6 mm diameter with a choice of tip temperatures 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. To increase the capabilities of a device.
4. A program starting program
5. A device for transmitting signals over a telephone line
9. The electrical elements in a circuit that increases power or multiply current flow (2)
11. A connected sequence of entities, such as characters, with a fixed length (2)
12. One or more electrical conductors usually covered with a sheath
13. Sometimes known as 'waiting time'
18. Transfer of a program from a remote computer to your computer
19. The hardware that connects computer and peripherals
20. To reserve specific parts of a system
22. The term that describes a system that controls an ongoing process (usually 2)
23. To place a program from external storage into central memory

DOWN

2. An electromechanical device used to create graphics from digital data
3. A keyboard key used to move a cursor from right to left
6. A basic cartridge storage device
7. A printing element in the shape of a disc (2)
8. A data item that uniquely identifies a stored data record
10. A set of programs and routines that guide a computer in performing its tasks
14. Instructions designed to be used by other instructions to accomplish particular tasks on a computer (2)
15. A device used to enter information into a computer
16. Numbering system using a base number of two
17. Code to be keyed in before a computer will operate
21. A list of choices available to a computer user



SEND IN YOUR ENTRY BY LAST MAIL MARCH 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:

"Weller Crossword"
Australian Electronics Monthly
PO Box 289,
Wahroonga NSW 2076

In case two or more entrants correctly complete the crossword, we'll have to judge who's best at waxing lyrically, in 30 words or less, over: ***"Why I think the Weller WTCPN is the soldering station for me".***

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Name . . . . . .

Address . . . . . .

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

— from page 34

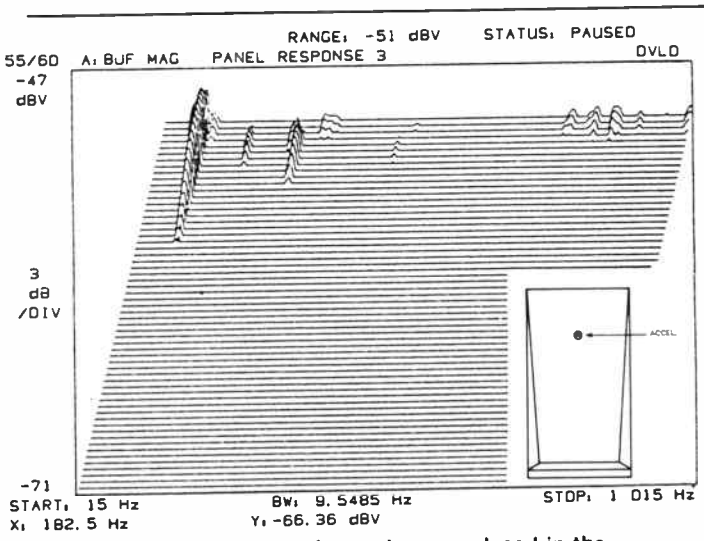

Figure 14. Here, the accelerometer was placed in the middle of the rear panel and an impulse source applied to the loudspeaker. The resonance at 92 Hz is well defined and takes around 0.8 second to decay to 60 dB.

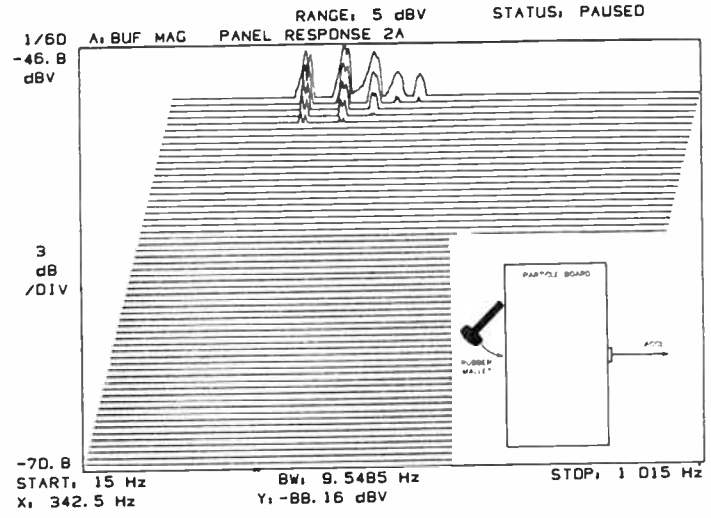

Figure 15. Vibration decay trace for a particle board panel measuring 350 x 550 mm, excited by tapping with a rubber mallet. Compared to the panel response of the CBR 200, there are more resonances at higher frequencies, but they decay more quickly.

of performance at higher frequencies. Bass response was not at first as good as I expected from a seemingly large loudspeaker, although I had to concede the performance was there if you really wanted it. Also, a disadvantage of asymmetrical boxes is that they look larger when their volume is, in fact, not all that large. Stereo imaging was good, and overall quality throughout the listening room was surprisingly uniform. Whilst this may seem inconsistent with my earlier comments concerning phase effects in loungerooms compared with studios, I also feel the listening criteria are different. Uniform frequency roll-off and dispersion, for example, is more important than exact balance when on axis, and in this respect the Jamo is good.

The panel resonances are audible, not badly, but they do colour the source material. When driven hard, the bass response falls behind the higher octaves and overall, I feel the performance is better at low levels. Voice quality, in most instances, I liked, as with stringed instruments, although I disliked the tendency for piano to sound more like electric piano that the acoustic instrument.

Probably because of panel resonances, some of the impact of impulsive material is lost, and performance for the lower to mid frequency is definitely muddy. This is a great disadvantage to classical music. However, the loudspeakers do have presence, the ability to produce very low frequencies without fuss, and the power to fill large rooms. I don't feel the loudspeakers would be all that satisfactory as monitors in the true sense, since the mid-low range is such an important one. For steel string guitar and impulse sources at higher frequencies I thought the speaker sounded excellent. Added to the extended bass, the makings are definitely there.

An overview

I have had to ask myself how a loudspeaker using damped panels could miss out so badly in the exact area it promotes. I can only assume that all tests during development used separate single panels, and not panels incorporated into a cabinet where edge damping is different, coupling between panels significant, and the performance of panels quite different from that when supported simply. We simply did not find the CBR 200 a well-damped enclosure.

If I was asked to listen to the CBR 200 for a very long period I would not be all that unhappy at the thought since the speakers have some very real qualities, but by the end, I am sure I would be intensely frustrated that a loudspeaker with so many good facets of performance has missed out so badly in just a few others. These loudspeakers have that rare quality, related to bass response, coupled with power, of being able to make one's hair stand on end. They can be exhilarating. The skeleton is there, let's hope Jamo finds the flesh to fill out some of their excellent conceptual ideas.

— from page 49

AEM 5504
Electromyogram

Note the EMG response when you shrug your shoulders, both together as well as separately. See what happens when you move your head from side to side. Try various shoulder positions to see which gives the lowest pitch output and you'll soon see how to lose that tight feeling in your neck so often experienced after travelling or poor sleep.

Using the EMG on your forehead can be very effective in controlling some headaches, even migraines. You can use it either sitting up in a comfortable chair or lying down on your back with your head and neck comfortably supported. The main electrodes can be placed not too far apart on your forehead, or on each temple. Close your eyes and slowly relax your face. By consciously trying to 'lose' the tension in your head, you'll be able to determine from the feedback what's effective. For migraines or cluster headaches which exhibit themselves on one side of the head, attach the electrodes over the affected area and follow the above procedure.

For re-training affected muscles, attach the electrodes over the area and set the sensitivity and threshold so that the slightest activity is registered. Commence relaxed and then attempt to tighten the affected muscle or muscles, noting the response. If you're not successful, always check the setting of the controls.

You never know, the EMG may be well-applied in treating galloping RSI (repetitive strain injury)!

The Australian Electronics Monthly

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Note The boards found in this issue are also available, price on application

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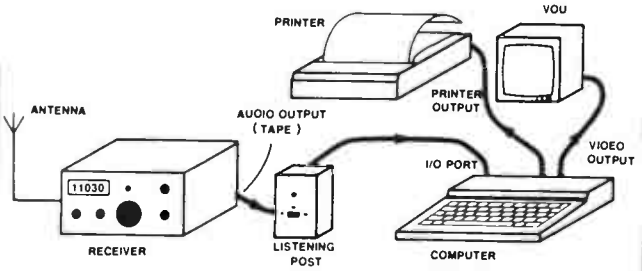
You can buy the boards at our offices if you wish, at any time during business hours We're located at WB Building, Cnr Fox Valley Rd and Kiogle St. Wahroonga NSW, the entrance is in Kiogle St.

LISTENING POST SOFTWARE



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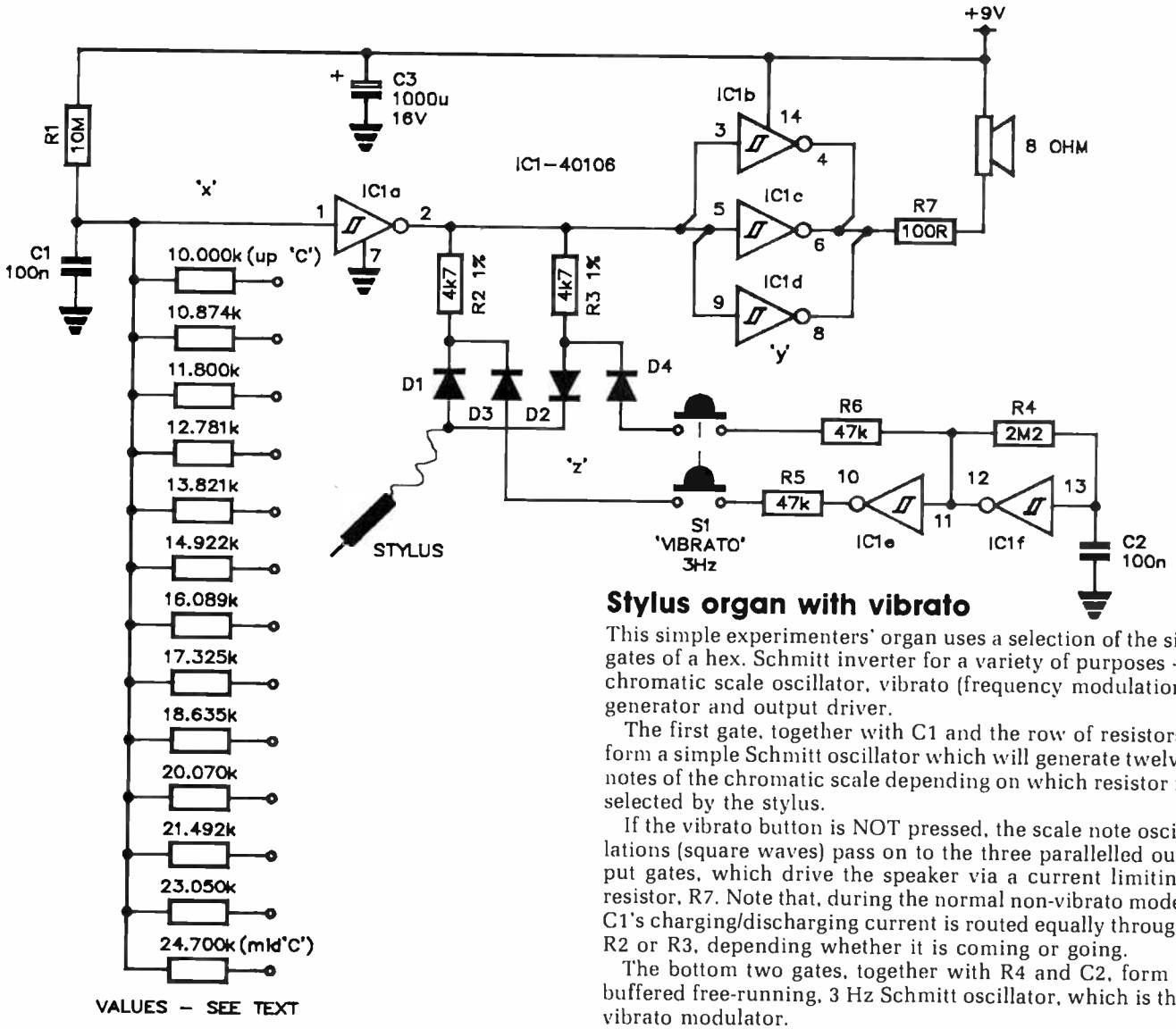


Stylus organ with vibrato

This simple experimenters' organ uses a selection of the six gates of a hex. Schmitt inverter for a variety of purposes — chromatic scale oscillator, vibrato (frequency modulation) generator and output driver.

The first gate, together with C1 and the row of resistors, form a simple Schmitt oscillator which will generate twelve notes of the chromatic scale depending on which resistor is selected by the stylus.

If the vibrato button is NOT pressed, the scale note oscillations (square waves) pass on to the three parallelled output gates, which drive the speaker via a current limiting resistor, R7. Note that, during the normal non-vibrato mode, C1's charging/discharging current is routed equally through R2 or R3, depending whether it is coming or going.

The bottom two gates, together with R4 and C2, form a buffered free-running, 3 Hz Schmitt oscillator, which is the vibrato modulator.

When S1 is pressed, current will pass from lines 'y' or 'z' into the diode circuit depending on which line is high at the time. They are contra-phased. If y is high at the same time as pin 2 is high, R6 shunts R3, and its extra current charges C quicker, shortening IC1a's mark period. If z is high at the same time as pin 2 is low, R5 forms a voltage divider with R2 and C won't discharge all the way down to zero volts. Thus as the vibrato oscillator's output moves up and down, the output frequency of IC1a rises and falls in sympathy with it — hopefully there is an equal addition using vibrato, so the note will not sing off-key.

The note resistors need not be exactly as shown. i.e: their theoretical value. Because value separation is about 8%, an attempt to get close to 1% of the values shown, using series or parallel 1% resistors, should get them near enough to on-key — otherwise, twelve 25k pots could be used, but the top resistor should remain fixed. (i.e: 10k, 1%).

Resistor R1 is essential because it charges up C1 when the stylus is not in use and causes current through the speaker to cease — reducing stand-by battery drain.

All resistors and capacitors can be altered to improve any effect, with the proviso that R2 and R3, together with the scale resistors, must be maintained as shown. ▶

Clock corruption fix for System 80/TRS80

Here's a small tip for people who have built a hardware clock into their System 80 or TRS80 and have experienced corruption of the clock when switching the computer on and off, or a program has loaded into the wrong RAM area and clobbered the DOS and therefore upset the clock.

As I had this problem and I thought of many complicated ways of overcoming this I came up with the simplest solution, a hidden pushbutton switch (normally off) which interrupts the write line to the hardware clock chip.

The only time that this write line is used is when setting the clock. So when I want to set the clock, all I have to do is set up the program and, while pressing the pushbutton, press RETURN (NEW-LINE) to enter the new time.

G. Reiter
Adelaide, SA

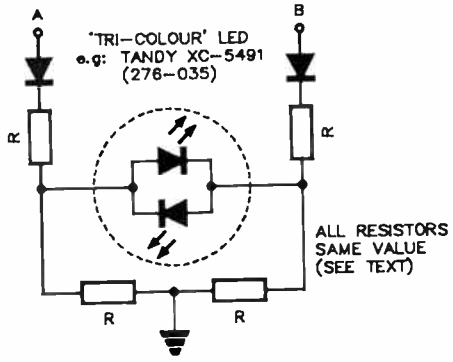
BenchBook

Red/green indicator

A dual (or 'tri-colour') LED, which consists of a red and a green LED in the one case connected back-to-back, can be made to show red ('stop') or green ('go') without the normal necessity of having to reverse the supply.

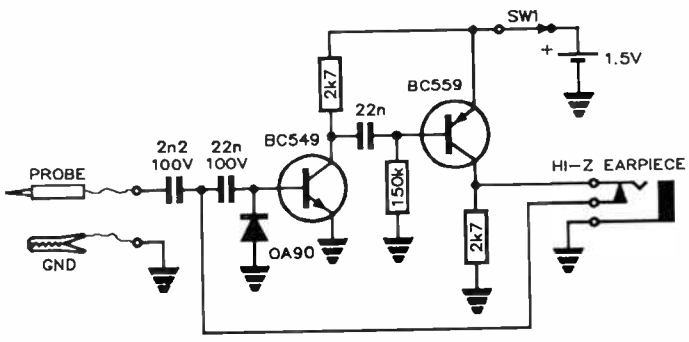
The simple bridge circuit here will change the LED colour appropriately when a positive voltage with respect to common is applied to A or B. If you turn the two diodes around, then it can be used with a negative source applied to A or B. Use 470R resistors, for a 12 V source, 180R for a 5 V source.

—Mike Collins
Camberwell, Vic.



Simple signal-tracer/signal-source

Probably the simplest test instruments you can use for fixing projects that won't work first time, the family's faulty transistor radios you're obliged to fix etc, is a signal-tracer and a signal-source. Combine them in one and what more could you ask?



This really simple circuit is a signal tracer when you plug-in a high impedance earpiece, but it becomes a pulse oscillator, which can be used as a signal source over a wide range of frequencies, with the earpiece unplugged. In this mode you can trace early-stage faults in a circuit with a working output stage.

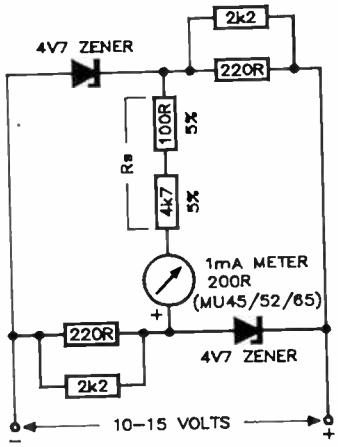
In the tracer mode, audio or RF signals are halfwave rectified by the OA90, then amplified by the BC549 and BC559. Use 100V greencaps on the input because you can encounter supply rails of 50-70 volts in some audio power amps. When checking receivers, the OA90 will detect the modulation on modulated RF signals, allowing you to trace the path.

The switch, SW1, may be left off if you like as the unit draws little power and the battery should last most of its shelf life.

—C. Johns
Unley, S.A.

Car voltmeter with 'expanded' scale

The performance of your car battery and charger can be readily determined from the battery voltage level, which usually varies between about 11 and 14 volts. Digital meters are only good for 'static' (non-driving) checking, but the traditional moving coil meter is best for permanent installation and for observing battery voltage variations under varying conditions.



This circuit 'expands' the reading range of a standard 1 mA moving coil meter so that it reads over the range from 10 to 15 volts. Two 4V7 zeners are used in a simple bridge circuit so that the meter only commences 'reading' above 9.4 volts or so. The meter series resistor, Rs, gives the meter a 5 V range, so that it reads up to 15 volts.

With 5% tolerance components, you get an accuracy of +/- 0.1 volt, which is quite adequate. The commonly available 1mA meters have an internal resistance of 200 ohms. If the meter you use has a lower internal resistance, increase the value of the 100R meter series resistor accordingly.

—L. Sharp
Mosman, NSW

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 ·sed solder, undoubtedly there's someone — or some hundreds — out there ho could benefit from you knowledge.

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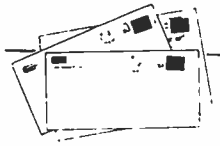


Plea for a big amp

Dear Sirs,

I am in a four-piece band and have been looking around for circuit diagrams for power amps. You recently published a 120 watt module (the '6500). However, I would prefer something larger. An amp with 250 watts per channel into 8 ohms, or upwards of that, would be terrific.

We are currently hiring PA systems, but would much rather put the money into a good power amp project. So, please — please — somewhere in your 6000 series of power amps, perhaps you could squeeze in a little unit with almighty grunt capabilities to appease a frustrated rock band?

Maybe? Yes??

Great magazine!

D. Johnson
Cooran, Qld

The first power amp to be described in the 6000 series is capable of delivering around 150 W into an eight ohm load. This is a very conservative rating and the actual maximum output power is likely to be considerably higher than this. Also, the power amps are configured so that they are particularly suitable to be connected in bridge mode. In this configuration the AEM6000 power amp will probably deliver around 400 W into an eight ohm load.

We also have a larger power amp under development that would suit your application ideally.

David Tilbrook

Consider the Amstrad owners!

Dear Sir,

I have been buying your magazine now ever since it was released and must say it is a very good one. However, in the last couple of issues you have published a Commodore column. Just what we need, I though, yet another Commodore column.

There is a veritable mine out there of Commodore magazines, listings and articles on this machine. I have not counted them all but the shelves are full.

I personally own an Amstrad CPC 664 and this machine has very little on it at all. There is a fast-growing number of people that are getting into this machine and would like to see the magazines run some columns on it.

The Listening Post is one piece of software I would like to see converted. I am very interested in building this project, but lack the expertise at this stage to convert the program myself.

So, how about it Ed., can we have a column on the Amstrad please? It is a very powerful machine and would attract a lot of enthusiasm I am sure. You would probably sell more magazines. Thanks in anticipation.

R. Warner
East Brunswick, Vic.

Your point about the Commodore column is well-taken and we are aware of the plethora of Commodore publications available. So is our principal correspondent, Neil Duncan. Our aim is to present ***practically oriented*** *material directed at electronics hobbyists interested in computing and computing hobbyists interested in electronics.*

As for the Amstrad, we have found a well-equipped correspondent to undertake the task, and you'll see the results of his efforts in the magazine as soon as we can possibly arrange it.

Roger Harrison

Preamp questions

Dear David,

I have some questions concerning the AEM6010 preamp. Firstly, the power supply section circuit diagram on page 43 of the November 1985 issue shows +/– 15 volt rails from the 7815 and 7915 regulators. Is it feasible to take +/– 15 volts from this area for external units and, if so, which would be the best point to tap from?

The reason I ask is that presently, I have an active system based on 4 x ETI-480 50 W amps, 2 x ETI480 power supplies and a no-frills version of your 5000 preamp. However, it's time to update to the 6000 series preamp and amps, the only problem being, can I tap the 15 volt rails from the preamp for the active crossovers?

My second question concerns the op-amps employed. My present active circuit, which comes from the National Semiconductor book (18 dB/octave), employs Texas Instruments TL074 low noise devices. However, I see NE5534s mentioned in articles frequently. Are these state of the art devices, or are the TL074s just as suitable?

Thanks very much for your time. Congratulations on the new magazine which is putting much-needed new blood into the marketplace. I'm eagerly awaiting the 6000 series amp!

Paul Martin
Paddington, NSW

The IC voltage regulators in the 6010 preamp dissipate a fairly large amount of power so it is probably not a good idea to use these to power your active crossover. We will be describing a complete active loudspeaker system based around the already described AEM6102 two-way and AEM6103 three-way loudspeakers. The fourth-order active crossover for the system was described in the February issue and the remainder of the active loudspeakers will be described soon. In this system we will be describing a power supply that is suitable for powering the power amps and the active crossover and would therefore probably solve your problem.

Both the TL074 and the NE5534 are excellent op-amps for high quality audio applications. Neither of these devices could now be described as "state of the art". Nevertheless, the TL074 is very good in active crossover designs. It has the advantage of being a quad device and features a high slew rate at unity gain. Furthermore, the very high input impedance arising from its JFET front end is extremely useful for active crossovers.

If you are searching for state of the art op-amps for audio applications then look at the OP37 or one of its derivatives.

David Tilbrook

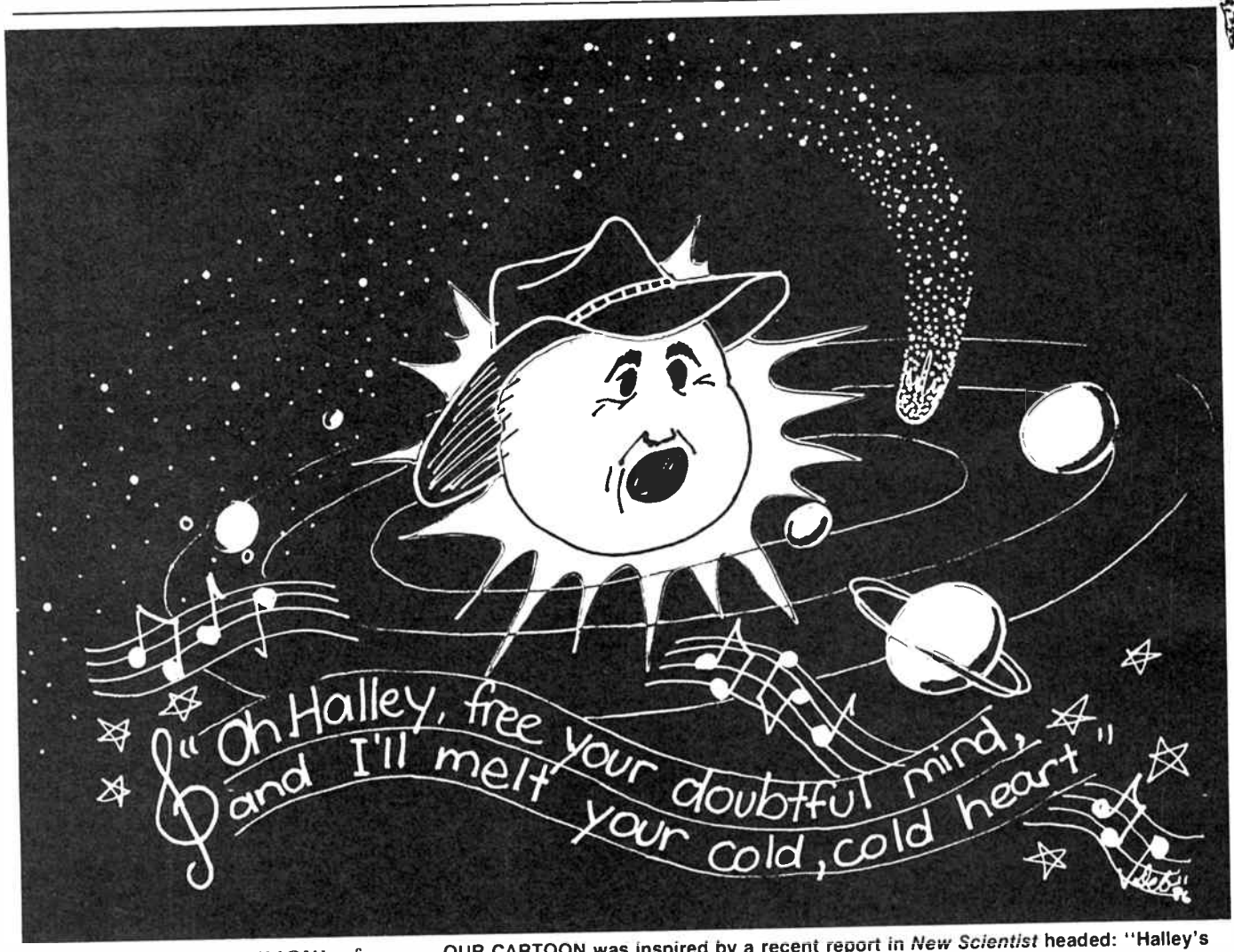
NOTES & ERRATA

AEM6103 3-way Loudspeaker, Jan. '86. In the box drawings on page 53, the section CC and section BB drawings are transposed. Also, the fairies at the bottom of the darkroom stole the port length measurement. It's 225 mm (9").

AEM4503 'Port-A-Bee', Jan. '86. The printers deleted the first line of the first column on page 62 when inserting a correction. The first four lines should read: "(similar) type. The prototype was obtained from Energy Control, PO Box 6502, Goodna Qld 4300. (07) 288 2455. They cost around $70. Other types may be used, of course, but this Hitachi display was the best value."

8 mm Video Tape Technology, Jan. '86. The second last paragraph in the first column on page 111, mentions ". . . the latest National CCD WVP F-2 camcorder . . .". In fact, the F-2 is *only* a camera. Malcolm Goldfinch, the author, apologises for this unfortunate error, but with 'camcorder' used so often throughout the article, it slipped through.

The Last Laugh

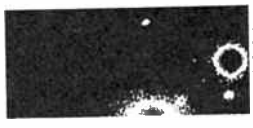


OUR CARTOON was inspired by a recent report in *New Scientist* headed: "Halley's heart is frozen water — official". Cartoon drawn by the talented Debb Currie, spouse of our also-talented draughtsman, David Currie.

New Scientist 17 October 1985 31

SCIENCE

Halley's heart is frozen water—official



Two exposures of Halley's Comet, one hour apart, show its motion relative to the background stars. The coma shows well in these computer processed pictures

READERS WILL KNOW, from AEM's October 1985 issue, that *surface mount devices* are bringing about a shrinkage in the volumetric size of electronic equipment the like of which has not been seen since the introduction of the integrated circuit.

One multinational company with a high profile in the Australasian archipelago seems to be doing remarkably better than their opponents in the market. Since sales figures are not bandied about (not yet, anyway), how do we know? Well, we have heard it from a usually impeccable source that said company is 'sniffing around' the commercial real estate market, looking for new premises.

"Big deal", we said. "If they're doing that well, it's obvious they're looking for room to expand their operation."

"No", said our informant, "their component miniaturisation program is so successful they have to look for smaller premises!"

Even if it plays dead, shoot it!

US President Reagan's widely-publicised militarisation of space policies — with tests of laser beam weapons, the strategic defence initiative ('Star Wars') proposals, etc — seems to have backfired (pun *definitely* intended).

In testing a new anti-satellite weapon last September, the US military blew an 'old' satellite out of the sky. Problem is, it was still working! Scientists complained to the Pentagon that the satellite, called Solwind, was not 'useless', as the Pentagon claimed, but was conducting solar measurements when destroyed.

Who was it said: "The only difference between men and the boys is the price of their toys"?

SPECIAL READER OFFER

A HANDHELD LCD 3 1/2-DIGIT DMM FOR LESS THAN $50

HERE'S A VERY SPECIAL OFFER, EXCLUSIVE TO READERS OF AUSTRALIAN ELECTRONICS MONTHLY.

As an introductory promotion, Parameters are offering their Model 8005 five-function, 3 1/2-digit Handheld Digital Multimeter with liquid crystal display ***exclusively*** to readers of Australian Electronics Monthly at an unbeatably low price.

This Parameters instrument **would be expected to retail for around 30% more than that.** How's that for a saving?

The Parameters 8005 features:

- 3 1/2-digit liquid crystal display
- 5 functions
- 15 ranges
- side pushbutton operation
- 'pocket' size — 130 x 75 x 28 mm
- dc volts to 1 kV in four ranges
- ac volts to 750 V in two ranges
- resistance to 2M in four ranges
- diode test
- basic accuracy, 0.5% (dc V)
- fully overload protected
- safety 'finger guards' on probes
- fully shrouded safety probe plugs
- low battery indicator
- 12 months warranty!

Special Offer Price: $49.75 inc tax, post and packaging

Here's a not-to-be-missed opportunity to obtain an extremely handy, **very portable** digital instrument. If you haven't got a digital multimeter, then **here's your chance to get a quality instrument,** backed by a well-respected organisation that specialises in electronic instruments. If you already own a DMM, then here's your chance to get a second one for those awkward occasions that always arise where you need more than one!

And the price makes it so affordable!

This offer is being made by Parameters as an introductory promotion and Australian Electronics Monthly is acting as a clearing house for orders. All mail orders will be despatched by certified post.

How to order;

COMPLETE THE COUPON AND SEND IT, TOGETHER WITH YOUR CHEQUE, MONEY ORDER OR CREDIT CARD DETAILS, TO:

'Parameters Multimeter Offer'
Australian Electronics Monthly
PO Box 289, WAHROONGA 2076 NSW

Please allow up to four weeks for delivery.

We have checked a sample of the Parameters 8005 DMM in our laboratory and, so far as we could determine, it was within specification and functioned well. The construction makes handheld operation particularly convenient; when held in the left hand, the range and function switches are readily thumb-operated while the probes are manipulated in your right hand. The large display is easily read and it seems to be a robustly constructed instrument. Any hobbyist, serviceman, technician or engineer should find the Parameters 8005 a useful instrument.

COUPON

PLEASE RUSH ME . . . Parameters 8005 dmm(s).

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Signature . . . . . .

(Unsigned orders cannot be accepted)

- If you would like to inspect one of these instruments, 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.

THE ULTIMATE HIS HERS PLUS PRIZE

For Him a Jaguar XJS HE Coupe ($72,000) & for Her a Jaguar XJS ($59,000) PLUS a Haines Hunter 733C Merc Cruiser 260 stern drive engine on a MT250 T-V Trailer ($49,000). TOTAL VALUE with $50 Book Buyers Prize **$220,000.**

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$40 – EIGHT CHANCES –
A Pajero Diesel Super Wagon.
TOTAL VALUE $26,000.
$20 – FOUR CHANCES –
A diamond pendant. TOTAL VALUE $20,000
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A Nimbus 5 speed wagon
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