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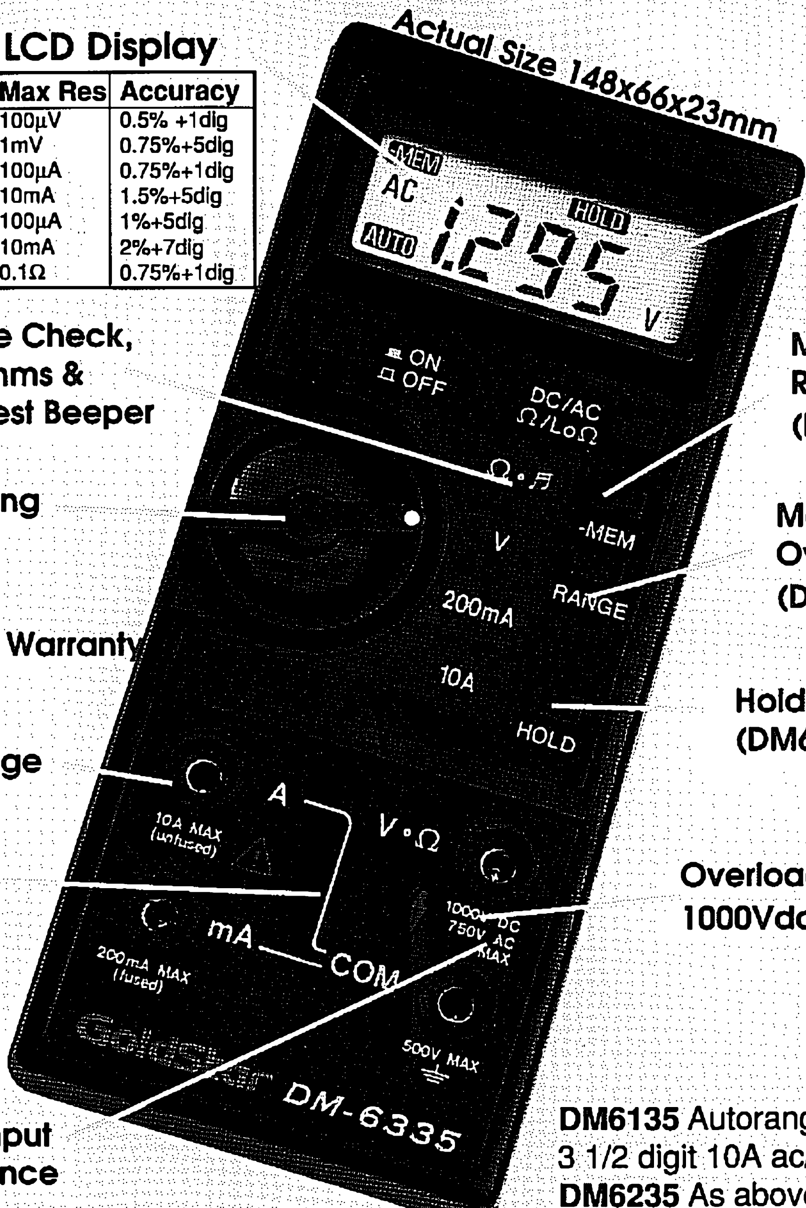

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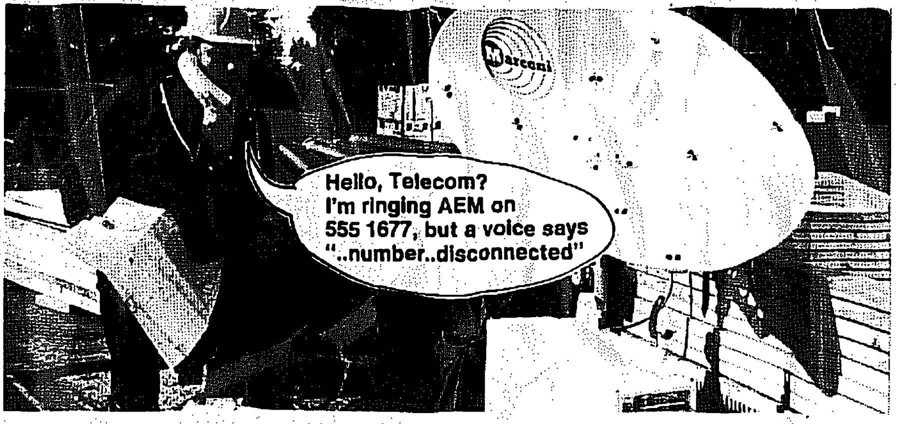

TELEPHONING AEM

If you've had reason to telephone AEM this year, chances are that you probably haven't got through on the first try, or the second try, or - given up after that. The number may have rung for 90 seconds and then dropped out. Or you might have got the busy tone, or perhaps a Telecom recorded message - "The number you have called has been disconnected. . ."

The first two are bad enough, but that last one *infuriates* us! And it probably infuriates another 10 000 or so subscribers on the 55X-prefix series of exchanges, all of whom will have the same problem imposed on their lines simultaneously!

You see, we're serviced by one of a new series of Telecom digital (AXE) exchanges, installed around Sydney's inner west over the past couple of years. Our 555 1677 number has three "rotary" lines (that is, with one call in progress, line 1 is allocated, with the next call, line 2 is allocated, etc). We've been *plagued* with problems ever since we moved to these premises in January. Never mind the problems we had with actually getting a phone service *installed* (as chronicled on Channel 7's *Probe* programme last July), the major problem is actually *getting* the service for which we're paying (in advance).

On a regular basis, and I mean almost *daily*, the lines go out of service, for anything from a few minutes to a few hours. When they do, and you attempt to ring in, the response may be any of those three listed above. The problem, we are advised by the local planning manager, is caused by traffic overload — too many users on the system at once. All the lines "drop out" for a period.

It seems that after thousands of complaints from disgruntled subscribers, especially businesses, Telecom has learned that it's better to have a "message" on the line if a call comes through while the lines are out, rather than the engaged signal or nothing (which means callers think the number is unanswered. . .). So, it was decided (I say "it" because we are unable to determine that a *person* made the decision) to put the "number disconnected" message on when the lines went out. That includes Balmain Police Station's new number. . . Good one, Telecom!

The local planning manager says that the growth rate in lines for this region has exceeded Telecom's planning projections. We understand something is being done to alleviate the congestion, but we are told that the problem of the lines "dropping out" will continue for the forseeable future, perhaps less frequently than in the past. Cold comfort, that.

The disruption to our business, which is very dependent on telephone communications and on Telecom providing an efficient service, is phenomenal. There's a further disruption, when it comes to paying the bill. Subscribers *have to demand* a rebate *each and every time* the lines drop out! You don't get it automatically and you, the subscriber, have to have it reported in order to get a rebate. The only rebate you get is on the rental for the accumulated period the lines were not available.

Ever tried to report a fault so that you get a rental rebate? Boy, the run around, rudeness and bad manners you get! No consideration for disruption, time lost in reporting the faults (from a public phone not on the same exchange), buck-passing, lost business, etc. We're not the only ones affected, there are probably another 10-20 000 subscribers in this area in the same boat!

So, if you call us at any time and the number is engaged for long periods, or goes unanswered, or you get the "number disconnected" message — don't give up, we are here, but it's likely Telecom can't put you through! The problem is not with the technology, I believe that's right up to the minute. It's a management problem. For all the hoo haa in the press recently about Telecom's management restructuring, when will subscribers (at least in this area) see the benefits?

Roger Harrison
Editor/Publisher

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SPECIAL FEATURES

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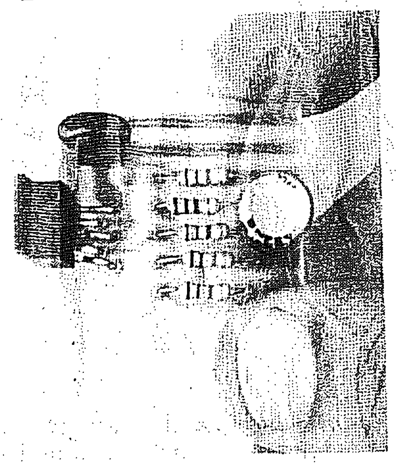
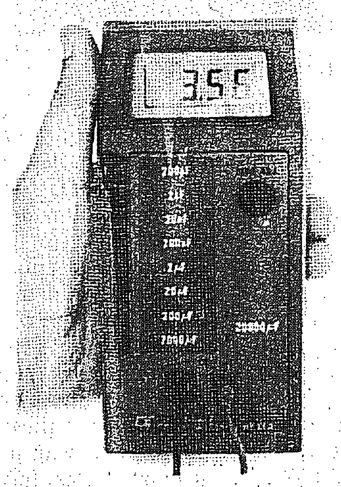
PRACTICALITIES

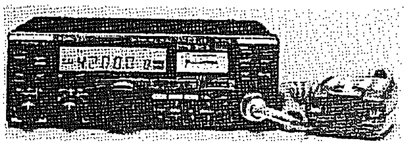


NOTE: The Vintage Restorations column has been held over owing to space constraints.

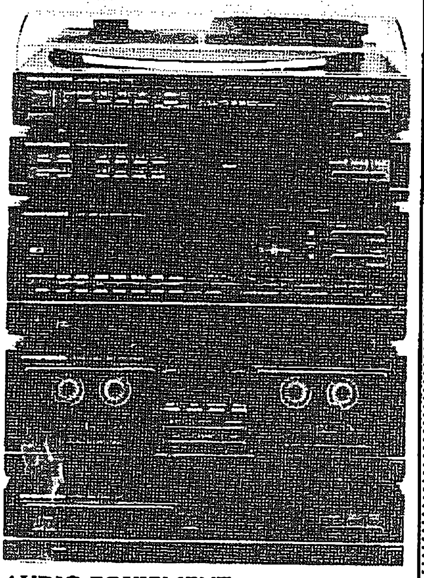
TECHNICALITIES



COMMUNICATIONS



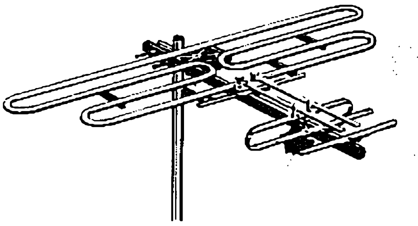
CONSUMER ELECTRONICS



REGULAR FEATURES

COVER
Looking for trouble to shoot in a microcomputer! **Pic:** Richie Nicholson. **Design:** Val Harrison.

NEXT MONTH



IMPROVING YOUR TV RECEPTION — PART1
Picture wobbles got you worried? Ghosting got you going? VHF or UHF — can't decide? Here's a guide to the tips and techniques to get the best TV reception you can in a two-part series. Ben Furby has spoken to the "experts" and gleaned their best advice to pass on to you.

A TEMP-CONTROLLED FAST NICAD CHARGER FOR R/C MODELS
Keeping the charge up to the 7.2 V NiCad batteries widely used in radio-controlled cars etc can be a daunting task. This nifty NiCad charger project properly charges those batteries in quick-fast time, but makes sure they don't overheat — which can be very destructive. It's much more effective than either the crude low-cost commercial designs but doesn't cost an arm and a leg like the "up market" commercial chargers made for this application.

BUILD OUR PROXIMITY/MOTION DETECTOR
This simple project is ideal as an add-on for a burglar alarm system to protect areas impossible to wire-up. Or it could make a great doorway alarm, etc. Dozens of applications! Uses all off-the-shelf parts.

Part 2 of 'Reading Your Oscilloscope' has been held over until next issue.

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

Satellites in Australian search and rescue network

Australia will use the international COSPAS/SARSAT search and rescue (SAR) system based on transponders carried by the Soviet COSPAS and US NOAA polar-orbiting spacecraft.

The system already has an impressive record for lowering times to find victims of marine and air mishaps and has saved hundreds of lives.

Satellite communications would also give reliable communications no matter where the craft was or what the weather was.

The Federal Government will finance a new satellite ground station at Alice Springs to monitor directly radio distress signals over Australia and a large area of surrounding ocean waters.

During this financial year the government will spend $1.24 M on the new facility known as a Local User Terminal (LUT). This will notify the Federal Sea Safety Centre in Canberra almost immediately of sea or air mishaps.

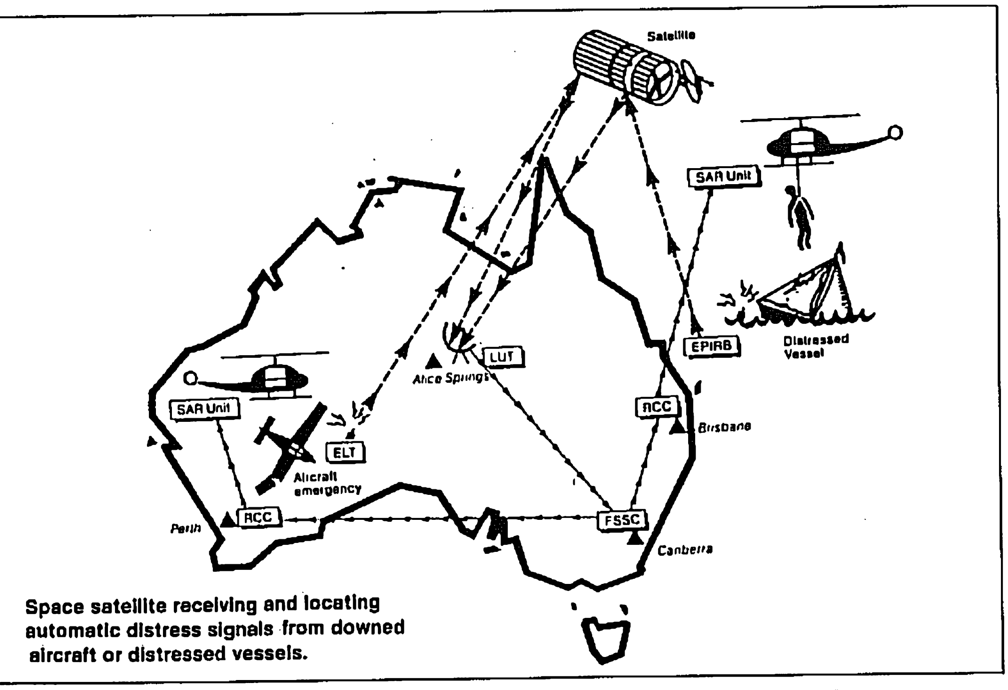
The orbiting spacecraft picks up an automatic distress signal from an Emergency Position Indicating Radio Beacon (EPIRB) and flash it to the LUT. This will then position the EPIRB and relay its location to the Sea Safety Centre.

The system can also receive signals from aircraft emergency location transmitters and savings of $3.5 M have been predicted for when the system is operating fully.

A symposium in Sydney in September provided an excellent forum for the government, shipping industry, maritime unions and state and Northern Territory authorities to discuss the Global Maritime Distress Safety System (GMDSS), according to Department of Transport and Communications spokesman.

"The symposium foreshadowed an international conference to be held in London which is expected to adopt amendments to the Safety of Life at Sea (SOLAS) Convention which will bring GMDSS into force on the proposed date of February 1 1992," she said.

"There will be a transition period of seven years, when all ships of more than 300 gross tons in international voyages will be fitted with either the new satellite or new terrestrial radio equipment depending on where each ship sails."



Space satellite receiving and locating automatic distress signals from downed aircraft or distressed vessels.

Space shortage

Little space for manoeuvre for the Australian Space Board remains after the Federal Budget raised its financing from $3.2M in 1987-88 to $5.4M this year. The board said the money was not enough to support major new space industry technology development projects in 1988-89.

The Industry, Technology and Commerce Minister Senator John Button said the level of financing would allow the Space Office, which was set up late in 1987, to carry on working with industry.

Its rôle is to identify opportunities, stimulate entrepreneurial attitudes and help overcome barriers to Australia's gaining a share of the lucrative international market for high technology space-related products and services.

The minister said a priority during the next year would be to co-ordinate the preparation of an Australian Space Industry Development Strategy. This would set a frame for industry, government, academe and other sections to work constructively towards developing a commercially-viable Australian space industry.

However, Australia is withdrawing from the European Space Agency's Lyman project, which is a powerful ultra-violet space telescope scheduled to fly in 1995.

Lyman would cost $400M and the Australian contribution was $50M. The head of the Lyman team, Dr Michael Dopita, expressed disappointment and said Australia could become involved for $15M, which would give Australia a rôle in spacecraft engineering and construction, and equipment design.

Australia has completed two space payloads: the Endeavour space astronomy payload, now awaiting a shuttle berth, and the digital flight electronics unit for the European ERS-1 spacecraft scheduled to launch in 1990.

Export award for bionic ear

Australian electronics technology has created a small but highly successful export market for Sydney high-tech company Cochlear, and has won for it Austrade's Media Marketing Award.

Cochlear, one of the Nucleus group of companies, was established in 1983 to make, market and develop the bionic ear implant which was based on work by Professor Clark and his team at Melbourne University and 20 years' heart pacemaker experience. The implant gives deaf people some hearing.

While presenting an award to the Cochlear company at its Lane Cove premises last month, Austrade's chairman Mr Bill Ferris said many Australian companies had resisted exporting because it was too much trouble or the margins were too low.

"But this company has established a rôle model of what can be achieved," he said.

"They have had to be competitive to exist," Mr Ferris said.

(One wonders how many gutless Australians who give up at the thought of competition need a bionic implant before they will hear the message. — Ed.)

More than 90 per cent of Cochlear's sales are in its export market, the breakthrough having come in 1985 when the US Food and Drug Administration approved the bionic ear implant.

Cochlear's export success with its bionic ear exemplifies the elements advocated for years as the sort of way this country must go.

The product is high-tech, owing a lot to university research. (Never forget that Hewlett Packard began in a garage, but based on Stanford University's research facilities.) It uses the high level of technical education existing in Australia.

It is batch production, so not likely to attract competition from the mass-manufacturers of the USA, Europe, or Asia.

As a product of small size but high value, it represents the classic Swiss watch export: to send the product around the world costs only a small proportion of its selling price. Thus Australia's distance from world markets becomes irrelevant in this instance.

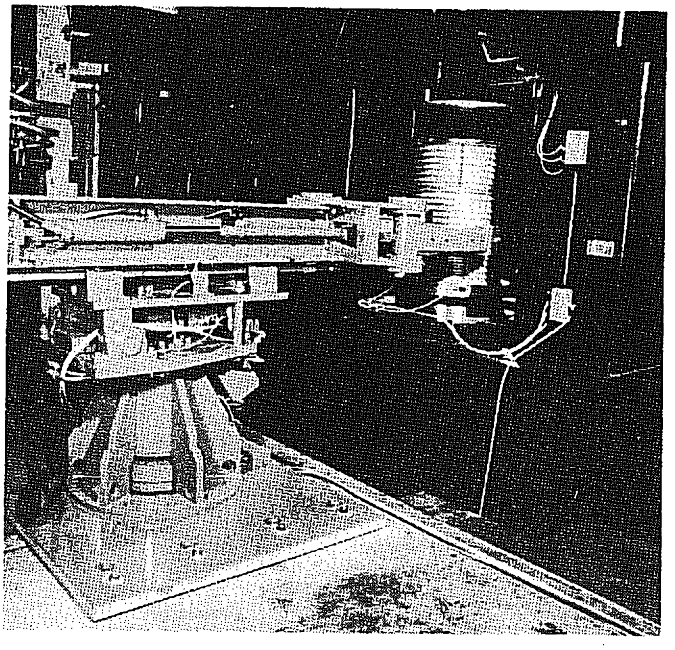
Cochlear has established for itself expertise and experience that make it uneconomic for any would-be competitor to challenge.

Recognition and encouragement of Cochlear's success by Austrade (the Australian Trade Commission), as an example to others, also in reverse recognises an enlightened political administration (Senator Button is the responsible minister), without which industry cannot flourish.

Our robot population growth reaches 30 per cent

Robots in manufacturing and industry formed the subject of a symposium at Sydney, November 6 to 10, when more than 70 speakers from Australia and overseas spoke to the theme: "Robots: Coming of Age".

Keynote speaker Dr Peter Davey of Meta Machines in the UK discussed the need for future robots to have sensors and intelligence developed to create new generations of machines.



He believed sensors would be necessary before the robots' population could rise dramatically, although industrial robots made up the great percentage of the robot population.

Dr Davey described three leading groups of industrial robot applications which sensors benefited: mechanical and electronic assembly; seam welding, including all arc, plasma and laser welding; and a third area including seam sealing, transport, deburring, cutting and similar operations that had to be related to the actual positioning of part surfaces or joints.

Another speaker, Mr George Dodd of the Computer Science Department of General Motors' Research Laboratories in the US, discussed artificial intelligence using robots, machine vision and knowledge-based techniques in car making.

Despite the numbers of robots in car making, Mr Dodd believed that area still needed a lot of development.

"Robot capabilities must be expanded to provide responsive control using input from sensors," he said.

"Robot hands and grippers should be generalised, eliminating the need to redesign the robot when it handles new parts.

"Material delivery systems and programming language capabilities must be expanded to accommodate variation in the workplace."

He said machine vision systems needed to be generalised, sped up and their costs reduced. Researchers working in those areas should become more familiar with industrial processes and issues.

The symposium, designated the 19th by the International Federation of Robotics, was the first in the Southern Hemisphere. It is sponsored by the Australian Robot Association, the national professional society concerned with robots and their applications and implications.

The symposium and exposition was being jointly promoted with World Expo 88, with financial help from the NSW Department of Business and Consumer Affairs.

The man regarded as the "Father of Robots" addressed the opening session in the Sydney Opera House, reporting steps to develop robots to do useful tasks in homes.

Australia has a robot population estimated at 950 with a yearly growth of 30 per cent. Like other countries, Australia uses them largely in car manufacture, with Ford and General Motors-Holden having increased their numbers. Arc welding is a large application for robots.

The Federal Government has designated robots as a "sunrise industry" worth being specially promoted and supported.

A novel Australian use for robots includes a system for loading nuclear waste containers into a press at the Australian Nuclear Science and Technology Organisation's demonstration SYNROC plant, where they handle payload temperatures above 1100° C.

Lower power bills

By maintaining extremely accurate temperatures in plant and equipment it controls, an energy saving device claims to provide dramatic savings in any commercial or industrial plant in refrigeration, air conditioning or hot water.

An invention from Queensland, the Energy Saver — an energy monitoring and control unit — has been tested commercially at such places as McDonalds, Seaworld, Australia Post, Southport Golf Club and the Ocean Blue Resort, the marketer says.

Average savings of more than 35 per cent in energy costs resulted, the general manager of the maker, Megapine, Mr Ross Hancock said.

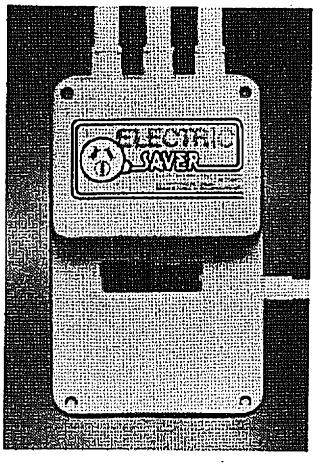
"Our trials suggest it is one of the most efficient energy monitoring and control units in the world, capable of dramatically improving the efficiency of refrigeration, air conditioning and hot water systems and reducing operating costs," he said.

"This is leading-edge Australian technology with worldwide market potential."

He said an example was Squirrells Restaurant on the Gold Coast.

"Trials at the restaurant showed a 48 per cent saving over a six week period, producing a projected full year savings of $956 on an annual power bill for the freezer equipment under trial."

Mr Hancock said Megapine was so confident of the unit it was backing it with a moneyback guarantee against a pledge to save at least 20 per cent in electricity costs or an 18 month payback period.



The Energy Saver is an intelligent, microprocessor-controlled thermostat/timer that replaces conventional capillary, bi-metal and thermocouple thermostats, significantly improving the efficiency and cost-effectiveness of energy use.

It is self-programming, adjusting to the thermodynamics of each individual application through a 24-hour "learning" cycle, enabling it to ascertain the period and frequency for the ▷

plant/equipment to be switched on to maintain a constant temperature and then modify the cycle to use energy best.

It has a differential thermostat precise to ±1° C, with a protective anti-short cycle mode for cooling compressors, reducing temperature swings and energy consumption. It automatically reprograms itself every 14 days to allow for changes in environment and season and load.

An override control ensures strict temperature maintenance. There is a constant digital temperature display with the temperature monitored and displayed every 30 seconds, and an alarm which is triggered should the controlled equipment fail or develop a fault.

Megapine's office is at Level 41, **Northpoint Tower, cnr Miller St and Pacific Hwy, North Sydney, 2060 NSW.**

Aussie company takes bells to Bell

A local telecommunications company, Perth-based QPSX Communications, 18 months after forming has broken through two barriers: the first, to create a revolutionary high speed transmission system, and to sell a pilot installation in the US to Bell Atlantic.

QSPX's executive co-director, John Hullet, said the technology of the integrated voice, data, conference video, image and graphics transmission system represented a breakthrough as significant as the computer chip's development for computers.

"The system enables different kinds of communication requirements, including those for computers and telephones, to share the same wiring and switchgear," Mr Hullet said.

"It also speeds up information transfer so that specially complex messages — pictures, plans and even medical diagnostic images — can be transmitted with speed and ease.

"Diagnosticians, for example, wherever they are, may have immediate access to patient X-ray and CAT scan records from vast computer memories."

QSPX is a joint venture between Telecom Australia and Unicom Research, which is a University of Western Australia company.

Mr Hullet said Bell Atlantic had evaluated the system, and had agreed with QSPX to install a trial system in Philadelphia.

"This contract is a major breakthrough for QSPX Communications," he said.

"Bell Atlantic is one of seven major Regional Bell Operating Companies providing telephone services to US customers. We are negotiating with the other six, as well as major telecommunication authorities in Europe and Japan.

"We expect this contract to encourage many of them to follow Bell Atlantic's lead."

Australia imports about $A1000M worth of telecommunications equipment each year but its exports come to only $A50M.

Mr Hullet said the imbalance arose because Australia was a only a maker of telecommunications gear, not a designer.

"The technology breakthrough gives Australia the very real capability to address the trade imbalance.

"One of our major coups has been having the system accepted as the new International Standard for Metropolitan Area Networks.

"This has been a primary factor in mounting an effective US marketing and positioning campaign."

A similar pilot project, for Telecom Austria, worth $5M, would provide trial Metropolitan Area Networks (MANs) in Sydney and Melbourne, beginning early next year.

Fibre optic transmission is ideal for the QSPX MANs because of fibre optic's high bandwidth and low bit error rate.

QSPX said the technology would make a major impact on telecommunications in the next decade, allowing the concept of a global electronic village to become reality.

Life after the Tower of Babel

Four ASC language laboratories have been added to the original two that Sydney University bought in 1977. The four new ones can each accommodate 22 students during class session, with 160 one-hour sessions scheduled each week.

French is popular, followed by Italian and German, but with Japanese increasing in popularity.

Big Australian spaces out

BHP has set up an aerospace and electronics subsidiary that it says is shortlisted to bid for the up to $500 M worth of work to develop Australia's Jindalee over-the-horizon radar network.

BHP Aerospace and Electronics is already talking with the US defence contractor Raytheon about possible involvement in the radar project and is looking to supply products and services for civil and defence areas.

The company will also take over BHP Engineering's joint bid for the Royal Australian Navy's $100M laser airborne depth sounder (LADS) project.

Electronics for dopey athletes

Illegal drugs are big money: and the Seoul Olympic doping-control laboratory bought about $US2M worth of equipment to help keep Olympic athletes honest.

The HP equipment had to analyse samples for more than 3700 banned substances, plus several hundred related ones. HP also lent the laboratory another $US1M worth of instruments during the games.

There are five main classes of drugs the athletes might use: stimulants, such as amphetamines and higher-than-normal levels of caffeine; narcotics, including morphine and codeine; anabolic steroids, used to accelerate muscle development; beta blockers, which have nothing to do with VHS but reduce heart rate and give a calming effect; and diuretics, which dilute urine to lower the presence of other banned substances and also help athletes to qualify for lower weight classes before an event.

HP supplied analytical equipment that included gas and liquid chromatograph spectrometer systems (GC/MS, LC/MS) that could detect concentrations as low as one part per 10^9: something like spotting a sugar crystal in a bucket of sand.

The equipment operated 24 hours each day of the games, handling as many as 200 samples daily. All medal winners, fourth place winners and randomly selected athletes were tested.

In all, some 6000 analyses were run on 2000 samples.

HP has supplied sports medicine laboratories to events such as the Pan Am and Asian Games and World Cup Soccer.

Life on the international airwaves

Furthering the modernisation of the Voice of America broadcasting, the American Government has contracted to spend more than $US56 M for state of the art 500 kW shortwave transmitters and ancilliary equipment.

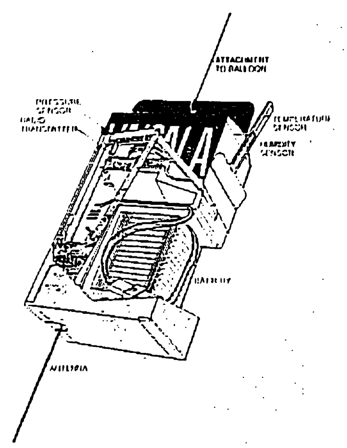
The latter includes a high power switch matrix, coaxial transmission lines, baluns, dummy loads and related equipment for VoA's new station in Morocco.

Contract options will allow standardisation on identical equipment if money is granted to for the VoA to proceed with planned new stations in Thailand, Sri Lanka and Botswana.

While 78 per cent of the money will be spent in the US, either Thomson-CSF of France or its American licensee, Varian-Eimac

Weather stations beam it down, Scotty

The 32 observing stations in the Australian Bureau of Meteorology will get a two year supply of modern, lightweight radiosondes and ground based equipment, including microcomputers for processing and transmitting weather information.



Cut away drawing of the Vaisala radiosonde, which in 1990 will be reporting weather data in Australia's skies up to 30 km. It is 1447 x 90 x 55 mm, weighs 100 grams, and is transported by a hydrogen-filled balloon.

The radiosondes are balloon-borne instrumented packages that transmit temperature, pressure and relative humidity measurements every few seconds, up to altitudes of 30 km.

Costing $4.12M, the contract provides for spending up to $11.7M over the next 10 years at the Bureau's option. The contract is with Vaisala, an Australian subsidiary of the Finnish firm Vaisala Oi.

The new system will be more accurate and reliable, and will make the data available faster and more frequently. The Bureau expects it to be operating in its upper air observing stations by early 1990.

WIN!

We could have said **SUBSCRIBE!**, but that's not as enticing as WINNING something. By subscribing to *Australian Electronics Monthly* in the next few months you could be doing both, subscribing **and** winning.

How, I hear you ask? Well, AEM, in conjunction with Tektronix are offering you, our devoted readers, the chance to win this Tektronix Electronic Workshop, as pictured.

Just think, you could be the proud owner of not only a subscription to Australia's finest electronics magazine, but the smug possessor of four pieces of lab equipment from the highly regarded Tektronix range, generously offered by Tektronix Australia.

So, you could say you'll be winning in two ways. You get the chance to win the Tektronix workshop and be the envy of all your mates, AND you get Australian Electronics Monthly mailed straight to your home or work, also becoming the envy of all your mates. HOW CAN YOU LOSE?

Don't wait! Complete the coupon provided and mail it TODAY! Just fill in the details, answer the question and tell us in twenty-five words or less what is attractive about this offer. It's that simple!

Yes, I would like to subscribe to Australian Electronics Monthly for:

☐ 1 year ($42)
☐ 2 years ($78)

NZ: A$60 1 yr surface mail, A$66 air mail.
(Unfortunately competition is unavailable to residents outside Australia)
Overseas rates on application.

☐ Yes, I do want to enter the competition.
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I am paying by:
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Name: ______

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Phone: (__) ______

Signed: ______
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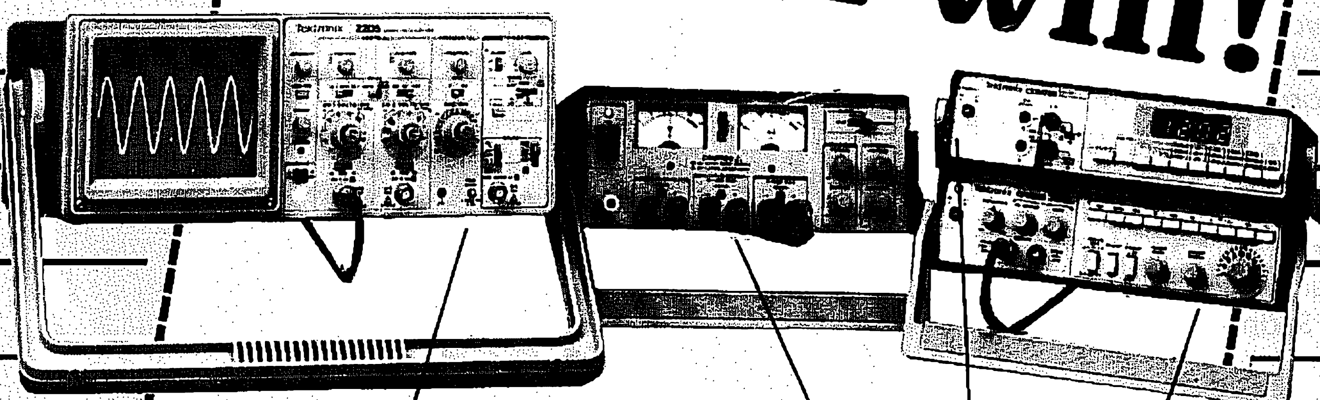
● Q. What is the name of the circuit in any oscilloscope which sweeps the spot from left to right across the screen?

Tell us in 25 words or less what is attractive about this special offer.

Here's what you can win!



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The competition is open only to Australian Residents authorising a new subscription or renewing an existing one before the last mail on December 31st 1988. Orders received postmarked after this date will not be included in the competition. 2. Employees of Australian Electronics Monthly, the printer Offset Alpine, the magazine distributor Network Distribution Company and Tektronix and their families are not eligible to enter. 3. Residents of South Australia need not order a subscription to enter, but may enter, once only, by submitting their name, address, and phone number on a hand written facsimile of the coupon. 4. The competition commences on 30 Sept. 1988. Judging will take place in Sydney between 3rd and 10th Jan. 1989 and the winner will be notified by mail and phone. Results will be published in the next available issue of the magazine. 5. Prize may not be transferred or exchanged or exchanged for cash. 6. Competition unavailable to residents outside Australia.

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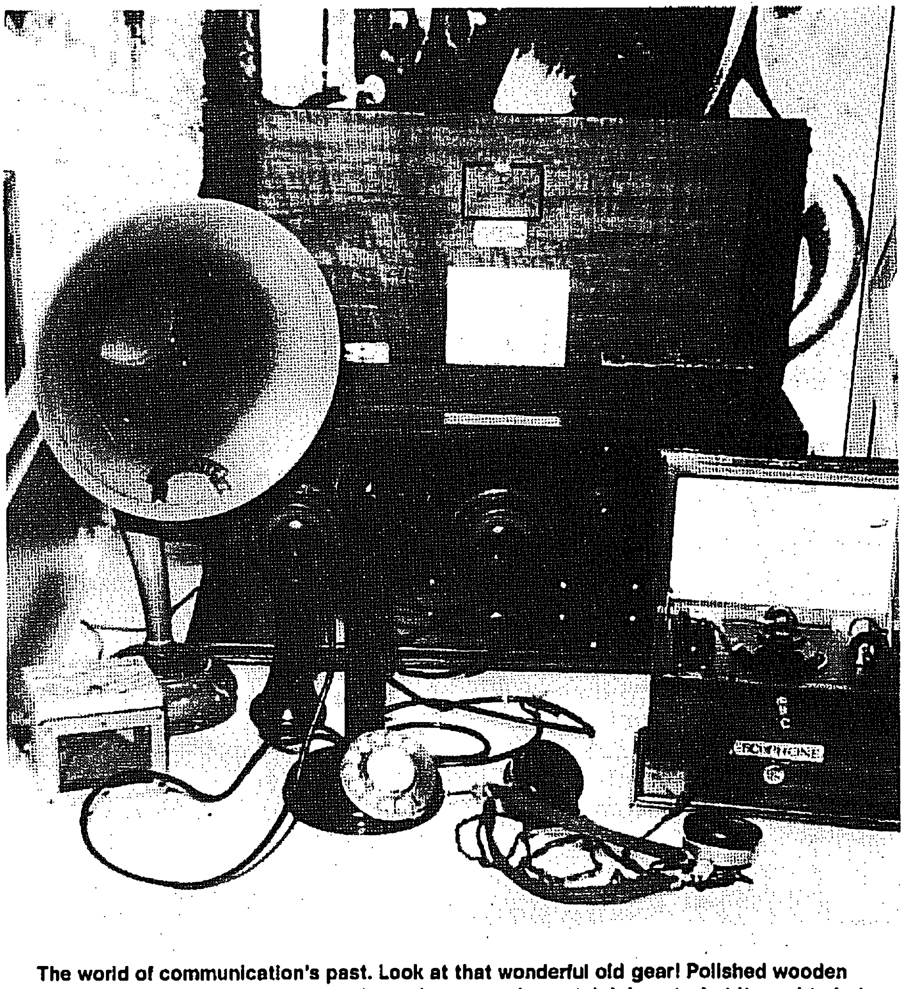
OTC on show

Ben Furby

If you thought OTC stood for *Old Timers' Communications* you could be forgiven, but only after viewing the OTC's "Settlement to Satellites" exhibition, currently on display in Sydney.



The world of communication's past. Look at that wonderful old gear! Polished wooden cabinets, bakelite panels, chromed metal parts — ah, nostalgia's not what it used to be!

NOW RECOGNISED as electronics' Most Endangered Species, a UV201A valve has been trapped and brought into captivity. If you live in Sydney, you have the chance to see it on display. The LEGENDARY '01A is one of many exhibits, old and new, on show daily, 10 am to 4 pm, until March next year at the Overseas Telecom Commission's International Communications Centre in Paddington, Sydney.

You can see fibre optic cable, with repeaters as will carry communications under the Tasman, along with models of satellites carrying communications above the Tasman, the Pacific and other seas.

Computer terminals where you can access news, airline bookings, and other information sources, that we have been saying for years must come, are glimpsed at the exhibition. You can try them for yourself, for hands-on experience.

Interesting times

What I found particularly interesting was the Wheatstone and Cooke single-needle telegraph: somewhat different from the pair I made in my schooldays, but the same principle. The single needle instrument was derived from the original five-needle telegraph, the world's first practical electrical one. Wheatstone also crops up again with his alphabet telegraph instrument, and Morse gets into the act with a sounder and inker or two.

Thomson, before he became Lord Kelvin, is represented by the classic mirror telegraph for the Atlantic cable.

Samples of cables, historical and recent, contrast with the small size of the Tasman fibre optic one which will carry our undersea telecommunications for decades to come.

For those who think that old radios with valves are boring modern technology, there are one or two examples of coherers, proving that there was radio BV (before valves!).

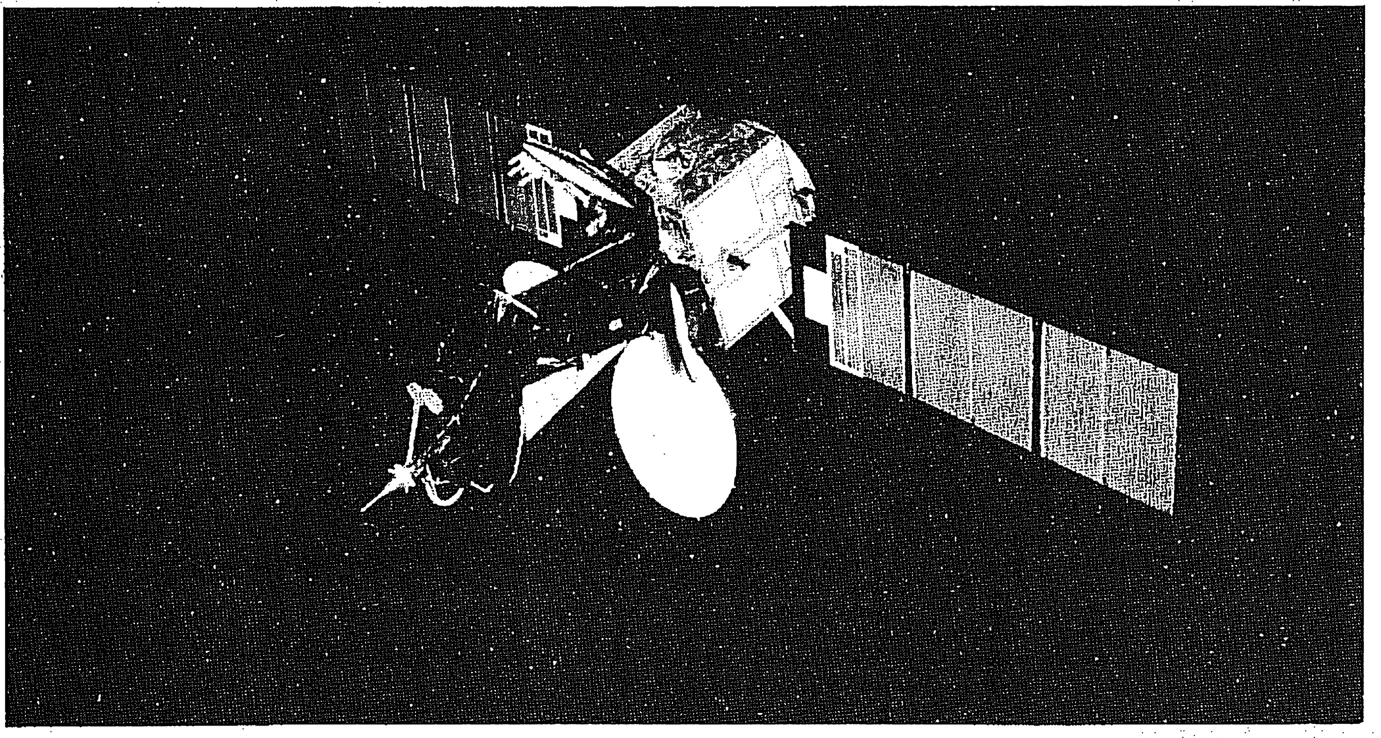
You can see solid-state, circa 1912, complete with catswhisker, illustrating the march of technology. The crystal and its holder take up more space than a board mounting half a dozen ICs.

If you bring a friend, you can talk to each other while watching the other person in a videophone. But if you're by yourself you can experiment with the Lost for Words game. This responds to five languages but despite its boasted erudition, it doesn't recognise French. Funny, because I had good teachers.... Alors! The computer must have a southern or Breton accent, which is why it couldn't understand my Parisien, bien sûr! At least one knows now that "destra" is Italian for "right", so maybe I had better take up Italian instead.

Wot bloke said electronics ain't cultural?

There are quite a few "brass pounder" Morse keys, but none of those bug keys, the answer to RSI before RSI became fashionable and got a fancy name.

The only other time I've seen so much



INTELSAT V, a geostationary satellite, one of today's links overseas provided for Australia via OTC.

interesting telegraph and early radio gear, I had had to find a job as a ship's fireman and work my passage to England to see the displays at the Kensington Science Museum. Now OTC has made that experience irrelevant by bringing this gear to Sydney.

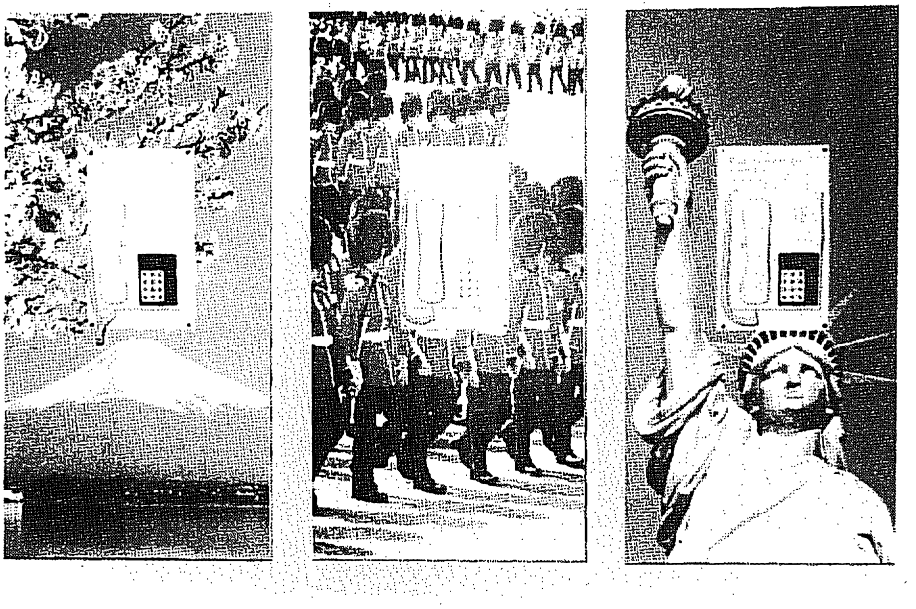
One trusts that all Australia Post staff in Sydney have been ordered to inspect the display? The demo on electronic mail ought to put the comeuppance on those Posties busy engineering themselves out of a job. Roll on electronic mail! No penalty rates for computers, so look forward to full weekday delivery service Saturdays and Sundays once electronics mail gets into full swing.

Australia's vast, empty spaces have always made it depend heavily on communications and this is partly why the advent of the electric telegraph meant so much to our European forefathers, as did the telegraph's developments and successors, such as "wireless telegraphy". The Aborigines, of course, had communications well under control, what with telepathy and other subtle ways, not of our understanding. Which is why this exhibition, although Australian, does not have any Aboriginal artifacts.

Old and young — get to see OTC's bicentenary year exhibition if you can. There are memories for the old, with some exhibits on loan from overseas museums. For the young, it's a brush with technical history that can be informative and instructive. You are not likely to get another chance to see this sort of gear for a pretty long time.

For both young and old, it's a glimpse into the electronics communications future, to help clear the mind of past encumbrances in readiness for dazzling concepts in communications. (Is that the sort of ringing stuff you hired me to write about, Roger?). And entry is free.

P.S: Not an answer to the questions they ask you at the passing-out exams at the RMIT, but did you know that the 6 V filament, triode 01A valve mentioned in the first par of the above story will also rectify? It used to work quite happily if an 80 rectifier died on you and you didn't have a spare. The 01A's pins fitted into an 80 socket, the 6 V filament chugged merrily along on the 80's 5 V supply, and the grid and plate each got a kick out of playing at being rectifier anodes. This is also the sort of useful, life-of-the-party information you can trot out if don't know what to say if you meet the Queen or when you are stuck for words having drinks with the Playhouse Pet of the Year at a JVC press function. Just be sure you say you read about it in AEM, of course!



You can try out OTC's free(!) international direct dial (IDD) service to find out the weather details in New York, what's to do in Tokyo or the London train timetable. Perhaps you should drop into OTC's Paddington exhibition on your way out to Sydney's international air terminal!

New speakers are literally 'off the wall'

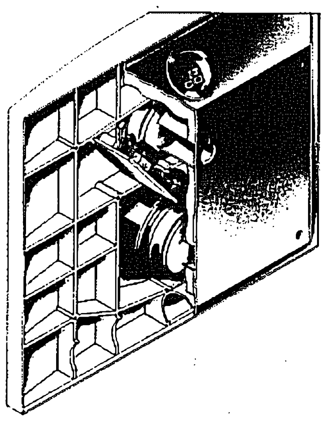
Danish loudspeaker manufacturer, Jamo, is "returning" to the quality hi-fi market with the launch of a new range of loudspeakers, including one innovative model designed for wall mounting.

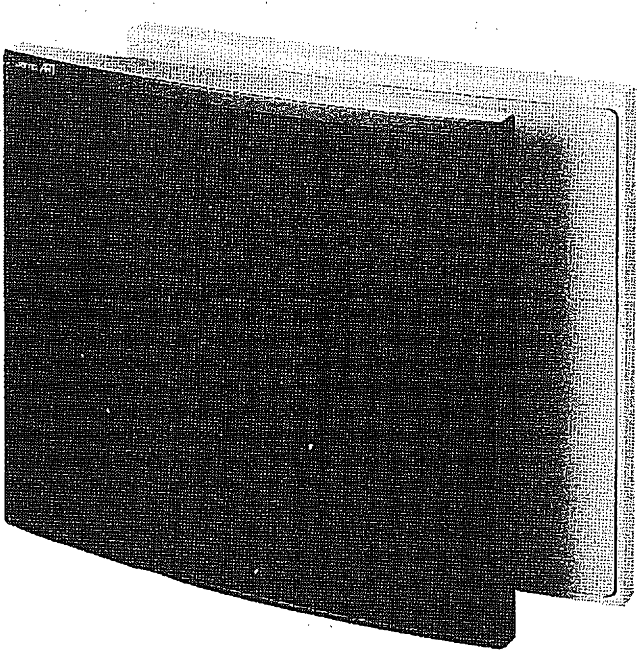
"Take down the reproductions and put up an original piece of art", goes the pun in the press release. But hype aside, the new Jamo Art loudspeaker is the size of a 20-inch TV monitor screen and flat — just 90 mm deep — to mount elegantly and unobtrusively on a wall.

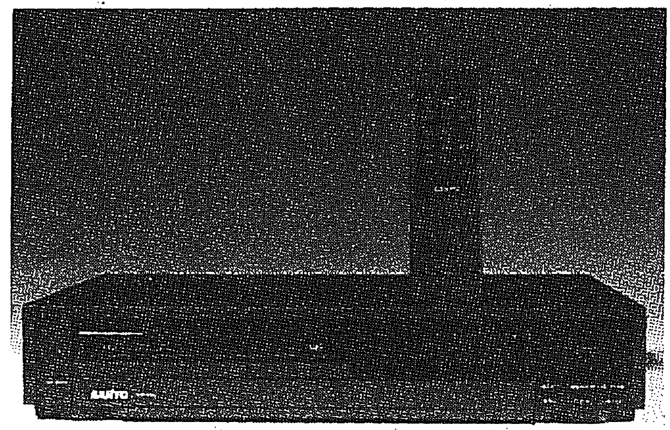
The company says it is almost impossible to make a flat loudspeaker using conventional production techniques. Which explains why the front panel of the Jamo Art is made of a one-piece injection moulded ABS material reinforced with what Jamo say is a computer-optimised pattern of ribs to provide stiffness.

The rear panel is a form-pressed heavy steel plate, covered on the inside with a synthetic foam material for optimum damping. Screwing the front and rear plates together locks the drivers in place, eliminating resonances, Jamo says.

The Jamo Art is a two-way design using a 125 mm diameter driver with rubber roll-surround for bass and mid-range.







Believe it or not, the cabinet is a bass reflex design, with the port designed into the moulding as an integral canal, venting to the rear. This arrangement is said to improve the bass by means of wall reflection.

The high frequencies are handled by a new 25 mm impregnated textile dome tweeter featuring wide dispersion, according to Jamo.

The crossover network is a computer-optimised (what *isn't* these days?) 2nd-order network with a crossover point at 3 kHz.

The front panel has a high-gloss, two-component lacquer finish in either black or white. The slight curvature of the front panel is said to eliminate diffraction at the higher frequencies. It measures 350 × 400 mm.

The Jamo Art is rated for 60 W continuous power; 35 W IEC standard rating. Jamo say it is suitable for amplifiers rated at 30 to 90 W. Frequency response is quoted as 40 Hz to 20 kHz.

For those wanting a more conventional loudspeaker, a bookshelf version of the Jamo Art is available, dubbed the Monitor-One. It, too, is finished in either black or white, uses identical drivers and technical data are very similar.

At the demonstration given by distributor, Scan Audio, in Sydney, the Jamo Art acquitted themselves very well, but they bear closer examination.

A powered subwoofer, the Jamo SW-50, was also released along with the Jamo Art and Monitor-One.

Further details available from Scan Audio, 52 Crown St, Richmond 3121 Vic. (03)429 2199.

Feature-packed VCR

Claiming more features in its price range than other VCRs, the Sanyo VHR-4100 numbers among them automatic play when a tape is inserted, automatic rewind at end of play, or automatic play on rewinding tape.

Its "lesson repeat" function allows any section of a tape to be replayed up to five replays at a time, as when a sports or training tape is being viewed. So if a step is missed, the "lesson repeat" is pushed twice to mark the segment, then push the "lesson repeat" control to see the segment repeated five times.

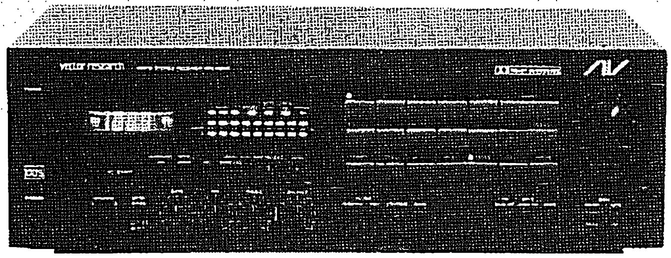
The VCR has a five minute memory back-up that retains all programmed functions such as clock time and program record for up to five minutes during a power failure.

The VHR-4100 is 79 mm high, and is priced at $649 rrp.

Vector Research back on the market

A concept of shared manufacture lies behind the launch of a new range of audio and video products from Vector Research, distributed in this country by NZ Marketing.

The range includes the VRX 2700 audio/video receiver; the VRX 3600R and 5200R receivers with remote control capabilities; the VRX 9200R receiver with surround sound; double cassette decks VCX 325 and 345; and VCD 400 CD player with remote control.



Initial production of these units begins in Korea, by specially licensed companies, with final assembly and quality test procedures completed at Vector's plant in California, USA.

The company says it combines advanced technological know-how with lower production cost, resulting in a more attractively priced, high quality product.

NZ Marketing is at 8 Tengah **Crescent, Mona Vale, NSW 2103.**

CD drivetime

A combined CD player and FM/AM tuner from Pioneer is designed for cars, and its high power amplifier has gold-plated RCA pre-outputs for easily adding another power amplifier for even louder sound, we're told.

The CD player has a three-beam laser pickup to attain accurate tracking under harsh conditions, and it has two-times oversampling to supply clear "soundstage" imaging and less noise, Pioneer say.

Other features in the installation are a preamp fader to control volume between front and rear speakers when another amplifier is fitted, and a memory for automatically presetting the six most powerful stations each AM and FM, along with 24 station presets and scanning function.

The DEH-66 has a "secret code" restricting its use to those who know the code. It will set you back $1299 (rrp).

Pioneer is also releasing its TS-1203 dual-cone speaker, ideal for small cars they say. The speaker handles 40 W, and has 120 mm diameter water-resistant cones. Its mounting depth of 26 mm allows it to fit into narrow door spacing in smaller cars; $90 (rrp) per pair.

ABC accepts Audiosound

The new ABC studio complex at Lismore, NSW, has for main studio monitors the Audiosound Laboratories 8035 extended bass system, which is claimed to offer subwoofer performance with smooth time aligned top end.

Other monitors used are the 8025 mini-monitor, which, although small, claims -3 dB at 50 Hz; the 8011A; and for general purpose monitoring 8002s are used.

Another unit supplied is the PM60 two unit balanced input MOSFET power amplifiers.

For more details: **Audiosound Laboratories, 148 Pitt Rd, North Curl Curl, NSW 2099.**

Head news

Reminiscent of those cracks about the blank space between the headphones, comes the news from tapemaker TDK that VCR video heads have gaps that are 0.5 (mu)m wide, which is four times smaller than the gaps in audio tape recorders.

"The result is that VCRs are much more sensitive to accumulated dirt deposits, the cause of dropouts and bad picture quality," says TDK.

Just so you do not blame the poor results on the tape, TDK has three new products on the market that will take the cleaners to the VCRs.

The VHS dry head cleaner, TCL-11, which replaces the TCL-30, is good for standard VHS and Super VHS VCRs, we're told.

TDK said the $15 TCL-11 not only cleaned the head but also regulated the head surface, and this was important because of the large area of tape scanned by the head.

Also, according to TDK, there is a further plus in it for the VCR owner worried about the state of his head: "Cleaning with the TCL-11 decreases vibration noise which affects the picture image detail considerably".

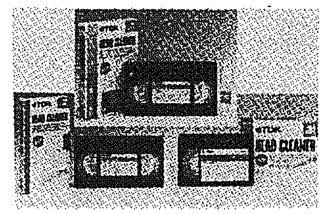
And with all good things coming in threes, TDK throws in the third benefit: "The cleaning effect lasts longer".

So you use the TCL-11 only when the picture image begins to deteriorate.

Second in the trio of cleaners is the TCW-11 Wet Head Cleaner (VHS and S-VHS).

This uses a V-type loading claimed to be unique, safer for the heads because of less friction.

It uses a fixed volume of liquid per shot so it does not damage the VCR's internals, and comes with precise instructions on using it. It's priced at $49.95 rrp.



Last but not least, TDK, which makes VHS-C videotapes shows its concern for getting best performance out of its products by offering the VCL-11 dry head cleaner.

This has the same features as the TCL-11 except that at $26 the price is greater but the cleaner is smaller, to it fit into a C-format camcorder.

TDK has a booklet available with useful hints on cleaning audio and video recorders.

Audio accessories

Designed and developed in Germany, "Monitor" speaker cables, distributed by Arista, are made from 100 per cent oxygen-free copper, with each strand 0.07 mm diameter and plated in silver claimed to be 99.97 per cent pure.

These strands are then woven to obtain greatest cable flexibility. Resistance is 0.00027 Ω per metre. Polarity is identified.

Extra wide centre cable dividers suppress interference patterns between cable conductors, and give a capacity <23 pF per metre. A full range of sizes and qualities available.

Contact **Arista, 57 Vore St, Silverwater, NSW 2141.**

Product improvement is the theme for the latest crop of audio equipment releases for 1989

Ben Furby

Without any startling innovation in hi-fi technology to make waves like CD and DAT did in recent years, this survey of recent releases of what puts the meaning of life into our ears sees product improvement rather than new technology.

COMPONENT HI-FI equipment still dominates the top end of the audio equipment market, while midi systems are consolidating market gains; but they're still far from winning universal acceptance in Australia, where the pattern seems distorted.

In the confined and expensive spaces of Japanese homes, the midi has prevailed 100 per cent, according to figures supplied by Technics, Panasonic's hi-fi subsidiary. The denizens of the UK seem to have an acceptance of the midi equal to the Japanese, while only 20 per cent of the German market is embracing the midi concept so far.

In the land of the gas-guzzler automobile, the US of A, the mentality that seems to think that size is everything does not see merit in the midi:it's a no-no in the land of the free.

In high-rent Sydney, where space is beginning to be a luxury not everyone can afford, the midi has achieved half the hi-fi market. Melbourne lags behind Sydney (so what's new? — just joking!) where only 30 per cent of hi-fi system buyers in the city of big broad boulevards see merit in the space-saving midi.

But in the wide open spaces of this country, where country homes sport wide fireplaces for log fires, the philosophy of "wide can have nothing to hide" has rejected the midi as totally as have the gas-guzzlers on the other side of the Pacific.

Technics says Australia was the first market outside Japan where the midi technology was introduced: but does not analyse our failure to get on to a good thing as smartly as the Brits have.

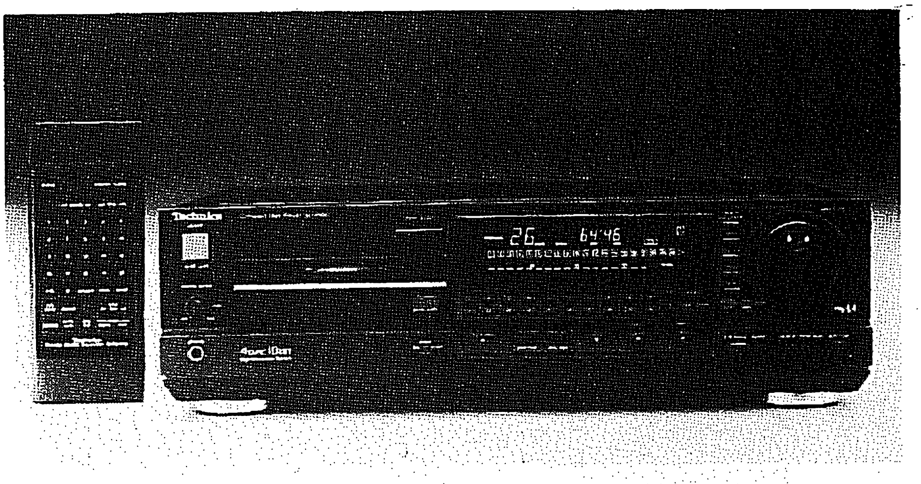
It's a CD future

Technics also said — if not in words, in figures — that it is looking to a CD future. The figures that are open to this interpretation are the 10 models of CD players in Technics' hi-fi product line-up. Contrast these 10 CD players with seven turntables and seven cassette recorders.

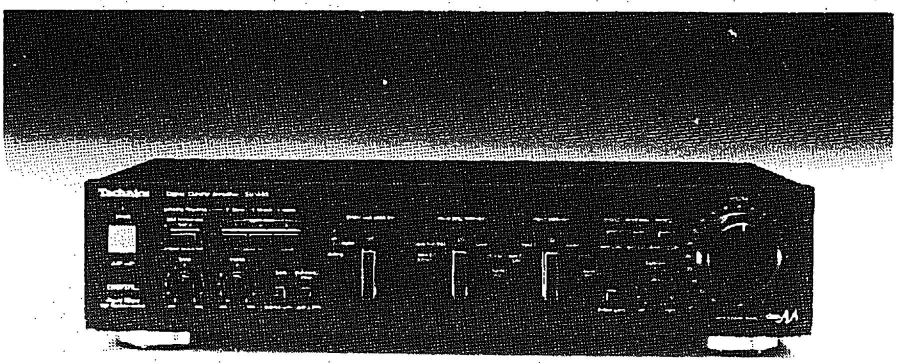
The SL-P1200K hits the top of Technics' CD parade. A professional unit, the P1200K has class AA circuitry in sample and hold circuits and the buffer amplifier, for finer musical detail, Technics claim. Among some of its other features are an anti-resonant tri-layer base construction with damping rubber and metal chassis. It has a two-speed search dial for precisely accessing tracks in three frame increments; high speed D-A converters for each channel to provide high phase linearity; and high resolution digital filter with double over-sampling for improved sound reproduction, the company claims.

With an RRP of $3999 the P1200K does represent the peak of Technics' CDs.

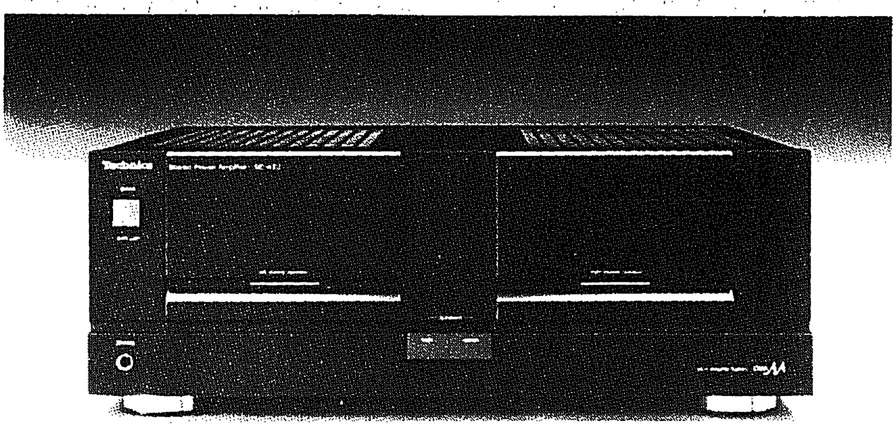
The next is the SL-P990K, which has a more modest RRP of $1599. It has four D-A converters, 18-bit high resolution system that prevents "digital crossover distortion", according to the manufacturers.



The new Technics SL-P990 CD player features a "search dial" that enables you to cue tracks or parts of a track on a disc.



Technics new SU-A60 Digital Control Amplifier features an in-built D-A converter with a facility to select any of three sampling frequencies to cope with differing digital sources.



The SE-A50K power amp heads-up Technics' new power amp range. It delivers 21 W RMS output.

It uses Technics' class AA analogue circuitry for improved sound quality in the line output and headphone circuits.

Except for the SL-P150K (RRP $499) and the SL-PJ25K (RRP $479), all the CD players have remote control. The SL-P400CK is an automatic changer with a six disc magazine.

All the hi-fi range are in "Technics Black", which co-ordinates with the prevailing fashion in TV receivers.

In amplifiers, there are eight models, ranging from the SE-A50K at an RRP of $1999 to the SU-300K at $279. RMS power ratings per channel are:SE-A50K, 210 W; SU-V65K, 150 W; SU-V650K, 135 W; SU-V550K, 100 W; ST-Z980/SU-Z980K, 100 W; SU-Z760K; and SU-300K, 30 W.

In other categories, Technics has five tuners, seven cassette decks, and seven turntables. There is a digital access amplifier, to accept digital signals from CD players with digital outputs, the SA-190K quartz synthesiser receiver with 35 W per channel output, and the SH-8038K graphic equaliser.

There are four pairs of speakers to complement the Technics range of hi-fi components.

There are complete systems also in the range, floor systems and midis. In the Z980 series, each system has a 31-key wireless remote control; 100 W per channel amplifier; double tape cassette deck; and quartz digital tuner with 24 channel presets. A CD player is optional in each of the Z98V, Z980H and Z980D.

The Z78 and Z80 series both offer 80 W per channel, and again the CD player is optional. The Z300V and Z300H are 30 W per channel and the Z190V and Z190H 35 W.

In the midi line of systems, there are the X980D (80 W per channel); X950 (60 W0, X930 (50 W),X920 (40 W), X900 and X900FS (30 W). In all the midi systems a CD player is optional.

Multi-play CD players take hold

Any rundown of Sony hi-fi audio products has to begin with - video!. However, it's a particular facet of Sony's video technology that has a hi-fi aspect. This is the capability of Video 8 (8 mm videotape) video cassette recorders to record up to 18 hours of digital stereo sound when they are not recording video.

The VCRs with this capability are the EV-S700 and the EV-S850. They put down six tracks of stereo audio on the videotape, with a dynamic range of more than 90 dB.

Sony is also active in another aspect of hi-fi and TV. This is in its Black Trinitron series of TV receivers, where some of the range have stereo sound outputs, and a spatial sound effect that produces a stereo sound-alike of a mono signal.

Sony is a strong entry in the hi-fi stakes with a stable capable of ranging over all the courses. As a company greatly involved in CD development it has several CD players representing a high level of variety and performance.

The CDP-C10 holds 10 CDs, guarantee- ▷

Sony's "Discman", probably the "ultimate" in personal portable audio. It plays the new 75 mm CD singles as well as full-size discs.

ing a day of high quality digital music without interruption. Specifications include two times over-sampling; digital filter; dual D-A converter; three-beam laser pickup; wireless remote control with 10-key disc select plus 10-key track select; random access to any selection on any disc and 20-key direct music select.

The disc magazine is fully compatible with the CDX-A20 car CD changer. The CDP-750 offers four times over-sampling, with other features like those of the CDP-M35, CPD-350 and CPD-S27. These include — with some features left out of some models:digital filter; dual D-A converters, envelope differential detection tracking servo; three beam laser pick-up; program edit; 20-key direct access; music calendar display; and others.

Cassette decks are strongly represented in Sony's hi-fi range, highlighting features such as auto-reverse, high speed dubbing, and Dolby B and C.

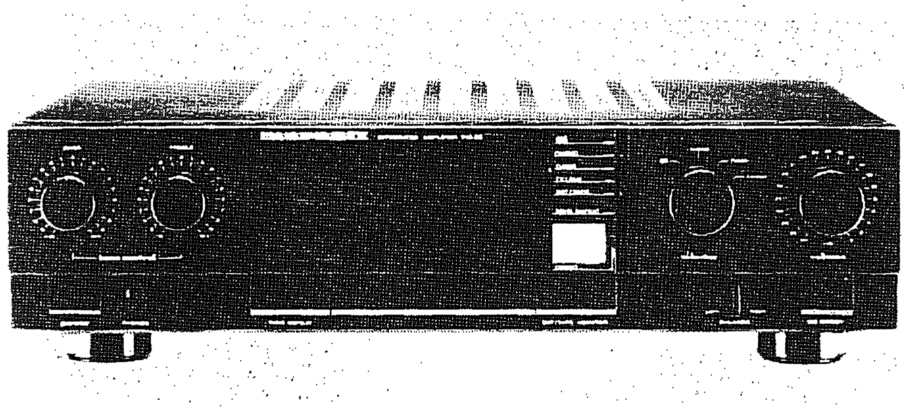
A range of amplifiers, tuners and graphic equalisers provides a choice of features to suit individual taste, while maintaining standards of workmanship.

Sony started the "personal audio" craze with their Walkman; and they have continued with a range of products in the same vein - the latest being the *tiny* "Discman" personal portable CD player. The bonus is, it accepts the new CD "singles".

While not hi-fi, Sony has also released a range of colourfully presented portable audio gear, such as: a radio cassette-corder, cassette recorder with microphone and walkie-talkie headsets. These products aim to attract children to Sony and keep them as lifetime Sony customers, hi-fi and all. That's marketing!

The digital-age power amp

Hailed as the first of a new generation of audio power amplifiers, the Marantz PM95 can accept digital audio signals and perform the D-A conversion all in the one cabinet, just before the power amplification stage.



The new Marantz PM35 integrated amp is in the "traditional mold", but incorporates a preamp bypass for direct input from the analogue output of a digital source such as a CD player.

The design philosophy is that with CD established and having introduced digital signals into audio reproduction, and with DAT and CD-video imminent, digital audio is beginning to supplement analogue. A likely development in the future, digital satellite broadcasting, will extend the trend to digital.

The PM95 accepts all three standard sampling rates:32, 44.1 and 48 kHz, so it will be compatible with future digital developments. By converting the digital signal to analogue just before the power amplification stage, the PM 95 renders unnecessary the exacting, but imperfect, preamplification stages with their penalty of inherent circuit noise.

For an amplifier handling extremely fast transient attack and wide dynamic range, the PM95 can deliver a conservative 150 W, even into complex loudspeaker loads, Marantz claim. But for the 'purest' listening at normal levels, you can switch it to class A operation, delivering up to 20 W output.

The amplifier accepts both optical and electronic digital inputs, and the DAT circuit also has an optical input for digital tape monitoring. Using technology developed from CD players and signal processors, the amplifier has four times over-sampling D-A converters. Other refinements include a newly-developed 9th-order digital filter and jitter elimination circuits, as fitted to the CD12 CD player, to improve distortion across the whole bandwidth, says Marantz.

Jitter is a problem, apparently, with optical coupling of digital signals; vibration or movement of the optical cables and circuitry introduces ever so slight timing variations of the digital pulses. In turn, this appears as distortion in the output. Hence the emphasis on anti-vibration chassis in Marantz equipment.

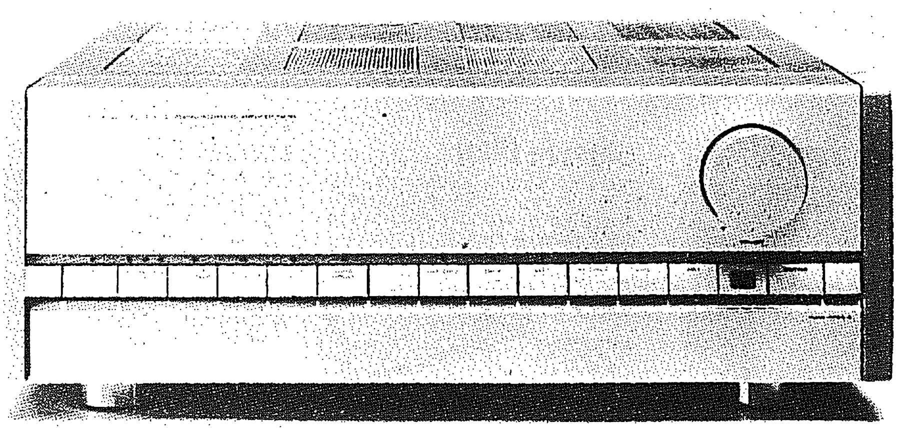
A "digital direct" switch bypasses the source selector and balance control to give the most direct audio path, to do away with further possible distortion sources. In keeping with present high fidelity thinking, there are no tone controls.

The chassis is diecast in non-magnetic aluminium; the top plate is a rigid aluminium extrusion; and the feet are plaster-filled:all to cut out sources of vibration.

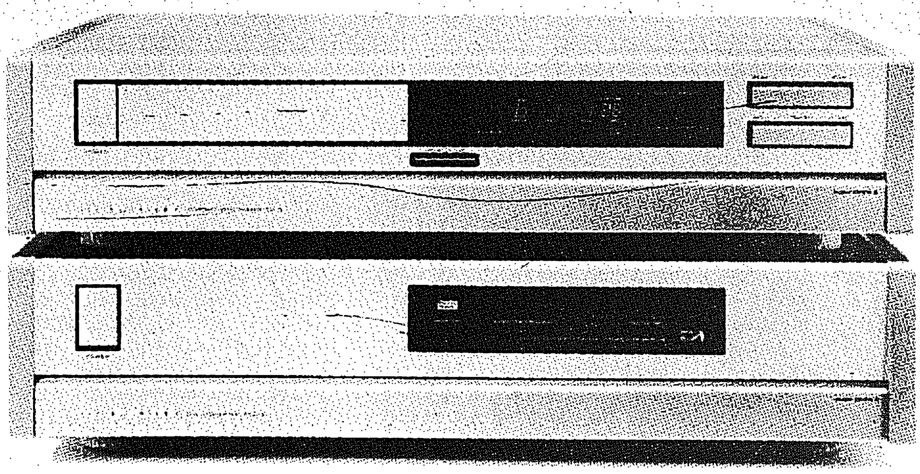
Other features are an intelligent table-top remote control pre-programmed for 10 components, and with a memory for 20. The remote control has its own LCD and can "learn" and store up to 150 codes from other audio and video remote control commanders. This ability of the remote controller to learn the codes of other controllers is now a well-established trend.

The PM95 is priced at about $5999, whereas the PM25, seen as a trend-setting integrated amplifier with many high technology advances, is at the other end of the scale, offered for about $399. This unit delivers 45 W per channel into 8 Ω speakers. A significant feature is a CD direct switch that feeds the signal from a CD player directly to the high accuracy volume control potentiometer, bypassing the preamp stage. This is often described as a "passive preamp" and improves the sound by cutting out unnecessary circuitry, we're told.

High resolution circuit philosophy improves channel separation, eliminates noise and reduces distortion. Under this philosophy ground paths from input to output stages are laid out independently and separate heatsinks are used for each channel.



Marantz' new PM95 amp will go on-sale here next year and probably represents the vanguard of what's to come in power amp design trends.



The new PM12 compact disc player from Marantz is a two-component unit: disc transport (top) and D-A unit (bottom). Teamed with an amp having direct digital input, the D-A unit is unnecessary.

Another Marantz CD player is the CD75X, claiming lavish features. It has FTS (favourite track selection), which pre-programs up to 226 discs. The FTS memory stores information on the preferred tracks on each disc:it identifies the disc and automatically plays the chosen items every time the disc is put into the player. The selections can be changed, or the FTS over-ridden so that all or any part can be played.

It has sophisticated conventional programming, directly accessing up to 99 tracks, with random memory access for 20 tracks. Programming can be by track, index or time, and can be controlled by the CD's remote control.

The CD75DX has twin 16-bit digital to digital converters and three separate power supplies. It has four times oversampling and digital filtering, plus optical and electronic digital outputs. RRP: $749.

Separate CD drive, D-A converter and intelligent table-top remote control are the main features of the Reference CD12 compact disc player. Marantz claims it sets new standards for digital sound, specially attending to all possible sources of distortion and "jitter".

A new fibre optical cable, using low loss polished mica rather than more common glass fibre ensures a quality connection between the CD drive and the D-A converter, keeping the two electrically isolated. Acoustic feedback has been minimised with a diecast chassis, strongly ribbed aluminium top plate and plaster filled feet with rubber isolators. Like the PM95 amplifier, this unit has a copper-plated chassis to provide a low impedance ground for the circuitry.

Electrical shielding is specially attended to for final signal quality, specially of low level, musical information. Of the independent signal and servo circuit boards each has its own copper plated shield.

Four toroidal low-stray field power transformers are employed. By automatically switching to the correct sampling frequency, the CD12 can accept DAT or digital satellite information.

It has a guaranteed S/N ratio of 104 dB; dynamic range of 96 dB and total harmonic distortion of 0.0015 per cent at 1 kHz, according to the specs. RRP: $5999.

However, there is more to the Marantz stock of products than CD players. The SD55 audiophile cassette deck has three heads, allowing each head to have a gap and alignment best suited to its dedicated job. Three heads enable recordings to be monitored as recording progresses. A strong bias current on the erase head ensures metal tapes are completed wiped; often a failing in cheaper decks.

Two-motor logic transport control is used for the deck's operation. The high torque dc servo capstan motor, with a heavy flywheel and precision capstan ensures low levels of wow and flutter. By providing constant back tension in the supply reel, excellent tape-to-head contact is promised. It has Dolby B, C and HX-PRO noise reduction circuitry.

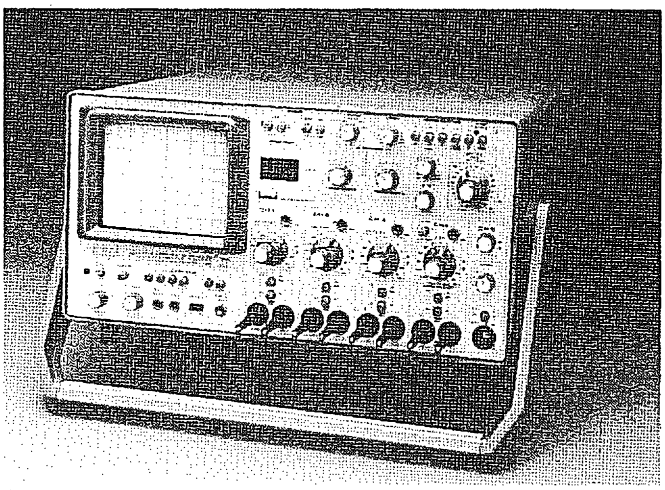
This cassette deck is one of the few on the market fitted with a clock for controlling times for recording or playing back. RRP: $899.

Marantz also has the MX 683: a midi audio system which can be used as an audio-video centre. It includes tape, tuner and vinyl disc, and with the comprehensive switching in the amplifier it can accept programs from TV, a CD-video player, two video recorders and DAT. In addition, it has Dolby Surround Sound. All components are linked for control by the supplied remote control.

And Marantz hasn't passed over the trend to surround sound. The three channel PM 683 audio-video amplifier delivers 40 W into each channel: left, right and rear surround. There is a seven-band graphic equaliser, too.

Improved Powerscope from BWD

Wider bandwidth, new attenuator and time base switches, and improved specifications in several areas are in the latest version of the BWD 881A Powerscope II.



It has five vertical amplifiers: four wideband differential channels and a 50 MHz single-ended channel. The new differential amplifiers are now direct reading from 20 mV to 200 V/div on all channels with 30 MHz bandwidth from 200 mV/div and 20 MHz from 20 mV to 100 mV/div.

The rise time of the combined amplifier and P91 10

probe is usually less than 10 ns. This is said to be ideal for switch mode power supplies, and together with the high common mode rejection of the amplifiers, enables direct on-line measurements to be accurate and safe.

A multiplier can display Ch 1 × Ch 2 over the whole sensitivity range with a bandwidth of dc to 12 MHz (3 dB).

With voltage applied to one channel and a voltage proportional to current on the other, a direct measurement of instantaneous power is available. Channel 4 incorporates a dc offset facility which is adjusted by a multi-turn control over the range ± 200 V up to 10 V/div and +3600 V above.

Phase can be measured to within 1° from 15 dB to more than 2 kHz in single or multiphase circuits. The zero reference can be selected from any channel or the input ac, where it is detected to within 1° of zero crossover at line frequency.

So the wide range timebase can lock on to very noisy signals, often met with in power control circuits, there is a selectable filter with a roll-off above 400 Hz. Without the filter, triggering extends to more than 50 MHz.

The CRO's circuit design conforms with all international standards such as UL, VDE and CSA. The whole operating front panel area, controls and probes are fully insulated against shock hazard when the CRO is working with high voltages.

Contact **Parameters, Centrecourt, 25-27 Paul St North, North Ryde, 2113 NSW.**

Mic cable

Available in seven colours, a two conductor microphone cable, said to be interference proof, also claims ease of termination because the outer screen is not braided and its thicker PVC insulation makes it even more durable.

The cable, type GAC-2/1 has low capacitance while still using temperature-resistant PVC material.

And the colours are: red, mint, yellow, blue, grey and pink, and black.

Get the cable to match your studio decor from **Hi-Phon Distributors, 1/358 Eastern Valley Way, Chatswood, 2067 NSW.**

Open frame power supplies

Designed to work over a wide range of ac input voltages, a line of open frame power supplies claim high reliability.

They are said to meet the requirements of many worldwide regulatory safety agency specifications.

Each supply is inspected and undergoes a two hour burn-in. Features include over-voltage protection on 5 V outputs, remote sense on most outputs, fully rated to 50° C, foldback/current limit, and industry standard case sizes.

The various types available include single output, dual output, triple output and disk drive linear power supplies.

These International Power power supplies meet or exceed: IEC380, IEC435, VDEO730 part 2; VDEO804, ECMA-57, CEE10 part 2P, UL1012, and CSA22.2 no. 143 and 154.

Details from **Tecnico Electronics, 11 Waltham St, Artarmon, 2064 NSW.**

Suppression filters

A series of new filters is said to be ideally suited to telecommunications, office equipment, computer peripherals and automotive industries to decouple unwanted emissions and help meet increasingly stringent regulations.

The BNP 002 and 004 are pc board mounting block type filters with π type circuit configuration consisting of barrier layer feedthrough capacitors with ferrite cores.

The BNP 002-02 and 002-03 have insertion losses of -40 dB in the range 20 to 500 MHz, a dc resistance of 0.05 Ω, and a current carrying capacity of 10 Adc, for supply rail filtering, according to the manufacturer.

The BNP 004-02 has an insertion loss of -40 dB in the range 300 MHz to 1 GHz, a dc resistance of 0.05 Ω, and 10 A capacity, for signal line filtering. The BNP series is rated at 50 Vdc.

The DS 306 and 310 series are three-legged capacitor style disc type filters. The DS type is purely capacitive while the DST type has ferrite beads on the leads external to the moulded package, and the DSS type has the ferrite beads moulded into the body of the package.

This series is made in 50 and 100 V types with capacitances from 22 to 2200 pF. There is a 16 V/100 nF version for decoupling.

Inquiries should be filtered through to **IRH Components, 32 Parramatta Rd, Lidcombe, 2141 NSW.**

Handheld scopes from Tek

Targeted to field service technicians but suggested as useful to a wider market, Tektronix' two handheld digital storage oscilloscopes weigh less than 900 grams and come with battery pack, probes and carrying case.

Already the T200 oscilloscopes are being used to troubleshoot design or service problems in diverse fields such as biomedical instrumentation, burglar alarm systems, lifts and process plant machinery.

The oscilloscopes use flat panel LCD technology to achieve their small size and although they can fit in a briefcase they can offer performance and features of full size storage CROs.

The Tek T202 offers a traditional oscilloscope interface with

the front panel controls divided into familiar scope functional sections. These include separate sections for channel one and two controls, as well as triggering.

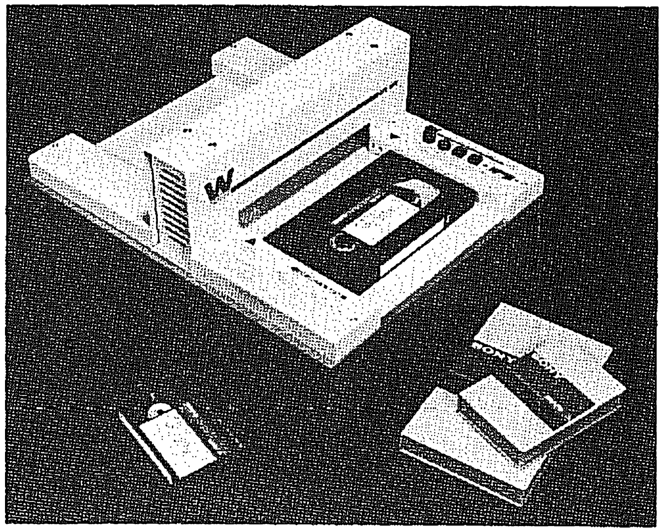
For other users more comfortable with left to right manipulations, the calculator-like interface of the T201 may be preferred.

Parameters such as timebase, sweep speed, trigger mode and cursors for auto setup are preset via simple programming sequences.

The digital voltmeter and timer-counter pinpoints voltage levels and timing problems. These allow the serviceman to measure time and frequency quickly plus true RMS, DC, peak-to-peak and ground-to-peak voltage.

Users can store up to nine front panel settings in non volatile memory. Screen one for yourself by contacting **Tektronix at 80 Waterloo Rd, North Ryde, 2113 NSW.**

Metal tape wiper



Specially designed for metal tapes, the BTE-1910 degausser accepts all current cassette sizes in metal formulation, including large and small U-Matic Beta SP, standard and mini MII, VHS (including S and C), Beta and 8 mm.

Its erasure level was determined after extensive consultation, and has an erasure rate of better than -80 dB, and can handle up to 40 an hour, the makers claim.

Microcassette tapes can be erased, but the BTE-1910's magnetic field was designed to be strong enough to erase modern metal formulations and microcassettes do not need such a strong field.

Weircliffe agent, **Amber Technology, is at Unit B, 5 Skyline Pl., Frenchs Forest, 2086 NSW.**

Now the tantalum chip

An extensive range from 100 nF (0.1 µF) at 35 V to 68 µF at 4 V marks Hitachi's tantalum capacitor chip format, the TMC series.

Auto insertion is made easy because the series is on tape, and the customer specifies the polarity on the carrier tape.

Quantities are 2000 per reel for the smallest case size to 500 per reel for the larger case size. They are reflow and immersion soluble, and washable without harming the markings.

Place a tantalising order with **IRH Components, 32 Parramatta Rd, Lidcombe, 2141 NSW.**

Augat expands activity

Now it has a joint manufacturing plant in Singapore, the US company of Augat promises more activity in Australia and New Zealand.

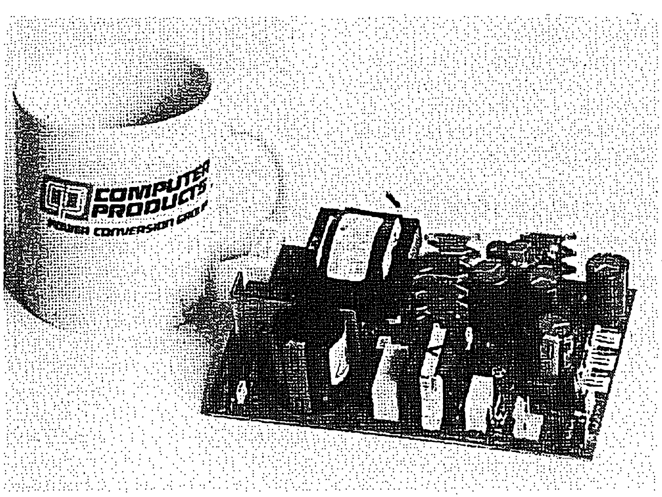
The company designs and makes a broad range of electro-mechanical components, which includes: IC sockets and accessories; connectors; coaxial cable network and fibre-optic interconnection products; subminiature switches; high reliability packages for microcircuits; computer aided design and wiring services; interconnection test probes and systems; and custom connector assemblies for the automotive and telecommunications industries.

Newly appointed managing director Grant Fisher said Augat's thrust in the local market would stem from a network of established distributors, supported by Augat sales offices in each city.

These offices would be staffed with professional sales staff, who would also be actively supporting an increasing number of OEM clients.

The company would be active in the areas of computers and peripherals, test and measurement, instrumentation, defence/aerospace, telecommunications, bio-medical, industrial controls, automotive engineering, local area networks, communications, CATV and telephone operating companies.

Mr Fisher brings extensive experience of electronic engineering to his new position, having specialised in test and measurement, electronic components and professional sound equipment. He comes from Anitech, where he was a national product manager in the electronics instrumentation division.



50 W switcher supply

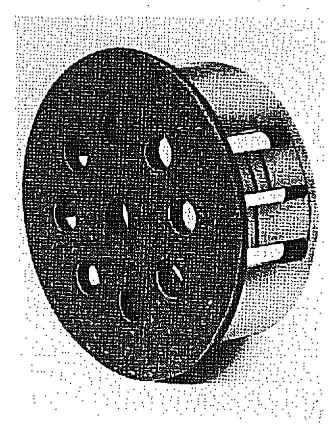
Boschert's new XL50-7601 switching power supply is a 50 watt device which mechanically replaces industry-standard 40 watt power supplies as it measures 100 x 160 mm and has totally compatible connectors.

It features a continuous input range of 85 to 264 Vac, which does away with the need for an external 115/220 Vac switch and cable assembly. Another advantage is that a minimum load is not required.

The XL50-7601 has a minimum switching frequency of 20 kHz, is protected against overvoltage and output short-circuit and has a holdup time of 16 ms.

Boschert claim that, because this supply is constructed with fewer components than most 40 W devices, it has an increased MTBF to 160 000 hours.

It is approved by UL, CSA and VDE and meets the Limit B line conducted noise standards of FCC and VDE. For further information, contact **Amtex Electronics, 13 Avon Rd, North Ryde 2113 NSW. (02)805 0844.**



Hole plugger

For the person who has everything, Nylon Products has a range of holes for your chassis. The vented hole plugs let air through for ventilation and dissipating heat, and come in 13 diameters ranging from 22.2 to 101.6 mm.

The plugs snap lock with fingertip pressure into chassis up to 6.35 mm thick. Made from nylon 6/6, the plugs are available coloured white or black.

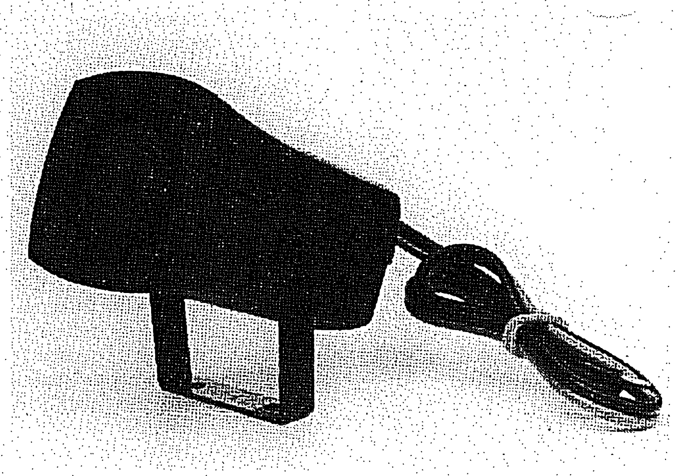
Get holey from **Nylon Products 350 Torrens Rd, Croydon Park, 5008 SA.**

Miniature siren

Said to be ideal for cars, the Murata KPE 1200 piezo miniature siren has a case size of just 57.5 mm long by 40 mm high.

It has a sound pressure level of at least 105 dB at 1 m with 12 Vdc, according to the specifications.

Its frequency sweep ranges from 1500 to 4000 Hz with a ▷



sweep rate of 4.5 Hz. At 12 V its current drain is 150 mA, and it will operate down to 6 V.

Check with **IRH Components, 32 Parramatta Rd, Lidcombe, 2141 NSW.**

Approval for isolation relays

Low profile pc board isolation relays, the Fujitsu FBR630 series, have a contact to coil isolation of 3.5 kV ac (one minute) and 5 kV impulse, meeting Australian Telecom Specification 1302 and receiving Approval No. RA84/136.

They are 10 mm high with sealed pc board terminals to prevent flux contamination, and are in Form A and C contact arrangements. Form C is the preferred type. They have contact ratings of 10 A 30 Vdc and 8 A 240 Vac (resistive).

Coils voltages cover 5 to 48 Vdc and their design allows them to work over -30° to +70° product identification by function, generic part number and specific maker's part number, to electrical characteristics for every part number covered in the Digest, and consistent easy-to-use pinout information.

The book's design is said to speed up and simplify device searches, with its streamlined format leading the user easily and logically from one product section of the Digest to another through cross-referencing specific parts, part numbers, or device specifications.

Concise packaging information and pinouts are shown, and for those not fully up with technological progress more than 800 discontinued devices are listed with information on alternate source or replacements.

The *Interface Integrated Circuits* covers 21 840 devices from 165 makers. The Digest presents: consistent descriptive pinout information; identifies devices by function, generic part number and specific maker's part number; electrical characteristics for every part number covered in the Digest; identifies more than 900 discontinued devices; and includes alternative sources for every device.

The 780 page Digest presents comprehensive technical characteristics and product specifications data about logic buffers and drivers, line drivers/emitters, peripheral and power drivers, A-D and D-A converters, level translators, data acquisition support ICs and others.

A 33rd edition of the *Application Notes Digest* presents more than 5270 application notes from IC and discrete semiconductors makers. The notes cover: linear, digital, microprocessor, interface and memory ICs; diodes; thyristors; optoelectronic components; transistors; and power semiconductors.

D.A.T.A. publications are available from **J.H. Book Services, 75 Archer St, Chatswood, 2067 NSW.**

Three phase 100 A power line filters

Designed to protect computers from massive third harmonic currents being induced in switchmode power supplies of some mainframe computers, "H" type filters from Tycor can protect equipment from repeated transients, the makers claim.

While filters are installed to protect computers from power lines, some computers draw a strong third harmonic load with the potential of damaging the filter equipment, particularly that designed to isolate the computer from common mode noise.

This was a problem with the Australian Taxation Office computers at Centrepoint, Sydney, and 150 Hz currents in the neutral measured at twice the line current.

The Tycor four wire H filter carrying 100 A per phase can withstand high third harmonic neutral currents and protect against repeated transients of the IEEE 587 Category B2 test. This is a 6000 V ringwave at 3000 A with an attenuation of 98.8 per cent (normal mode) and 99.5 per cent (common mode).

Tycor are represented by **Electromark, 43 Anderson Rd, Mortdale, 2223 NSW.**

Desoldering debugged

A new desoldering tool is said to eliminate the need for separate pumps, vacuum lines and additional bench-mounted equipment.

The Denon DIC SC-5000 is compact, self-contained and is said to combine high working efficiency with operation ease.

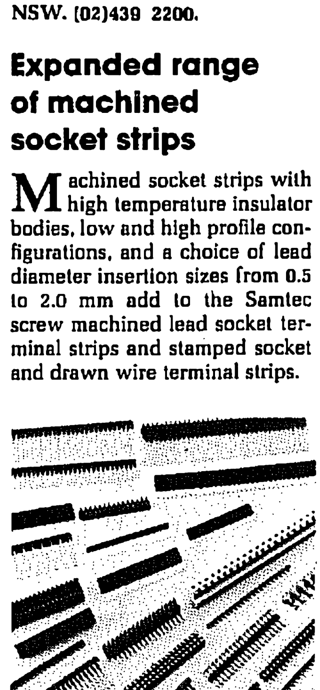
Integrating the suction nozzle and vacuum pump increases the suction power while the thermosensor feedback control circuit and 60 W ceramic heater ensures rapid warm-up and immediate temperature recovery during use.

Exact temperature control prevents damaging ICs, LSI circuits and pcb tracks. A zero-crossing feature also prevents RF interference irrespective of the selected temperature.

There are more features, details of which can be supplied by **Technico Electronics, 11 Waltham St, Artarmon, 2064 NSW. (02)439 2200.**

Expanded range of machined socket strips

Machined socket strips with high temperature insulator bodies, low and high profile configurations, and a choice of lead diameter insertion sizes from 0.5 to 2.0 mm add to the Samtec screw machined lead socket terminal strips and stamped socket and drawn wire terminal strips.

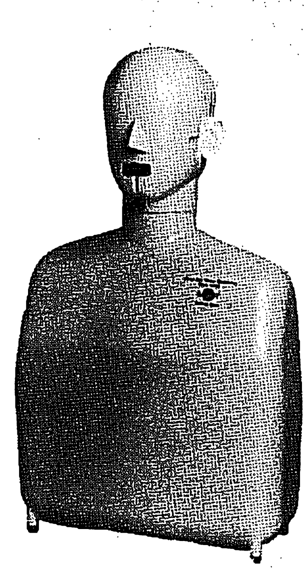


Machined lead sockets can be supplied with "snap-strip" bodies or on various carriers, with many more options.

Samtec's 80 page book provides a selection workbook for engineers specifying board to board interconnects. Board spacings range from 7.44 mm to 46.3 mm and are shown in increments of 0.13 mm.

Various interconnect choices are available including precision machined systems and 0.635 mm square post sections. The book is given without charge.

The agent is **Multi-Contact, 53-55 Whiting St, Artarmon, 2064 NSW.**



Will the real Max Headroom please stand up?

Said to offer a new dimension in electro-acoustic measurements, Brüel & Kjaer's head and torso simulator has already been used to develop the *Beocom* telephone from hi-fi firm Bang and Olafsen.

The simulator was designed for objective in-situ research and evaluation of various devices such as telephones, headsets, group audio terminals, microphones, headphones, hearing aids and hearing protectors.

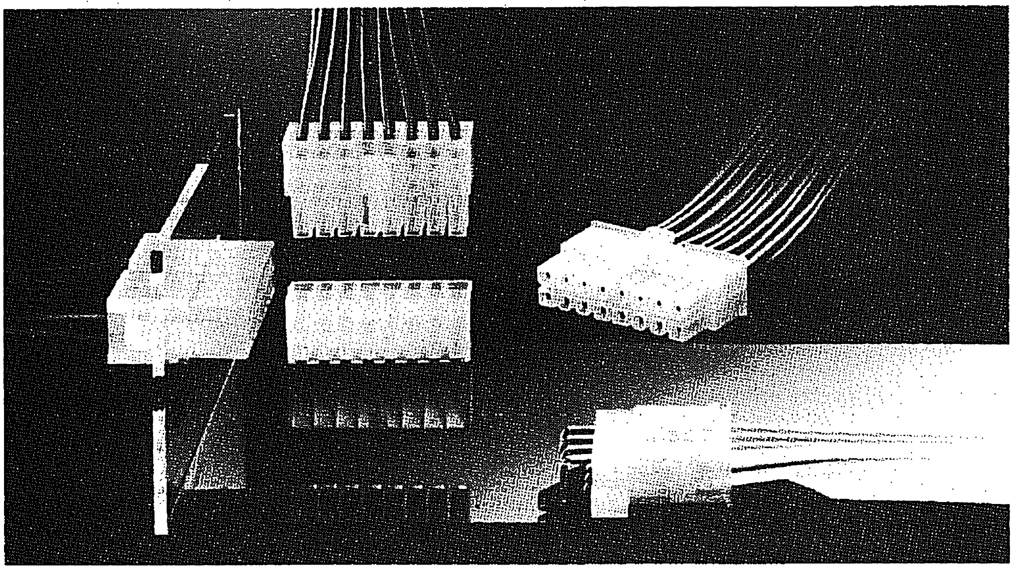
The type 4128 also has uses in evaluating room acoustics, vehicle audio systems and noise control measures in vehicles.

It replicates the geometry of a median adult human head and torso and complies fully with the acoustic requirements of ANSI S 3.36 and IEC 959.

It is equipped with an ear simulator based on the industry standard Brüel and Kjaer type 4157, and with a mouth simulator which produces a sound field that closely replicates the sound from a human mouth. An additional ear simulator is available to make binaural measurements.

The telephone designed by Bang and Olafsen using the 4128 has remarkable fidelity compared with conventional telephone handsets. The sound quality is consistent even at varying distances from the ear.

Brüel and Kjaer simulates its office at **24 Tepko Rd, Surry Hills, 2084 NSW.**



Jr power connectors

Designed for the growing number of high current/high density packaging requirements of OEMs, the Mini-Fit Jr range of power connectors is claimed to handle standard equipment I/O currents.

The two circuit pc board connectors can handle 9 A at 240 Vac. It is said to be able to achieve these higher current ratings in part because its dual row system dissipates heat.

Three row systems surround the centre row terminals and trap the heat. The dual row system also provides for simpler board layouts, since there is no tracing for an inside row of pins.

The mated length of the wire-to-wire version is 34.6 mm, and the mated height of the wire-to-board version is 23.5.

The terminals in the dual-row pc board assembly are set in a 4.2 × 5.5 mm ladder arrangement, the lowest spacing for a connector with its current carrying capabilities.

Both halves of the connector are fully shrouded, protecting against shorting, and avoiding damage during assembly and shipping.

In place of the traditional terminal of round pin and socket design, the Mini-Fit has a female contact that is formed into a box shape.

Dimples on two sides of the box give four distinctive points of contact with the male. The square contact design also eliminates terminal to terminal "butting" that occurs on some round contact systems.

The terminals have special locking tangs that enable them to be inserted into the housing with only 60 per cent of the force needed for equivalent connectors.

Because insertion tools are not needed, assembly speeds are higher. The pressure to mate the connector halves is about a quarter of the industry standard.

The locking tangs together with a positive lock moulded into the housing provide strength in high vibration. The positive lock helps prevent accidental disconnections.

The system is UL and CSA approved. There are vertical and right angle headers for pc board applications and standoffs to stop flux-wicking.

Circuit sizes are two to 22 inclusive. Housing material can be specified as 94V-2 or 94V-0. Terminals are made from brass or phosphor bronze, with tin or selective gold plating. They are available to cover either 18-24 AWG or 22-28 AWG in chain or loose form. Tooling is available.

For more information, **Utilux Electronics at 14 Commercial Rd, Kingsgrove, 2208 NSW.**

Monster cable for pros

Microphone, speaker, balanced interconnect and musical instrument cables for professional and commercial audio complement Monster Cable Prolink products already available for consumer hi-fi.

In the cable products, there are four for microphones claiming latest technology and increased dynamic range and clarity. The Series 1 is available as a four pair multicore and the Series 3 in 8-or 28-pair multicore.

Get through to **Convoy International, 400 Botany Rd, Alexandria, 2015 NSW.**

Solar modules

A newly released range of solar modules from Solarex is said to be perfect for operating low power remote telemetry units, security sensors and signals.

Rated at 1.5 and 2 W, the SA1.5 and SA2.0 respectively produce 105 mA at 15 V and 320 mA at 7.5 V.

Other uses for these low cost modules will arise around the home, farm, boat, 4WD or caravan. These could be automatic door and gate openers, and float switch indicators. Solarex uses a SA1.5 to keep the battery charged on a 10 km electric fence.

The modules are styled with the appearance of black glass framed by a UV stabilised polymer. The frames are drilled so as to install easily on almost any surface, and they have flying leads.

Size and weight make them satisfactory for portable use. The SA1.5 measures 330 × 124 × 11 mm, weighs 4.5 g and costs $65. The SA2.0 measures 349 × 172 × 12.7 mm, weighs 6.5 g and costs $75.

Get your sun power from **Solarex, 78 Biloela St, Villawood, 2163 NSW.**

Chips set to get subs

Good news for Adelaide's Austek Microsystems may be bad news for enemy submarines. As submarines become harder to track down, the technology of the sub-hunter becomes more complex. Thus Western defence forces go through hundreds of thousands of sonabuoys in their tireless task of keeping us free from killer subs.

Defence scientists have a lifetime job searching for more effective detectors, such as chipsets to send up the boys in the submarines.

However, Australia has its unique, high-performance Barra Sonobuoy in production with increasing sophistication and Austek now has a $1 M contract to develop a VLSI chipset for Sonobuoys Australia which is Canberra's prime contractor for our new generation, chipset sub-hunters.

The buoy relies on in-buoy acoustic processing which is possible using VLSIs. This processing will allow the sonobuoy's information transmissions to be compatible with a wide range of airborne and processing systems.

Email enters flat panel LC displays

With LCDs used for many years in its petrol pumps, Email is extending its design and manufacturing capabilities to other companies in a new marketing push.

The manager of LCD Products, the newly-appointed Mr Alan Fancke, aims to help innovative companies use the flexibility and cost advantages of LCDs.

A customer LCD Design Guide describes the capabilities of the displays and how a new module is developed. Features include a background to LCD technology, operational specifications, recommended driver ICs and a custom design questionnaire.

Enquiries to **Email Electronics, 15-17 Hume St, Huntingdale, 3166 Vic.**

Read all about them

Linear ICs fill 685 pages in the D.A.T.A. Digest which lists and cross-references main electrical characteristics for almost 18 000 devices from more than 260 makers.

The second in the IC Digest series, this volume ranges from C. Inquiries to IRH Components, 32 Parramatta Rd, Lidcombe, 2141 NSW.

Introduction to troubleshooting personal computers and other microprocessor equipment

Part 1

Graeme Teesdale

A great deal of electronic equipment these days is based on a microprocessor, or uses a microprocessor in some capacity. The most obvious example is the 'home' or personal computer. But they are also found in microwave ovens, industrial controllers, burglar alarms, VCRs and a host of other equipment. Troubleshooting microprocessor based electronics requires a different approach and some different techniques to that used for traditional analogue or digital electronics.

A MICROPROCESSOR can be thought of as an integrated digital system on a large scale, an extension of traditional digital logic where many individual circuits are connected to act as a single unit or provide a certain set of operations or functions. However, there are some differences.

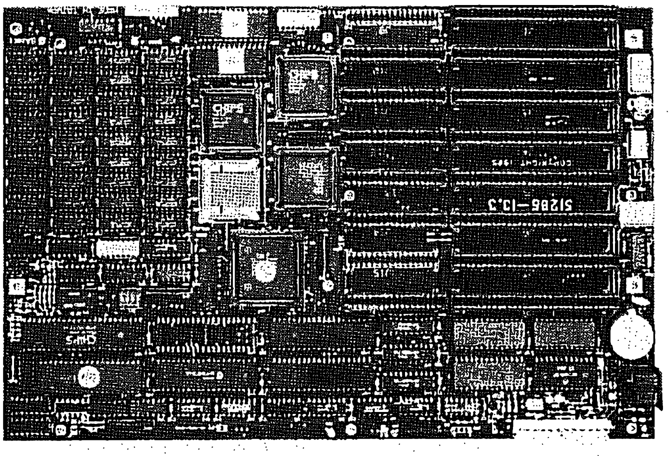
Microprocessor systems are built around a *bus* — that is, they have a system of multiple wires for interconnecting related devices. There may be eight or 16 wires, or whatever, but each wire or line has a set, pre-defined specific function. The purpose of the bus is to carry signals between the various devices in the system. Many of the chips connected onto this bus are extremely complex LSI (large-scale integration) devices.

At this early stage, if you aren't familiar with microprocessor jargon and abbreviations, I would recommend you get yourself a good reference on the subject (such as Ref. 1, listed at the end of the article) and use it as you would a dictionary — look up unfamiliar terms as you come across them. While most of the terms I have briefly defined or explained as they're introduced, such a reference you'll find an invaluable aid as you learn your way round microprocessor based systems.

The methods of fault location useful in traditional digital circuitry e.g: logic level probes, current probes, and pulser (injection) probes, have limited use on systems which employ a microprocessor.

The microprocessor operates at high speeds (typical "clock" cycles are measured in 100s of nanoseconds) and programs are completed in seconds or fractions of a second. Most troubleshooting must be done at "real-time" speeds (that is, as it's operating). The *logic analyser* was developed to do this, and such an instrument "tracks" the processor as it carries out *(executes)* the steps in a program.

A very important fact about a microprocessor is that it is very *sequential* in nature. That is, it takes one step at a time. At the level of the microprocessor itself, a program will cause the processor to look for (or *fetch*) an instruction, which it will then *execute. (For some background on what goes on inside a processor*

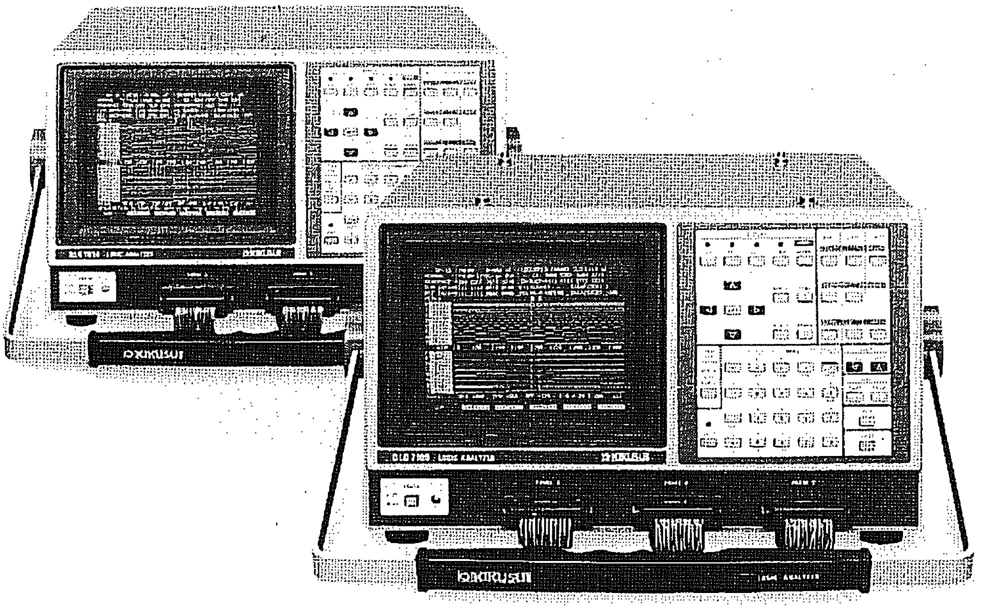


here, see Ref. 2). The program flow, that is — how it runs, depends on the correct action of the fetch and execute cycles, and this fact helps tremendously in debugging faults.

If signals (more properly referred to as data) on a bus are incorrect, especially if the system is fetching an instruction, the processor may execute an *entirely different* instruction to what was intended by the software designer! This often results in the system "crashing" for no apparent reason. Noise pulses ("glitches") and "bad" (non-functioning) bits in memory are the most common causes of what is termed "single bit" errors, about which more will become clear a little further down the track.

First isolate the problem area

Owing to the complex functions often performed by microprocessor systems, we must develop special techniques to isolate the problem. The first step is to verify that a problem really exists before starting any troubleshooting analysis. Nothing is



The "logic analyser" is the microprocessor world's equivalent of the analogue world's oscilloscope; it is the 'ultimate' troubleshooting tool, but by no means always essential. Logic analysers can display, in real time, what's happening on many data lines (or channels) at the one time, among a host of other sophisticated functions. The two instruments shown here are the Japanese-made Kikusui DLG7050 (at rear) and DLG7100 (front), distributed in Australia by Emona Instruments. (02)519 3933.

more frustrating trying to fix a problem that is not there! In certain situations the system software may be the limitation, not the hardware.

If you are not familiar with the system, you must go through a learning process gleaning information from:

(a) the person or people who normally use or operate the equipment;

2 (b) "milking" any indicators (or other outputs), like front panel status and operating indicators on a microprocessor controller, for example;

(c) Checking the service literature.

A great deal of information can be obtained by watching the operator and observing these indicators. Similarly, referring to manufacturer instructions, circuit explanations, schematics, block diagrams, troubleshooting trees and software listings, especially such things as the "PRN" file printout (talking about microprocessor controllers here), where it's available.

When first trying to section-off the fault, schematics can often provide too much detail, making it difficult to obtain the overall picture. A "troubleshooting tree" is a graphical means of showing the sequence of tests performed on a product under test or under normal operation. These "trees" are often drawn as flowcharts in which the results of each test determine what test is taken next.

They can be extremely useful, however, as a microprocessor system is complex covering all combinations can make it difficult to write. In many situations, none of the above is available.

It may come as a relief that many causes of failure in microprocessor systems are identical to those arising in other types of electronic equipment. These could be divided into the following groups:

(a) **Components failure.** Microprocessor systems will usually include passive components such as resistors and capacitors, a few discrete semiconductor devices, such as transistors and diodes, and the integrated circuits which perform the computing tasks. Failure of any of these components can cause system malfunction;

(b) **Open circuits;**

(c) **Short circuits;**

(d) **Externally induced interference.** Mains-borne interference is probably the most common, however, interference from RF sources can also occur;

(e) **Software faults.** These can result from ROM or EPROM faults or sometimes systems can be installed with undetected faults in the software. These can go unnoticed until unusual combinations occur in the inputs or outputs;

The purpose of this article is to develop an approach when little or no service data is available.

The approach

The approach used in troubleshooting microprocessor based systems can be divided into two groups:

(1) STATIC tests, i.e: no software program required in tests but the system generally will be executing (that is, running some program).

(2) DYNAMIC tests, i.e: using software as a tool to test other chips on the system or test equipment that checks or tests the system at real-time speeds.

Under STATIC tests we look at essential areas that are necessary for the system to run.

(i) Visual inspection.

(ii) Power supply rails.

(iii) Power-up RESET.

(iv) Clock.

(v) Condition of State lines.

(vi) Interrupts.

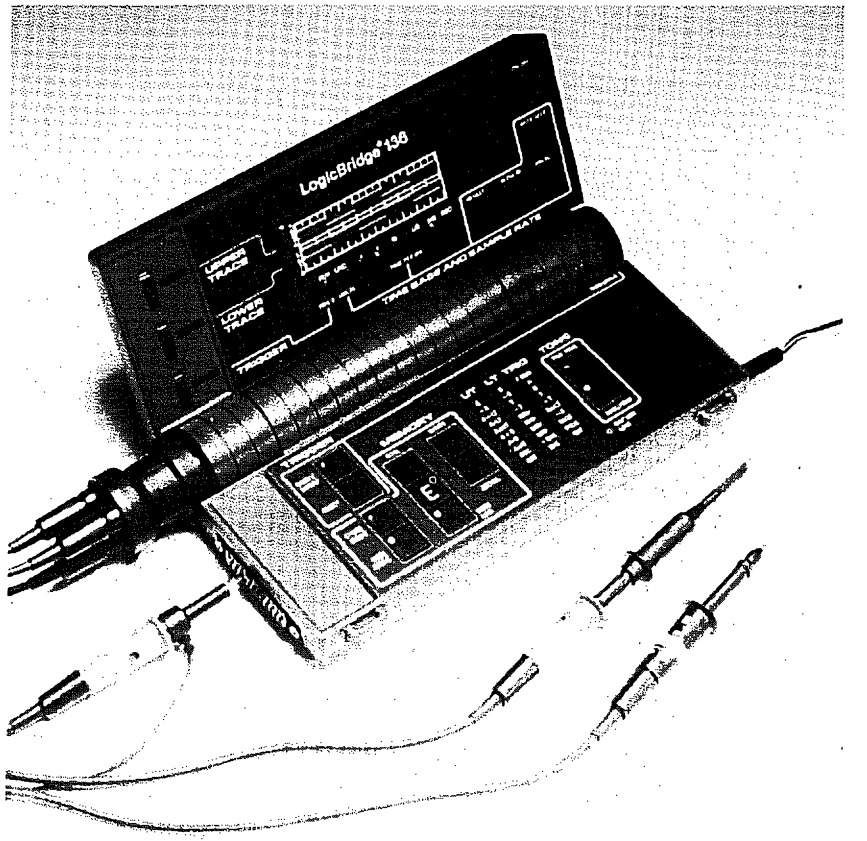
Visual inspection

When carried out with care, visual inspection is easily the most cost effective of all fault-finding techniques. It is also useful in generating a mental picture of the board and location of components.

Useful also, if no circuitry information is available, is to look up each IC type in a data book. It helps to identify it's possible function. e.g: Spotting a 74HCT138, you look it up to find out it's an address decoder.

Such items as the following can be detected by visual inspection;

- Presence of "whiskers" — no, *not* the editor!-minute strands of wire causing short circuits or intermittent shorts.
- "Dry" joints as a result of faulty soldering techniques or thermal stress.
- "Leaking" components, such as electrolytic capacitors.
- Failed components, such as over-heated diodes and resistors; and finally,



This is rather a new concept in test instrumentation for microprocessor systems. It's the LogicBridge 136, a 'dual trace" digital storage device that combines the functions of logic analyser and oscilloscope in a compact, handheld instrument. The LED array display shows two logic 'waveforms' of 100 bits simultaneously and can capture pulses down to 50 ns, according to the makers. Effective bandwidth is 10 MHz, they say. Up to 100 traces of 100 bits can be stored in memory and recalled to be visually and logically compared. The case folds over for carrying. It weighs a little over 2 kg. Emona Instruments distribute it.

- less obvious are faulty or intermittent edge connectors and IC sockets.

You must *resist* the temptation to remove ICs and clean sockets using a contact cleaner. We want to isolate the fault down to a dirty socket, if that is what the problem is. Remember to look with your eyes, *don't* use fingers if at this stage no *electrostatic* precautions have been taken. (See Ref. 3).

Power supply checks

One of the factors that contributes to reliable system operation is a "clean" power supply rail. "Gridding" of power supply tracks on a pc board and copious use of decoupling using tiny, low inductance 'monolithic' bypass capacitors is extremely important on large systems, especially when equipment such as disk drives etc, get added on.

Since RAM and EPROM chips have variations in their noise immunity 'margins' (the amount of noise signal they will tolerate), poor design or loss of rail decoupling can result in "hard" errors. i.e: if a memory location consistently can't be written-to and read-from properly. If it only fails occasionally, it's called a "soft" error.

The various major support chips in a microprocessor system — RAM, EPROM, input/output (I/O) devices — are all connected to the bus. The microprocessor can only "talk" to one at a time, else confusion would reign! Hence, each of these peripheral devices has a pin that, when activated, says "hey, turn me on!" — the *chip enable* (CE) pin.

Most static or dynamic RAM chips when first "chip enabled" draw large peak currents of 50 to 100 mA for a duration of less than 20 nanoseconds. These tend to cause very sharp "spikes" on the supply rails when coupled with the inductance of the printed circuit board track. Even though the inductances involved are very small (50 nH), coupled with these fast rise times, they can produce voltage variations in excess of the 350 mV noise figures for LS TTL devices.

To reduce the amplitude of these fluctuations, "decoupling" capacitors are distributed around the pc board. So far as dc is concerned, they're all connected in parallel. But so far as the pulses of operating current are concerned, the supply rail track looks like a string of capacitors each connected to the other via a small inductance. The distributed capacitors provide two functions:

(1) They absorb excessive voltage peaks above the nominal rail voltage.

(2) They supply the bulk of the switching current, hence not allowing the rail voltage to 'droop'. The result is less peak current is required to be supplied by the supply.

The distribution of the capacitors is done in two ways:

(a) Small capacitors of about 100 nF (0.1 µF), generally 'monolithic chip' ceramic types, are connected across supply rails directly adjacent to a chip.

(b) A larger value capacitor, often a tantalum type, is connected across the supply input to the board or across supply rails to RAM area. Values can be anywhere from 10 to 100 µF, depending on RAM speed and number of RAM chips in the array.

The choice of capacitor replacement types is very important. They must have a low internal inductance and low effective series resistance at the 20 ns rise time, which is why tantalum and "Hi-K" ceramic types are used.

As well as a multimeter, a scope must be used to check the power supply rail voltages. In general, dc operating voltages are quoted as:

5 V, ± 5%. i.e: 5.25 to 4.75 volts.

Use an oscilloscope to check the noise level on supply rails, it should be less than 300 mV peak-to-peak. The checks should be made at the supply pins of each chip, from a common power supply ground and the chips' ground.

Power-up reset

Virtually all microprocessor systems have a "Power-up reset" function and manual reset button. When a reset is applied it clears and resets certain internal registers, especially the PRO-

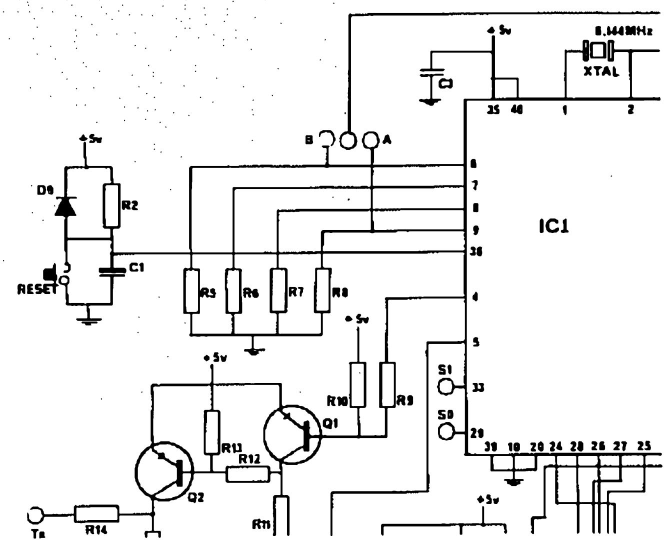


Figure 1(a). The typical power-on reset circuit of a microprocessor employs an RC network, R2-C1 here. When power is applied, C1 initially appears as a short circuit, holding IC1's reset pin low. C1 charges slowly via R2. When power is switched off, C1 discharges via the diode, D9. The system may be reset at any time by pressing the RESET button.

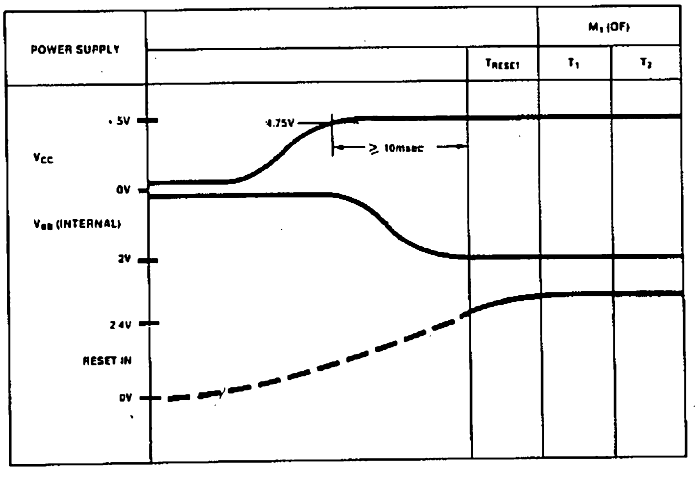


Figure 1(b). This shows the required power-on timing for the 8085 microprocessor chip.

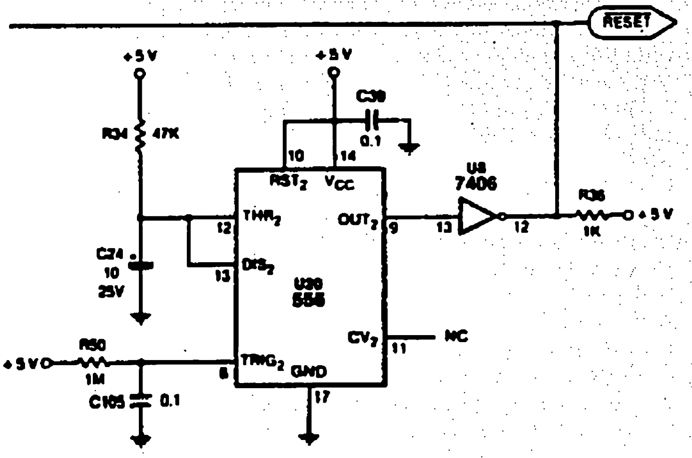


Figure 2. A 556 (dual 555) is sometimes employed as a reset timer. This shows the Commodore 64's reset circuit.

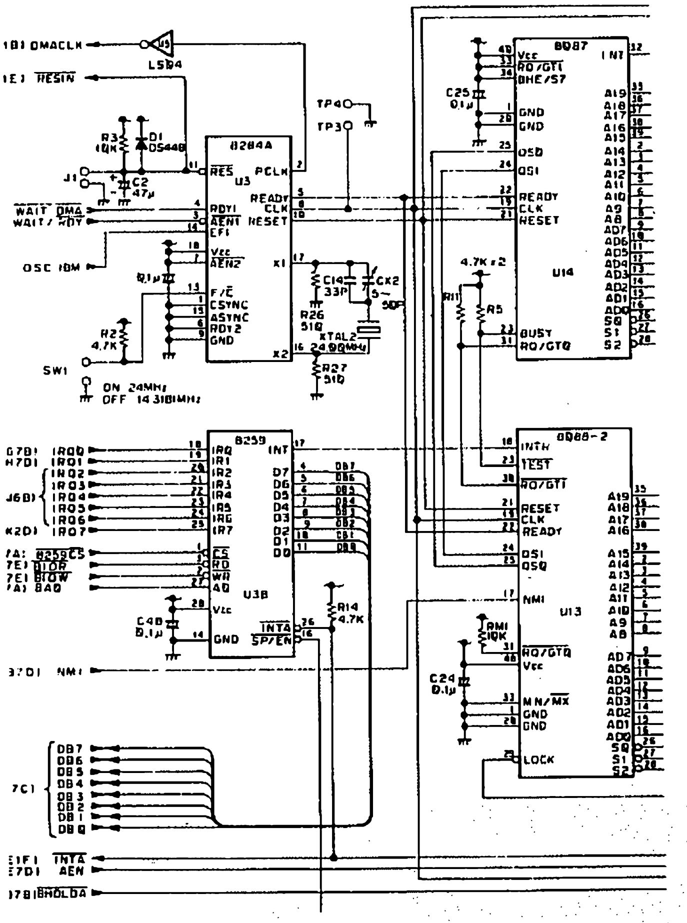


Figure 3. An 8284 support chip generates the 8088's reset in some systems. This shows portion of the circuit from the Sanyo MBC 775 PC.

GRAM COUNTER, so that after reset the first fetch cycle obtains data from the correct memory location. If the reset pulse, is too short, not of correct amplitude, noisy or has the wrong rise or fall time, the program can start at the wrong point, resulting in out-of-sequence operation.

To increase speed and replace the previous negative supply rails on older triple rail microprocessors, an on-board negative rail voltage bias generator is employed. The circuit employs an oscillator and a charge pump which requires a certain amount of time to stabilize after power is applied.

For example the 8085 chip is not guaranteed to work until 10 ms after the supply (Vcc) reaches 4.75 volts. The NOT RESET IN pin must be kept at logic '0' during this period.

The reset input of a microprocessor is generally a Schmitt trigger gate to overcome the slow risetime of the RC network used; see Figure 1(a). The diode is included to discharge the capacitor quickly when the mains supply is suddenly switched off.

A number of CPU chips provide a buffered RESET output that is connected to other LSI chips, so that on power-up they are reset to a default state. For example, a software programmable input-output (I/O) device whose lines may be set as either inputs or outputs, may set ("default") all its lines to inputs when reset.

Some CPUs, like the Intel 8048 series, have an internal pull-up resistor so only requires an external capacitor and diode.

A popular method with some of the home computers, e.g: the Commodore 64 and VIC-20, the Acorn BBC, is to use the 555 timer chip in the one-shot (monostable) mode as a reset timer, as shown in Figure 2. A 556 is a dual version of the 555 timer chip.

On IBM PC-type machines, which use the 8088 microprocessor, the 8088 reset line provides an orderly way to start ▷

up at power-on. When the processor detects the positive-going edge of a pulse on the RESET line, it terminates all activities until the signal goes low, at which time the internal CPU registers are set ("initialised") to the reset condition.

The reset signal to the 8088 is normally generated by a support chip, the 8284. The circuit in Figure 3 is from the Sanyo MBC 775 PC.

The 8284 has a Schmitt trigger input (RES) for generating RESET from a logic 0 external input. To guarantee reset from power-up the reset input to the 8284 must remain below 1.0 V for a minimum 50 us after Vcc has reached the minimum supply voltage of 4.5 volts. R3 and C2 (top right of diagram) provide the timing, and D1 the rapid discharge of C2 when the power supply is switched off and on quickly.

Motorola has a constraint on the rising edge in that it must be less than 100 ns, and also the RESET input must be held low for a minimum of eight machine cycles. Hence the values of R and C depend on the crystal frequency.

Figure 4 shows the timing between clock and internal reset. The Address and Data bus will 'float' to the "three state" condition, more commonly known as *tri-state*. It "floats" until the CPU comes out of RESET.

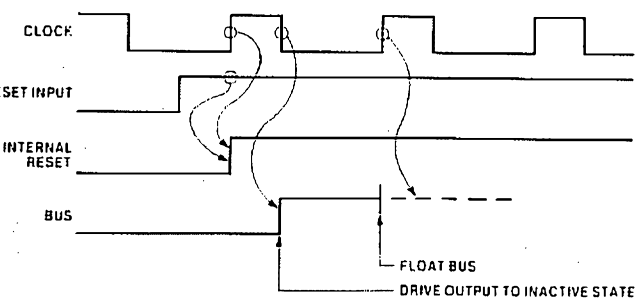


Figure 4.

A logic probe or oscilloscope can be used to check the operation of the RESET circuitry. Here, we basically wish to check that:

(a) Input and outputs exceed the required logic 0 and 1 threshold levels and,

(b) the RC network provides some delay.

Connect the two inputs of the scope to the RESET input and the buffered output, or if not provided, an address or data buss line. Depress the manual RESET button or switch the mains off/on. You should, with the 'scope set to a slow scan speed, observe the input ramp waveform and the delayed "clean" RESET output.

If your CPU does not have a buffered output, the address or data line should "tri-state" when the RESET is active. What is a suitable logic 1 and logic 0 level? Well, it depends wHether you have CMOS or TTL family devices. Most microprocessors have TTL-level compatible inputs and outputs.

Reference to a data sheet will reveal that the minimum logic high input level is 2 V. i.e: the input must recognize any input over 2 V as a logic 1 to be within specification. A logic low input level (logic 0) must be below a maximum of 0.8 V. In general, most LS TTL devices "recognise" logic 1 at around 1.2 volts, HCT versions just slightly higher at 1.7 volts.

When driving another device's inputs, any device's output must be capable, at real-time speeds, of swinging the input above 2 V for a logic 1 and below 0.8 V for logic 0. Data sheet figures give limits of 3.6 V and 0.4 V maximum.

In summary, if we look at the typical input characteristics for an HP Logic Probe we see that it recognizes a logic 1 in the range of 1.8 to 2.4 volts as the minimum, and logic 0 in the range of 1.0 V maximum to 0.5 V or less.

Observing Figure 5 closely will reveal an area in between the

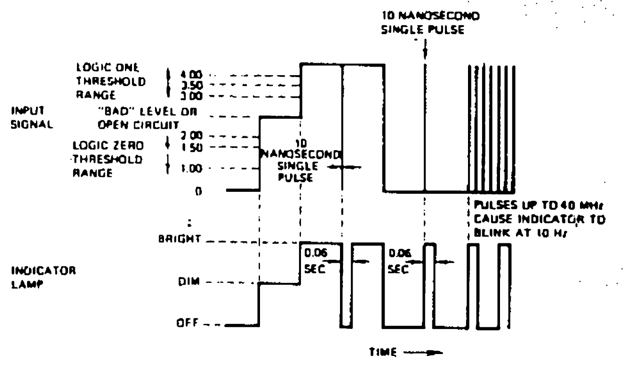


Figure 5. Logic level limits and how an HP Logic Probe responds to the different conditions.

logic 1 and 0 threshold areas termed "Bad or open circuit". The probe circuitry can sense whether it is "sinking" (drawing) or "sourcing" (supplying) current to the input. If it fails to do so, the input "floats" to about half the supply rail voltage and the indicator lamp glows dim. Tri-state is a situation where the probe is unable to sink or source current.

The oscilloscope will show a voltage around half rail depending on capacitances to adjacent lines, ground, supply rail and their respective potentials for tri-state. Generally it is very obvious when compared to other switching waveforms. See Figure 6.

There are a number of occasions when the microprocessor will tri-state the bus lines (e.g: reset halt, hold) and some microprocessors have a bus tri-state input as well.

The clock

All microprocessors require some form of clock oscillator to time the events that occur during the fetching and execution of an instruction. Microprocessors like the Motorola 6800 and the Intel 8080 require a two-phase clock that is generally generated by a support chip, the 8224 for the 8080, and the 6875 for the 6800.

Most modern 8 bit microprocessors have a clock oscillator included on the chip. A crystal or resonant circuit is simply connected between the appropriate pins to satisfy the clock requirements of the device.

Internally, the circuitry generates the phase 1 and phase 2 signals; these are pulses of the same frequency but displaced in time. See Figure 7 for the clock logic of the Intel 8085. Note also that the clock output is *half* the crystal frequency; microprocessors vary here, the 6802 divides by 4, the 6809 divides by 3 and the 8048 by 3, to list but a few.

To save the expense of the clock generator chips for Z80-and

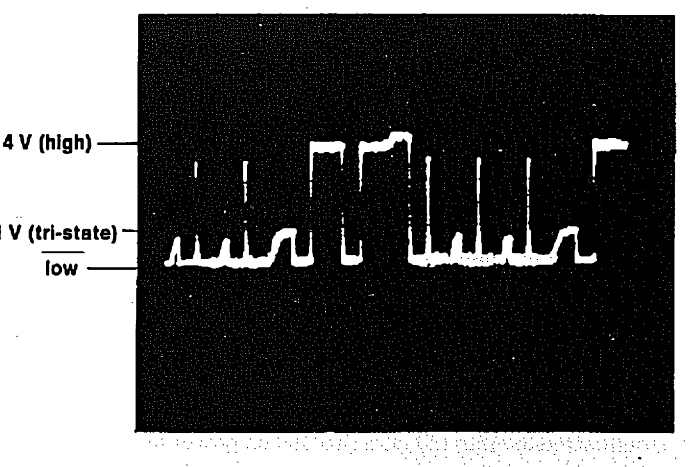


Figure 6. Oscilloscope picture showing typical tri-state level pulses.

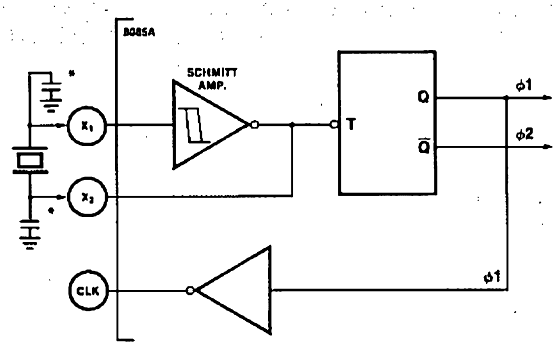


Figure 7. The 8085 only requires the connection of a crystal and two capacitors to supply its clock requirements. An internal flip-flop circuit supplies the necessary two-phase clock pulses, φ1 and φ2. Note the buffer providing a clock output from φ1.

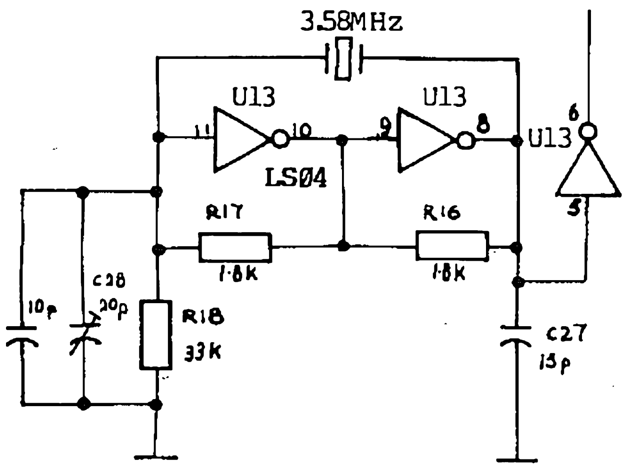
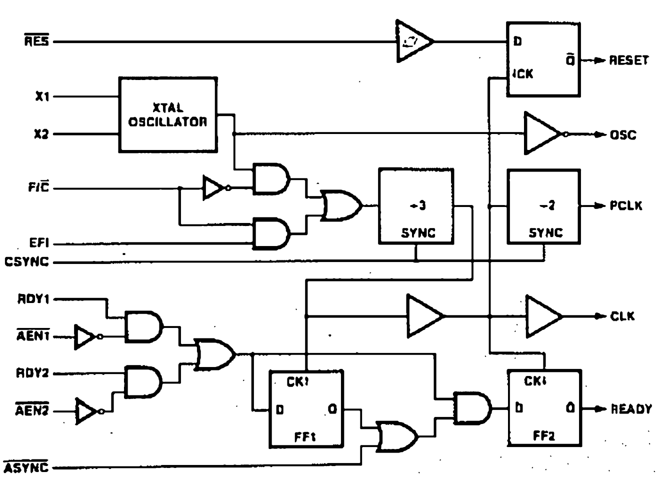


Figure 8. A circuit such as this is often employed to save the expense of a clock generator chip in Z80-and 6502-based systems.



8284A Block Diagram

Figure 9. The 8284 clock generator support chip for the 8088 microprocessor. The clock output, CLK, is one-third the oscillator frequency.

6502-based systems, designers will often use a crystal in a feedback circuit involving two inverters as shown in Figure 8.

The 8088 requires the use of a clock generator chip, the 8284. It requires a clock signal with fast rise and fall times (10 ns maximum) between logic 1 and 0 levels. The maximum clock frequency of the 8088 is 5 MHz, it's 8 MHz for the 8080-2. Figure 9 shows the 8284's internal logic for the clock and reset circuitry. Note the crystal frequency is three times the microprocessor's clock frequency.

No matter what clock is used, total failure of the clock is usually easy to find, but when the clock has the incorrect frequency, shape, mark-to-space ratio and amplitude, troubleshooting is more difficult. Many microprocessors are sensitive to clock speed, both too slow and too fast. The clock may be used to drive other LSI chips, like a dynamic RAM (DRAM) controller. Too low a frequency ("slow" clock) will cause "soft" errors in such memory.

Microprocessors like the 6800 series are dynamic devices, if the clock stops for more than 9.6 µs it will lose its data contents in internal registers. Sometimes crystals break into overtone frequencies or change to series-resonant frequency mode when they're supposed to operate in parallel-resonant mode, which causes a change in clock frequency. This change in clock frequency can cause timing problems with I/O devices, resulting in intermittent system malfunction, especially when the system is operated at its maximum specified clock rate. ▷

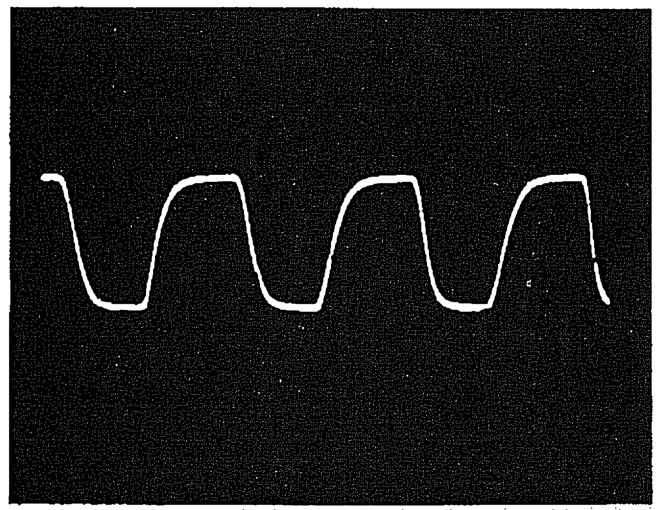


Figure 10(a). This shows the waveform on a 20 MHz bandwidth scope in its expanded timebase mode, with the probe switched to the ×1 position. i.e: no compensation. The input signal is the 3.07 MHz output from the clock of an 8085. Here, probe lead capacitance loads the output, note the effect of non-symmetrical output from the chip.

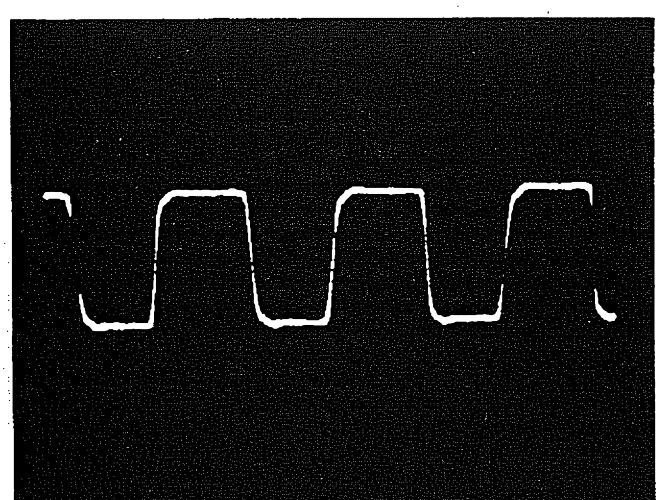


Figure 10(b). Same scope using x10 probe setting, with compensation correctly set.

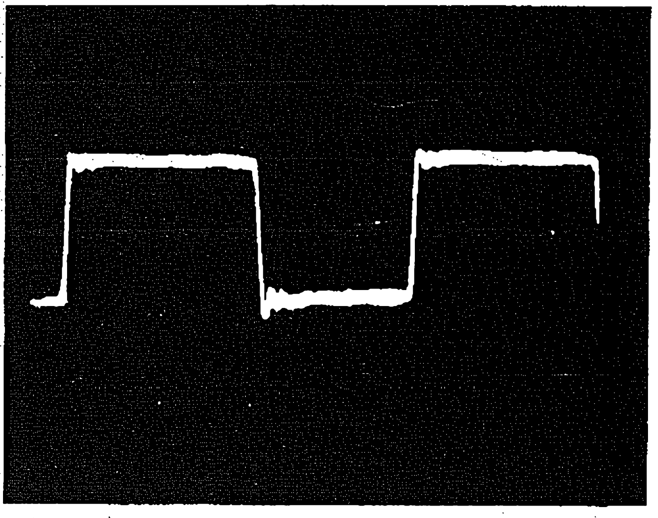


Figure 10(c). Shows waveform on 100 MHz HP scope using correct probes with compensation set. Rise/fall time 10 ns.

Microprocessor clock specifications can be found on device data sheets. The actual clock pulses in the system canbe checked for amplitude and mark-to-space shape using an oscilloscope. However, because of the importance of clock rise and fall times the oscilloscope should have a good bandwidth, preferably 60 MHz or greater.

An oscilloscope probe has a finite capacitance which may "load" the oscillator. The probe compensation must be set correctly to maintain proper pulse shape, but the probe's input capacitance can change the clock signal's rise and fall times. In addition, the signal amplitude on the 'scope can also be incorrect if the wrong probes (not of correct bandwidth to match the 'scope) are used or a limited bandwidth 'scope is used. Figure 10 illustrates.

When checking the clock with a 'scope, always probe at the buffered output of the clock oscillator. Measuring the frequency presents a small problem as most frequency counters have low impedance inputs in the 10 to 20 MHz range, requiring a buffer to stop placing excessive load on the oscillator.

Status lines

Some microprocessor systems give the external hardware, and the user, an indication of its present cycle status. For example the 8085 chip has three "status" lines: IO/ $\overline{M}$, S1 and S0. At the beginning of every cycle, the 8085 sends out a 3-bit status signal to define what type of machine cycle is about to take place. See Figure 11.

The status lines, S1 and S0, are extremely useful when the processor "falls over". If S0 = S1 = logic 0, the processor is in a "halt" state. It can be in this state as a result of finding a HALT instruction in the program (waiting on an interrupt), through an error in an instruction code from a faulty memory location, or noise on the data bus causing the instruction decoder to detect a

MACHINE CYCLE			STATUS			CONTROL		
			IO/$\overline{M}$	S1	S0	$\overline{RD}$	$\overline{WR}$	$\overline{INTA}$
OPCODE FETCH	(OF)		0	1	1	0	1	1
MEMORY READ	(MR)		0	1	0	0	1	1
MEMORY WRITE	(MW)		0	0	1	1	0	1
I/O READ	(IOR)		1	1	0	0	1	1
I/O WRITE	(IOW)		1	0	1	1	0	1
INTR ACKNOWLEDGE	(INA)		1	1	1	1	1	0
BUS IDLE	(BI):	DAD	0	1	0	1	1	1
		INA(RST/TRAP)	1	1	1	1	1	1
		HALT	TS	0	0	TS	TS	1

0 = Logic "0"   1 = Logic "1"   TS = High Impedance   X = Unspecified

Figure 11. The 8085's STATUS lines provide an indication of the processor's present cycle status.

code outside its instruction set. This processor, like many others, will go into a halt mode; some processors will cause an internal software interrupt to a set memory address where the designer inserts a "re-boot" which restarts the system, preventing a disastrous lockup.

Alternatively, S1 may stay at logic 1 with S0 toggling between logic 0 and 1, the processor is trying to complete a memory read or instruction ("op-code") fetch without success. The 8088 processor uses the IO/ $\overline{M}$, DT/$\overline{R}$ and SSO lines. The SSO line when decoded with the IO/ $\overline{M}$ and DT/$\overline{R}$ specifies the type of bus activity in progress. Figure 12 shows the Status table for the 8088.

IO/$\overline{M}$	DT/$\overline{R}$	$\overline{SS0}$	
1(HIGH)	0	0	Interrupt Acknowledge
1	0	1	Read I/O port
1	1	0	Write I/O port
1	1	1	Halt
0(LOW)	0	0	Code access
0	0	1	Read memory
0	1	0	Write memory
0	1	1	Passive

Figure 12. Status table for the Intel 8088.

Not all processors have this form of status indication, but careful decoding of read and write, valid memory address (VMA) and enable lines can be valuable in fault-finding, but nowhere as useful as the previous status lines discussed. Refer to the CPU data book for any status information.

As for checking, a scope is the most useful as it gives logic state and activity if any. Some technicians build up simple gating arrays with latches to display status of these lines.

In summary, processors that don't have software re-boots will generally go into a HALT state when an invalid instruction is found. You need to apply some form of hardware reset to 're-start the system'.

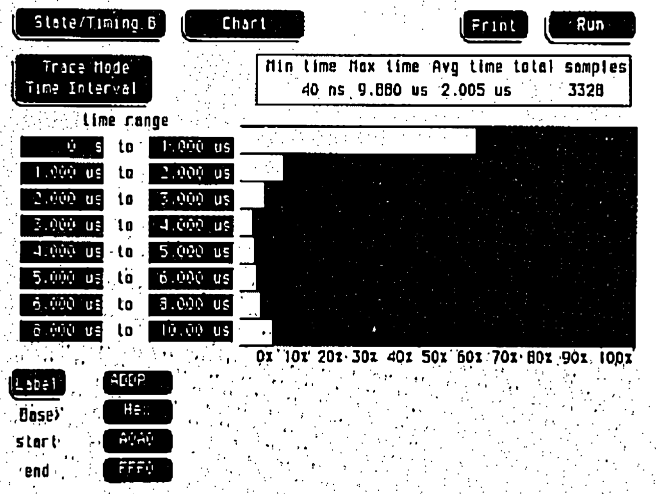
Interrupts

One important function found in microprocessors is the capability of responding to an *interrupt* signal or service request. e.g: the from keyboard, video controllers, disk controllers etc. In effect, an interrupt says "Hey!, stop what you're doing and pay attention to whatever caused the interrupt."

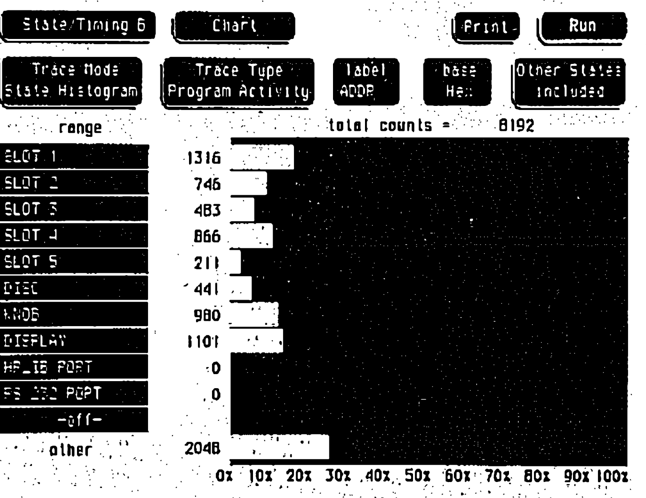
An interrupt request causes the control logic to interrupt the main routine (if no interrupt "mask" is incorporated), jump to a "service routine" which takes care of the peripheral or whatever it is requiring attention, and then automatically return to the main program when completed. When there are several interrupts, each interrupt is usually assigned a priority. This eliminates a conflict when two or more interrupts occur simultaneously.

As the IBM PC is interrupt driven, it contains a support chip, the programmable interrupt controller (PIC) 8259 to handle interrupts in the correct sequence. Stuck or noisy interrupt lines can cause faulty system operation, where the processor spends too much time servicing the "phantom" interrupts. With phantom interrupts, the system can give the appearance of slowing down, e.g: lack of terminal or keyboard response. It is not always possible to mask the maskable interrupts without writing additional software for a system.

Microprocessors generally contain both level sensitive and edge sensitive interrupt inputs; they also tend to be active at logic 0 input levels except for Intel types which have interrupts active at logic 1 levels. *(Somebody's* gotta be different!).



Time Interval Mode



State Histograms

Figure 13. This shows the sort of histogram displays available on Hewlett Packard and Tektronix logic analysers.

Edge sensitive input can "capture" noise pulses or induced noise pulses. As the latter is often random they are very difficult to identify. Level sensitive inputs tend to be active for longer periods as sometimes they don't set internal flags and the microprocessor must poll the interrupt lines in software to determine its status.

Looking at the circuit diagram or the microprocessor's data, you can identify which pins are interrupt inputs and how they are driven. Interrupt line activity can be monitored with a logic probe, logic analyser or storage oscilloscope. A logic probe with sensitive pulse detection input and pulse stretcher is useful.

Some logic analysers have a mode in which they provide a "map" or a "histogram" of where the processor spends most of its time over a sample period of time. When compared with another unit, it gives you an idea which interrupt line is causing the problem.

— continued next month.

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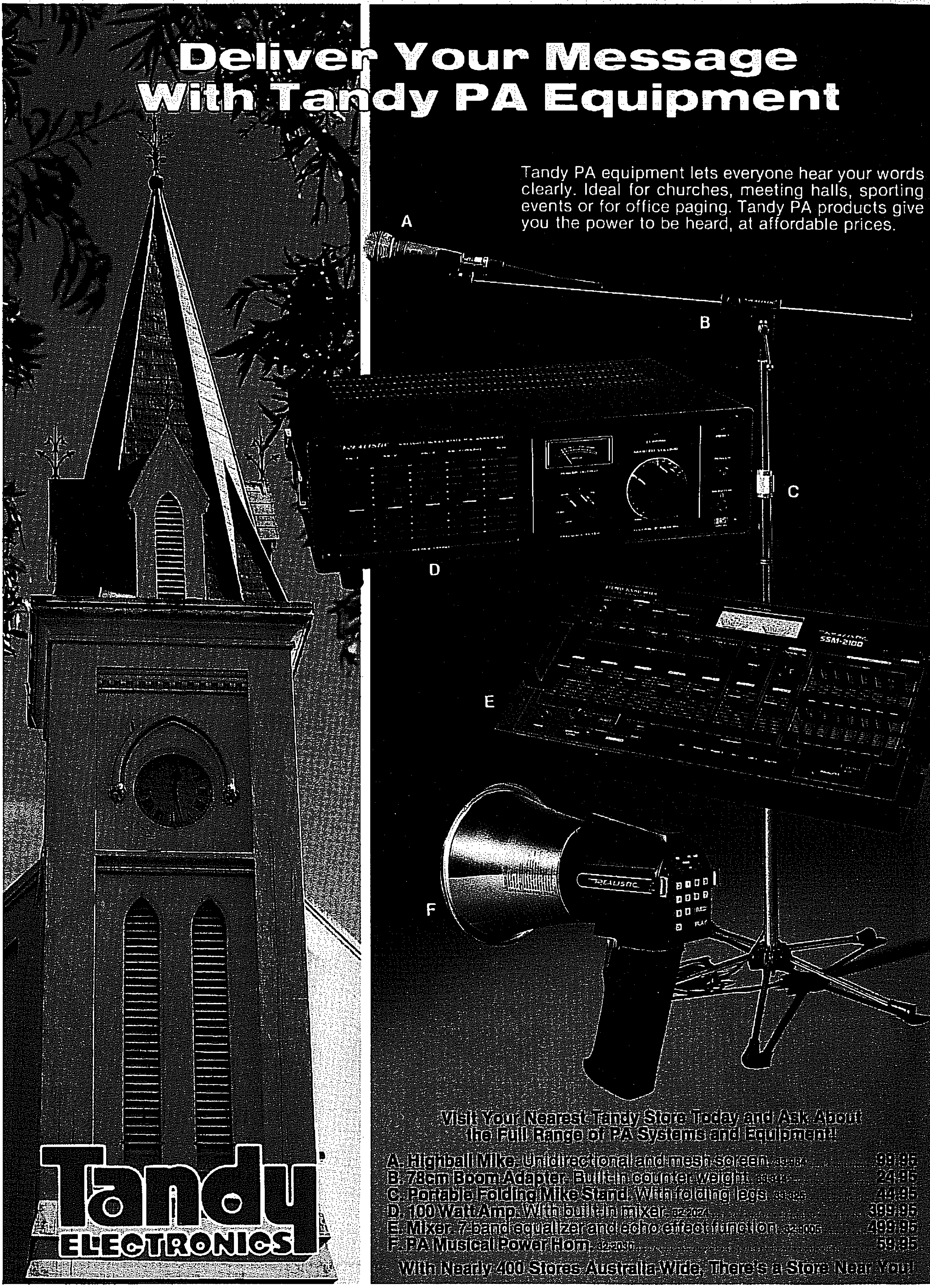
NOTE: Back issues of AEM cost $4, including post and handling.



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ELECTRONICS

On balanced lines, indecent connections and laying your cables

Robert Azzopardi

Getting a PA system to "work" requires a mixture of physics, electronics, experience and good ears. Here are some practical tips on getting it together, along with the "why" in technical terms.

WHAT DO a large PA and a home hi-fi have in common? Quite a lot, really. The basics are the same. Systems comprise: *signal source(s)* — mics and DIs versus tape players, turntables etc; *preamplification* — mixing vs phono-tuner-preamp; *signal conditioning* — e.g: graphic equalisers and signal modifiers, delays, etc, though this is optional for home hi-fi's; *amplification* — 100s to 1000s of watts vs 10s to 100s of watts!; and *speakers* — truck size as opposed to bookshelf size.

The differences lie in scale, user adjustability and of course, $$$. The home hi-fi is a very user friendly unit designed to sound good with a minimum amount of fiddling and generally to stay in one place. Of course there is also the aesthetic factor, and to most people (but not all — roadies are a strange bunch, some having been known to mount a 300 watt PA in the cabin of their truck for a particularly long and loud tour), a sleek high-tech hi-fi looks much better than a one tonne double three-way in the lounge-room.

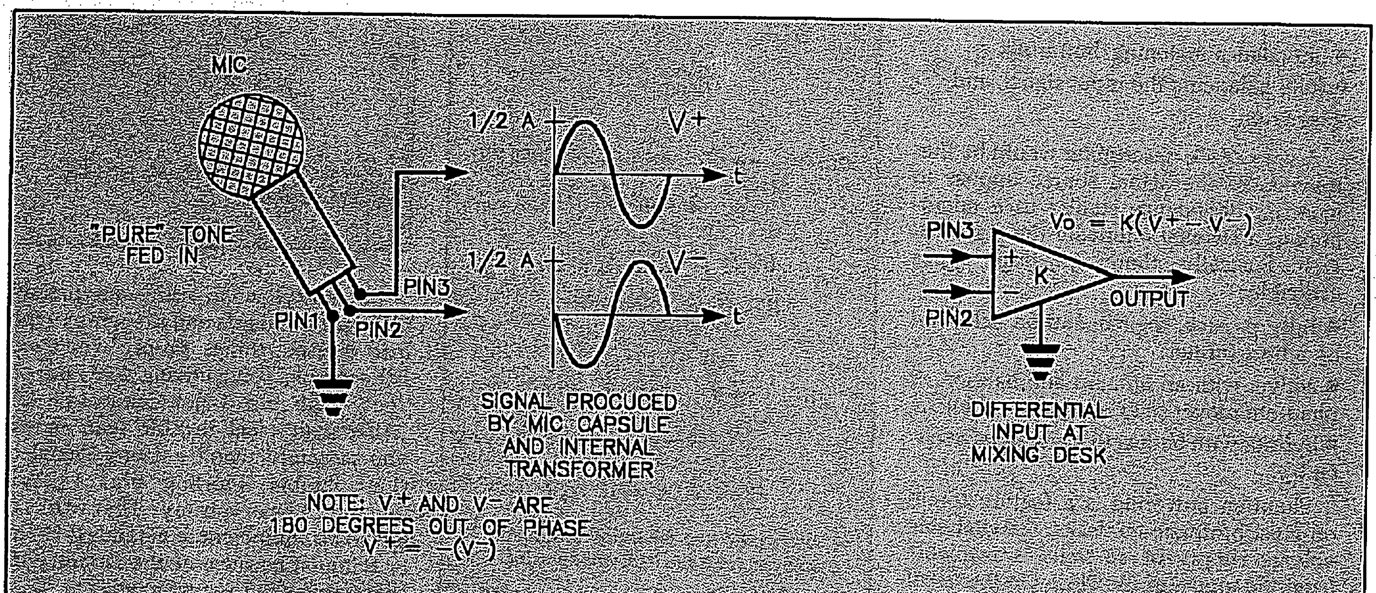
A PA, on the other hand, has to work in a range of environments, from the great outdoors to smokey dens, with a range of signal sources and qualities. To optimise its performance, a greater degree of adjustability is required. Hence the use of comprehensive desk equalisation, 31-band graphic equalisers, plus system compression and limiting.

This is also where the black art of the sound engineer comes into play: a mixture of physics, electronics, experience and good ears. You have to try pretty hard to make a hi-fi sound awful, but with a big PA system it ain't so hard! One nightmarish situation is when you're doing foldback (monitors) from the front of house desk, the guitar player has his amp turned up too loud, the sax player can't hear himself, howls of 2 kHz feedback periodically tear the room apart and the band's manager keeps telling you what to do, saying "Get it together man!"

With a bit of technical background it is possible to solve a lot of common problems and avoid common pitfalls.

Sources and balancing

Let's start at the very beginning with signal sources. As discussed in other articles, most of the microphones used (Shure, Beyer etc) are the low impedance type with a balanced output and a normal mic cable has two conductors plus a screen, or shield. The way it works is this: Assuming pure sinewaves —

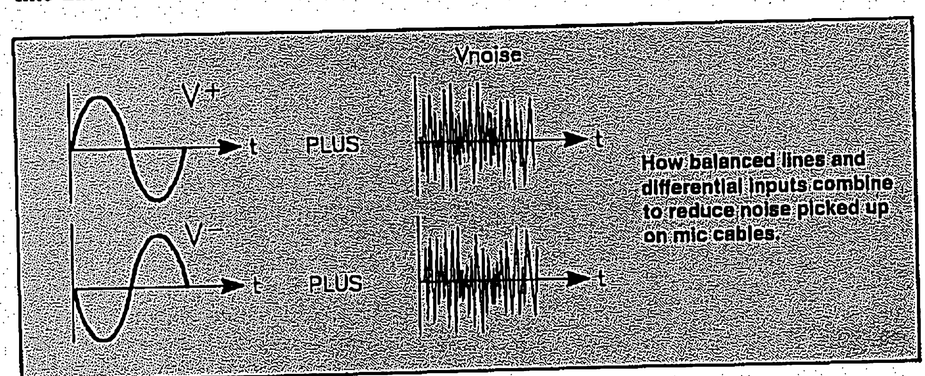


The microphone output consists of two sine waves 180° out of phase fed (via a mic cable) into the input of the mixing desk, which is a differential amplifier. A differential amplifier operates by taking the difference between its inputs and multiplying them by a gain factor. In the above example

$V_o = K.[\frac{1}{2} A.\sin.\omega.t - (-\frac{1}{2} A.\sin.\omega.t)]$

$= K.A.\sin.\omega.t$

Where ω is $2\pi \times$ frequency. Now, the two conductors are twisted together in the mic cable and as a result are exposed to the same amount of external noise (a random signal). So the signals become, like this



How balanced lines and differential inputs combine to reduce noise picked up on mic cables.

Putting the resulting signals into the differential amplifier gives:

$V_o = K.[\frac{1}{2} A.\sin.\omega.t + V_{noise}$

$- (-\frac{1}{2} A.\sin.\omega.t + V_{noise})]$

$= K.A.\sin.\omega.t$

which cancels out all the garbage. The noise is called a *common mode* signal and its cancellation is known as *common mode rejection*. It is this noise reducing characteristic which makes balanced lines so useful.

DIs, or *direct injection* units are little "black boxes" plugged into splits from guitar, bass or keyboard signals to be fed to the mixing deck. They serve several purposes:

- impedance matching/buffering,
- fully balancing the input signal, and
- isolation.

A very crude description would be that they make the signal source appear to have an impedance similar to a microphone; a DI may attenuate the signal as well. Basically, there are three types available:

- fully passive, their operation achieved by a transformer,
- active, with an op-amp and battery, or phantom power (that is, via the cable), or
- hybrid, with both active and passive circuitry.

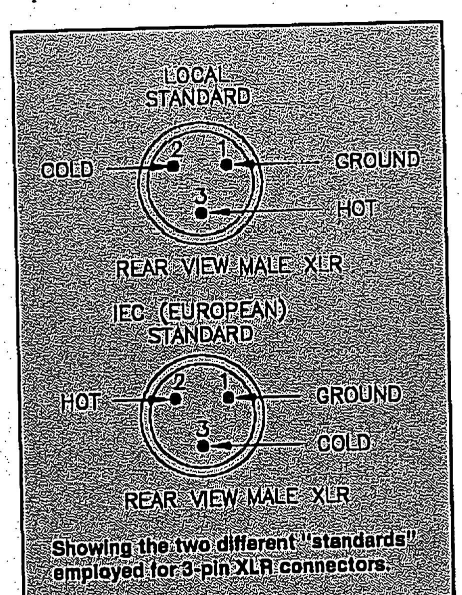
Phantom powering is a feature found on most professional desks. A switchable voltage supply of 48 volts is available from the inputs of the desk. On the usual XLR connector, pin 1 is grounded and pins 2 and 3 both carry 48 volts. This is used to power condenser microphones and DIs. The normal microphones are not affected by the presence of the dc.

A useful feature on the DIs is the ground lift switch which isolates the shield (pin 1) between the input and output of the DI, thereby preventing "ground loop" problems — that ominous 50 Hz hum you often get when various parts of the sound system are plugged into different power points. The loop of cable shields acts like a huge one-turn coil and picks up mains wiring radiation which mixes with common signal returns — and you get hum.

Connectors

Three types of connectors are commonly used in audio systems: Cannons (3-pin), 6.5 mm Phono jacks and RCAs. Phono jacks are used for guitars and effects desk patching while RCAs are used on the outputs and inputs of tape recorders.

The 3-pin Cannon or XLR (*E*xtra *L*ow *R*esistance) connector is the most widely used. It comes in both male and female types. The standard signal always comes out of a male connector and into a female one (e.g: mics take the female end of the mic lead). Just like biology! The only exceptions to this are speaker leads which now commonly use female to female connections for safety's sake. On XLRs, pin 1 is *always ground* or shield; from then on, it can get confusing as there are two standards.



Showing the two different "standards" employed for 3-pin XLR connectors.

The first is the IEC standard, where:

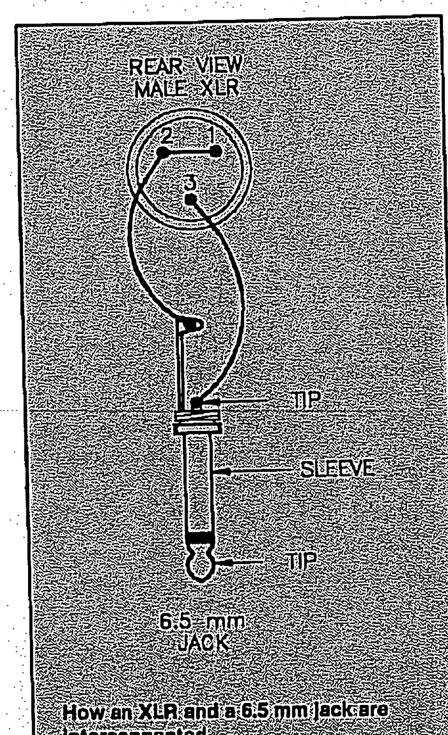
- Pin 1 is ground,
- Pin 2 is "hot", or in phase, and
- Pin 3 is "cold", or out of phase.

This is found on some imported equipment such as power amplifiers and mixing desks.

The second is the one used in Australia, where:

- Pin 1 is ground,
- Pin 2 is "cold", or out of phase, and
- Pin 3 "hot", or in phase.

Problems arise when interconnecting different equipment. For example, balanced and unbalanced systems, like jack to XLR connections. For both standards the jack tip is taken to the "hot" pin of the XLR while at the XLR end, ground (pin 1) and the "cold" pin are shorted together; e.g: for the Australian standard:



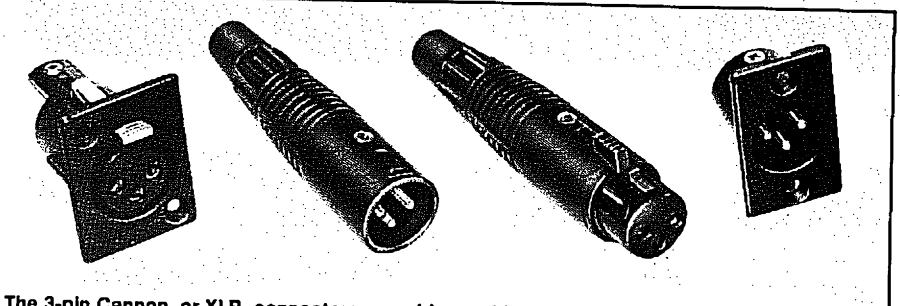
How an XLR and a 6.5 mm jack are interconnected.

Obviously, when using equipment of different standards and the wrong type of lead is used, things simply won't work. For example, some mixing desks are pin 2 "hot" with pin 3 not connected. If an "Australian" jack-to-XLR lead is used, you certainly won't get any signal out! Don't bother shorting pins 2 and 1 together, I hear you say? That works too, but some equipment (e.g: Jands JM10 mixer outputs) because of the circuitry used require pins to be connected.

The moral is to be aware of what your equipment is and, where possible, use normal mic leads for interconnections and let the equipment itself do its own balancing/unbalancing.

There are a variety of XLRs about, the most annoying thing about them being the small securing screws which end up getting lost whereby the connector falls to bits. In addition to this, when a lead dies at a gig you've never got a screwdriver, ring of keys or ringpull small enough to unscrew them!

Perhaps the best are the new Neutrik XLRs which have no screws. The only catch is that they are expensive and the small clips on the female connectors have been known to fall out. No pun intended, though.



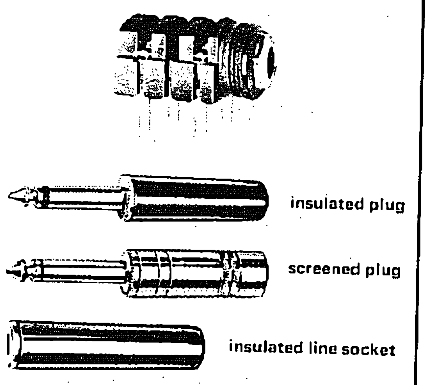
The 3-pin Cannon, or XLR, connectors are wide used in sound systems.

RCA connectors are commonly employed on tape decks (and widely used in hi-fi gear!).

A roll and a lay

A final note on the rolling and laying of cables. It's a fact of life that sound systems need to use *kilometres* of cable — signal cable, mic cable, speaker cable, power cable. For storage and carriage, you roll them up; common sense. But, as in everything, there are practical ways and impractical ways of doing things.

Don't roll cables over your arm, this strains the cable and puts twists in it which are very difficult to get out, making it nearly impossible to lay the cable flat.



The 6.5 mm jack is about as widely used as XLRs, but in different applications.

There are three schools of thought on the rolling of cables and leads:

1) wind it in a "figure-8";

2) wind it flat;

3) wind it "under and over".

The "figure-8" method is a must for the laying of power cables and to a lesser extent speaker cables. That laying a great perfect coil of cable creates an inductor which may lead to overheating and noise generation of large currents is a paining thought. Laying the cable in a figure 8 results in this cancellation of magnetic fields (remember Ampere's Law and the Right Hand Rule?).

For flat rolling, the cable is held in one hand and with the other, is looped on itself. If the cable has not been abused, it should have a natural loop.

Under and over is a variation on this idea involving putting an extra twist in the loop. It is very difficult to describe, and much easier to get someone to show you! The idea is that the cable is easier to feed. But if the cable is fed from the wrong end of the roll, it will quite happily knot itself at regular intervals!

Most hire companies will spit their dummies if you return your leads in a tangled ball. Some even charge a lead re-rolling fee! If a lead returns to a loop easily it sometimes helps if it is left out in the sun for a short while. This will soften it, allowing it to be re-rolled.

Lastly, never lay power cables parallel with mic cables. It is the quickest way to create hum! When laying mains cable, always cross signal cables at 90°.

Understanding the op-amp and its applications

Part 1

Brian Hammill

The operational amplifier, or op-amp for short, is one of the most important and widely used "building blocks" in electronics. For that reason, it's important to know and understand the op-amp and its applications. This short, practical series will introduce you to the op-amp through one of the cheapest, most widely used types, the 741.

THE OP-AMP would come closest to that "ideal" object in electronics — the "universal" active component. My dictionary of electronics says that ". . . it is an amplifier that can perform various operations . . . it can be used to add, subtract, average, integrate and differentiate signals." That seems a pretty incredible array of applications! No matter how much digital electronics seems to dominate these days, the op-amp still reigns supreme as a building block, despite being an analogue device.

Basically it's an amplifier to which you apply feedback — a connection between the output and the input so that some output signal is *fed back* to the input. With an op-amp, the characteristics of the circuit are determined entirely by the feedback, for most practical purposes.

Op-amps come in a variety of configurations:

- single input — single output,
- differential input — single output, or
- differential input — differential output

However, the most common configuration you'll run across is the second one — differential input, single output. Circuit-wise, this appears as shown in Figure 1. While there's a mass of electronics inside that little triangle, for most practical purposes, we can ignore what's inside the integrated circuit it represents and simply concentrate on what it does. Before ICs, op-amps were built using individual components, but the overall approach was the same

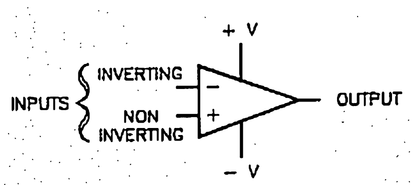
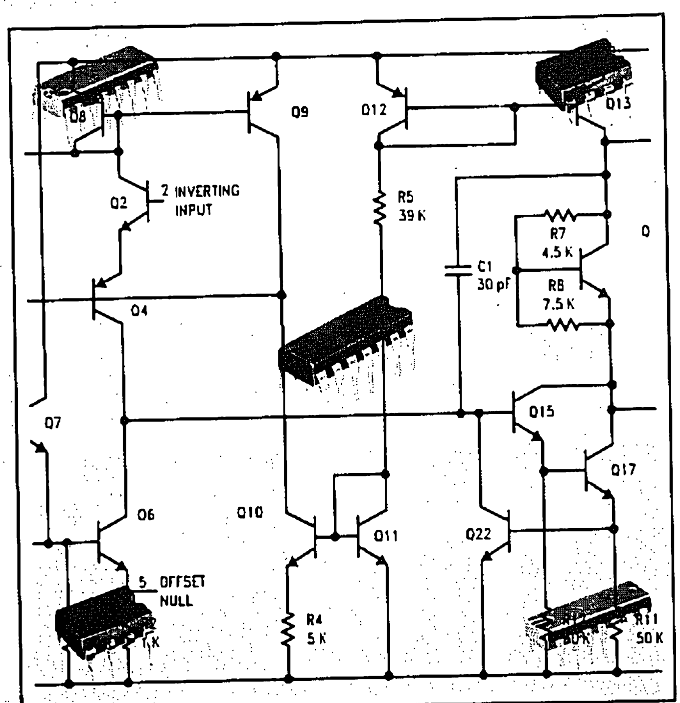


Figure 1. This is how the most common op-amp configuration is drawn, with differential input and single output, as explained in the text. Note the use of positive and negative supply rails; some op-amps, however, are manufactured to operate from a single supply rail.



The *differential* input means that the op-amp takes the *difference* between the signals at each input. The input marked with a "-" is known as the *inverting* input, while its counterpart, marked with a "+", is known as the *non-inverting* input. The inputs do just what you expect: the output goes positive when the (+) input goes more positive than the (-) input, and vice versa. And we'll get around to what all that means and how it's exploited shortly.

That ubiquitous op-amp — the 741!

The best way to get acquainted with how op-amps work and what you can do with them, is to take a practical example. Of all the op-amp ICs you can buy, the '741 is perhaps the most ubiquitous, and it's easy to see why. It's the cheapest — under a

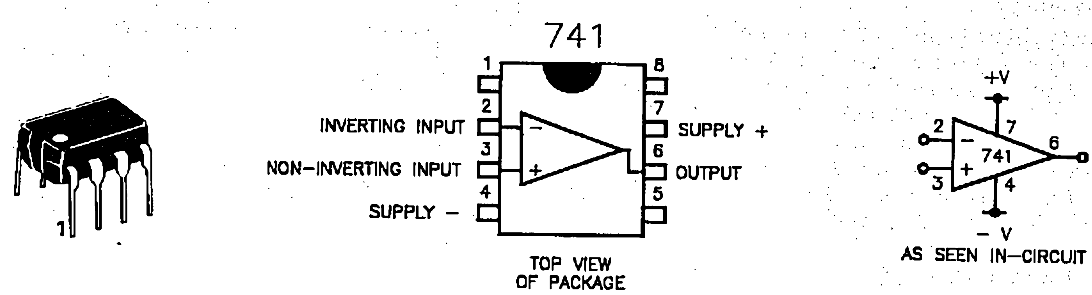


Figure 2. The typical 8-pin package, the pin connections and the circuit symbol of that ubiquitous op-amp, the 741.

dollar at most retailers, and it's made by quite a number of different manufacturers and comes in a variety of shapes, sizes, numbers of legs and colours (well, grey or black!).

No matter how it's packaged, somewhere on the outside should appear '741'. It may be as part of a large part number, like "uA741CP", "SFC2741" or "LM741CN", but the '741' will still be there.

When you go into a shop to buy a 741, you can usually get one by simply asking for a "741". All of the other letters in the part number refer to things like the name of the manufacturer and the type of package it comes in.

There are three main types of package for the 741. The first is called the 8-pin DIP and, as it's the most common form, is the one that we'll be dealing with. The '8-pin' means that it has eight pins (simple enough), and the DIP means that the pins are arranged in two lines (DIP means "dual in-line package").

The second form of package you may see is the 14-pin DIP, which is similar to the 8-pin, but longer, and the third is the TO-99 package, which looks a little like a metal hat, with wires coming out of the bottom.

We'll be concentrating on the 8-pin DIP variety, but if you get hold of one of the other types, you will probably be able to work out which wires or pins correspond to the 8-pin version by consulting the supplier's catalogue, or something similar.

So, the 741 you're likely to buy from your favourite electronics store can be represented physically and circuit-wise as shown in Figure 2. The package may have either a notch at the pin 1/pin 8 end or a 'dot' depression adjacent to pin 1. The important thing is that the mark or dot shows you which end of the IC is which.

Holding the IC with the pins pointing away from you, the pin anti-clockwise from the marked end is called pin 1. The rest of the pins are numbered anti-clockwise from this pin.

Now for the connections. We'll ignore pins 1, 5 and 8 — because pin 8 doesn't do anything, and the use of pins 1 and 5 is complicated, and in many applications, unnecessary. So, we're left with five pins. Two of these are inputs, one is an output, and the other two are for the power supply. ▷

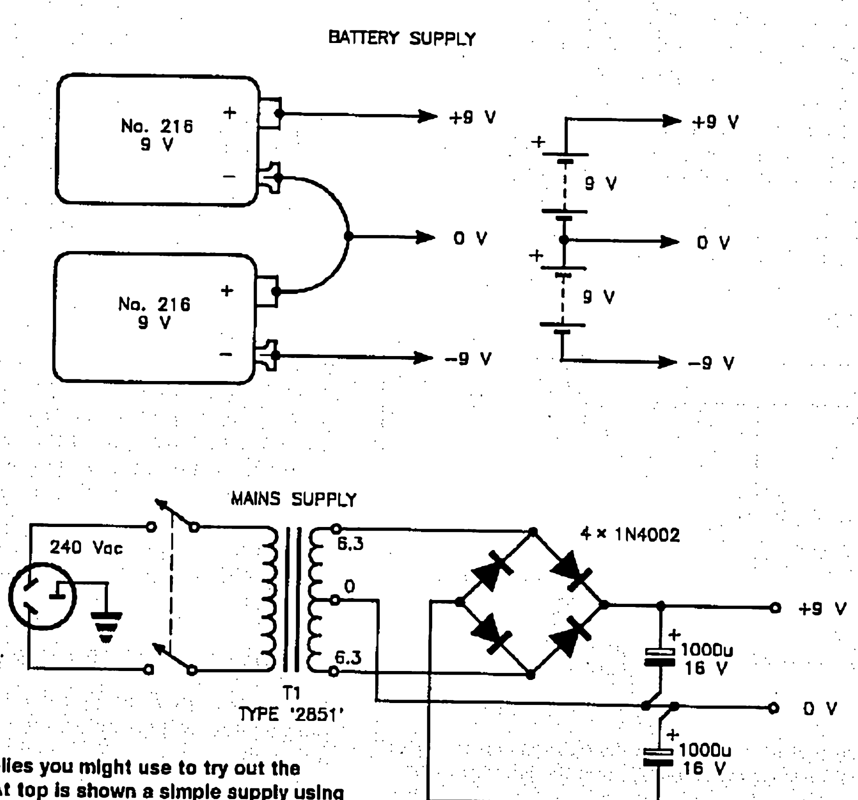


Figure 3. Suitable power supplies you might use to try out the circuit examples given here. At top is shown a simple supply using two 9 V "transistor radio" batteries. Beneath it is shown the circuit of a suitable ±9 V mains supply using common, cheap components.

POWER SUPPLIES

The 741 will work quite happily off a couple of 9 volt batteries connected as shown in the top diagram in Figure 3. Alternatively, a suitable simple mains supply is shown in the bottom diagram of Figure 3. The battery supply, however, is simple and safe. This sort of supply is known as a "split" or "balanced" supply because there are two outputs from it — a positive supply rail and a negative supply rail, with the common connection between them being the zero volts (0 V) circuit return or "ground".

The 741 will work with supply voltages down to 4 V (that is one +4 V supply and one -4 V supply) and up to 15 V. But for most purposes, the ±9 V supply is ideal.

AROUND THE PINS

Now, let us run around the pins of our 8-pin DIP to get familiar with the "pin allocation", as they say in the trade:

Pin 1. Not used here.
Pin 2. The inverting (-) input.
Pin 3. The non-inverting (+) input.
Pin 4. The negative supply.
Pin 5. Not used here.
Pin 6. Output.
Pin 7. Positive supply.
Pin 8. Never used — not connected.

So, connect the positive rail of your power supply to pin 7, and the negative rail to pin 4, and the 741 will be ready to go! Just leave pins 1, 5 and 8 disconnected and forget about them.

There are a *host* of other op-amps that have the same basic pin allocation as the 741, and in many circuits these others may be readily substituted — but not always. And that subject's a bit beyond the scope of this article. However, the data books do indicate that the 741 is a direct pin-for-pin replacement for the older 709C, as well as the LM201, the MC1439 and 748 devices. If you are going to do some experiments, by the way, I would recommend you use one of those little plastic boards with the sockets in it, generally referred to as a "proto board". Be sure to get that type which has the socket spacing which fits the pins of the IC (that is the type with the sockets every 0.1 inch, or 2.54 mm if you want to be metric about it.

If you can arrange it, I would recommend you install a double-pole switch in series with the supply rails so you can switch off the supply whenever necessary. If you're using batteries, this saves battery drain while you're hunting for parts or figuring out what to do next — or if you forget to disconnect the batteries when you mosey off for a meal. Note that you must switch off each supply rail, not just one.

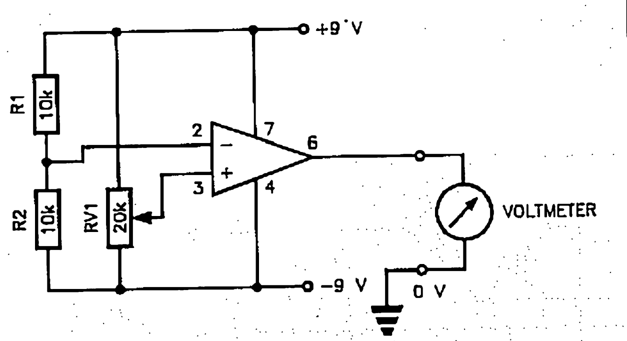


Figure 4. The "comparator" circuit. Here, the op-amp compares the fixed voltage on its inverting input (pin 2), from the junction of R1 and R2, with the voltage on its non-inverting input (pin 3), from the wiper of RV1. If the wiper of RV1 starts at the bottom, the op-amp output will be at about - 8 V; as the wiper passes the "half-way" point here, the op-amp's output will swing to +8 V.

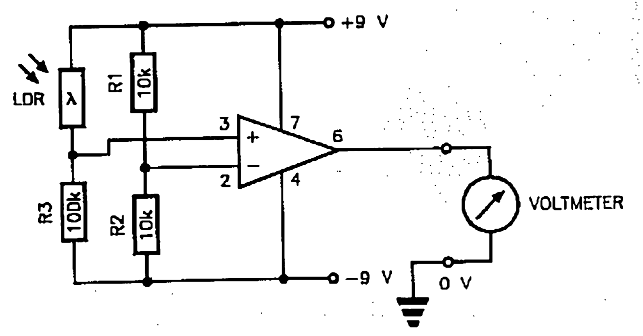


Figure 5. A comparator at work. Here we have a light-sensitive switch. The peculiar resistor marked "LDR" is a light dependent resistor. Its resistance decreases with increasing light level. In the dark, it may have a resistance of 1 MΩ, in bright light it may be less than 1 kΩ. So, when it's dark, the voltage at the junction of R3 and the LDR will be lower than at the junction of R1-R2, hence the op-amp's output will be at - 8 V. When it's light, the voltage at the junction of R3 and the LDR will be higher than at the junction of R1-R2 and the op-amp's output will swing to +8 V.

Now, having got yourself set up with a real op-amp and a power supply, let's see what you can do with it.

SO HOW DOES THE 741 OPERATE?

There are, as you can see, two inputs: respectively, the non-inverting input (+) and the inverting input (-), as we saw earlier.

When connected to a power supply, what the 741 will do is this: it will *subtract* the voltage on the inverting input from the voltage on the non-inverting input, *multiply* the answer by a very large number and produce the result of the multiplication as a *voltage* on its output.

Now, the actual value of the "very large number" that I referred to in the last paragraph is not important, but just out of interest it may range from 200 000 to 1 000 000!

Let's say that +2 V is applied to the non-inverting input and that the inverting input is at +1 V. Now, 2 — 1 = 1, and 1 multiplied by 200 000 is 200 000, so you would expect the 741's output to be at 200 000 volts. What?!

Naturally, this does not happen. The voltage at the output of the device is limited by the supply voltage. Thus, instead of 200 000 V appearing on the output, you would get about 8 V. This is because the 741 will produce output voltages to within about 1 V of the supply rail voltage. So with ±9 V supplies, the output is limited to between -8 V and +8 V. All voltages, by the way, are with reference to ground — that is, the common of your ± supply, the 0 V point on Figure 3.

So, if the non-inverting input is a *fraction* of a volt more positive than the inverting input, the 741's output will be +8 V. Likewise, if the non-inverting input is a fraction of a volt more negative than the inverting input, the output will be -8 V.

This means that we can use the 741 to *compare* two voltages applied to its inputs, and have the output swing to almost the supply rail, as appropriate. Now that's a fundamental application, so let's have a look at the op-amp as a *comparator.*

The op-amp as a comparator

Look at the circuit in Figure 4. Here I am using the 741 to compare a fixed voltage at the junction of R1 and R2 with the variable voltage on RV1. You might like to try this, and some of the other examples I am going to give, just to familiarise yourself with the workings of the 741.

As the wiper of potentiometer RV1 is moved towards the positive supply, the output of the 741 will suddenly change from -8 V to +8 V, indicating that its non-inverting input is now more positive than its inverting input. Move the pot's wiper back down and you will send the output back to -8 V. If you actually build this circuit and try it out, you will notice that it takes but the *slightest* movement of RV1 at that point to cause the op-amp's output to swing one way or the other.

How can this be used in a practical application? Well, let's see an example of a comparator at work. The circuit shown in Figure 5 is a light-sensitive "switch"; that is, the op-amp's output will swing, or switch, from -8 V to +8 V with variations in light level. The peculiar resistor symbol at the top left is a *light dependent resistor*, or LDR, such as an ORP12 or equivalent (e.g: a DSCD01 from Dick Smith Electronics). This is a device whose resistance varies from around 1 MΩ in the dark to about 500 Ω in bright sunlight. It is worth buying one because they are fun to play with!

So what happens here? When the LDR is in the dark, its resistance will be around 1M and the voltage on the 741's non-inverting input will be lower than the voltage on its inverting input. In this condition, the 741's output will be at -8 V. When enough light falls on the LDR so that its resistance drops to just slightly below 100k, the voltage on the non-inverting input of the 741 will rise above the voltage on the inverting input. When this happens, the output will go to +8 V.

By varying the resistance of either R1, R2 or R3, you can vary the "set point" of the circuit — the amount of light which will cause the output of the op-amp to go positive.

Resistors R1 and R2 may be fairly high values, rather than the 10k shown here, resulting in less current drain if the circuit is battery powered. The 741 inputs will draw only *minute* input current — microamps — so R1 and R2 may be 10 or 20 times the value shown here. The 741's input resistance will not 'load' R1 and R2 by drawing so much current that it affects the voltage at their junction. In precision applications, a stable, precise "voltage reference" device is used.

This circuit Figure 5 might form the basis of an automatic daylight-night switch or relay, to turn on and off house number illumination, or a porch light, etc.

Hysteresis can be handy

Let's say, for the sake of illustration, that you're using the Figure 5 circuit to turn on your air conditioning when the Sun comes up. For this, the comparator's output would operate a relay circuit when it switched from -8 V to +8 V. So, you have got it adjusted such that the street lights aren't enough to turn it on, but when dawn comes the LDR gets enough light to switch the relay.

Fine. But what if, just as the Sun comes up, a cloud gets blown in front of it, and that's enough to turn the circuit back off. Remember — the op-amp's output will swing from minus to plus, and vice versa, at the same point as the light increases and decreases, respectively. This means that, on some mornings, the air conditioning will go on and off a few times before it actually gets light enough to keep it on. That won't do the air conditioning any good.

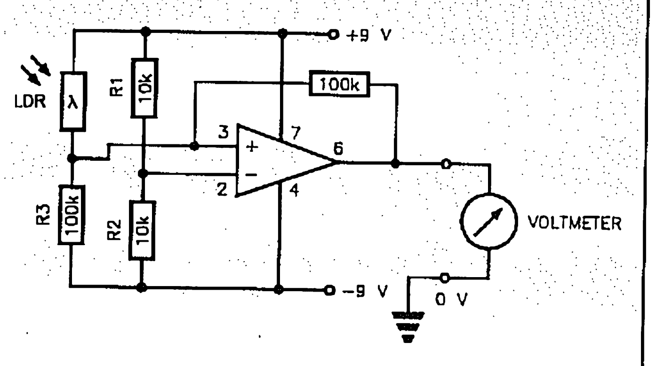


Figure 6. By adding a feedback resistor from the output to one of the inputs, we can give the circuit a characteristic known as "hysteresis".

So now what we want is a circuit which will turn on when it gets to a certain brightness, and will stay on even if that brightness should vary a little. But the circuit will have to switch off when it gets dark enough, too.

In Figure 6 you will notice I have added a resistor between the op-amp's output and the non-inverting input. It provides *feedback* and here it will give the circuit a characteristic known as *hysteresis*.

First, let us say it is dark, and so the resistance of the LDR is very high. That means that the non-inverting input of the 741 is negative with respect to the inverting input — which is in fact at 0 V, and thus the 741's output is at -8 V.

Now, when the Sun comes up the resistance of the LDR will drop slowly, until it is 100k — this is the point at which the op-amp output went positive last time. But it won't this time. The output of the op-amp is still negative, and current flowing through the 100k feedback resistor is holding the non-inverting input negative.

Okay, instead of the output going high with the LDR at 100k, it is going to switch a little later. In fact, it will switch when the LDR resistance is about 900 kΩ. At this point, the voltage on the non-inverting input will be equal to that on the inverting input.

Now, when the output of the op-amp goes positive, that will reverse the effect of the feedback resistor. The voltage on the non-inverting input will jump suddenly to about +1 V, because the op-amp output is now at +8 V, instead of -8 V as it was when it was dark.

So when a cloud covers the Sun, and the resistance of the LDR varies slightly, say to 950k, the output of the 741 will stay

— to page 45. ▷

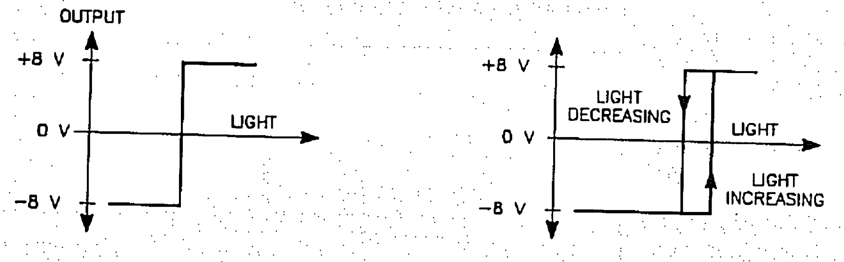


Figure 7. The graph at left illustrates the operation of Figure 5, while the graph at right shows how Figure 6 works. The difference between the 'light increasing' and 'light decreasing' paths is the hysteresis of the circuit.

Seven fundamental electronic facts

Part 4 – Power and superconductivity

Bryan Maher

In this final part of this article we ask "Why does Power = VI?", and also we look into that miracle of the present future - superconductivity.

POWER is a quantity or a measure of what *work* is done by any electronic (or mechanical, for that matter) system. It is a quantity or parameter of enormous importance; witness the quoted specifications of audio amplifiers, loudspeakers, electric motors, radio transmitters, etc. But justs *what* does it denote and how to we arrive at it?

The sixth law

Since our schooldays we haves known that: *"Power is equal to the product of volts and amps"*. If dealing with dc we say the product is simple and direct:

$$\text{Power} = VI$$

But if dealing with ac, then it must be taken into account that the current and voltage waveforms in a circuit may not be in step — that is, *in phase* — and thus a factor, known as the *Power Factor*, must be included in the product. This is simply a measure of the difference between the cycles of voltage and current, which turns out to be the cosine of the *angle* by which voltage *leads* or *lags* the current; thus:

$$\text{Power} = VI\cos\theta$$

where θ is the phase angle of lead or lag.

Let's restrict our discussion to the dc case: Just how do we know that "Power = VI" ? Our sixth fundamental law makes this claim....but on what grounds? As before, we only believe theories which are in agreement with multiple experimental results!

First, let's look at what the law says, then afterwards how experiment has shown agreement.

A law of power

A current *i* is defined as a rate of progress of charge q along a path, thus:

$$i = \delta q/\delta t$$

That is, the change (δ) of unit charge per change in unit time. Voltage drop between two points A and B is usually defined in terms of the work W(A — B) done in bringing a charge q from A to B through distance s against the electric field E existing between those points. Thus:

$$[V(A) - V(B)] = \int(E\delta s)$$

where the integral is evaluated between A and B.

Shifting this charge requires a force f = qE, the force doing work W(A — B). As work is the product of force by distance:

$$W(A - B) = \int(f.\delta s)\text{, or}$$
$$W(A - B) = \int(qE\delta s)$$
$$= q\int(E\delta s)$$

The ∫ is the *integral* sign and means to sum, or add together, all the fractional changes (δ) over a given interval. Here, the integrals are evaluated from A to B.

And, by the integrals above, this means:

$$W(A - B) = q[V(A) - V(B)]$$

Suppose the charge moved in the resistance (see Figure 1) through a distance (A — B) at a uniform rate in time, t1 — t2. i.e: suppose the current is steady dc.

Recall that power is defined as the time-rate of doing work. Work done in time [t1 — t2] requires power p(t1,t2) given by:

$$p(t1,t2) = W(A - B)/[t1 - t2]$$
$$= q[V(A) - V(B)]/[t1 - t2]$$
$$= (q/[t1 - t2])[V(A) - V(B)]$$

But charge q divided by time equals current flow, i.e:

$q/[t1 - t2]$ = current *i* flowing from A to B

So the total power needed to move charge a distance [A — B] in time [t1 — t2], is:

$$p(t1,t2) = i[V(A) - V(B)]$$
$$\text{power } p = i[V(A) - V(B)]$$

So, the power required to pass current *i* through a resistance R is given by the product of the current and the voltage drop across that resistance, or simply:

$$\text{power} = iV$$

So far, that's been all theory, no basis for believing anything! The important question is "What does one see experimentally?"

Experimental verification

Electro-calorific (that is, electricity/heat) experiments are done wherein the passage of measured current causes heat, which can be "captured" and measured by temperature rise.

So the answer to "What does one see experimentally?" is that repeated electro-

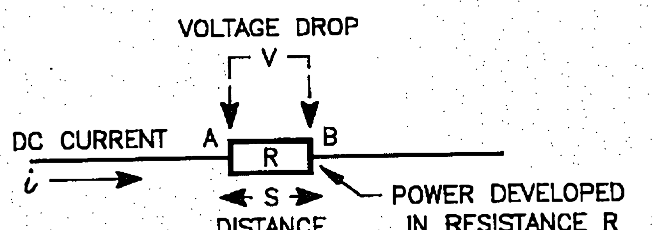


Figure 1. The story in the text shows *why* the power developed in the resistance is given by P = VI. Other electro-calorific experiments verify this theory.

calorific experiments agree with the equations given above. For that reason, and that reason alone, we believe the above power law, and the theory which has been invented to explain it.

Notice that we have made no attempt to define "charge", assuming that the student will be happy to rely upon an intuitive idea of the meaning.

[*Aside:* It is true with most studies that the meaning of one or two words must be accepted as undefined starting points. This is so with the art of mathematics, as it also was when Euclid invented geometry thousands of years ago.]

Nevertheless we can measure charge and define its value.

The seventh law: superconductivity

Superconductivity — that miracle of the future (or so we're told) — is too new for its still-evolving theory to be sufficiently formulated and tested to rank as "law".

Stated briefly, it is found by experiment that if some conductors are cooled below a very low critical temperature, the electrical resistance drops abruptly to approximately zero, as in Figure 2. The "critical temperature" depends on the element.

This effect was discovered by H.Kamerlingh Onnes of Holland in 1911. He found that the resistance of Mercury apparently dropped to zero when he cooled it below 4.15°K, (-268.85°C).

Losslessness

Currents flowing in such superconductors consume no measurable power, no measurable voltage drop occurs, no heat is produced and strange magnetic effects occur. At first, two types of superconductors were observed and the critical temperatures below which superconductivity occurs were measured in the range 0.01 to 20.05 degrees Kelvin (-272.99°C to -252.95°C).

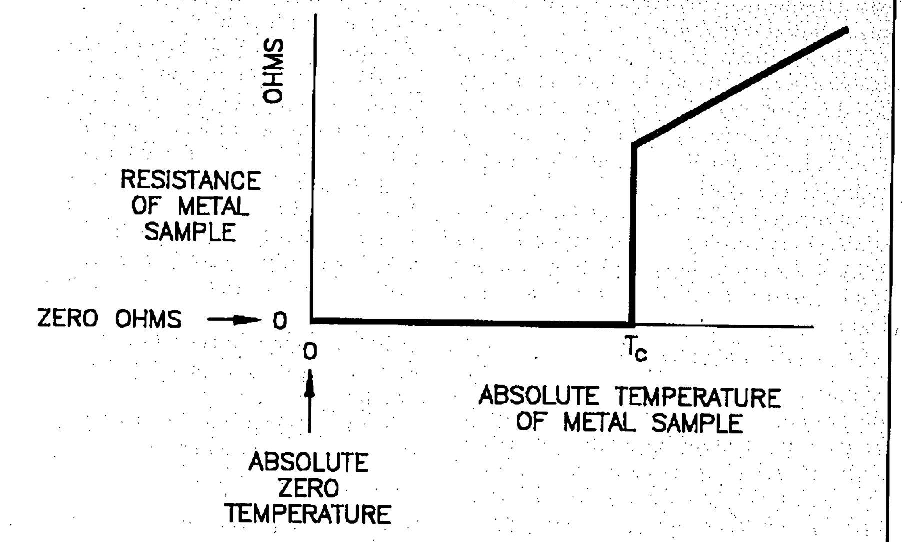
Because such very low temperatures require refrigeration with liquid Helium, a messy expensive process, classified experiments continue to find new materials for which the critical temperature is higher still.

New results are made public from time to time. Everyone hopes that new materials will be found with much higher critical temperature, so that simple refrigeration (or even no refrigeration?) will be sufficient.

Exotic metals

Some exotic metals and their alloys form good superconductors, Neobium, Nb, and its alloys being highly favoured. More recently new experiments are using strange ceramics.

The engineering promise of superconductivity is almost limitless. Applications to next generation super-computers use two properties of superconductors:



Resistance of metal sample as a function of temperature. At temperatures above the critical temperature Tc, resistance is Ohmic and varies with temperature. Below Tc there is no measurable resistance at all. Known values of Tc for different materials range from 0.05 to over 90 degrees Absolute (Kelvin).

SUPER COMPUTERS

(1) Logic gates consume minuscule power, so can be packed into integrated circuits in incredible concentrations without heat problems. Millions of gates per chip or addresses per memory chip seems quite a real target for developers.

(2) Strange magnetic properties allow materials to be switched by magnetic fields from superconducting to almost non-conducting states in extremely short times, forecasting logic circuits at yet higher speeds; AND gates having six picosecond delay, and nine picosecond OR gates have been reported.

SUPERCONDUCTING MACHINERY

Superconductivity is only now entering the electrical machinery marketplace. The General Electric Company is developing a rotor for a large turbo-alternator. The rotor conductors will be superconducting so that the very large dc exciting currents (many thousands of Amps) flowing in the rotor the rotor coils will produce no heat. (The stator coils are planned for ordinary circulating-water cooling methods).

Obvious problems are — how to circulate liquid Helium from the stationary ground based refrigerator, via pipes and 'pipe sliprings' into the rotor coils while the rotor tears around at 3600 RPM?

But no doubt human ingenuity will win. There already exists at least one ship propelled by a General Electric ac induction motor in which the stator coils are superconducting.

HIGH VOLTAGE CABLES

From the outskirts of London, high voltage power is taken into the city via superconducting single phase cables miles long. Neobium strip superconductors 0.025 mm thick are formed on copper or aluminium strips of 2.5 mm thickness (in case of loss of fridge systems).

An active conductor may consist of 56 such strips laid up in two layers, surrounded by concentric insulation and a similar neutral conductor. Such a cable can be used at temperatures up to 6°K (-267°C).

The conductors are laid on a hollow former. Through this, liquid Helium (from refrigerators at both ends) is continuously pump-circulated, up the hollow centre and back via as channel between the surrounding concentric neutral conductor and the outer thermal shield, then through the pump and fridge at each end, in an endless cycle.

STRIP SURFACE SUPERCONDUCTORS

Because currents mostly flow on the surface of superconductors, not in the thickness, thin strips are used rather than thick cross sections. The current rating is usually quoted per circumferential measurement, rather than cross sectional area.

Niobium strip 0.025 mm thick is rated at 400 Amps per cm of circumference. At 50 Hz frequency for each 1.0 cm circumference strip carrying 400 Amps, the superconductor power loss is 1.0 Watt per kilometre of cable length plus some small dielectric and screen losses.

As these power losses are frequency dependent, high voltage dc cables have almost no loss, leading to dc cable ratings up to 10 000 Megawatts.

Polyethylene or cross-linked-polyethylene (XPLE) seems to be the current favourite insulating material. Great care must be exercised in the application of insulating tapes (laid on at room temperatures) for as soon as the refrigerant is applied to the finished cable the insulating materials contract much more than ▷

the conductors, leading to mechanical stress in the insulation.

The decision to use superconducting systems was taken as the London area is so short of space that the alternative (many, many conventional cables in copper or aluminium) just would not fit in the available corridor.

Superconducting high voltage cable research and development is continuing in USA, Russia and Japan. Niobium-Tin alloy is one superconducting material being used.

MAGNETIC EFFECTS

Superconducting materials are perfect diamagnets, that is they reject magnetic fields out of their interior completely. This is known as the *Meissner effect*. It can be used to produce magnetic levitation, as you have no doubt seen from the many pictures published and programmes on television.

MATERIALS

So far Copper, Aluminium, Silver, Gold, Lithium, Sodium, Potassium, NaK (Sodium-Potassium alloy) have not been found to superconduct, though all have been tested down to very low temperatures, e.g: Copper down to 0.05°K.

Many other metals do superconduct. Obviously, metals with the highest critical temperature will be the easiest to refrigerate sufficiently. Of the pure metals Niobium (9.1°K) has the highest critical temperature, followed by Vanadium (5.03°K), Tantalum (4.48°K) and Mercury (4.15°K).

Higher critical temperatures can be achieved using intermetallic compounds and alloys, e.g: Vanadium/Silicon (17.1°K); Niobium/tin (18.05°K); and Niobium/Aluminium/Germanium (20.05°K).

NEW ADVANCES

In 1986 Alex Muller and Georg Bednorz of the IBM research labs at Zurich gained the Nobel Prize in Physics for the production of ceramic superconductors. The story goes that they didn't tell their company of their ceramic research until successful, as at the time anyone would rubbish such a dream. They used Lanthanum-Barium-Copper-Oxide ceramic which superconducts at 35°K (-238°C).

By January 1987 other materials were developed which superconduct at 70°K (-203°C). The next month Prof. Chu of Houston attained superconductivity at 95°K (-178°C) using Yttrium-Barium-Copper-Oxide ceramic. Refrigeration to this temperature is easy using cheap liquid Nitrogen, a huge improvement on the previous expensive liquid Helium cooling method. The only catch is that Yttrium is scarce and costly.

At the Universities of NSW, Monash (Vic) and Houston (Texas, USA) and at the CSIRO, in Japan, Ohio and other parts of the USA new superconducting materials are being produced.

Professors Shi Xue Dou and H.K.Liu at UNSW produced a compound of Bismuth, Calcium, Copper Oxide and Strontium having a critical temperature of 88°K, (-185°C). As well as the high critical temperature, this compound is cheaper than the Yttrium-based new superconductors recently described in the literature, and still "warm" enough to use cheap liquid Nitrogen as the refrigerant. This new material is reported to be too brittle for cable construction, though further research is hoped to alleviate this problem.

There appear to be two types of superconducting materials:

TYPE (1)

Type (1) superconductors are characterised by their existence in one of two states: Either fully superconducting or fully normal resistive. For these materials no intermediate state exists.

This type includes many pure metals which at room temperatures are reasonable conductors, but not among the "very good conductor" group named above. They superconduct abruptly when their temperature is dropped below the critical temperature. Raised above the critical temperature these materials are immediately in the ordinary resistive state.

The critical temperature is affected by even slight traces of ferromagnetic metal impurities, e.g: Iron or Gadolinium. In these materials superconducting currents flow on the surface, not in the metal bulk. Magnetic fields will not penetrate these materials when superconducting.

Under certain conditions magnetic fields above a critical field strength Hc can abruptly destroy the superconducting property of these "type (1)" materials. Therefore type (1) materials are not suitable for the coils of superconducting magnets.

In type (1) superconducting materials sufficient current in a straight wire can produce magnetic field exceeding Hc, so destroying the superconducting property. Then the material reverts to normal resistive state, even though still at low temperature.

Partly for this magnetic effect, dc high voltage superconducting cables have been used in England.

Type (1) materials were once called "soft superconductors".

TYPE (2)

Other materials, usually alloys, intermetallic compounds or transition metal elements which are poor conductors at room temperature, form the second type of superconducting materials.

Some of this type are brittle intermetallic compounds, such as the Niobium-Tin compound Nb^3Sn or Niobium-Zirconium NbZr. Others are alloys such as Titanium-Tantalum, which can be formed in any Ti-Ta percentage, all of which superconduct though with properties varying with Ti-Ta percentage.

["Intermetallic compounds" are of fixed composition, as distinct from "alloys", a name which usually means a solid solution of two or more metals (in each other) in arbitrary proportions.]

Different again are the newer ceramics previously described.

For type (2) materials the critical magnetic effect divides into two different values of field strength called Hc1 and Hc2.

Below critical temperature Tc, at zero magnetic field they superconduct completely. Then (while still below temperature Tc), if the external magnetic field is increased past Hc1 the superconducting properties will decline, the material is in a "mixed state". Current and magnetic field begin to penetrate the material, and small power loss in incurred as the material becomes partly resistive.

Still held below critical temperature Tc, if the magnetic field strength is increased losses increase, magnetic fields penetrate deeper into the material, until at higher field strength Hc2 the material has no superconducting properties, becoming again a normal material.

Removal of the magnetic field causes the material to return to full superconducting state. This action is reversible and follows the precepts of thermodynamics.

Type (2) superconductors are used for electromagnet coils, and in this service they have produced some of the strongest magnetic fields known to mankind, 60 Tesla (1 Tesla = 1 Weber/sq.m = 10 000 Gauss).

Because of their high value of Hc2, type (2) superconductors in straight configuration can carry very large currents, considering the magnetic field such currents must induce. At the IBM Research Centre in New York, thin film superconductors carried 100 000 Amps/sq.cm, and later workers repeated this work raising the current density to 1 000 000 Amps/sq.cm.

Therefore, type (2) materials have been chosen for some superconducting high voltage power cables, because over and above the normal current rating the cable must remain superconducting during fault currents, in the time between the onset of the fault and the opening of protective circuit breakers.

Theories

A theory to describe superconductive effects, first put forward by three physicists, Bardeen, Cooper and Scrrieffer in 1957, has been extended by later research. This theory has become known as the "BCS Theory".

Effects which any successful Superconductive Theory must account for are:

(1) The absence of any resistance.

(2) The existence of an energy gap in superconductors, (whereas normal good conductors like Copper at room temperature have no energy gap).

(3) Thin films of suitable material become more transparent to microwaves and infra-red light below the critical temperature Tc than above.

(4) Each isotope of a given element has a different critical temperature. (Isotopes are versions of an element having extra neutrons, but the same number of electrons).

(5) Magnetic field will not penetrate any fully superconducting material (the Meissner Effect).

(6) Earlier work found that all known superconductors were metals or composed of metals, which are conductors (though not good conductors) at room temperature. But modern research uses superconductors which are compounds/alloys containing non-conductors such as Copper Oxide.

(7) The infra-red and microwave transparency of thin film superconductors appears to contradict the Meissner Effect.

(8) The "London Equation" viz:

$$j = V/(-mc/ne^2)$$

which replaces Ohm's Law in superconductors. Where

j = current density
V = voltage
n = number of superconducting electrons per unit volume
e = charge of one electron
m = effective mass of an electron

(9) The entropy (i.e: the disorder) of the material structure is less in the superconducting state than in the normal state. (i.e: the superconducting state is more ordered).

(10) Changing from normal to superconducting state involves a latent heat (analogous to the latent heat of freezing or boiling).

The BCS theory of 1957 (and later extensions) has been very successful so far, but is not yet sufficiently tested to rate as a "law".

We are in the privileged position, watching a new theory evolving towards the "law" status, with new contributions to the world's deposit of knowledge of this topic being published weekly.

The BCS theory of superconductivity

The mechanism of superconductivity is explained by the BCS theory, which is briefly stated thus:

(a) At the low temperature an electron acts upon the crystal lattice, changing its form; and lowering the energy of the electron and lattice, which allows a second electron to lower its energy by interaction with the changed lattice.

(b) In this sense, pairs of electrons "couple" together, the deformed lattice-electron attraction overcoming the usual repulsion of two similarly charged negative electrons.

(c) This lowered ground energy state of "coupled" electrons leaves an Energy Gap between the coupled electrons and the more numerous normal electrons. The small number of "coupled" electrons do the superconducting, short-circuiting all those normal electrons left in the normal energy state far above.

(d) The existence of the Energy Gap in superconductors accounts for most of the electrical, magnetic and thermal properties.

(e) The Meissner magnetic repulsion effect follows from the lowered electron energy state.

(f) The BCS theory predicts that (within certain conditions) the more the crystal lattice attracts the electrons in the normal state, the higher will be the superconducting transition temperature.

This agrees with practical results as in the normal state more crystal lattice-electron attraction means less free electrons, i.e: poor normal conductivity.

Experience shows that the poor normal-state conductors make the better superconductors.

(g) This would seem to predict that we should look amongst the insulators for the really best superconducting materials with highest critical temperature Tc.

Perhaps this explains the appearance of Copper-Oxide in the new superconducting materials used so recently at UNSW, and the 95°K critical temperature Yttrium-Barium-Copper-Oxide superconducting ceramics manufactured in Japan, Houston Texas and Ohio last year, and the similar development work being carried out at Monash University, CSIRO, SECV and Olex Cables.

Will we progress to superconducting materials of such high critical temperature that no refrigeration at all will be necessary? Well may we ask, and wonder! Only the future will answer our question, there is no theoretical reason against it. And the future is happening now, before our very eyes!

And so it ends

So ends our tour of the seven basic experiments upon which all our electronics and everything electrical are based. Readers who are still awake may now put their feet up.

Bye!

• from page 41.

high, because the feedback resistor is 'holding up' the non-inverting input of the op-amp. In fact, it is not until sunset, when the resistance of the LDR rises above 100k, perhaps to about 110-120k, that the 741's output will switch over again.

At this time, as the output of the op-amp goes to -8 V again, the feedback resistor will "pull" the non-inverting input negative once more, putting the circuit into the same state that it was on the previous night.

To get a better picture of what's happening, you can draw a graph of what happens with the 741's output against the amount of light falling on the LDR for Figure 5, and also for Figure 6.

The graph on the left in Figure 7 shows what happens in the circuit of Figure 5, which does not have feedback. When the light increases just beyond that point where the LDR resistance is 100k, the op-amp's output swings very abruptly from -8 V to +8 V. Later, as the light decreases just beyond that same point, the output swings very abruptly back to -8 V.

Now take a look at the graph on the right of Figure 7. This shows what happens in Figure 6. The arrows show the direction in which the light level is going — up or down. When the light level is rising (in other words, when the output of the 741 is initially -8 V), the right-hand path on the graph will be the one that the output takes.

If you can imagine the light output rising so that the 741's output has just switched to positive, and then the light level falling slightly, the output will *stay* at +8 V, as it follows the falling part of the graph. So, when that cloud I mentioned earlier passes over the Sun, the output of the 741 will stay positive. In fact, it's not until the light falls to the level where the left-hand path starts to fall that the output of the 741 will drop.

The *difference* in light levels between the rising and the falling parts of the graph is called the *hysteresis*.

If you can imagine that the feedback, or hysteresis, resistor is variable, then *decreasing the value* of it will *increase the hysteresis* — if you like, the two paths on the right hand graph in Figure 7 will move apart symmetrically.

If we *increase the value* of the feedback resistor thus *decreasing the hysteresis*, the two lines will move together. They will finally become one, as in the graph on the left in Figure 7, when the value of the feedback resistor is too large to have an effect on the operation of the circuit.

Observant readers will notice the similarity between the Figure 6 circuit and the circuit of our AEM5510 Night-N-Day Relay published in the October '88 issue. Next month, I'll show you how an op-amp is used in a *linear* manner — to amplify signals, rather than just switching.

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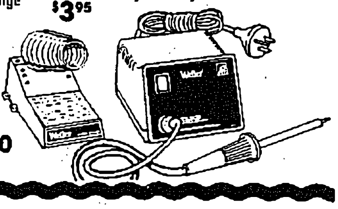

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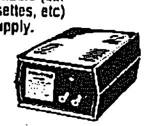

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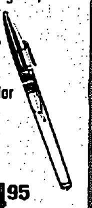

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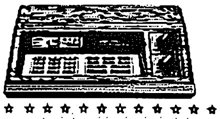

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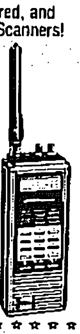

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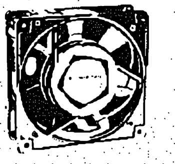


XMAS GIFT IDEAS FOR HIGH-TECHS

Hey! That's probably you! Wouldn't you like to pit your wits against a smart-alec chip that's trying hard to show you it's smarter than you are?

Into Backgammon?

Now you can play by yourself and really sharpen your skills! Sensory Backgammon has 9 adjustable levels, even has game position program. Cat Y-7066

$249

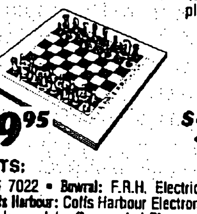
How About Chess?

The Novag Piccolo is ideal for all levels - from beginners up. Mini sized game in fold-up wallet. Cat Y-7080

$79.95

And More Chess?

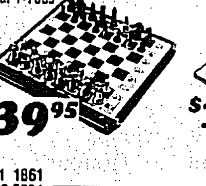
Slightly better, slightly higher price: the Kasparov Mk10 is a 238mm square set with 8 levels of play. Programmed to full international rules. Cat Y-7070



$89.95

And Even More?

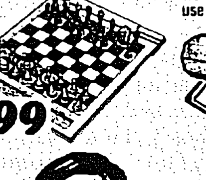
Yep! The Novag Allegro is suitable for everyone from novices to club tournament level with a 2K program capacity and 15MHz clock speed. 8 levels of play. Cat Y-7085



$139.95

And The Best

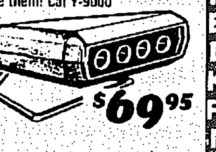
The superb Kasparov Mk12 is the ultimate in chess computers: not just 8 levels of play, but three levels of coaching, threat warnings, 8 pre-programmed study levels . . . everything. Cat Y-7065



$199

Finally: Not Chess!

Here's the perfect gift for the high-techer: a neg ion generator! What, you say? Fantastic for ham shacks, workshops, etc - we know they work because we use them! Cat Y-9000



$69.95

MAJOR DICK SMITH ELECTRONICS AUTHORISED STOCKISTS:

• NSW • Armidale: Sound Components 72 4981 • Ballina: Ballina Electronics 86 7022 • Bowral: F.R.H. Electrical 61 1861 • Broken Hill: Hobbies & Electronics 88 4098 • Charlestown: Newtronics 43 9600 • Coffs Harbour: Coffs Harbour Electronics 52 5684 • Dubbo: Chris's Hi-Fi 82 8711 • Forster: Forster Village Electronics 54 5006 • Glen Innes: John Sommerlad Electronics 32 3661 • Griffith: Miatronics 62 4534 • Inverell: Lyn Willing Electronics 22 1821 • Lismore: Decro 21 4137 • Moree: Moree Electronics 52 3458 • Mudgee: Headware 72 3895 • Nowra: Nowra Electronics 21 4979 • Wagga: Phillips Electronics 21 6558 • VIC • Morwell: Morwell Electronics 34 6133 • Shepparton: Phillips Electronics Pty. Ltd. 21 9497 • Warrnambool: Marrtronics 62 9870 • QLD • Bundaberg: Bob Elkin Electronics 72 1785 • Kingaroy: Holmes Today Electronics 62 1658 • Kawana: Splitec 94 7349 • Mackay: Stevens Electronics 51 1723 • Maryborough: Keller Electronics 21 4559 • SA • Mt Gambier: Hutchessons Communications Centre 25 0400 • WA • Albany: Micro Electronics 41 2077 • Geraldton: Batavia Lighting & Electrical 23 1842 • Karratha: Dave's Oscitronics 85 4836 • TAS • Devonport: A.I. Electronics & Hobbies 24 8322

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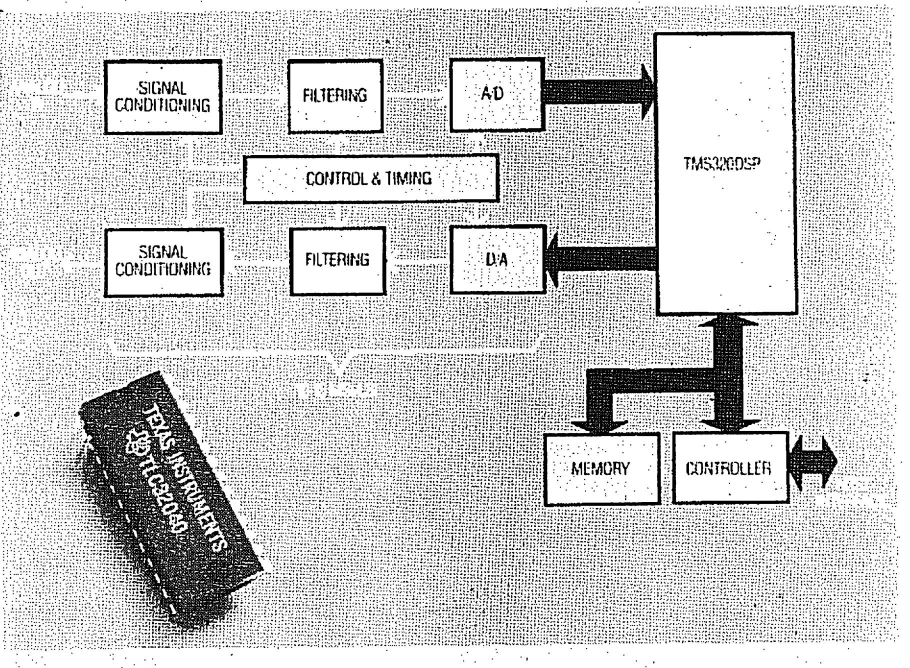
A universal DSP peripheral

A single chip interface from Texas Instruments is said to greatly reduce the need for analogue design expertise in developing digital-signal-processing (DSP) systems. Dubbed a universal DSP peripheral, the new analogue interface device is said to be a complete, flexible, high performance analogue-to-digital input-output system.

The TLC32040 integrates the functions of 10-15 MSI and LSI devices, including an anti-aliasing input filter, A-D and D-A converters with 14-bit resolution and 10-bit linearity, a low pass output reconstruction filter, signal conditioning blocks, a multiplexer, timing and control logic and a four-mode serial interface. The device's filter characteristics, sampling rates, gain selection and phase adjustment are all software programmable.

Texas Instruments designed the chip primarily for telecommunications applications, such as modems, with sampling rates of 7.2, 8, 9.6, 14.4 and 19.2 kHz and for high definition speech analysis, synthesis, recognition and storage systems.

The device can also be used in industrial control applications, biomedical instruments, acoustic signal processing, data acquisition and as a general analogue interface for DSP systems. **Texas Instruments is at 6-10 Talavera Rd, North Ryde, NSW 2113.**



Pretty flash A-D converter

Designed to be easy to use, the THC1070 A-D converter claims to offer an integrated approach to high speed A-D signal conversion. It is said to sample at 20 megasamples/s (Msps), and to be based on the TDC1020 monolithic 10-bit flash converter. It includes an analogue input amplifier, precision voltage reference, tristate output register and data overflow flag.

It is fully tested with factory adjusted linearity and signal amplification. It reduces board space and component assembly and test costs, the makers say. It does not need external adjustment and guarantees performance over the 0° to 70° C case range. Available in hermetic 32-pin DIP.

Other features include: complete analogue front end; low input capacitance wideband amplifier; two bipolar analogue input ranges of 1 or 2 Vp-p; gain and offset voltage internally trimmed; and TTL compatible three-state outputs.

Contact **Email Electronics, 15-17 Hume St, Huntingdale, Vic 3166.**

Semiconductor fuses

Because of small mass and low transient thermal capacity in semiconductor chips, they need over-current protective devices that are ultra-fast acting and limit short circuit peak currents to a suitably low value.

Designed to protect solid-state components under these conditions, Bussman's semiconductor fuses are said to prevent destructive excursions of heat energy from being impressed upon devices, and to isolate faults in parallel branches.

There are four ac voltage ratings: 150, 250, 500 and 700. Current specifications ranges from one to 1000 A. The fuses can be applied at their full voltage rating or any lesser voltage.

Further details from the distributor, **Technico Electronics, Waltham St, Artarmon, 2064 NSW.**

Electrically erasable CMOS PALs

Evolved to meet increasing demand for logic devices that offer low-cost, high-performance alternatives to custom solutions, the first of a family of programmable array logic (PAL) ICs have been developed with an electrical erasable (EE) CMOS process.

They are said to be quickly and easily programmed, erased and reprogrammed by customers to meet specific requirements not available in standard parts.

Suggested ideal applications wanting easy programmability and low power consumption would be laptop computers, instruments, medical data logging systems, telephone line cards and on-line transaction processors. Some key markets include communications and electronic data processing, the makers say.

These devices replace as many as seven standard logic parts, reducing system component count and economising board space. They resulted from a four year joint development by Monolithic Memories and SEEQ Technology.

Contact **RAE Industrial Electronics, 62 Moore St, Austinmer, 2514 NSW.**

Infrared optocouplers

Long life operation for applications like telephony and data processing is offered in some optocouplers featuring emitters in new heterojunction GaAlAs infrared technology.

They claim to offer a current transfer ratio (CTR) drop of only five per cent after operating 10 000 hours. This compares with the 40 per cent drop found in GaAs infrared optocouplers.

Type numbers of these devices are: CNG35, CNG36, PO40/44A CNR36, 6N135 and 6N136.

The new technology optocouplers have a higher current transfer ratio at lower input currents, e.g: usually 0.5 in the CNG35 driven at 500 µA, about five times higher than equivalent GaAs devices. This makes the optocouplers suit low current CMOS circuit drive and ensures better linearity over a range of drive currents, which is important in transmitting analogue signals.

Stability and reliability are exemplified in the new optocouplers, where the PO40/44a series has successfully undergone the British Telecom input diode overstress (so-called "killer" test) of a drive current of 100 mA for 96 hours, followed by 300 mA for 72 hours. CTR drop for the PO40/44A remains within only seven per cent, where the greatest allowed drop for the test is 25 per cent and the allowed average drop 10 per cent.

The maker says other tests at 85 per cent relative humidity and temperature of 85° C showed the electrical performance of the devices to remain stable.

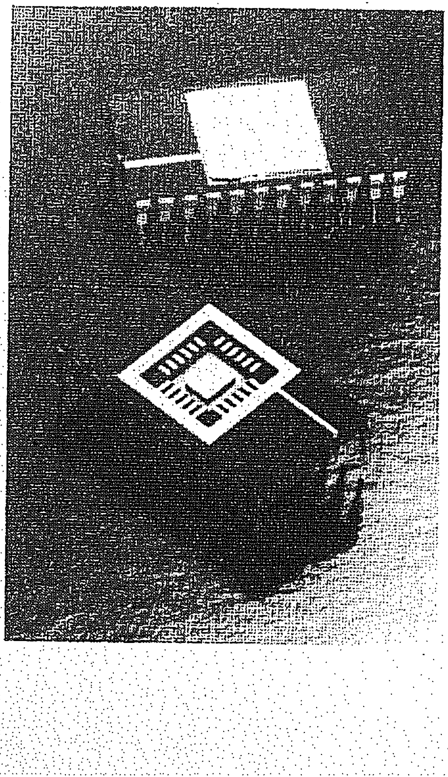
The CNG35 and CNG36 in a 6-pin DIL can provide a dc isolation voltage as high as 4.4 kV. The PO40/44A, also in a 6-pin plastic DIL, has UL recognition, and is fully approved by British Telecom for telephony applications and can replace each of the individual PO40A, PO41A, PO42A, PO43A and PO44A types.

The CNG35 and 36 have VDE approval and UL recognition. The CNR36 in an 8-pin plastic DIL features a fastest propagation time of 8 µs. As the 6N135 and 136 are implemented in the new technology they offer lifetime operation, according to the manufacturers.

Contact **Philips Components at 11 Waltham St, Artarmon, 2064 NSW.**

New Datel A-D converters

Five A-D converters have been released by Datel. The ADC-208 is an 8-bit, 20 MHz, low power, video flash converter which uses a high speed 1.2 micron CMOS process to achieve top linearity and temperature performance. It operates from a single +5 Vdc power supply at 500 mW. The ADC-208MC operates from 0° to 70° C, and the ADC-208MM from -55° to +125° C. They are priced at $125 and $195 respectively.



The ADC-303 is an 8-bit, 100 MHz bipolar monolithic video speed, low power flash A-D converter. Its input signal bandwidth is 40 MHz and it accepts an analogue input voltage from 0 to -2.0, with a -2 V reference.

Its digital inputs and outputs are ECL compatible, and it is designed to operate with an external clock and reference sources.

Applications include: CRT graphics; radar pulse and motion signature analysis; sonar, optical and character recognition; and high speed data acquisition systems.

Operating temperature range is given as -20° to +100° C, and it's priced at $1295. Not your everyday A-D chip!

The ADS-111 sampling A-D converter that uses an innovative hybrid design which combines a high speed 12-bit A-D converter and a fast sample and hold amplifier. It digitises sinusoidal input signals at lowest rates of 500 000 samples per second with 12-bit binary performance.

By combining the A-D and S/H, critical layout factors achieve stable, high bandwidth operation. The converter uses a sub-ranging, or two-pass, technique for the conversion process for high speed and precision.

The ADS-111 has an internal clock, and an internal reference that can supply +10 Vdc at 1.5 mA externally. It needs ± 15 Vdc to operate and dissipates only 1.4 W.

Applications include spectrum, transient, vibration and waveform analysis. This device is said to be also ideally suited for radar, sonar, video digitisation, medical instrumentation, and high speed data acquisition systems.

Operating temperatures and prices are: ADS-111MC, 0° to 70° C, $395; and ADS-111MM, -55° to +125° C, $495.

These devices are distributed by Elmeasco, who have offices in all states.

New CMOS EPLD device offers direct drive of VMEbus, NuBus & Multibus II

Recent design and process improvement has produced an erasable programmable logic device (EPLD) with four 64 mA and four 48 mA drive outputs, the PLX 464. This is said to improve over the existing PLX 448 with four 48 mA and four 24 mA drivers.

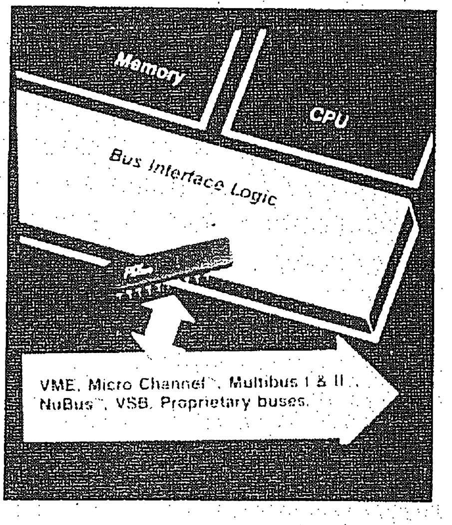
The new CMOS EPLD is said to be the first offering direct drive capability of the 60 to 64 mA control signals of VMEbus, NuBus, Multibus II and other high performance buses.

It can also drive eight bits of data to 48 mA levels, and designers can program the chip to be an 8-bit wide "intelligent transceiver" for 48 mA drive buses including VME and Multibus II.

The chip includes functions doing away with the need for transceivers, Schmitt triggers and other discrete ICs used in bus interface circuits. This reduces board space by a claimed factor of 20 to 1 over discrete logic.

The four 64 mA "quadstate" drivers are individually programmable to four states: open collector, totem pole high, and totem pole low or high impedance. This allows the device to drive open collector signals which are common in bus logic.

The 48 mA drivers are tri-state devices. Metastable hardened registers implement arbitration and synchronisation functions internally.



All I/Os have two input paths making the device bidirectional and providing buried register and combinatorial feedback. There is some 200 mV of input hysteresis to filter out bus noise so the device can monitor the bus directly. Two separate clock inputs allow the PLX 448 to monitor the CPU and system bus clock at the same time.

The PLX 448 is housed in a 24-pin, 300 mil wide windowed DIP. Program your inquiries through to **Energy Control, 26 Boron St, Sumner Park, 4074 Qld.**

Jumbo logic array offered

Sample quantities of an electrically programmable logic device containing 2500 functional gates are now available from Qld-based semiconductor distributor, Energy Control. The ATV2500, a CMOS device, offers speeds of 33 MHz with propagation delays of 35 ns and a power dissipation of 5 mA, according to the specifications.

It is available in ceramic or plastic packages in either a 40-lead, dual in-line package or a 44-pin leadless chip carrier.

The device can be programmed electrically, erased with UV light and reprogrammed. It uses a structured architecture so that designers can program by methods similar to those used with earlier device generations. Designers can also use existing programming software and hardware with only small updates.

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This Luton capacitance meter features a very wide range

Ben Furby

While the old "LCR bridge" seems to have fallen into disfavour over the past decade, probably due to the influx of cheap digital multimeters, the need to measure capacitance seems to have risen considerably. Hence, capacitance meters have "boomed". This model from Luton is the widest range instrument of its type we've encountered.

ONE OF THE NICE THINGS about the editor of AEM is the way he shares the good things of life around here. Like, passing over the Luton DM-6023 capacitance meter to me to test drive, instead of hogging it to himself. The bad thing was that he didn't happen to offer it to me until I had laboriously worked my way through identifying the multitude of tiny capacitors used in the Dick Smith Teletext decoder kitset I had been assembling! Such is life, someone famous once said.

Considering that when I began studying wireless (I mean, "electronics") one of my main textbooks, the classic *Admiralty Handbook on Wireless Telegraphy*, was announcing that the Royal Navy no longer would measure capacitance in "jars", it's not so easy adapting to these new-fangled tantalums and polyesters, the picos, nanos and whatever.

Grid leak condensers (I mean, capacitors) were in good old honest µµfds and you knew where you were. None of that new-fangled picos and nanos in those days to make you want to burst into print about them.

What's more, capacitors then were big enough to say boldly on them what their capacitances were and you didn't have to pass a colour-blindness test or use a magnifying glass in order to figure out the value. Which is leading up to say that if your workshop doesn't have a capacitance meter it should do.

If you have reached the stage where you are long-sighted and need a magnifying glass as well as reading glasses to decipher the hieroglyphics on a ceramic capacitor, a capacitance meter is the ideal compensator.

This is where the Luton with its many admirable features comes in handy. At about 180 x 85 x 45 mm it's small, doesn't need a power point, and goes anywhere in the pocket, if it's not too small a pocket!

Eight ranges

There are eight test ranges, and the meter will read from 0.1 pF to 2000 µF. This can be extended to 20 000 µF (0.02 Farads!) by parallelling the two top scales in this extra-featured model. Calibration was not hard to do, and did not need adjusting frequently.

The unit employs LSI circuitry, and a crystal oscillator clock for accuracy and fast sampling. It takes around half a second for a reading. It is protected from danger from charged capacitors, in case you hadn't already got a kick from that electrolytic and so discharged it when you connected it up. Short test leads are provided for the 4 mm sockets on the front panel. These are polarised, for measuring electrolytics I presume, as the handbook doesn't mention it. You can plug the capacitor's leads directly into the sockets if you wish. The handbook tells how to take the test lead capacitance into account. A 9 V "transistor radio" battery powers the instrument.

The range selection switches are pushbutton types, arrayed down the left hand side of the instrument. To measure capacitors above 2000 µF, you press the 200 µF and 2000 µF switches in together. It is possible to push other range switches in at once also, but the display just over-ranges so you can't operate the unit if you make such a mistake.

The meter has a handy folding stand in the case rear, for flat or half-upright use. When handheld, it has a solid, substantial feel about it; none of your flimsy, fragile, el-cheapo feeling of "drop it two centimetres and it'll crack in 10 places" about it. This is the sort of instrument to stand hard field service for professionals.

The four-figure LED readout (3½-digit) is large enough, with 12 mm high figures, that I did not need my reading glasses in poor light to read it. Accuracy is quoted as 0.5% of full-scale, ±1 on the last digit on the 200 pF to 200 µF ranges, and 1% of full-scale ±1 on the last digit above that, except for the top range, where it's 2%. Such accuracy is well within the bounds of the broad range of requirements encountered in most service and development work, I believe.

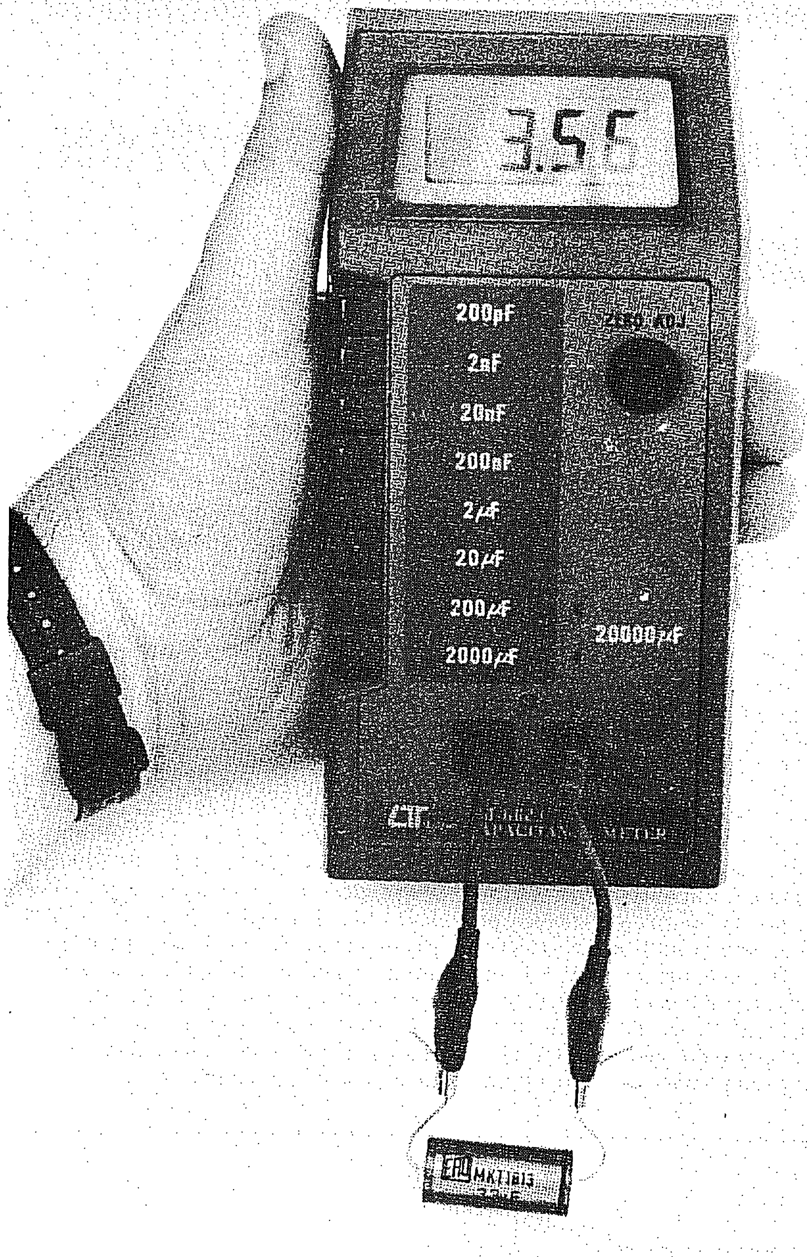
In use, it measures a capacitor's value within the blink of an eye! Even large value electrolytics don't slow it down. Checked against our Philips PM 6303 Automatic RCL Meter, the Luton came up well within specs. The handbook says leaky capacitors can be detected by a varying display reading — handy if you're into vintage radio restorations.

The instruction booklet is comprehensive, its main fault being that it was written in Japanese English. At least it gave a useful pico/nano/µF conversion table, which I found worthwhile. After all, why bother writing about nanos when you can see by a glance at the table how many pics make a nan? Enough digression, the instrument's operation is fairly self-evident and the language in the book clear enough that common sense will see you through.

For a retail price of $149 the Luton DM-6023 capacitance meter is well worth investing in, whether you're a serviceman needing quickly-read, accurate measurements or an old codger like me trying vainly to cope with modern capacitors ever-diminishing in size and legibility of markings.

So, see the distributors, Wagner Electronic Services, for your Luton capacity meter and your answer to capacitance questions.

About the only "fault" I could find with it, was that it doesn't have an alternative scale in jars. Us Kiwis like our jars, you know, be they Leyden or foaming nut-



brown: that's where capacity counts!

If the "magic eye" on your 30-year old LCR bridge or capacity tester has become geriatrically weak, you had better upgrade to a digital readout unit like this Luton. (Roger jumped in here to say I had better explain what a "magic eye" is, or was). Well, the magic eye was a valve with a green circular fluorescent "target" at the top, the fluorescence describing 360° with a radius line from the centre to the circumference at the bottom. How much of the target was covered by fluorescence was controlled by a grid in the valve, leaving a narrow wedge dark or a narrow wedge light at the extremes.

They were a very popular gimmick in receivers. The magic eye was usually mounted on its side, so that the target was seen through a transparent bezel or hole in the front panel. The target control grid was connected to the receiver's AGC. Lack of AGC voltage made the fluorescence spring apart at the radius line, and presence of it made the fluorescence tend to come together with a greater or lesser gap depending on the voltage.

A magic eye made a good tuning indicator, and in those days when such a valve was cheaper than a meter, it also made a useful indicator for tuning a null or peak in applications such as a capacitance tester or LCR bridge. It had a very high input impedance and was thus a very sensitive indicator. Thus endeth today's lesson.

The Luton DM-6023 review instrument was kindly lent to us by Wagner Electronic Services, 305 Liverpool Rd, Ashfield, NSW 2131. (02)798 9147, 798 9233.

• from page 49.

The ATV2500 can replace from five to eight 22V10 circuits and reduce power significantly. It has 48 registers and 24 I/O ports. Its 5 mA power guarantees high system performance with the power charge of PALs, and it will need only one per cent of the power needed for the same system configured with 22V10s.

The chip is tested 100 per cent for programmability before being shipped. Inquiries to **Energy Control, 26 Boron St, Sumner Park, 4074 Qld.**

PS/2 uses VLSI Design chip

IBM has formally announced that its PS/2 model 35 is an AT compatible machine using the VLSI VL82CPCAT chip.

This chip is made by VLSI Design of Hong Kong, represented in Australia by **Energy Control at 26 Boron St, Sumner Park 4074 Qld.**

Hyper-red LEDs not found under beds

With luminous intensities of up to 200 mcd at a wavelength of 650 nm possible, from drive currents of 10 mA, high luminous flux hyper-red LEDs are aimed at two market segments.

The first market includes standard display panels, information boards, moving advertisements and electronic games, and the second for expanding low-power applications such as battery warning lights or indicators in portable equipment. An extra feature claimed is longer life.

The range offer light outputs from 0.7 to 200 mcd, 2 or 10 mA drive current, beam widths from 20° to 110°, and various encapsulations. There are four 2 mA types with more planned, and intensities go from 1.6 to 35 mcd, and all can be driven directly from CMOS ICs.

The LEDs are single heterojunction GaAlAs devices, fabricated by a single-step liquid phase epitaxy process. A relatively high percentage of aluminium gives high electron injection efficiency so that the LEDs are driven at high currents or alternatively have more luminous output at low current.

High electron injection and low non-radiative recombinations provide a high photometric efficiency of between 2 and 4 Lm/A. Also a result of the high Al content is that the new LEDs operate at a wavelength of 650 nm, where the human eye is more sensitive than the output wavelength of other LEDs. The chip passivation and the hermetic plastic encapsulation ensure the crystal does not oxidise under even the most humid conditions.

A wall chart of the range is available from the distributors. Full details from **Philips Components, 11 Waltham St, Artarmon, 2064 NSW.**

Measuring the output properties of audio equipment

Jack Middlehurst

When interconnecting audio equipment, a tape deck to a preamp/control unit, for example, it is often desirable to know or to determine the impedance "looking back" into the "source" equipment. Here's how you do it.

SO YOU'VE just bought this expensive new tape recorder (or whatever) and you connect it into your hi-fi system. It sounds marvellous. After a few weeks you notice that the lows are not perhaps as solid as you first thought. In fact, now you come to think about it, they could even be described as a bit thin. You may even decide to go back to the vendor and ask about the problem. He (or she) will assure you that the equipment has a response that is flat well beyond your ears both at low and high frequencies, so the trouble must be in the rest of your electronic system. You know perfectly well that your system works well with all the other bits and pieces, so what is the trouble ? It may well lie with the output characteristics of the equipment that you just bought.

Apart from power amplifiers, all pieces of electronic equipment use some form of small discrete or IC amplifier to provide the signal at the output socket. Often this amplifier is a BC547/635, a uA741, or part of an LF353 or similar IC, always with some feedback, and usually in series with a capacitor to prevent any dc voltage appearing at the output. In addition, there is often a series resistor to protect the output amplifier stage in case of an accidental short circuit on the output.

The output impedance of this combination is set by the designer assuming that there will be a particular load on the output. If, for example, the designer assumes that the minimum load will be one megohm in parallel with 30 pF (a common input impedance in much equipment), the capacitor can be quite small (say 10 nF — 0.01 µF) and the amplifier output impedance can be quite high (several thousand Ohms). This minimizes the cost of the equipment.

If the designer uses a 2.2 µF capacitor, the equipment can cope with a wider range of possible loads, but it will be more expensive. Since the ratio of the cost to the consumer to the cost to the manufacturer is at least 2.5, every cent that can be saved improves the chance of beating the competition.

While this may be nice to know, it doesn't help much with your problem with the new equipment. If you could find out what the values were for the capacitance and the output impedance of the amplifier you would be in a better position to do something about it. So you go to the instruction book and circuit. Sorry, only joking! Even Nakamichi don't provide a circuit with their gear and give little information about the output impedance (but I know my Nakamichi tape deck's 1.2k!).

So, short of taking the whole thing apart and tracing the output circuit, what do you do? The answer is to measure the properties that you need without opening the equipment.

The approach

Figure 1 shows the simple circuit that you are trying to measure. The shunt resistor to earth is usually a very large value and can be ignored. It would be a trivial job if you could get at the junction of the output resistor and capacitor but unfortunately this point is not available, being buried somewhere inside the equipment. If there was no capacitor, you could measure the output impedance by putting a load on the output terminals and seeing by how much the output voltage was reduced. The capacitor complicates things, so we have to be a little more crafty.

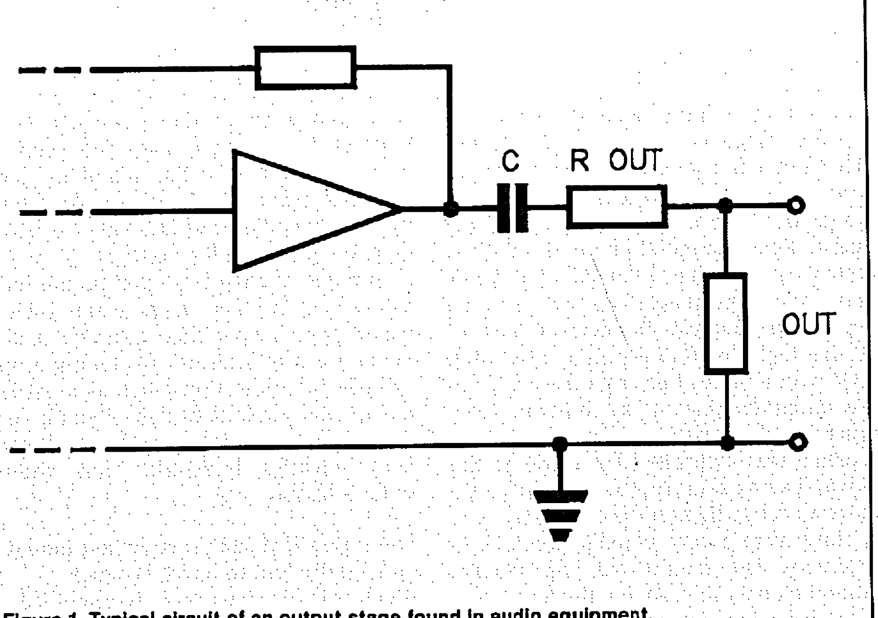


Figure 1. Typical circuit of an output stage found in audio equipment.

The equipment needed is an audio oscillator together with a high impedance ac voltmeter (at least 1M or better) that works over the audio range, and/or a high impedance oscilloscope (that is, having a Y input impedance of 1M in parallel with a small capacitance — a pretty standard specification). Having gathered all of this, we proceed as follows:

A. With no load on the output, arrange to get 1.000 Volts for a frequency of about 200 Hz at the output terminals. If you are testing a tape recorder, simply record a few minutes of 200 Hz on tape and play it back.

B. Then put various resistors across the output until the output falls to, say, 0.7 volts or less.

C. Write down the frequency that you are using and call it F*high*, as well as the voltage, that is 0.7 V (call it V*high*), and the value of the load resistor (R*load*).

D. Remove the load and arrange to get 1.000 Volts of a lower frequency, F*low* (say 40 Hz), at the output. Put the same resistor, R*load*, across the output and measure the output voltage V*low*. The voltage will probably be 0.5 V or less. You may have to try a few different frequencies and values of load resistor until you get a useful reduction in output voltage at each of two reasonably separated frequencies. The advantage of using an oscilloscope is that you can see if you are overloading the equipment and getting a distorted waveform. If so, the load resistor will have to be increased. The formulae that you will be using are only correct if the waveform is a sine wave.

E. Having taken the measurements, you now have to do some arithmetic to get the information that you need, so get out the calculator and some paper and a pencil to write down the values of all the things you have to calculate.

1. Calculate
$\omega_h^2 = 39.4784 \times Fhigh \times Fhigh$
(Note — 39.4784 is $4 \times \pi^2$)
2. Calculate
$\omega_l^2 = 39.4784 \times Flow \times Flow$
3. Calculate $V_h^2 = Vhigh \times Vhigh$
4. Calculate $V_l^2 = Vlow \times Vlow$
5. Calculate $R_l^2 = Rload \times Rload$
6. Calculate $V^2 = V_h^2 - V_l^2$
7. Calculate $\omega^2 = \omega_h^2 - \omega_l^2$
8. Calculate
$C^2 = V_l^2 \times V_h^2 \div V^2 \times \omega^2 \div \omega_h^2 \times 1\,000\,000 \div R_l^2 \times 1\,000\,000 \div \omega_l^2$
9. Calculate $C = \sqrt{(C^2)}$ (This gives C in µF)
10. Calculate
$Diff = V_l^2 \times \omega_h^2 - V_h^2 \times \omega_l^2$
11. Calculate $R^2 = \omega^2 \times Diff \div V_l^2 \div V_h^2$
12. Calculate $Rout = \sqrt{(R^2)} - Rload$
(This gives R*out* in Ohms)

You now have the values of C and R*out* that you need. When calculating, follow the equations step by step; enter the quantity, then press the required operation key (×, ÷ etc), enter the next quantity, etc. Where there are brackets, evaluate them first.

If you are going to put a load R*l* on the equipment, then the frequency at which the output will be 3 dB down in response is given by:

$F_{3dB} = 159155/C/(Rout + Rload)$ Hz,

where C is in µF and the resistors are in Ohms.

The load would usually consist of a volume control in the main control unit. These are commonly 100k or 1M, but in the better class of equipment, to keep the noise level as low as possible, they can be 10k or lower. This can be the cause of the trouble if the output capacitance that you have just measured is, say, 0.22 µF (220n). For an output resistance of 2k the 3 dB down frequency with a 10k load would be 60 Hz; not particularly hi-fi!

For everyone's edification, and to give you a little confidence when tackling the exercise yourself, here's a "worked example". Let us take the case of an outboard phono preamp feeding a preamp/control unit. Say we set F*high* to 200 Hz and apply a signal generator at the phono preamp's input and arrange to get 1.000 V on its output, with no load connected. Trying a few load resistors, we find that a value of 10k causes the output to drop to 0.68 V (V*high*).

Now we set the signal generator to 45 Hz (F*low*)and adjust the level (if necessary) so that the phono preamp's output is again 1.000 V with no load. Applying the 10k load resistor again, we find the output drops to 0.47 V. Now we run those values through the calculator as follows:

1. $\omega_h^2 = 39.4784 \times 200 \times 200$
$= 1\,579\,136$
2. $\omega_l^2 = 39.4784 \times 45 \times 45 = 79\,943.76$
3. $V_h^2 = 0.68 \times 0.68 = 0.4624$
4. $V_l^2 = 0.47 \times 0.47 = 0.2209$
5. $R_l^2 = 10\,000 \times 10\,000 = 100\,000\,000$
6. $V^2 = 0.4624 - 0.2209 = 0.2415$
7. $\omega^2 = 1\,579\,136 - 79\,943.76$
$= 1\,499\,192.24$
8. $C^2 = 0.2209 \times 0.4624 \div 0.2415 \times 1\,499\,129.24 \div 1\,579\,136 \times 1\,000\,000 \div 100\,000\,000 \times 1\,000\,000 \div 79\,943.76$
which gives $C^2 = 0.050226$
9. $C = \sqrt{0.050226} = 0.224$ µF
10. $Diff = (0.2209 \times 1\,579\,136) - (0.4624 \times 79\,943.76)$
$= 348\,831.142 - 36\,965.995$
$= 311\,865.15$
11. $R^2 = 100\,000\,000 \div 1\,449\,192.24 \times 311\,865.15 \div 0.2209 \div 0.4624$
$= 203\,655\,325$
12. $Rout = \sqrt{203\,655\,325} - 10\,000$
$= 14\,270.79 - 10\,000$
$= 4271$ Ohms

So the phono preamp has an output impedance of 4271 Ohms with a series capacitor of about 220n. So, the -3 dB bass end rolloff with a load of 10k will be:

$F_{3dB} = 159155 \div 0.224 \div 000)$
$= 159155 \div 0.224 \div (14\,271)$
$= 49.79$ Hz

So much for the bass! As illustrated earlier, lower values of R*out* make matters worse.

The cure

The difficult question is, having found the cause of the problem, how do you fix it? The best answer is to get into the equipment and install a larger capacitor, but if that was easy to do, you wouldn't have had to take all these measurements! There may be lots of good reasons why you still don't want to attack the equipment: warranties, lack of confidence, the sheer difficulty of getting at the necessary components, and so on.

If the equipment has plenty of output the simple solution is to use a voltage divider on its output. If you are feeding directly into a volume control, this can take the form of a resistor in series with the output (*providing* the output doesn't go directly to the volume control's wiper, in which case you progressively lose bass as you lower the volume. - Ed.).

Suppose that you can reduce the output to one-third without straining things unduly, and that the volume control is 10k. Simply putting a 22k resistor between the output of the equipment and the input to the volume control will do the trick. This will reduce the 3 dB frequency from 60 Hz in our example to 21 Hz which will produce a very noticeable improvement in the sound.

The resistor is best screened, either by mounting it in a tiny box, or possibly mounting it inside the plug (e.g: DIN 7-pin) that goes into either the control unit (preferably) or the equipment (not as good). It is not likely that a resistor of this value will significantly affect the high frequency response unless you have masses of shielded cable between the resistor and the volume control in the control unit. In this case a small capacitor, say 100 pF, across the 22k resistor will help.

If you do not have any output voltage to spare, the only thing for it is to build a small amplifier having a high input impedance and a gain between 1 and 2, and insert this between the equipment and the control unit. Since you are now the designer, make sure your amplifier has a low output impedance and that there is a large capacitor at its output. It is a good idea to insert a series resistor of, say, 470 Ohms for protection against accidental short circuit of the output.

NOTICEBOARD

This special page is for the benefit of readers, to help you make better use of your magazine.

Please check this page **every month** as notices **will** be changed often.

GOT OUR RIGHT ADDRESS?

Most important! It has become obvious to us that a lot of readers are still addressing mail to our old addresses (there are three variations) so will you make sure that you have our new address, phone and fax numbers?

AEM
1st Floor, 347 Darling Street,
BALMAIN 2041 NSW.
Ph. (02)555 1677. Fax: (02)555 1440

Back Issues

If you are looking for a particular back issue, it's simple, just write to us: **AEM, 1st Floor, 347 Darling Street, Balmain 2041** NSW and state which issue(s) you need, enclosing a cheque or money order for $4 for each back issue.

It is wise to state which particular article or project interests you in the issue(s) you have specified, because if we don't have the issue in stock, we can send you a photostat of your specified article or project. We are unable to process back issues by credit card, unfortunately, unless the order is above $10.

MAGAZINES WITHDRAWN FROM SALE

Commencing with the July issue, and until further notice, copies of AEM will no longer be available through Jaycar stores, having been withdrawn by the publisher. We apologise to readers who may be inconvenienced by this.

The magazine will still be normally available through newsagents, of course, and other electronics stores; Dick Smith Electronics in all states and New Zealand; in Adelaide, Eagle Electronics and Force Electronics; in Melbourne, All Electronic Components, Preston Electronics, Ritronics and Stewart Electronic Components; in Sydney, David Reid Electronics and Hi-Com Unitronics.

WHERE DO YOU GET IT?

Where do you buy the parts and PCBs for the projects? Every issue has a column called "Retail Roundup", in which you will find the "Project Buyers Guide", usually in a box on the page. This provides a guide to where you might buy your needs for the projects featured in that particular issue.

PROJECT LEVELS

In general, with our projects we include a panel indicating the "level" required for successful construction. This is included only as a guide, the three levels we show being: "beginners", "intermediate" or

LEVEL: We rate this construction project as suitable for:

BEGINNERS

If you've had little or no experience in electronics construction, you should be able to successfully complete this project.

Special Offers

We pride ourselves in making available to you special opportunities to purchase interesting products at a special price.

Mostly, we act as a clearing house for orders and have to contend with the usual SNAFU's. Fortunately, they're not too prevalent. If you have a problem with an order, kindly write or call and give us your full name address and ordering details, and most importantly, your phone number. We'll do our level best to sort it out and inform you.

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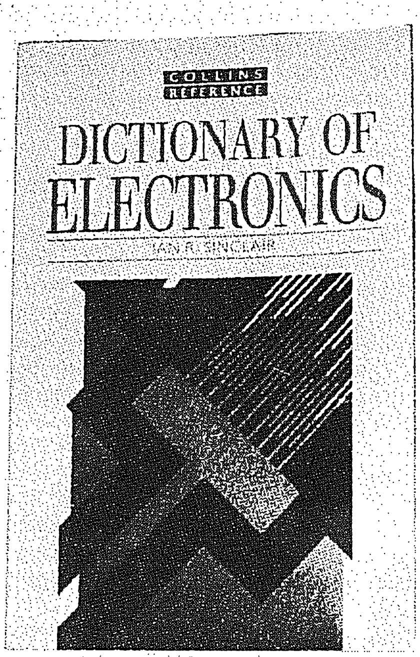
Technical Enquiries

Please, only after 4.30 pm EAST.

If you were a fly on the wall in our office you would notice that the people who answer these enquiries do not sit all day with baited breath awaiting your call. In actual fact they are crucial members of our team and are expected to do 'some' other work during 'normal' business hours. So please, while we are happy to answer your technical enquiries we also have a magazine to get out. After all, isn't that how you found us in the first place?

Literature Review



DICTIONARY OF ELECTRONICS by Ian Sinclair. Collins Publishers, 1988. Paperback, 378 pages 196 x 130 mm. ISBN 000 434345 10. Priced at $12.95. Review copy from William Collins, 55 Clarence St, Sydney, NSW 2000.

I wouldn't like to count how many words are defined in this dictionary in the Collins Reference series. Too many to count while writing this, and any rate the number is not a question in Trivial Pursuit. It's easier to say that there are 373 pages taking you all the way — or most of it — from aberration to z-parameters.

The author prefaces his work with the remark — among others: "There are still dictionaries which present slang words of the Second World War period as if they were part of modern-day electronics; in contrast, the present volume is an attempt to define and explain the terms which I believe to be relevant to modern electronics."

Well, there's a lot to be said for not cluttering up the book with obsolete words. However, I would have thought that with a dictionary being a reference for its subject, students and others could look to such a work for definitions of things that dropped out of use many years ago. So if you don't know what an induction coil, Nipkow disc, crystal or grid leak detector, or coherer were, you won't find the answers here.

One omission I still think is a little puzzling. We know there ain't no mho no mo', so we do not find any in this dictionary. To the modern student trained in Siemens who stumbles across a reference to "mho", this dictionary will not help.

There is, though, a wealth of computer and general, relevant, engineering and scientific nouns and symbols defined. The author reminds us of the needs of the non-specialists and that this dictionary helps them. "This book has therefore been designed with more than the needs of the traditional electronics student in mind," he writes.

Full marks go to the setting out in easily-read large type, the clear English — not American — language or spelling (except for "z" in words like *stabilisation).* Mathematics are used infrequently, and then only in necessity.

Occasional diagrams add to clarity, specially for people like me who can never remember the circuit of a Darlington pair. There are useful lists of symbols, the resistor colour code and other reference material found in the last five pages.

Not until I browsed through this fascinating adjunct to electronics was I aware that microwave ovens operate on 2.45 GHz. Until now, as a denizen of the low frequencies, with odd excursions into VHF through TV, FM and 2 m amateur radio, I had assumed that microwave ovens cooked by stirring up the action in the molecules of food for my dinner.

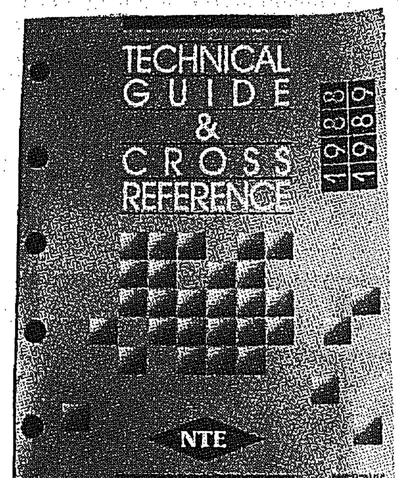
Now I know that 2.45 GHz is the frequency the ovens' magnetron oscillators are tuned to because that frequency corresponds to a resonance of the hydrogen atoms in water. From now on I shall be trying to visualise all those hydrogen atoms in my cabbage resonating into a really hot dance as they swing round on the turntable!

Further use for a dictionary: imagination stimulator.

A dictionary like this is very useful if you've only limited experience in the world of electronics. When you hear or read an unfamiliar term, it gives you the chance to find out what the thing is. Is "sporadic E" an intermittent EMF or an occasional sharp between E natural and F natural? Well, once you've looked it up in the dictionary, you know to get out a volume on the ionosphere and propagation to learn more.

I recommend this dictionary also for those who find the computer and solid-state worlds not as open a book as this one is, when opened at the right page.

— Ben Furby.



NTE TECHNICAL GUIDE & CROSS REFERENCE, 4th Edition, 1988-1989. Published by NTE Electronics Inc. Card cover, 640 pages total, 215 x 277 mm. Available from Stewart Electronic Components, PO Box 281, Oakleigh Vic 3166. (03)543 3733. $17.50. Review copy from Stewart Electronics.

There's one thing that every laboratory, service bench, home electronics workshop or ham shack never has enough of, and that's data books component reference books. This book would have to be a *must* in any of the aforementioned places.

NTE Electronics is a US component distributor with a huge variety of products, particularly specialising in semiconductors. Their NTE461 dual-JFET was specified in the front end of our 6000 Series Ultra-Fidelity Power Amp, you may remember. Stewart Electronic Components imports and stocks some 1500 of NTE Electronics' product lines and this book provides an invaluable reference "back-up" to that.

While the NTE product guide and data is useful and interesting in its own right, the cross-reference and replacement ▷

guide should prove invaluable to anyone involved in electronics.

The range of NTE semiconductor products is particularly "meaty", with some excellent devices for low-noise audio and RF applications and — surprise, surprise! — some germanium transistors. There are power MOSFETs and RF power transistors covering from HF through UHF, matched pairs and complementary pairs, FETs and bipolars, power diodes and signal diodes, zeners and voltage multipliers. Comprehensive dimensional outlines and pinouts are included.

Also included in the semiconductors are a range of linear and digital ICs (CMOS and TTL), all with comprehensive pinout diagrams. There are display drivers and microprocessor listings, too.

Just in case you thought the emphasis on active devices was too one-sided, NTE list a range of resistors and capacitors, and quartz crystals, too.

The cross reference and replacement guide for semiconductors is *voluminous!* It covers US, Japanese and European part numbers and is arranged sensibility in alpha-numeric order. Thousands upon thousands of semiconductor types are listed. In fact, the publishers say they have included some 14 000 *new* cross references in this edition!

Usefully, the area next to the spine has had a series of five 12 mm diameter holes punched in it, making it ideal for storage and protection in a "Lever Arch" file or similar.

Get a copy, you won't know how you ever did without it. At $17.50 it's a cheap investment. But don't let it out of your sight!

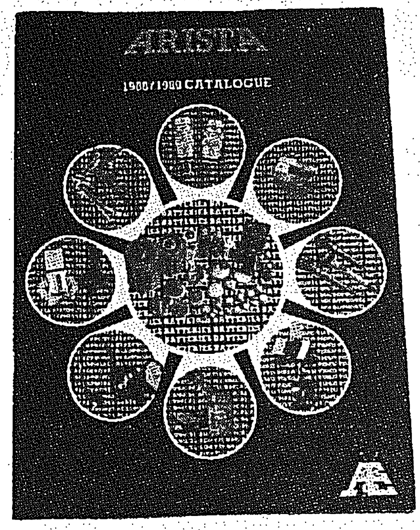
— Roger Harrison

ARISTA ELECTRONICS 1988/1989 CATALOGUE. Publisher: Arista Electronics, PO Box 191, Lidcombe NSW 2141. (Cost: $2.50, inc. post and handling).

If not perhaps destined to take a place in English literature like the plays of Shakespeare, the 1988/89 Arista catalogue - in glorious Technicolor — would nevertheless be compulsive reading for every retailer in Australia wanting to make a buck selling components and accessories to public, professionals and enthusiasts alike. Likewise, if you're in one of the latter categories, this catalogue will appeal.

This quarto-sized book has 121 pages (including inside the covers) of enthralling and tempting hardware for dealers seeking to lure more custom into their shops. Enthusiasts who also want to gloat over the goodies in Arista's catalogue can get a copy, by sending rustproof coin of the realm through the mail service. For dealers it's free, all others pay $2.50 a copy. A cheap investment — let your fingers do the walking!

The story begins with connectors on



page 2, and from there on the pace mounts steadily as connectors give way to utility boxes on page 17. The action becomes even faster: batteries charge into action on the next page (18): but can the author hold this pace? Buttons, NiCads, alkaline cells, chargers and testers have their day, however, and the remorseless grind of swift action sees audio cables begin their rise.

No, this is not a chronicle of the rise and fall of kings and queens of some European dynasty: rather, the cadences of the variations of electronics technology of our day.

Black and white is as dead as its TV equivalent: while B&W outline sketches of connectors profusely illustrate the opening pages against a colourful setting, they give way to colour pictures of such exciting objects as tools, amplifiers, tape erasers and microphone mixers.

Not to be missed are the "Arista Solutions": five brochures covering certain categories of accessory listed in the catalogue but elaborated with more descriptive detail, with installation and use explained.

Seven more brochures will follow the original five, covering: Speakers and Speaker Systems, Microphones and Sound Reinforcement, Audio Accessories and Headphones, Public Address Installation, Telephone and Intercom Accessories, Tools and Technical Aids, and Computer Accessories.

Customers need only ask at an Arista dealer for copies of the brochure or brochures of interest.

Thus does the rich tapestry of electronics componentry bedazzle the reader; for the retailer, it will hypnotise you with this kaleidoscope of colour into ordering stock from Arista to enliven what might otherwise be dull, unenlightened wares.

The style is prosaic: no literary embellishments to garnish an assembly of items useful in any ham shack, laboratory, technical teaching college, radio station or whatever. The plain simplicity of the style, like George Orwell's *Down and Out in Paris and London*, enhances the directness of the message, perhaps far more effectively than elegant and enflowered English could do.

Of direct appeal to retailers would be the Arista Stylii Selection Bar, featuring 48 replacements for top brands of stylii. The cabinet is painted silver gloss and each stand has transparent swing doors to keep out dust and prying fingers, while displaying the goods in all their beckoning temptation.

The catalogue's story theme is constant, and the author does not become enticed into side issues which could otherwise detract from the message implicit in the narrative: profit opportunities for retailers. The tempo of the presentation of this theme is constant: there are no crescendos or diminuendos, peaks and troughs, hills and valleys to usher the reader into moods of enthusiasm and ennui, highs and lows. The profit and loss account has no red troughs of despair or black peaks of exultant brevity: only a steady, if upwardly mobile, progression in the profit line.

I have seen Roger the editor gnaw his nails to the quick, emotionally rent between the Dick Smith Electronics and Arista catalogues when he wants details of a TV high gain antenna amplifier or foam pads for the earphones on his Walkman. This is how the Arista catalogue, if not used with strict self-control, will convert strong dealers into hapless addicts to the opportunities the Arista stock promises.

Take it to Perth with you, because certainly it will make better reading on the plane trip to next year's Perth Electronics Show than the insipid, frothy, in-flight magazines that the airlines insult the intelligence of right-thinking, entrepreneurial retailers with. Far better to spend the time learning the Arista catalogue off by heart if you are a Retravision, Betta, BVS or Electricentre — or just an independent — dealer, working out how you can use the knowledge to make more profit.

So compulsive is this book, and so hard it is to put down, once started, we recommend you ask those helpful Arista people at Silverwater, Sydney for more copies: one each for the caravan, the boat, the townhouse, the Cessna, the holiday home, and the 4WD.

If you haven't got all those appurtenances of commercial success yet, don't despair! — If you stock Arista parts and fill your shop with Arista display stands, PoS material, carrybags and transparent bags (as depicted in colour in the catalogue), there's every chance that you will!

For the enthusiast/consumer, for the first time this year, the catalogue has recommended retail prices "... to give you an indication of the price for comparison", says managing director Mike Dean.

— Ben Furby

PN100/PN200 TRANSISTORS

Rod Irving Electronics has introduced two new general purpose transistors which are ideal for a wide variety of "ordinary" electronics applications, and for replacing a multitude of common and uncommon devices.

The PN100 is a "Process 19" NPN transistor, while the PN200 is a "Process 63" PNP transistor. They are not complementary devices. A whole host of device numbers may be applicable to a particular process number. However, the data sheet indicates "principal device types", listing a small range of different numbers. This may simply mean the same-process device is housed in a different case style. However, different devices will be chosen for a particular set of parameters within the range specified for the process.

PN100

The PN100 is a general purpose NPN transistor for medium power amplifier and switching applications requiring continuous collector currents between 0.1 A (100 μA) and 500 mA. The Process 19 data sheet is reproduced here giving detailed characteristics of devices produced using this process.

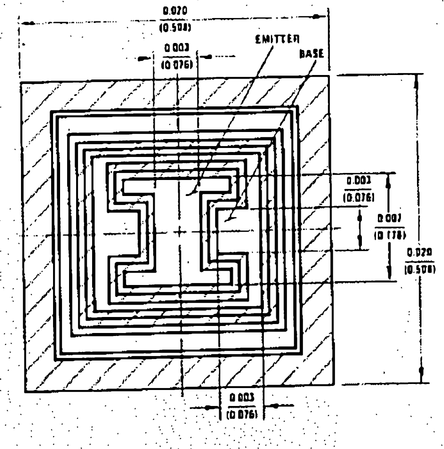
While the data sheet lists the "principal device types", following is a list of other devices made under Process 19, for which the PN100 may be used as a direct replacement. Note that, owing to the "spread" in device parameters, with substitution performance may vary from that expected in some applications.

The PN100 can be directly substituted where a 2N2222 is called for, so often seen in circuits of US origin.

PN100 MAY REPLACE:

2N696	2N2222	2N3643	PN2221
2N697	2N2222A	2N3678	2N2221A
2N1420	2N2897	2N4140	PN2222
2N1566	2N3115	2N4141	PN2222A
2N2218	2N3116	2N4969	PN5135
2N2218A	2N3299	2N4970	PN5136
2N2219	2N3300	2N5128	PN5137
2N2219A	2N3301	2N5129	TIS92
2N2221	2N3302	2N5135	TN2219
2N2221A	2N3641	2N5136	TN2219A
	2N3642	2N5137	

Process 19 NPN Medium Power



DESCRIPTION

Process 19 is a non-overlay, double-diffused, gold doped, silicon epitaxial device. Complement to Process 63.

APPLICATION

This device was designed for use as a medium power amplifier and switch requiring collector currents of 0.1 mA to 500 mA.

PRINCIPAL DEVICE TYPES

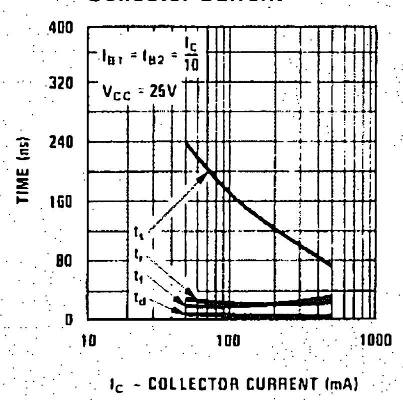
TO-5:	2N2219
TO-18:	2N2222
TO-92, EBC:	MPS3642 PN2222
TO-237:	TN2219

Parameter	Conditions	Min	Typ	Max	Units	Notes
t_{ON}	$I_C = 150$ mA, $I_{B1} = 15$ mA		25	35	ns	
t_{OFF}	$I_C = 150$ mA, $I_{B2} = 15$ mA		200	285	ns	
h_{fe}	$I_C = 20$ mA, $V_{CE} = 20V$, $f = 100$ MHz	2.0	3.5			
C_{ob}	$V_{CB} = 10V$, $f = 1$ MHz		4.0	6.0	pF	
C_{ib}	$V_{EB} = 0.5V$, $f = 1$ MHz			25	pF	
NF (spot)	$I_C = 100\,\mu A$, $V_{CE} = 10V$, $R_S = 1\,k\Omega$, $f = 1$ kHz		1.2		dB	
h_{FE}	$I_C = 100\,\mu A$, $V_{CE} = 10V$	30				
h_{FE}	$I_C = 1$ mA, $V_{CE} = 10V$	40				
h_{FE}	$I_C = 10$ mA, $V_{CE} = 10V$	50				
h_{FE}	$I_C = 150$ mA, $V_{CE} = 10V$	60	180	420		
h_{FE}	$I_C = 500$ mA, $V_{CE} = 10V$	30				
$V_{CE(SAT)}$	$I_C = 100$ mA, $I_B = 10$ mA			0.50	V	
$V_{CE(SAT)}$	$I_C = 500$ mA, $I_B = 50$ mA			1.0	V	
$V_{BE(SAT)}$	$I_C = 100$ mA, $I_B = 10$ mA			1.2	V	
$V_{BE(SAT)}$	$I_C = 500$ mA, $I_B = 50$ mA			1.5	V	
BV_{CEO}	$I_C = 10$ mA	35			V	
BV_{CBO}	$I_C = 100\,\mu A$	60			V	
BV_{EBO}	$I_E = 10\,\mu A$	6			V	
I_{CBO}	$V_{CB} = 40V$			100	nA	
I_{EBO}	$V_{EB} = 4V$			100	nA	

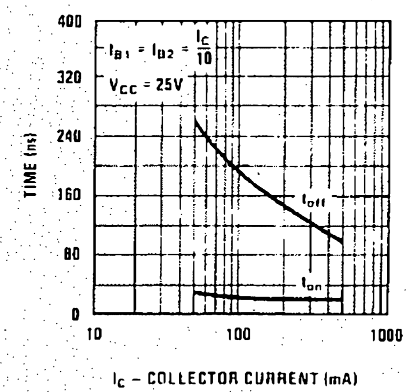
SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

Symbol	Characteristic	Typ	Units	Conditions
h_{ie}	Input Resistance	700	Ω	$I_C = 10$ mA, $V_{CE} = 10V$
h_{oe}	Output Conductance	120	μmhos	$I_C = 10$ mA, $V_{CE} = 10V$
h_{fe}	Small Signal Current Gain	240		$I_C = 10$ mA, $V_{CE} = 10V$
h_{re}	Voltage Feedback Ratio	460	$\times 10^{-6}$	$I_C = 10$ mA, $V_{CE} = 10V$

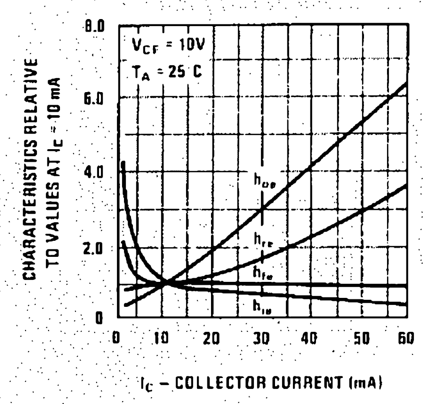
Switching Times vs Collector Current

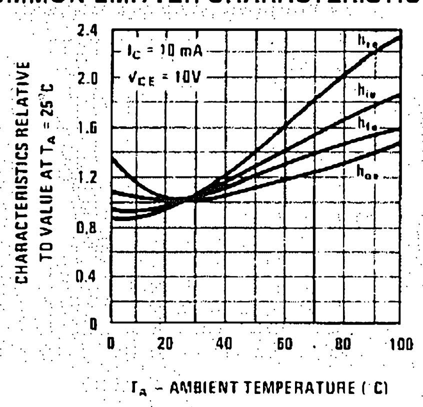


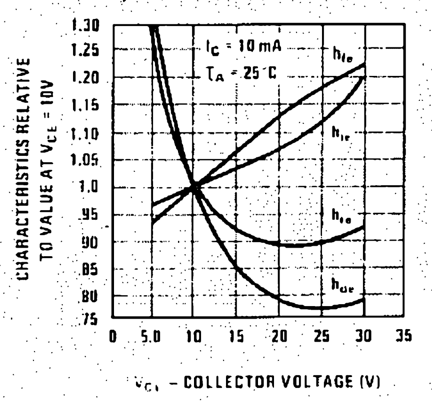
Turn On and Turn Off Times vs Collector Current



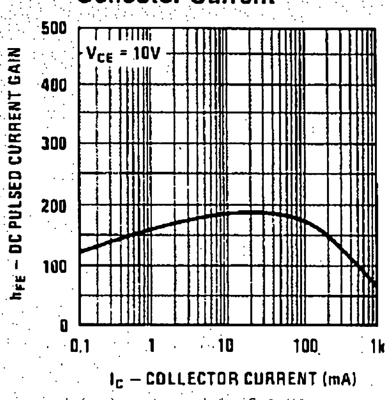
TYPICAL COMMON EMITTER CHARACTERISTICS (f = 1.0 kHz)



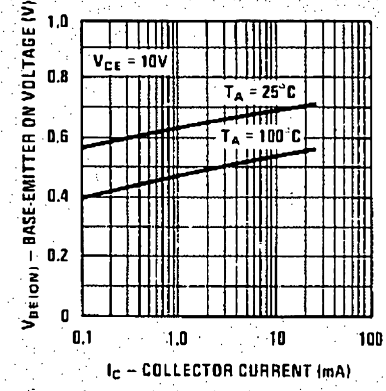




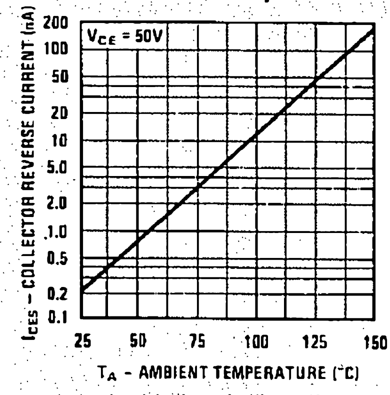
DC Pulsed Current Gain vs Collector Current



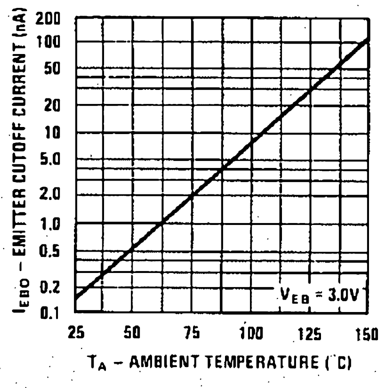
Base-Emitter ON Voltage vs Collector Current



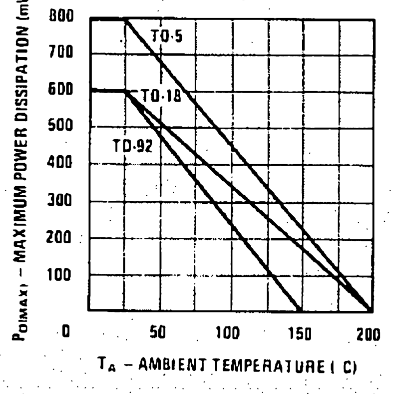
Collector Reverse Current vs Ambient Temperature



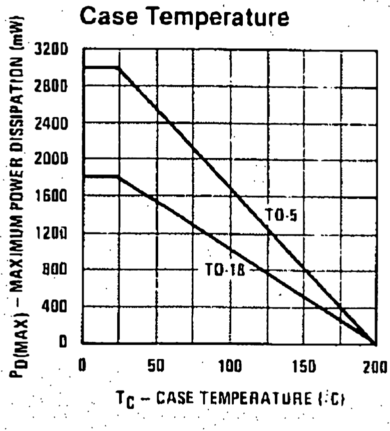
Emitter Cutoff Current vs Ambient Temperature



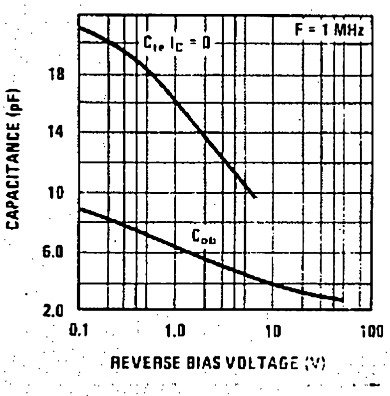
Maximum Power Dissipation vs Ambient Temperature



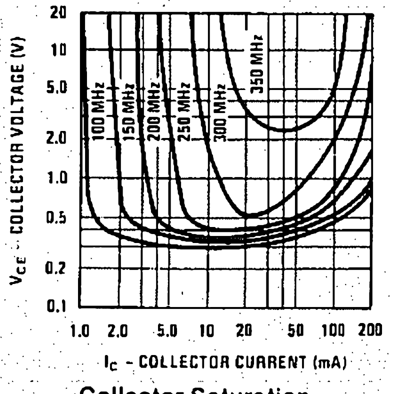
Maximum Power Dissipation vs Case Temperature



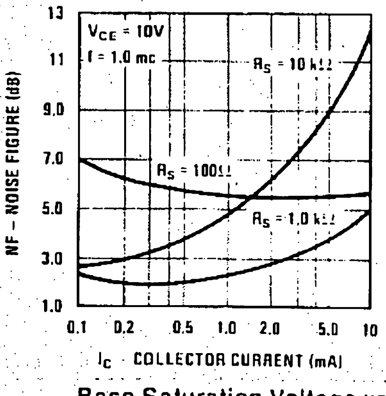
Emitter Transition and Output Capacitance vs Reverse Bias Voltage



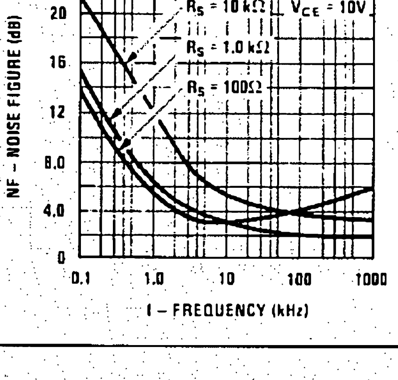
Contours of Constant Gain Bandwidth Product (f_T)



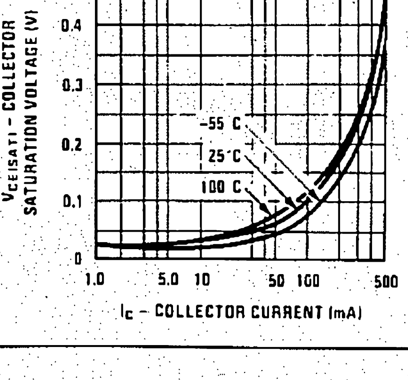
Noise Figure vs Collector Current



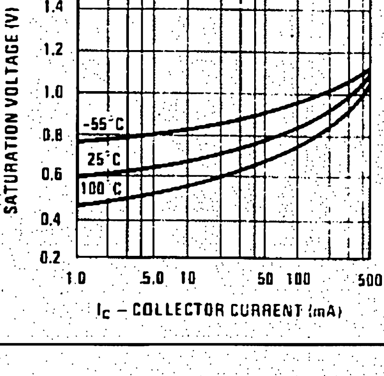
Noise Figure vs Frequency



Collector Saturation Voltage vs Collector Current



Base Saturation Voltage vs Collector Current



PN200

The PN200 is a general purpose PNP transistor for medium power amplifier and switching applications requiring continuous collector currents to 500 mA. The Process 63 data sheet is reproduced here giving detailed characteristics of devices produced using this process.

The data sheet lists the "principal device types", but following is a list of other Process 63 devices for which the PN200 may be used as a direct replacement. Note that, owing to the "spread" in device parameters, with substitution performance may vary from that expected in some applications.

The PN200 can be directly substituted where a 2N2905, 2N2907 or 2N4403 is seen, so often specified in circuits of US origin.

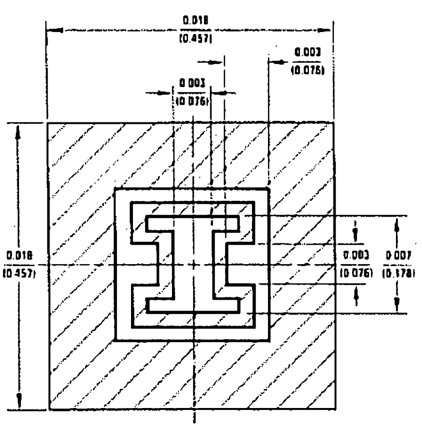
PN200 MAY REPLACE:

2N718A	2N3644	2N5447	PN2907A
2N1132	2N3645	BC212*	PN3638
2N2904	2N3702	BC213*	PN3638A
2N2904A	2N3703	BC214*	PN3644
2N2905	2N4142	BFX29	PN3645
2N2905A	2N4143	BFX30	PN4141
2N2906	2N4290	BFX87	PN4142
2N2906A	2N4291	BFX88	PN5142
2N2907	2N4402	MPS3638	PN5143
2N2907A	2N4403	MPS3638A	TIS91
2N3072	2N4970	MPS3644	TIS93
2N3073	2N4971	MPS3645	TN2904A
2N3120	2N5142	MPS3702	TN2905
2N3121	2N5143	MPS3703	TN2905A
2N3133	2N5221	MPS6533	
2N3134	2N5226	MPS6534	
2N3135	2N5354	MPS6535	
2N3136	2N5355	PN2906	
2N3638	2N5365	PN2906A	
2N3638A	2N5366	PN2907	

* These have suffixes of A,B,C etc, all of which are included.

Data derived from the "Transistor Databook", published by National Semiconductor.

Process 63 PNP Medium Power



DESCRIPTION

Process 63* is a non-overlay, double-diffused, silicon epitaxial device. Complement to Process 19.

APPLICATION

This device was designed for use as general purpose amplifiers and switches requiring collector currents to 500 mA.

PRINCIPAL DEVICE TYPES

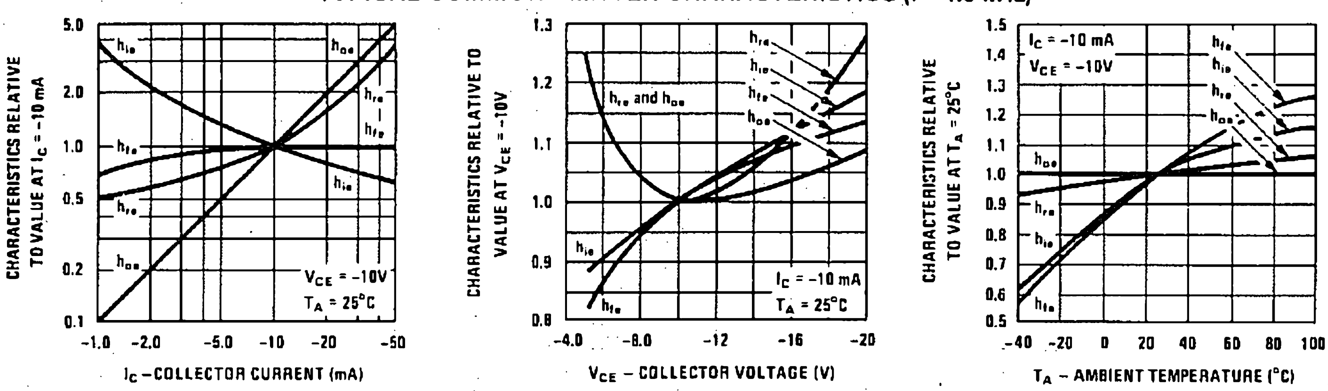
TO-5:	2N2905
TO-18:	2N2907
TO-92, EBC:	2N4403
TO-92, ECB:	2N3702
TO-237:	TN2905

Parameter	Conditions	Min	Typ	Max	Units	Notes
t_{ON}	$I_C = 150$ mA, $I_{B1} = 15$ mA		30	45	ns	*Figure 1*
t_{OFF}	$I_C = 150$ mA, $I_{B2} = 15$ mA		220	290	ns	*Figure 2*
C_{CB}	$V_{CB} = 10V$		6	8	pF	
C_{EB}	$V_{EB} = 0.50V$			20	pF	
h_{fe}	$I_C = 20$ mA, $V_{CE} = 20V$, f = 100 MHz	1.5	2.5			
NF (spot)	$I_C = 100\ \mu A$, $V_{CE} = 10V$, $R_S = 1k$ f = 1 kHz		1.5		dB	
h_{FE}	$I_C = 1$ mA, $V_{CE} = 10V$	50				
h_{FE}	$I_C = 10$ mA, $V_{CE} = 10V$	50				
h_{FE}	$I_C = 150$ mA, $V_{CE} = 10V$	50	150	400		
h_{FE}	$I_C = 500$ mA, $V_{CE} = 10V$	30				
$V_{CE(SAT)}$	$I_C = 150$ mA, $I_B = 15$ mA			0.5	V	
$V_{CE(SAT)}$	$I_C = 500$ mA, $I_B = 50$ mA			1.2	V	
$V_{BE(SAT)}$	$I_C = 150$ mA, $I_B = 15$ mA			1.3	V	
$V_{BE(SAT)}$	$I_C = 500$ mA, $I_B = 50$ mA			1.6	V	
BV_{CEO}	$I_C = 10$ mA	35			V	
BV_{CBO}	$I_C = 100\ \mu A$	50			V	
BV_{EBO}	$I_E = 10\ \mu A$	6			V	
I_{CBO}	$V_{CB} = 35V$			100	nA	
I_{EBO}	$V_{EB} = 4V$			100	nA	

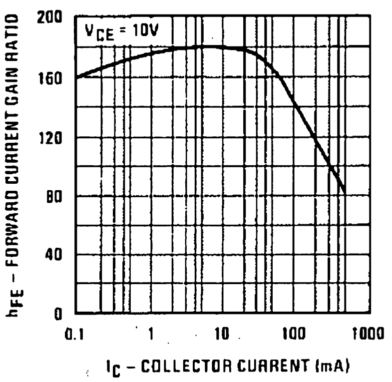
SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

Symbol	Characteristic	Min	Typ	Max	Units	Conditions
h_{ie}	Input Resistance		480	2000	Ω	$I_C = 10$ mA, $V_{CE} = -10V$
h_{oe}	Output Conductance		80	1200	μmhos	$I_C = 10$ mA, $V_{CE} = -10V$
h_{re}	Voltage Feedback Ratio		162	1500	$\times 10^{-6}$	$I_C = 10$ mA, $V_{CE} = -10V$
h_{fe}	Small Signal Current Gain	100				$I_C = 10$ mA, $V_{CE} = -10V$

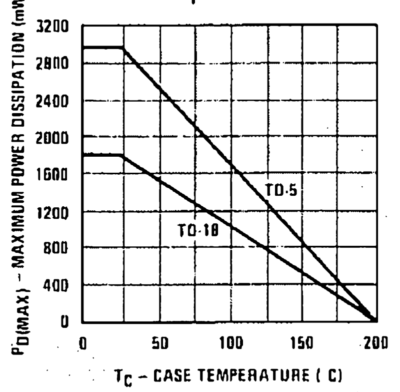
TYPICAL COMMON EMITTER CHARACTERISTICS (f = 1.0 kHz)



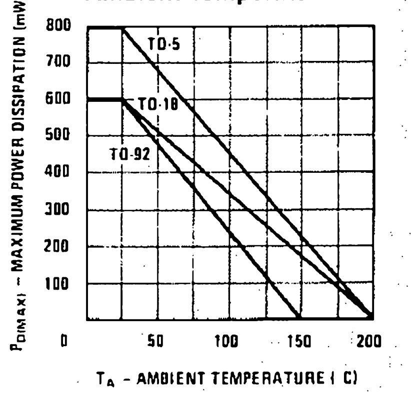
DC Pulsed Current Gain vs Collector Current



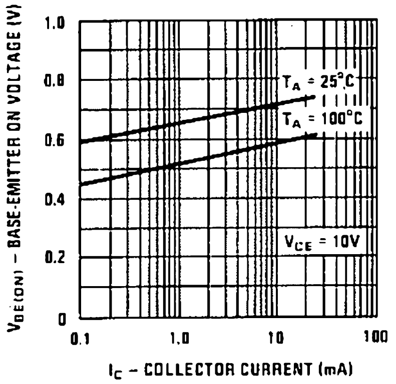
Maximum Power Dissipation vs Case Temperature



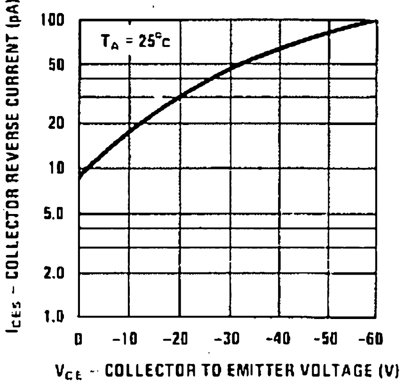
Maximum Power Dissipation vs Ambient Temperature



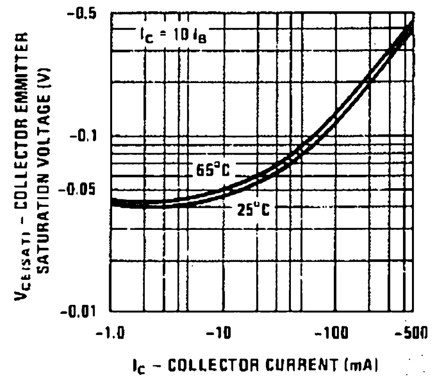
Base-Emitter ON Voltage vs Collector Current



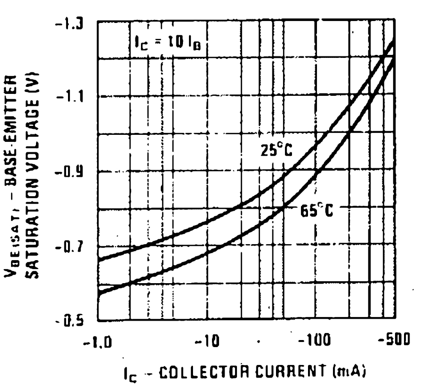
Collector Reverse Current vs Reverse Bias Voltage



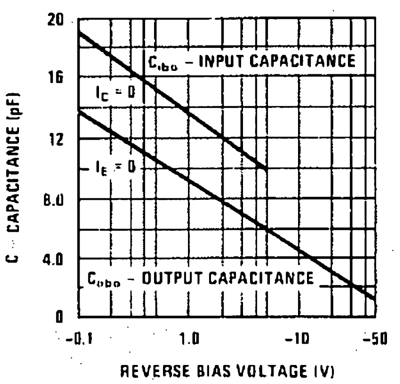
Pulsed Collector Saturation Voltage vs Collector Current



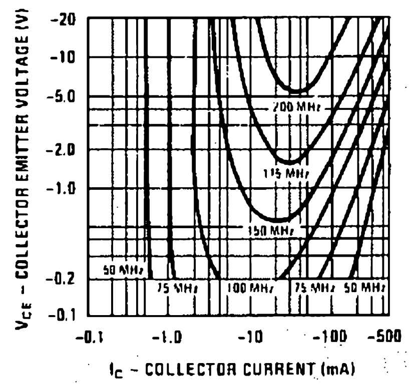
Pulsed Base Saturation Voltage vs Collector Current



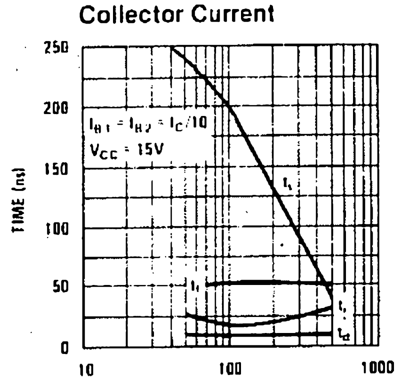
Input and Output Capacitances vs Reverse Bias Voltage



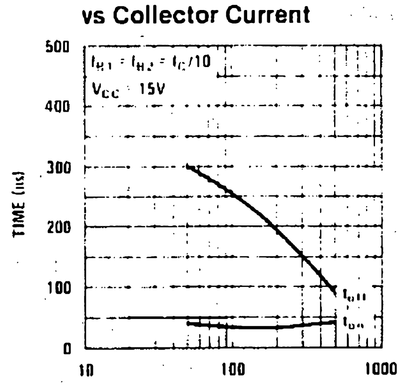
Contours of Constant Gain Bandwidth Product (f_T)



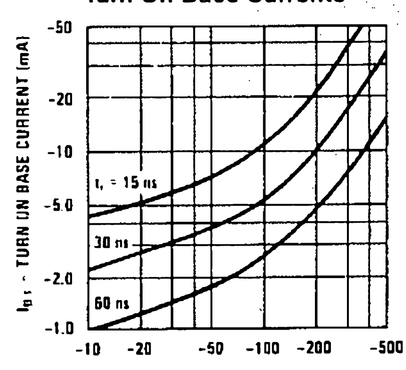
Switching Times vs Collector Current



Turn On and Turn Off Times vs Collector Current



Rise Time vs Collector and Turn On Base Currents



AEM FM antenna

Dear Sir,

I was impressed with the very practical design, construction techniques and the performance of such a compact unit as the AEM FM antenna. I have a very serious multipath distortion problem where I live, as observed on the TV, and expect similar effects on the VHF FM signal (I'm 15 km from the Dandenong transmitters so signal strength is good).

I would like to use my "cheap" Sherwood Tuner and send a really nice signal into it to get a good sound out as I understand reasonable tuners can produce top sound if you give them an excellent signal to decode.

I have an interest in VHF antennas (an obsession really from my TV reception problems) and enjoyed the antenna prac sessions in my Electronic Engineering Course at Melbourne University a generation ago. I really don't believe your antenna would completely solve my problem and I would be interested in your reaction to my proposal.

1. Your log-periodic (hybrid Yagi reflector) design produces a good front lobe and F:B ratio, or directivity, but does not quite meet my needs.

2. I need a front lobe more like a cigar shape and am quite happy to increase the boom length but not impressed with the idea of horizontal stacking to optimise the directivity as it would be fairly difficult to erect, not to mention tuning the signal.

In trying to dissect your design I used the rules in Carrel, ARRL, etc and was not surprised to find that your design had a σ 0.05 and the frequency of 90 MHz chosen sets the first active element at 1666 mm.

I tried using the various formulae and taking end effect etc, into account and using 88 MHz came up with L1 = 1653 mm. I was surprised how close it agreed with your design. I guess we are not dealing in a truly theoretical situation as so many parameters are varied in construction such as boom material, element h/a, connecting arrangements between active elements, and so on.

I tried to optimise σ and τ to achieve the best directivity and finished up with a boom length 3.5 times your boom length. Not very practical really.

A boom about two metres (plus a bit, possibly) is realistic and I would like to see if you have a design that you could whip up "quickly".

I know about tree problems, SWR, matching etc, so have reasonable understanding of the problem; especially the multipath problem as a Hills EFC-2 mounted well above my roof still produces some imaging (not your normal ghosting) before and after the main image.

Whatever your reaction, I would be open to any suggestions other than shifting home as the bush around me is too enjoyable to leave. Keep up the good work in your magazine as I have only missed one copy (someone borrowed it off my desk and didn't leave an IOU!).

Michael Taylor,
Ringwood Nth, Vic.

A more directive antenna may not solve your problem, sorry to say, as it rather seems, from the description of your TV problems and my knowledge of your area (having lived in Melbourne), that you have multipath signals from a narrow forward angle. It would be impractical to construct an antenna with a sufficiently narrow forward lobe to raise the ratio of direct-to-reflected signal.

All is not lost, however. Your multipath problems most likely arise from ground reflection from a point (or points) between you and the transmitter. There are two techniques you can use to attack the problem.

By all means, build an antenna for your FM tuner. Erect it so that you can readily vary the height of the antenna a few metres. You should then be able to position it so as to reduce the effect of the reflected signal. Also, tilting the antenna upwards, so as to place the reflected signal more in the underside "null" of the antenna can help. Both these actions can improve the direct-to-reflected signal ratio, reducing the multipath effect.

Modem comms software

Dear Sir,

I have recently constructed your AEM4605 *Super Simple Modem* from the September 1986 issue of your magazine and was wondering if you could suggest a software package for its use with an IBM that will support the V23 (1200/75) option. As yet I have been unable to find a suitable program.

Trevor Harrison,
Lalor Park, Vic.

There are a number of communications programs for PC/MS-DOS to suit your application. You might investigate "Mirror II", which Roy Hill reviewed in the July '87 issue ***(Some Reflections on Mirror).*** *There are also a number of public domain programs around that could suit your purpose (and your purse!). Check out Roy Hill's survey in our* ***Dial Up*** *column from October to December '87.*

Supermodem and V23

Dear Sir,

I have recently purchased a Maestro 2400 ZXR complete, having decided against the kit with only $50 more for a built-up (and Telecom approved). I am quite happy with the performance of the unit except for a problem I have in the V23 mode when accessing Westpac's Videotex service. Before I elaborate further, I should note that I can access Viatel without any problems and the comms software I am using is Mirror II. I have also tried the public domain program Itel with the same results and had no problem with the PC in-modem and program from Netcomm previously owned.

Through the software, the number is dialled, both ends appear to handshake OK and the connect is issued to the program, but no <com> appears on the screen as it does with Viatel. The Westpac introductory screen comes up and the cursor sits on the ID, waiting for an input. This is where it stays no matter what key is pushed. The Host Transmitter LED flashes each time a key is pushed, but there is no response from Westpac. Of course, I am eventually cut off with a time-out.

I telephoned Westpac's difficulties, but all they could tell me was that their service was different from Viatel's and I should be using a Prestel emulation, even parity, 7 data bits and 1 stop bit. As this is exactly the same as Viatel, there hardly seems to be a great difference. I can't say that they were a great help. Is there a possibility that the ZXR is not close enough within the 75 baud rate boundaries and the Westpac service is more particular than Viatel?

I also had another problem with the 6010 preamp. I know this is going back a couple of years, but I wonder if I had the correct solutions to the problem at the time? I built the unit from pieces rather than a kit so I could get the best quality components I could obtain. However, on completion there was a lot of crosstalk from one input line pair to the other.

The only way to stop this was to change the earthing so the input grounds (except the phono) were earthed at the 0 volt point on the main board rather than through the shields of the unbraided link wires. I could have turned the sources off each time, I suppose (mainly tuner), but it was a nuisance and this arrangement does not appear to have altered the performance.

Also, with the resistor arrangement at the CD input I could not get a reasonable volume even though I have an early Sony which has a relatively high output. I just reduced the value to where it balanced fairly well with the tuner and video inputs, but it was a hell of a lot less than 100k. Apart from that, the performance is superb. The phono stage really excels and shows up the problems with compact discs and their players.

I have a quad-amp system using some of your projects and it works well. Of course there is always room for improvement add-ons and updates.

I have bought every magazine since you started in '85 and, while being interested mainly in audio and computers, I think you cover a broad range quite well. It is hard to keep everybody interested all the time, but informative articles help; especially the way new ideas, components, and equipment keep arriving. Keep up the good work.

Peter Crawford,
Chadstone, Vic.

The trouble you have with the 2400 ZXR modem has not been reported by other users to our knowledge, but that doesn't mean to say there may not be a problem with your modem. However, as you are able to "hook up" with the Westpac service, this would seem to preclude problems with the hardware, throwing suspicion on the software. There may be some problem arising between your comms software and the ZXR software. I suggest you contact the designers at Maestro Distributors, Calool St, South Kincumber 2256 NSW.

It's good to know you sorted out your 6000 series problems and that you derive such pleasure from the system — that, after all, is what it's all about! And thanks for the accolades.

Roger Harrison

The 555 as a CRO timebase

Dear Sir,

I bought a copy of September's AEM and am very interested in your article on the 555 IC. I seek your comments on the suitability of the 555 as a sawtooth generator.

You see, if the modification is simple, I wish to change the timebase on my Dick Smith "cheapie" oscilloscope from repetitive to the triggered type and a linearised capacitor charging of pin 6-7 of the 555 in its monostable mode seems to be suitable.

Secondly, I wish to endorse the comments of your correspondent Fabio Barone in advocating a practical treatise on transformers and inductors. When I wish to 'swat' up on this subject I have to get hold of my copies of *Radiotron Designers Handbook*, or *Babani Coil Design and Construction*, and these must be 30 years old — well before transistors were a force as they only relate to valves.

B.C. Porter,
Port Macquarie, NSW

If you bite a 555 hard enough you'll get a sore tooth! Puns aside, it should certainly be possible to replace your CRO timebase with a "linearised" 555 incorporating a trigger facility. The accompanying circuit and data, from the National LM555 data sheet, should be a good starting point. The 2N4250 (or PN4250) is a "process 62" small-signal PNP transistor; a suitable substitute would be the 2N3550. Either is available from Rod Irving Electronics.

Hash Harrier trip up

Dear Sir,

I recently built the AEM5505 "Hash Harrier" mains filter, and found it is impossible to use in my house, as all the outlets are protected by an Earth Leakage Circuit Breaker. At switch-on, the ELCB is tripped.

I have found nothing wrong in the construction of the project, as it is working with a non-protected supply.

Could you please tell me what modifications should be made to the project to make it operational – and still effective – on earth leakage protected power supplies, as I believe I am not the only one with this kind of protection.

The Varistors, and/or R2 in the circuit, could be the problem. Looking forward to a solution.

A.Ripoll,
Richlands, Qld.

The 'problem' you experience with your Hash Harrier is not caused by the Varistors and/or R2, but by the combined capacitive reactance of capacitors C2-C4-C7 and C11-C13-C16. These are all connected between the active and earth.

At 50 Hz, they are effectively all in parallel, their total capacitance being some 495 nF (i.e: about 0.5 uF). This has a reactance of about 6400 Ohms and thus 37 mA (240 V/6400 Ohms) will flow from the active, through the capacitors, and the mains earth wire. Your Earth Leakage Circuit Breaker will have a "trip current" set at something under 30 mA, typically 20-25 mA. (ELCBs detect "fault" currents flowing in the mains earth line, these fault currents arising from a presumed resistive path between active and earth.)

What you need to do is reduce the value of capacitors C11-C13-C16 each to 68n, which will reduce the earth line current to around 18-19 mA. You should also drop C12-C14-C17 to 68n each also, to balance the values.

If there is some reduction in the effectiveness of the filter, then wind another two layers of wire on each of L3A, L3B, L4A and L4B (the ferrite rods). Really, only one more layer is needed, but the third layer brings the start and finish out at opposite ends of the coils, making them easy to fit on the pc board.

Roger Harrison

Inductor info

Dear Sir,

Regarding the September '88 issue, Page 15, *Losses In High Frequency Inductors*, Fabio Barone asks about a series on inductors. I would like you to do this too! I have spent a lot of time trying to find good, practical information on inductors.

The best book I've found so far is from Doug DeMaw, called *Ferromagnetic Core Design and Application Handbook*. At $70 it is not so cheap. I found it in North Sydney Technical College.

Peter Baxter,
Gordon, NSW

Thanks for the request, and for the tip for other readers. That's one of the functions of these pages — sharing your knowledge and experiences with others. That book is published by Prentice Hall and the publishers would be able to indicate outlets where readers may buy it. It's quite a good book, with fairly wide coverage, but does not go deeply into any one subject.

Speech synthesiser

Dear Sir,

A few years ago you published a project that performed a text-to-speech conversion. As I recall, it was designed as an IBM-PC add-in board, although that may be wrong. The project was based around two ICs sourced from Tandy Electronics — the SPO256A-AL2 and CTS256-AL2 Speech Synthesiser ICs.

From what I remember, the project had provision for an "exception EPROM", but the original article did not have details on how to program one. Perhaps the information for this was published in a later article which I did not read, or an erratum, but a copy of any such information will obviously be very beneficial. Could you tell me where I can obtain further information?

Frank Van Hooft,
Lathlain, WA

The project your refer to is the AEM4505 Code-to-Speech Synthesiser which was based on the chip set made by General Instruments. While the project provided for inclusion of the "exception EPROM", we did not publish details on programming it as it required knowledge of a relatively obscure programming language. However, if you can get hold of the General Instruments Application Note AN-0505, you'll find details there. General Instruments is now represented by RIFA in Melbourne.

The "little block", one-chip 30 watt audio power amp module

Graham Dicker

This would have to be the *simplest* audio power amp project above a few watts ever described! Based on the National Semiconductors' LM1875 IC, it requires just eight components and a tiny pc board, and delivers hi-fi performance.

IT PAYS TO BROWSE the semiconductor manufacturer's data books and application notes from time to time. It's amazing what you can turn up. The IC used in this project has been around for several years, but its praises have been unsung.

The National Semiconductor LM1875 is a monolithic power amplifier IC in a TO-220 case with five pins. It's *tiny!* The TO-220 case measures just 10 mm wide by 15 mm tall, plus the legs. And it will deliver over 30 watts when powered from ±30 V supply rails! What's more, it features internal output current limiting and thermal overload protection. A data sheet for the LM1875 is reproduced elsewhere in this issue.

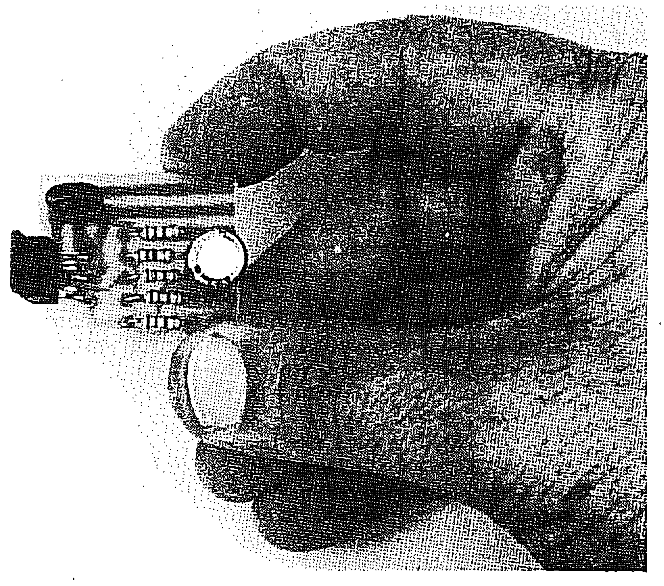
The whole amplifier consists of only eight components, including the IC. It is assembled on a pc board measuring just 32 × 42 mm. It may be used with power supply rails ranging from 10 to 30 volts and delivers hi-fi performance with distortion at 20 W being 0.05%, and a frequency response flat from 1 Hz to 50 kHz. This allows you to use simple, external RC filters to tailor the frequency response without affecting "slew limiting" distortion which mostly affects transients.

The module is simply mounted by bolting the tag of the IC's TO-220 case directly to a chassis or heatsink (using an insulating washer). Power supply requirements are quite modest, as just noted, and a variety of commonly available, low cost transformers may be used as the basis of a power supply for it. You can connect two modules in "bridge" configuration to give twice the output power, if you wish. In addition, the module will happily drive 70/100 V line output transformer for use in PA applications.

Circuit of the project

The circuit is simplicity itself! The LM1875 is powered from using 'split' (+/-) supply rails. Capacitor C2 provides supply bypassing at high frequencies. As no additional low frequency decoupling is provided on the board, constructors should use no more than 150 mm of wire between the main filter capacitors of the power supply and the pc board.

The closed loop voltage gain is set to about 20 by R3 and R4. Capacitor C1 ensures the gain of the LM1875 is rolled off at very low frequencies, and has no gain at dc. If fitted, C3 rolls off the high frequency response at 50 kHz. The non-inverting input is ground-referenced by R1.



This is the module; 30 watts on a postage stamp-sized printed circuit board!

A capacitor in series with the input may be needed to block any dc from a preamp stage, but provision is not included for this on the pc board as most preamp designs around have ac-coupled outputs with a capacitor. If you have to add one, a suitable value would be 2.2 µF. This could be either a metallised polyester or polypropylene type, or a low voltage electrolytic or tantalum.

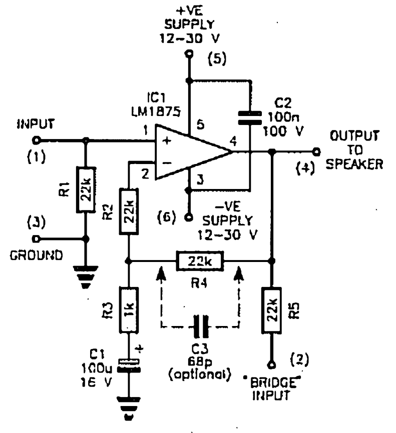
The bracketed numbers on the circuit refer to the pc board track connections, which are numbered correspondingly.

If two modules are to be bridged, the output of one module *only* is connected to the "bridge input" of the other module, as shown in Figure 2.

LEVEL: We rate this construction project as suitable for:

BEGINNERS

If you've had little or no experience in electronics construction, you should be able to successfully complete this project.



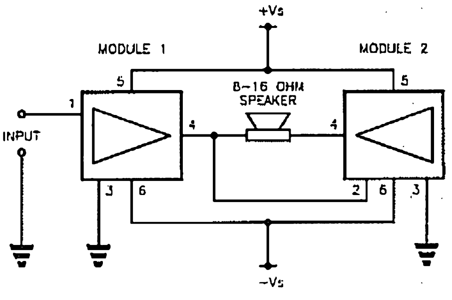


Figure 2. How two modules may be connected in a "bridge" configuration to provide double the output power. If ± 30 V supply rails are used, the load (speaker) must be no lower than 16 Ω. With supply rails of ± 25 V, the load may be as low as 8 Ω.

Figure 1. Circuit diagram of the AEM6511 module. The numbers in brackets refer to the numbered pc board tracks providing the external connections. (See the component overlay and accompanying table).

Assembly

Putting the power amplifier module together is quite straightforward because of the few parts and the LM1875's simplicity.

The first thing to do is to give the printed circuit board a close visual inspection. See that all the holes are drilled and the correct diameter. Check that there are no tiny "whiskers" of copper between closely spaced tracks or pads. Check that there are no small cracks in the narrow tracks on the board. While these things are rare occurrences, they can be frustrating faults to track down after you've built your project. Once the board checks out OK, you can proceed with putting on the components.

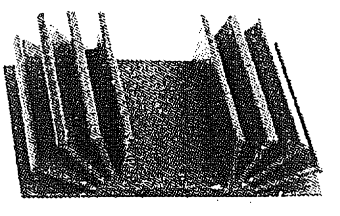
The component overlay diagram here shows where the components go. Do the resistors first. Note that all but one of the resistors are 22 k Ω. Next, install the two capacitors, but take care to get the polarity of the 100 µF electrolytic right. Lastly, mount the LM1875 IC with its metal tab facing the back of the board. The accompanying photographs show clearly how the completed module should look.

Heatsinking

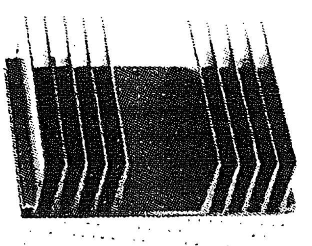
The LM1875 must be mounted on a heatsink. But what size heatsink? Well, this will depend on your application and the supply rails. The latter determine the maximum power output, while the speaker impedance determines how much power the LM1875 must dissipate. However, in a stereo amplifier playing music, your power amp doesn't run at maximum output all the time. The *average* level when playing music is around one-fifth, or even less, than the peak level.

So, in a stereo setup, assuming ± 30 V supply rails and 8 Ω speakers, most of the time the amplifiers will be running at an average level around 5-6 watts, or maybe less. The IC's data sheet tells us that it will dissipate around 20 watts and for an ambient temperature up to 50° C, a heatsink rated at about 2° C/watt is required. You'll find some retailers' catalogues will list heatsink ratings in this manner.

A number of common heatsinks will fill this requirement ▷



A radial fin heatsink of the type suitable for use with this module.



This is an example of a straight-finned heatsink of the type which may also be used with this module.

AEM6511 PARTS LIST

Semiconductor

IC1 .... LM1875

Resistors all 1/4 W, 5%

R1, R2, R4, R5 .... 22k
R3 .... 1k

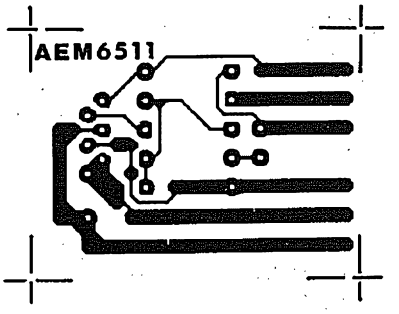
Capacitors

C1 .... 100µ/16 V RB electro.
C2 .... 100n/100 V greencap
C3 .... 68p/50 V (optional) ceramic (see text)

Miscellaneous

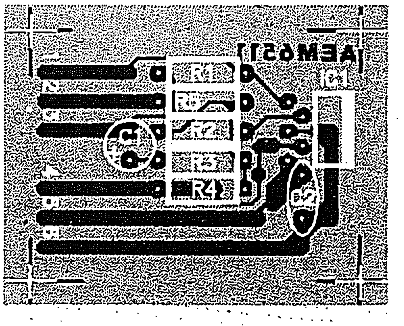
AEM6511 printed circuit board; heatsink (1° C/W or 2° C/W), as required; nut, bolt and washer to secure IC tab to heatsink.

Estimated cost: $16-$18
(less heatsink)

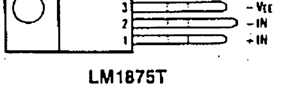


MODULE CONNECTIONS

PCB track	Function
1	Input
2	Bridge
3	Ground
4	Output
5	Pos. supply
6	Neg. supply

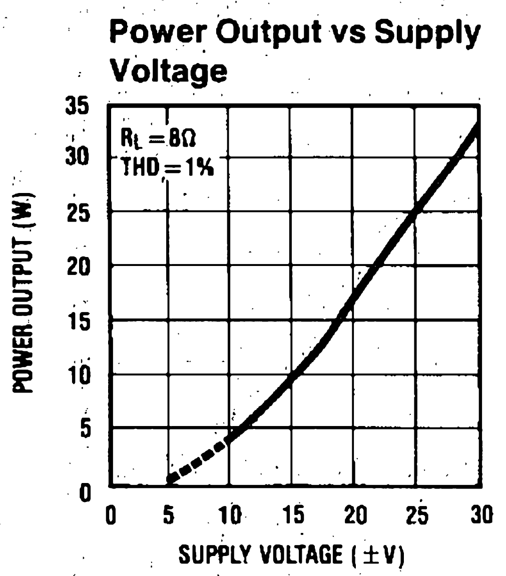


Component overlay showing where the parts go. Note that C2 has a different orientation to that shown in the pictures of the prototype as it was rotated 90° in the final version.

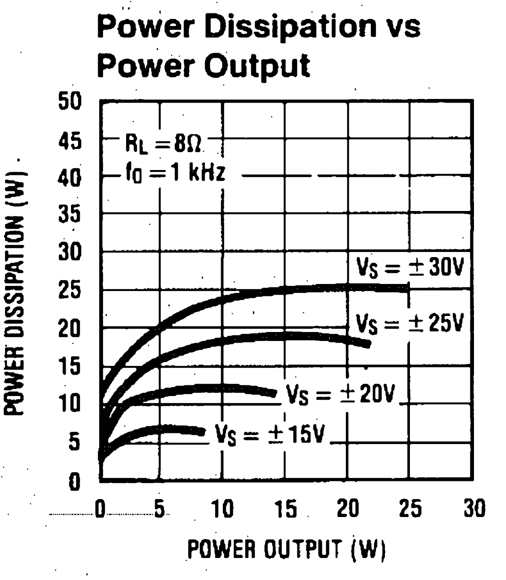


Front View

LM1875T



How the power supply rails determine the module's power output.



The power dissipation of the LM1875 depends on the load (8 Ω here), the supply rails and the power output level it operates at.

nicely. For example, a 75 mm length of 105 mm wide "radial fin" heatsink from Rod Irving Electronics (cat. no. H10525). This is flat on one surface with fins radiating from the other surface either side of a central channel that runs the length of the heatsink. It's Australian designed and made. Dick Smith Electronics has one similar, 101 mm wide by 80 mm long, cat. no. H-3422. Altronics, too, has a similar type, 105 mm wide by 72 mm long, cat. no. H0522.

Another type that suits, from Dick Smith Electronics, is the single-sided, straight-finned "versatile power heatsink", measuring 102 mm wide by 74 mm long and with 25 mm high fins, cat. no. H-3460. (undrilled, the H-3461 is drilled to mount a variety of transistors). Rod Irving Electronics has a similar type, cat. no. H10675 (undrilled; H10676 drilled). The Altronics H0560 (110 × 72 mm), another of the same type, is also suitable.

Such heatsinks will provide quite adequate cooling for the LM1875 in stereo amp applications, and for that matter, PA or background music systems.

If you envisage that your amplifier may have to spend considerable periods operating at or near full output, then a heatsink rated at 1° C/watt or perhaps 1.2° C/watt is required. A 150 mm length of radial fin heatsink, as mentioned earlier, will do the job. Rod Irving's catalogue no. for this is H10535. Altronics also has a single-sided, straight-finned heatsink, 125 mm wide with 35 mm high fins either side of a centre channel. A 125 mm length of this, cat. no. H0585, is rated at 1.2° C/watt. Note that a single length of this or the Rod Irving H10535 would suit a stereo pair.

Unless you can guarantee your heatsink will not be grounded, the LM1875 has to be mounted to the heatsink with an insulated mounting kit. This comprises a thin mylar or mica "washer" to go between the IC's metal tab and the heatsink and two plastic bushes used to insulated the bolt that secures the tab to the heatsink. To ensure good thermal conduction between the tab and the heatsink, use a generous smear of thermal compound on both sides of the insulating washer. This is obtainable from most electronics retailers and is a white paste in a small tube.

You'll need to drill a suitable hole in the heatsink to clear a 6 BA or 3 mm dia. bolt. Locate the hole so that the IC's tab is placed centrally on the face of the heatsink. Clean off any burrs around the hole using a much larger diameter drill bit held in your hand. Any burrs here will likely puncture the insulating washer.

Before powering up the module, as a last test, check with a multimeter that the case of the LM1875 is insulated from the heatsink.

While the heatsink is *ideally* mounted with the fins vertical, for best ventilation, in some arrangements this may not be possible. However, it is necessary to see that the heatsink gets adequate ventilation, else its cooling efficiency is affected and your amp may run unexpectedly into thermal shutdown. The module itself may be mounted vertically or horizontally, or any angle in between if it suits you!

A stereo pair of modules could be mounted on one heatsink, say a 150 mm length of radial fin type. The modules should be positioned as if you were mounting each on a separate 75 mm length of heatsink, i.e: 37.5 mm in from each end.

Power supply

A suitable power supply circuit is shown in Figure 3. The transformer T1 may be chosen to suit your purse or your application. For supply rails of around ±30 V, a transformer with two 18-20 V secondaries rated at 1.5 to 2.0 amps is required.

Two locally-made transformers by Ferguson fit the bill: the low profile type PL40/60VA has two 20 V secondaries rated at 1.5 A, as does their conventional type, the PF3993. Both of these are available from Rod Irving Electronics stores. These would be suitable where the module is largely used to play music, in a stereo setup, for example. The peak current requirement is around 2 A, but as the amp module will spend most of its time running at a relatively low power level, only reaching peak out-

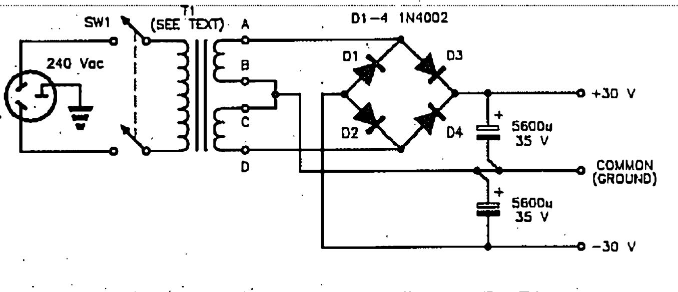


Figure 3. Suggested power supply circuit diagram. For T1, use either a transformer with two separate secondaries or a centre-tapped secondary, or two separate transformers of the same type having the required secondary voltage. For ±30 V rails, 20 V secondaries are required, rated at 1.5-2.0 A. You must make sure to connect the secondaries in series, else you'll get no output from the rectifier (but no damage will result). The B-C connection is the "centre-tap", marked "C.T." on the wiring diagram. The text has important details on the diodes and capacitors.

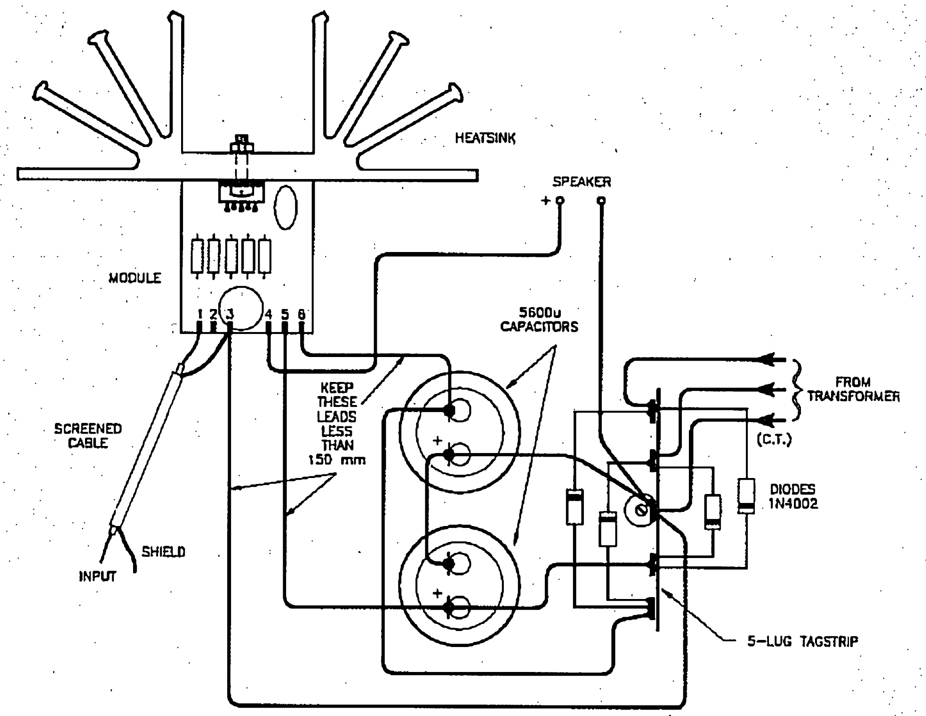


Figure 4. How you might wire-up a power supply and module. Use "heavy duty" (at least "32 x 0.2 mm") hookup wire. For stability, keep the leads between the module and the filter capacitors shorter than 150 mm. Note that the wire from track 3 on the pc board must return to the common earth point, the centre lug on the tagstrip here, and not to the junction of the two filter capacitors. This avoids the capacitor charging current from flowing in the module's earth line, causing 100 Hz buzz to be heard in the output. The speaker earth lead comes from the same point, too. Bolting the tagstrip to a chassis via this lug automatically connects the circuit earth to the chassis.

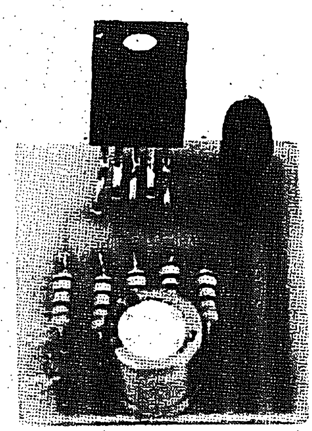
put on musical crescendos, the power supply capacitors will be able to supply the extra energy.

One of the ILP range of toroidal transformers is ideal, the 50 VA model with two 18 V secondaries. These are obtainable through the distributors, Electromark (Sydney), and Sydney retailer Hi-Com Unitronics in Caringbah.

Dick Smith Electronics stocks a transformer with a single 18 V secondary rated at 2.2 A; two of these with their secondaries connected in series would do the job well. In fact, this arrangement would suit applications where the modules are called upon to provide sustained output at maximum power for long periods.

The diodes specified in Figure 3 are rated at 1 A continuous, which is fine where the module is used in music reproduction. It would be wise to use type 1N5404 diodes, rated at 3 A continuous, where the module is to be used in applications where it's run at or near maximum output for sustained periods.

The electrolytic capacitors specified, at 5600 µF, represent a minimum value. Either can type (chassis mounting), or pigtail type (if available) may be used. Higher values and/or higher voltage rating types may also be used. Dick Smith Electronics stores stock a 5600 µF/40 V can type electrolytic, cat. no. R-4570, that's ideal. Rod Irving Electronics stores stock a pigtail-type 5600 µF/40 V capacitor, cat. no. R16592.



View of the board showing how the IC is fitted. The module is self-supporting when the IC tab is bolted to a heatsink.

If you use the latter, make sure they're mechanically secure, by tying them down to the chassis or mounting them on a piece of perforated board or pc board, along with the rectifier diodes perhaps.

Figure 4 shows the construction and wiring of a power supply and module. The exact arrangements will depend on your particular application and physical constraints, but this diagram should provide a good guide. Note that the leads running between the module and the rectifier should be no longer than 150 mm. The supply wiring should be made with "heavy duty" hookup wire, at least (32 strands of 0.2 mm wire). The same goes for wiring to the speaker connector or line transformer. For a stereo setup, I recommended separate power supplies for each module.

For lower supply rail voltages, choose a transformer with secondary voltages between 65% and 71% of the required dc rail voltages, provided a suitably rated type is available. That is, for ±18 V rails, which will give around 15 watts power output from the module, use a transformer with two 12 V secondaries, or two transformers with single 12 V secondaries. Current rating will need to be around 1-1.5 A.

Note that, with ±30 V supply rails, it is not advisable to connect a load (loudspeaker) of lower than 8 Ω impedance, else the ▷

SPECIFICATIONS

Output power	32 W RMS, 8 Ω load, +/-30 V rails
Distortion	0.02% at 1 kHz/10 W
Noise	-96 dB wrt 30 W RMS
Frequency response	±1 dB, 1 Hz-50 kHz

INSIDE THE LM1875

Designing an IC audio amplifier would appear to be simple. Just use it as a "black box" with a simple circuit, adapting it for the appropriate application. To some extent this what we have done but note a few of the problems and differences the designers of the LM1875 were up against.

Usually, ICs designed for audio power amplifier applications do not vary greatly in internal design from conventional discrete audio power amplifiers, except that the ICs probably use current sources extensively, 'active' loads (transistors instead of resistors) and balanced differential amplifiers. Designers use these techniques mainly because on a substrate they can fabricate a transistor more cost efficiently than a resistor or capacitor. Fabricating a transistor is easier and uses less silicon, hence its cost efficiency.

Figure 5 shows the internal circuit of the LM1875. As with most amplifiers, this IC can be broken down into various component parts. The input buffer consists of dual differential input pairs in a long-tail pair arrangement. These are Q3, Q4, Q5 and Q6, with constant current sources Q1 and Q2 in the combined emitters of Q4 and Q5, and active loads (Q7, Q8, Q9 and Q10) in the collectors of Q4 and Q5.

The base of Q11 is driven from these active loads. Together with Q22 as a current source in its collector circuit, it forms a high gain voltage amplifier.

Capacitor C1 provides pole-splitting compensation to achieve a unity-gain bandwidth of about 1 MHz. This stabilises the circuit with the internal compensation of loop gain down to 10 or so.

Q25 forms an emitter follower to give the bias stage of the output driver transistors a stable source impedance.

The output stage consists of two NPN output transistors as against the typical NPN-PNP symmetrical pair usually found in conventional designs. This is because good quality high current, high voltage PNP transistors cannot be formed on a substrate.

Q35 is configured as an emitter follower with Q34 forming a Darlington pair. Q39 is in common emitter with Q38 and they form a super-alpha pair, which is the complement of a Darlington pair, emulating a PNP transistor.

The problem with this configuration is low f_t, which usually results in poor unity gain bandwidth so it probably oscillates on the negative half cycle output swings. This is one of the main sources of instability found in designing a pc board layout so this must be done carefully to stop such effects.

Another cure is to use a standard series step network (100-270 nF capacitor and 1 Ω resistor to ground) on the output, as in Figure 6. Or you can use the traditional Zobel network (See Figure 7), which employs a small inductance damped by a resistor.

Although the main circuit shows an optional 68 pF capacitor, C3, the pc board does not provide for it. This capacitor can be bridged across R4 should there be any instability. In this application, I have kept the loop voltage gain as high as possible to reduce the internal collective sources of instability.

Q36 and Q37 form a current limiter by sampling the voltage drop across the emitter resistors of the output stage and removing base drive to the output transistors at about 3-4 A output current.

Transistors Q26, Q27 and Q28 are wired as diodes and provide the quiescent bias voltage for the output stage of 60 mA to reduce crossover distortion. To achieve good power supply rejection ratios (PSRR) an internal regulator of Q12, Q13 and Q14 supplies the main differential and voltage amplifier stages.

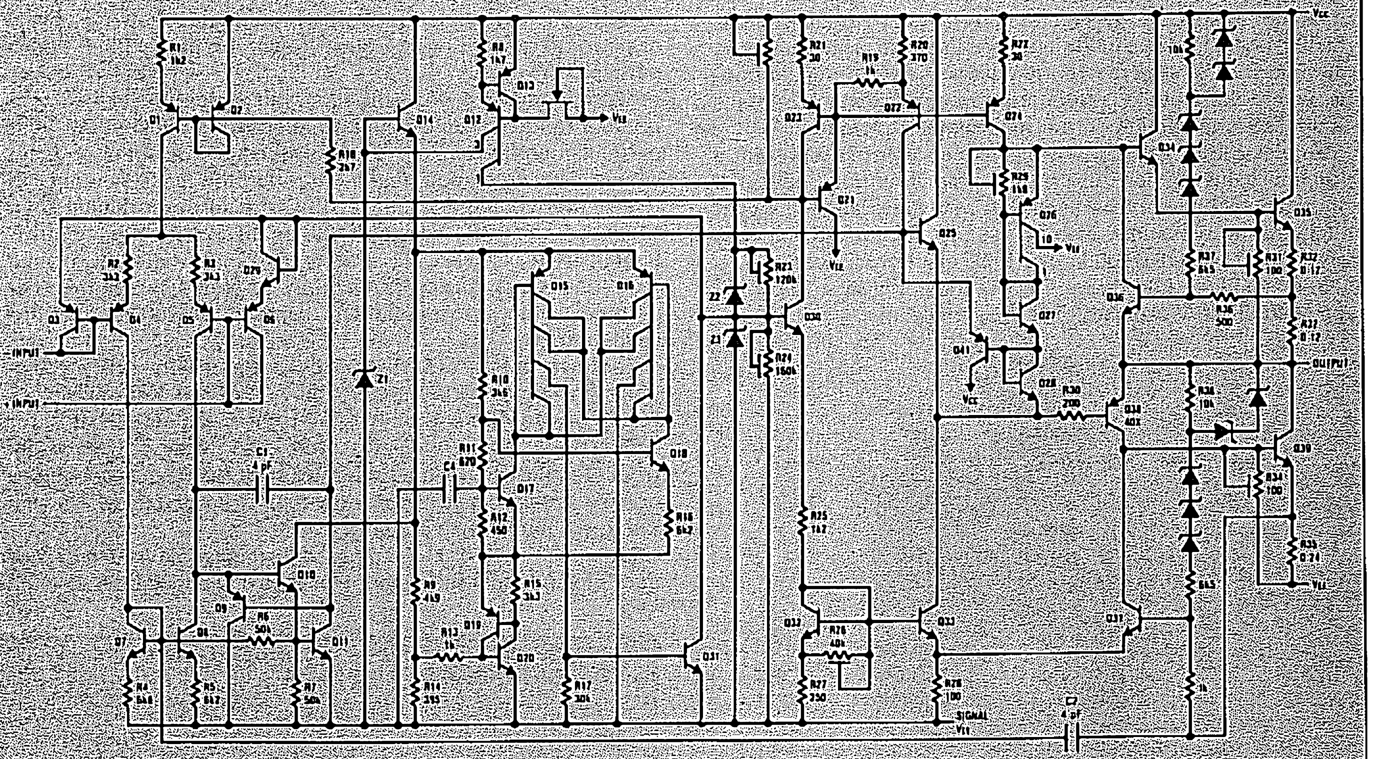


Figure 5: Internal circuit of the LM1875.

dissipation rating of the LM1875 will be exceeded when the module is operated at maximum output.

There is one last thing to note about the power supply; make sure you connect the transformer secondaries in "series aiding", that is — the secondary voltages must be in phase, else you will get no output from the rectifier! However, if you get it wrong, no damage will result.

Checking it out

If all is well you can power up the module without a load (that is, a speaker or line transformer). Then a quick check with a multimeter should show less than 25 mV dc from the output to ground. Connecting your multimeter in series with one of the supply rail leads should show the module draws less than 100 mA of current (with no signal and no load). If you don't get these indications, switch off immediately and check for a wiring error.

These tests may be done without the module mounted on a heatsink, provided it only takes a few minutes. Note that applying power and signal to the module without having it mounted on a heatsink is not a good idea, the internal thermal shutdown is likely to operate after a brief period.

If you have access to an oscilloscope and an audio signal generator, then you can perform the next test for your own interest. You will need to make up a "dummy load" of about 8 Ω — six 47 Ω/5 W resistors connected in parallel will do nicely. Connect you dummy load to the module's speaker output. Feed in a 1 kHz sinewave. Use the oscilloscope to check for any high frequency instability especially on negative half cycles at full or near full output. This will manifest itself as a clear "thickening" of the trace. If there is any, then add the 68 pF ceramic capacitor (C3) across R4. Simply solder it across the pads on the underside of the pc board.

This cured the instabilities in the only two unstable ones out of the 50 or so amplifiers I have built so far. In those two, the main cause was too-long power supply leads, but the capacitor completely cured the problem.

If you wish, you can fit C3 as a matter of course and for peace of mind. If you're going to add the RC series network (Figure 6) on the amplifier's output, the components should be soldered directly to tracks 3 and 4, using very short leads, one end of each on each track, joining the other leads in "mid air".

If you've decided to add the Zobel network on the output (Figure 7), L1 should be made up of two layers of 10 turns each of 1.0 mm diameter enamelled copper wire (20 turns total) on a 10-14 mm diameter former (piece of wooden dowel or P24 potcore bobbin). This coil, and its parallel resistor, should be mounted close to the module so that lead length between coil and module is kept to a minimum. The resistor may be rated at ½ or 1 W.

Since all is well, you can now plug in those eagerly awaiting speakers and CD player and enjoy the fruits of this midget-size, big performance beast!

Bridge operation

You can bridge two modules together to give twice the output power. Figure 2 shows the interconnections. In this mode you must raise the output impedance to 16 Ω or lower the supply voltage to ±22 V if an 8 Ω speaker is used.

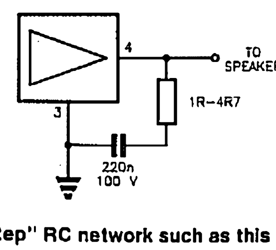


Figure 6. A "series step" RC network such as this is useful in ensuring amplifier stability, but not essential. The resistor should be rated at 1 W and the capacitor should be a low inductance metallised polyester (MKT) or polypropylene (MKP) type.

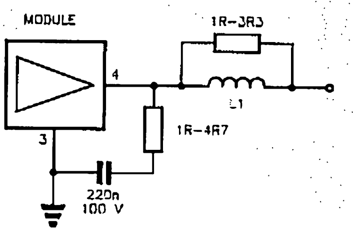


Figure 7. The traditional "Zobel" network employing a coil (L1) is another means of ensuring amplifier stability under widely varying circumstances. The text gives practical details.

Your power supply transformer (or transformers) must be rated to deliver at least twice the current specified above for a single module. Heed the earlier advice about the use of heavy duty hookup wire when wiring-up bridged modules.

70/100 V line operation

The module will happily drive a 70/100 V PA line transformer if you wish to use the module in a public address system. There are a number of suitable multi-tapped PA line transformers available from retailers.

The Arista LMT4 is one suitable low-cost type; it's rated at 20 W, so your module would have to be run at lower output to suit, otherwise the Arista LMT11, rated at 35 W, is the type to choose. Altronics stocks two similar transformers, the M1120 rated at 20 W and the M1122 rated at 40 W.

Whatever transformer you chose, the module's output (tracks 3 and 4) should be connected to the line transformer's 8 Ω primary connections. From experience, the module exhibited no instability when driving a line transformer at this impedance.

Data Sheet

National Semiconductor Corporation

LM1875 20 Watt Power Audio Amplifier

General Description

The LM1875 is a monolithic power amplifier offering very low distortion and high quality performance for consumer audio applications.

The LM1875 delivers 20 watts into a 4Ω or 8Ω load on ±25V supplies. Using an 8Ω load and ±30V supplies, over 30 watts of power may be delivered. The amplifier is designed to operate with a minimum of external components. Device overload protection consists of both internal current limit and thermal shutdown.

The LM1875 design takes advantage of advanced circuit techniques and processing to achieve extremely low distortion levels even at high output power levels. Other outstanding features include high gain, fast slew rate and a wide power bandwidth, large output voltage swing, high current capability, and a very wide supply range. The amplifier is internally compensated and stable for gains of 10 or greater.

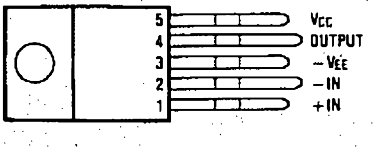
Features

- Up to 30 watts output power
- A_{VO} typically 90 dB
- Low distortion 0.015%, 1 kHz, 20 W
- Wide power bandwidth 70 kHz
- Short circuit protection
- Thermal protection with parole circuit
- High current capability 3A
- Wide supply range 20V-60V
- Internal protection diodes
- 94 dB ripple rejection
- Plastic power package TO-220

Applications

- High performance audio systems
- Bridge amplifiers
- Stereo phonographs
- Servo amplifiers
- Instrument systems

Connection Diagram

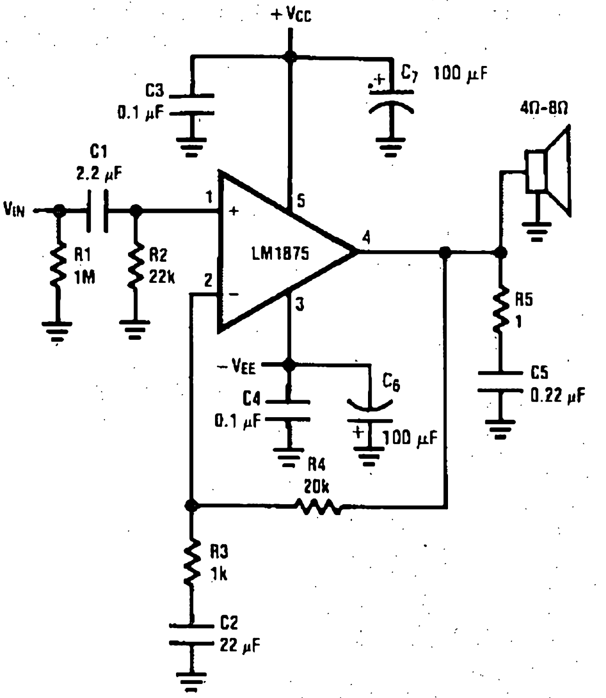


TL/H/5030-1

Front View

LM1875T

Typical Applications



We would like to acknowledge the assistance of NSW National Semiconductor distributor, Geoff Wood Electronics, who provided the information and permission to publish the details presented in this data sheet.

Absolute Maximum Ratings

Supply Voltage	60V
Input Voltage	$-V_{EE}$ to V_{CC}
Operating Temperature	0°C to + 70°C
Storage Temperature	−65°C to + 150°C
Junction Temperature	150°C
Power Dissipation (Note 1)	30W
Lead Temperature (Soldering, 10 seconds)	260°C

Electrical Characteristics

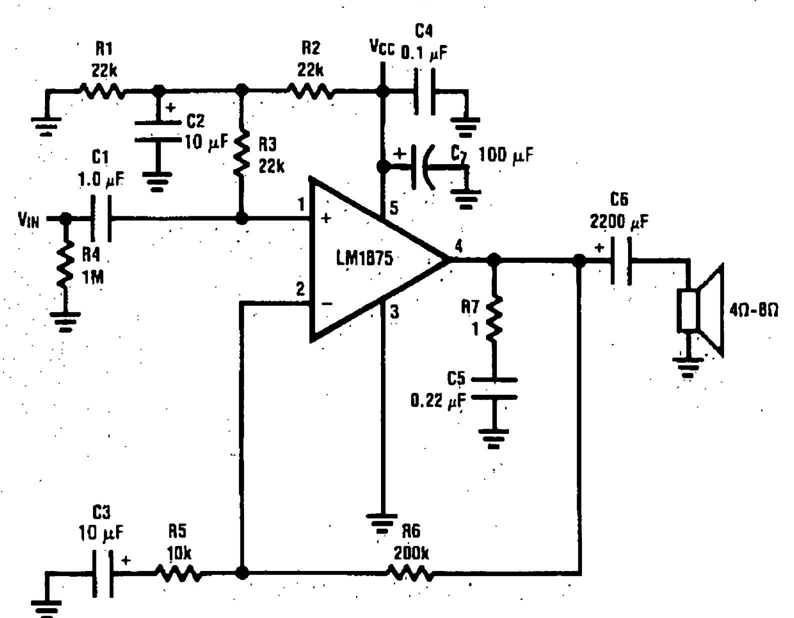
$V_{CC} = +25V$, $-V_{EE} = -25V$, $T_{TAB} = 25°C$, $R_L = 8\Omega$, $A_V = 20$ (26 dB), $f_o = 1$ kHz, unless otherwise specified.

Parameter	Conditions	Typical	Tested Limits	Units
Supply Current	$P_{OUT} = 0W$	70	100	mA
DC Output Level		0		V
Output Power	THD = 1%	25		W
THD	$P_{OUT} = 20W$, $f_o = 1$ kHz	0.015		%
	$P_{OUT} = 20W$, $f_o = 20$ kHz	0.05	0.4	%
	$P_{OUT} = 20W$, $R_L = 4\Omega$, $f_o = 1$ kHz	0.022		%
	$P_{OUT} = 20W$, $R_L = 4\Omega$, $f_o = 20$ kHz	0.07	0.6	%
Offset Voltage		±1	±15	mV
Input Bias Current		±0.2	±2	μA
Input Offset Current		0	±0.5	μA
Gain-Bandwidth Product	$f_o = 20$ kHz	5.5		MHz
Open Loop Gain	DC	90		dB
PSRR	V_{CC}, 1 kHz, 1 Vrms	95	52	dB
	V_{EE}, 1 kHz, 1 Vrms	83	52	dB
Max Slew Rate	20W, 8Ω, 70 kHz BW	8		V/μs
Current Limit		4	3	A
Equivalent Input Noise Voltage	$R_S = 600\Omega$, CCIR	3		μVrms

Note 1: Assumes T_{TAB} equal to 60°C max. For operation at higher tab temperatures and at ambient temperatures greater than 25°C, the LM1875 must be derated based on a maximum 150°C junction temperature. Thermal resistance depends upon device mounting techniques. θ_{JC} is typically 2° C/W. See Application Hints.

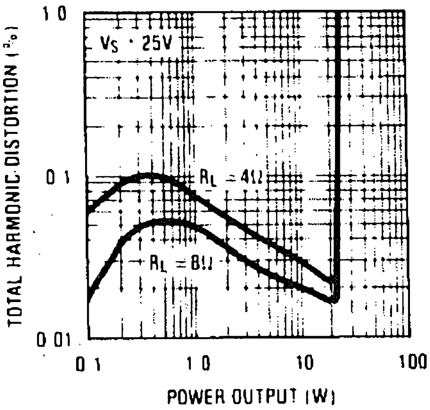
Typical Applications (Continued)

Typical Single Supply Operation

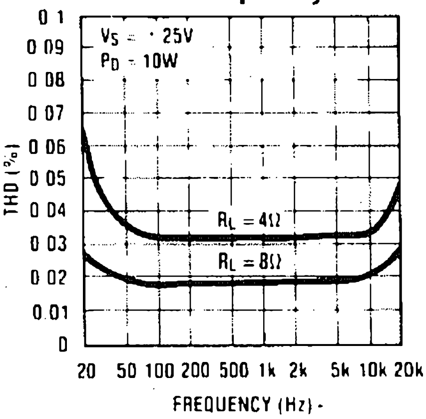


Typical Performance Characteristics

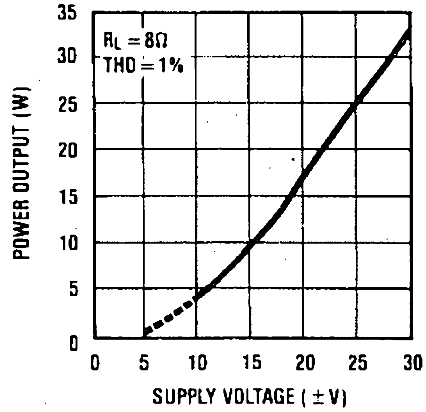
THD vs Power Output



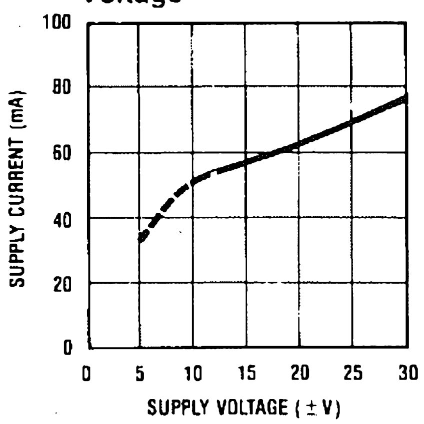
THD vs Frequency



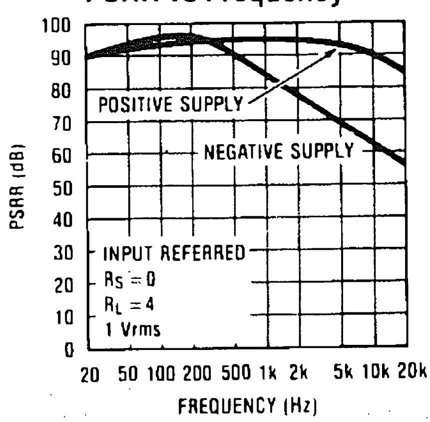
Power Output vs Supply Voltage



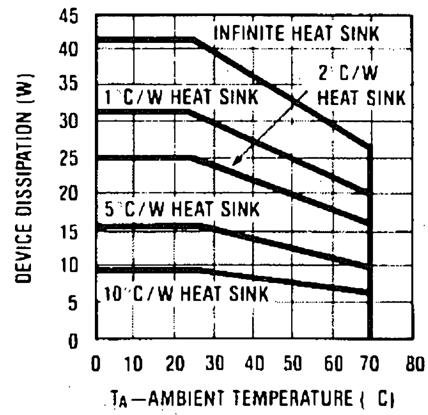
Supply Current vs Supply Voltage



PSRR vs Frequency

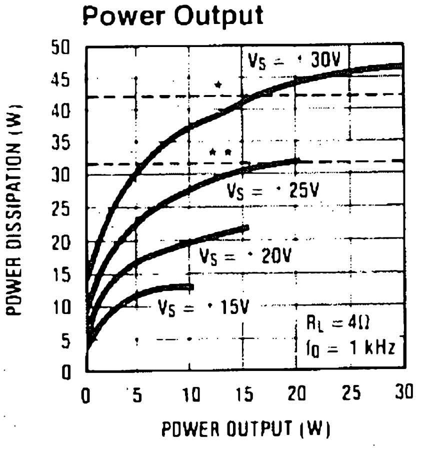


Device Dissipation vs Ambient Temperature†

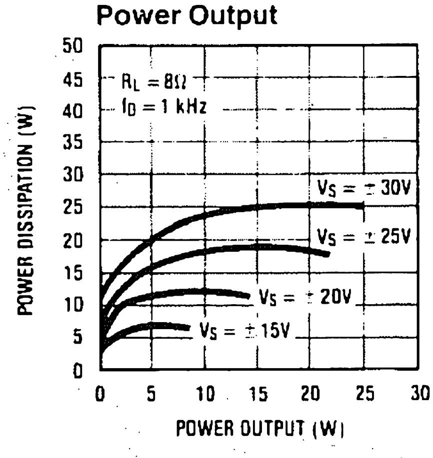


†θINTERFACE = 1°C/W.
See Application Hints.

Power Dissipation vs Power Output



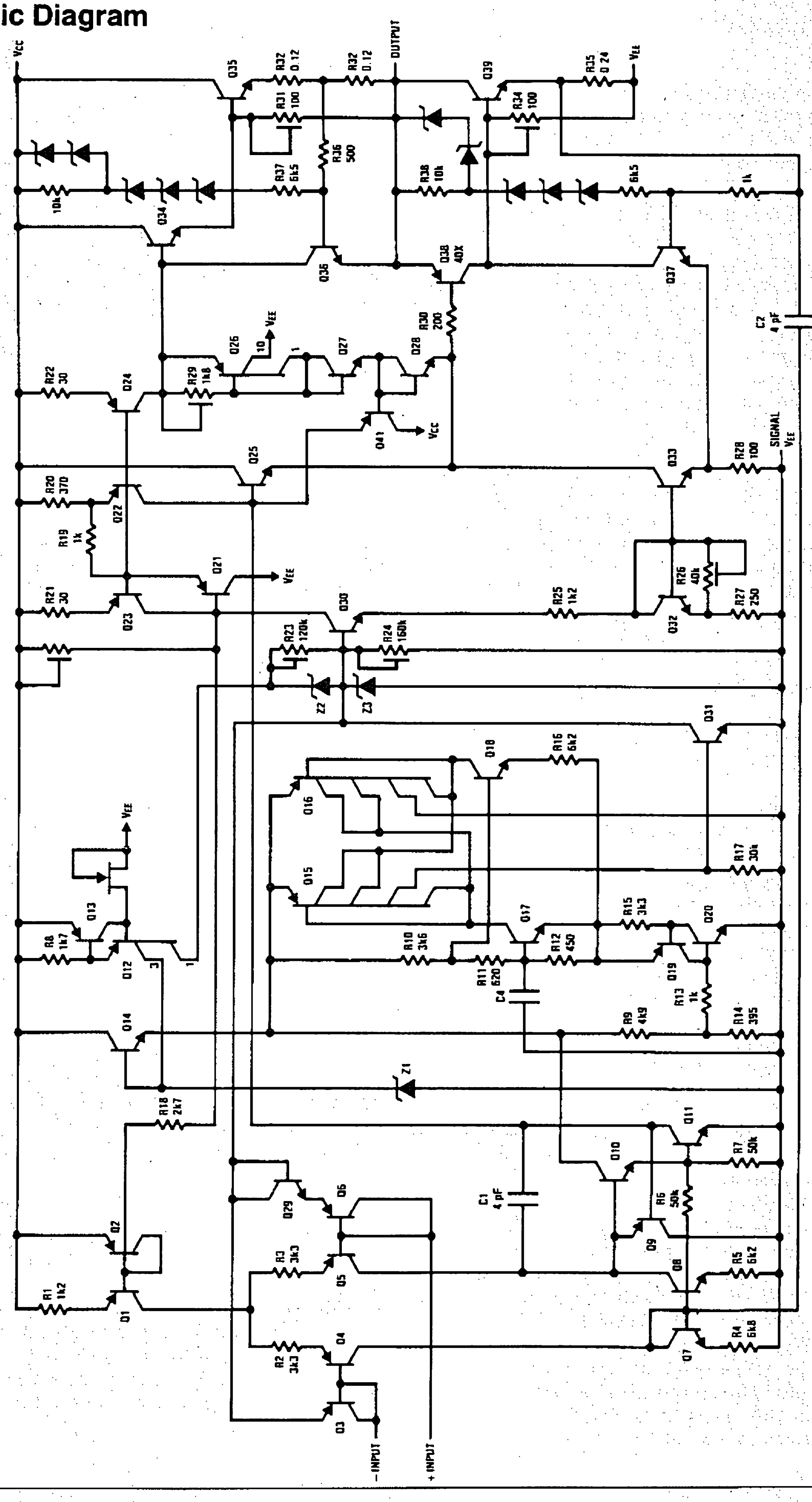
Power Dissipation vs Power Output



*Thermal shutdown with infinite heat sink

**Thermal shutdown with 1°C/W heat sink

Schematic Diagram



Application Hints

STABILITY

The LM1875 is designed to be stable when operated at a closed-loop gain of 10 or greater, but, as with any other high-current amplifier, the LM1875 can be made to oscillate under certain conditions. These usually involve printed circuit board layout or output/input coupling.

Proper layout of the printed circuit board is very important. While the LM1875 will be stable when installed in a board similar to the ones shown in this data sheet, it is sometimes necessary to modify the layout somewhat to suit the physical requirements of a particular application. When designing a different layout, it is important to return the load ground, the output compensation ground, and the low level (feedback and input) grounds to the circuit board ground point through separate paths. Otherwise, large currents flowing along a ground conductor will generate voltages on the conductor which can effectively act as signals at the input, resulting in high frequency oscillation or excessive distortion. It is advisable to keep the output compensation components and the 0.1 μF supply decoupling capacitors as close as possible to the LM1875 to reduce the effects of PCB trace resistance and inductance. For the same reason, the ground return paths for these components should be as short as possible.

Occasionally, current in the output leads (which function as antennas) can be coupled through the air to the amplifier input, resulting in high-frequency oscillation. This normally happens when the source impedance is high or the input leads are long. The problem can be eliminated by placing a small capacitor (on the order of 50 pF to 500 pF) across the circuit input.

Most power amplifiers do not drive highly capacitive loads well, and the LM1875 is no exception. If the output of the LM1875 is connected directly to a capacitor with no series resistance, the square wave response will exhibit ringing if the capacitance is greater than about 0.1 μF. The amplifier can typically drive load capacitances up to 2 μF or so without oscillating, but this is not recommended. If highly capacitive loads are expected, a resistor (at least 1Ω) should be placed in series with the output of the LM1875. A method commonly employed to protect amplifiers from low impedances at high frequencies is to couple to the load through a 10Ω resistor in parallel with a 5 μH inductor.

DISTORTION

The preceding suggestions regarding circuit board grounding techniques will also help to prevent excessive distortion levels in audio applications. For low THD, it is also necessary to keep the power supply traces and wires separated from the traces and wires connected to the inputs of the LM1875. This prevents the power supply currents, which are large and nonlinear, from inductively coupling to the LM1875 inputs. Power supply wires should be twisted together and separated from the circuit board. Where these wires are soldered to the board, they should be perpendicular to the plane of the board at least to a distance of a couple of inches. With a proper physical layout, THD levels at 20 kHz with 10W output to an 8Ω load should be less than 0.05%, and less than 0.02% at 1 kHz.

CURRENT LIMIT AND SAFE OPERATING AREA (SOA) PROTECTION

A power amplifier's output transistors can be damaged by excessive applied voltage, current flow, or power dissipation. The voltage applied to the amplifier is limited by the design of the external power supply, while the maximum current passed by the output devices is usually limited by internal circuitry to some fixed value. Short-term power dissipation is usually not limited in monolithic audio power amplifiers, and this can be a problem when driving reactive loads, which may draw large currents while high voltages appear on the output transistors. The LM1875 not only limits current to around 4A, but also reduces the value of the limit current when an output transistor has a high voltage across it.

When driving nonlinear reactive loads such as motors or loudspeakers with built-in protection relays, there is a possibility that an amplifier output will be connected to a load whose terminal voltage may attempt to swing beyond the power supply voltages applied to the amplifier. This can cause degradation of the output transistors or catastrophic failure of the whole circuit. The standard protection for this type of failure mechanism is a pair of diodes connected between the output of the amplifier and the supply rails. These are part of the internal circuitry of the LM1875, and needn't be added externally when standard reactive loads are driven.

THERMAL PROTECTION

The LM1875 has a sophisticated thermal protection scheme to prevent long-term thermal stress to the device. When the temperature on the die reaches 170°C, the LM1875 shuts down. It starts operating again when the die temperature drops to about 145°C, but if the temperature again begins to rise, shutdown will occur at only 150°C. Therefore, the device is allowed to heat up to a relatively high temperature if the fault condition is temporary, but a sustained fault will limit the maximum die temperature to a lower value. This greatly reduces the stresses imposed on the IC by thermal cycling, which in turn improves its reliability under sustained fault conditions.

Since the die temperature is directly dependent upon the heat sink, the heat sink should be chosen for thermal resistance low enough that thermal shutdown will not be reached during normal operation. Using the best heat sink possible within the cost and space constraints of the system will improve the long-term reliability of any power semiconductor device.

POWER DISSIPATION AND HEAT SINKING

The LM1875 must always be operated with a heat sink, even when it is not required to drive a load. The maximum idling current of the device is 100 mA, so that on a 60V power supply an unloaded LM1875 must dissipate 6W of power. The 54°C/W junction-to-ambient thermal resistance of a TO-220 package would cause the die temperature to rise 324°C above ambient, so the thermal protection circuitry will shut the amplifier down if operation without a heat sink is attempted.

In order to determine the appropriate heat sink for a given application, the power dissipation of the LM1875 in that application must be known. When the load is resistive, the maximum average power that the IC will be required to dissipate is approximately:

$$P_{D(MAX)} \approx \frac{V_S^2}{2\pi^2 R_L} + P_Q$$

where V_S is the total power supply voltage across the LM1875, R_L is the load resistance, and P_Q is the quiescent power dissipation of the amplifier. The above equation is only an approximation which assumes an "ideal" class B output stage and constant power dissipation in all other parts of the circuit. The curves of "Power Dissipation vs Power Output" give a better representation of the behavior of the LM1875 with various power supply voltages and resistive loads. As an example, if the LM1875 is operated on a 50V power supply with a resistive load of 8Ω, it can develop up to 19W of internal power dissipation. If the die temperature is to remain below 150°C for ambient temperatures up to 70°C, the total junction-to-ambient thermal resistance must be less than

$$\frac{150°C - 70°C}{19W} = 4.2°C/W.$$

Using $\theta_{JC} = 2°C/W$, the sum of the case-to-heat-sink interface thermal resistance and the heat-sink-to-ambient thermal resistance must be less than 2.2°C/W. The case-to-heat-sink thermal resistance of the TO-220 package varies with the mounting method used. A metal-to-metal interface will be about 1°C/W if lubricated, and about 1.2°C/W if dry. If a mica insulator is used, the thermal resistance will be about 1.6°C/W lubricated and 3.4°C/W dry. For this example, we assume a lubricated mica insulator between the LM1875 and the heat sink. The heat sink thermal resistance must then be less than

$$4.2°C/W - 2°C/W - 1.6°C/W = 0.6°C/W.$$

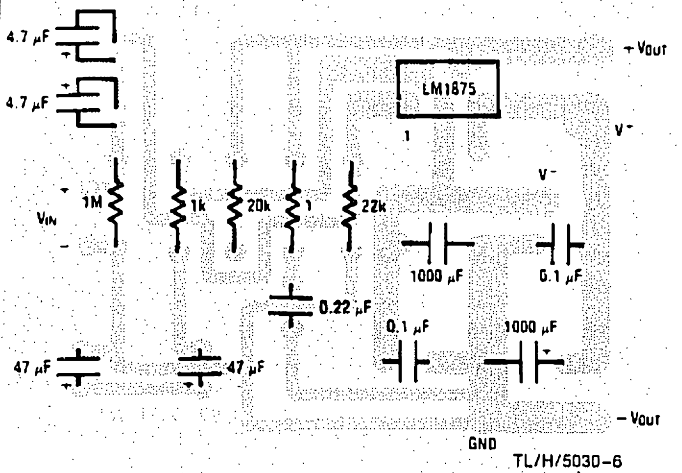
This is a rather large heat sink and may not be practical in some applications. If a smaller heat sink is required for reasons of size or cost, there are two alternatives. The maximum ambient operating temperature can be reduced to 50°C (122°F), resulting in a 1.6°C/W heat sink, or the heat sink can be isolated from the chassis so the mica washer is not needed. This will change the required heat sink to a 1.2°C/W unit if the case-to-heat-sink interface is lubricated.

Note: When using a single supply, maximum transfer of heat away from the LM1875 can be achieved by mounting the device directly to the heat sink (tab is at ground potential); this avoids the use of a mica or other type insulator.

The thermal requirements can become more difficult when an amplifier is driving a reactive load. For a given magnitude of load impedance, a higher degree of reactance will cause a higher level of power dissipation within the amplifier. As a general rule, the power dissipation of an amplifier driving a 60° reactive load (usually considered to be a worst-case loudspeaker load) will be roughly that of the same amplifier driving the resistive part of that load. For example, a loudspeaker may at some frequency have an impedance with a magnitude of 8Ω and a phase angle of 60°. The real part of this load will then be 4Ω, and the amplifier power dissipation will roughly follow the curve of power dissipation with a 4Ω load.

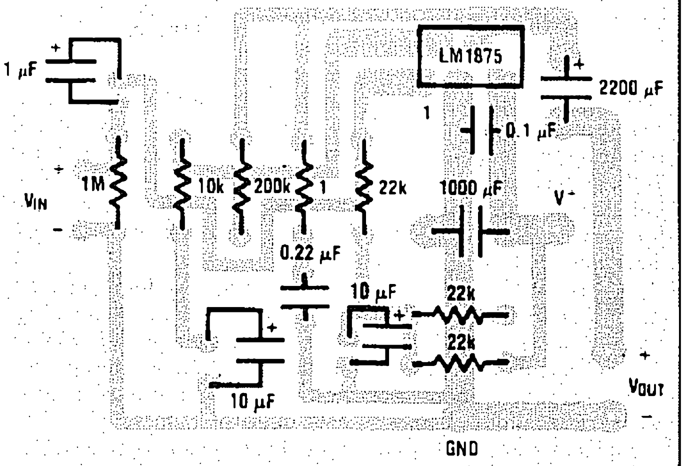
Component Layouts

Split Supply



TL/H/5030-6

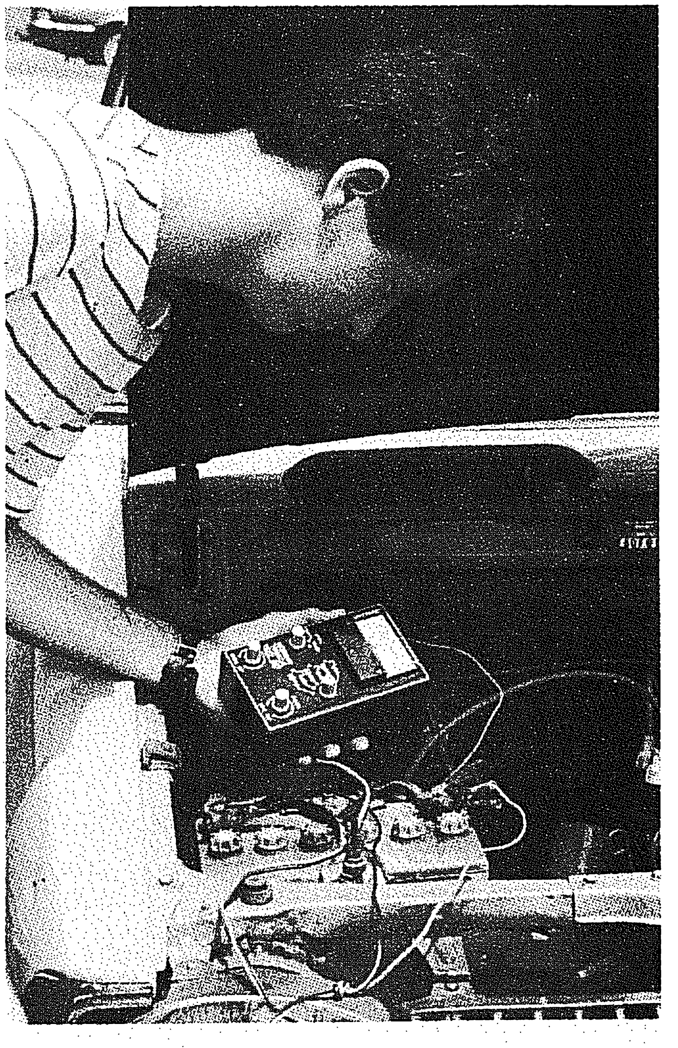
Single Supply



Build this vehicle test set and keep that 'old rattler' on the road

Charles Ray

Older vehicles, while they may offer certain pleasures in terms of appearance and economy, require more maintenance than today's vehicles. That may be part of the pleasure, or part of the pain, of ownership. Either way, this low-cost, simple to build little test set will prove very handy.



UNDOUBTEDLY, one of the attractions of "older" vehicles - sedans, utes, trucks or 4WDs — is their relative simplicity which, given a basic knowledge of mechanics and automotive electricals, permitted (permits!) owners to carry out most straightforward maintenance tasks, given the tools for the job. The required tools for the mechanical jobs are readily available. Any owner of such a vehicle would be well equipped here. But the same so often does not apply to the electrical maintenance side of things. This project aims to correct the balance.

Virtually, the single component on which all older vehicles rely is — *the points!* I know from experience; I have owned a 1960 Mini Minor and, later, an early '70s Volvo! This discussion, and this project, are confined to internal combustion-engined vehicles, diesel types are another matter!

The Kettering ignition system used on internal combustion engines, with spark plugs, coil and points, for all its simplicity, robustness and tolerance of the harsh conditions encountered in the engine compartment, is critically reliant on the points for both reliability and engine performance in general. Regular points maintenance is a must. Electronic ignition systems were first developed to overcome this focus on points maintenance and reliability.

In addition, in engine tuning procedures, the points may be used to provide "signals" of basic engine operating characteristics such as revs, and the "dwell angle" of the points. The latter is a measure of the length of time the points remain closed, supplying current to energise the coil primary, for each revolution of the distributor cam shaft.

Hence, an electrical "tool" to provide a readout or measure of the required parameters is an essential item in the toolkit for older vehicle owners.

LEVEL: We rate this construction project as suitable for:

BEGINNERS

If you've had little or no experience in electronics construction, you should be able to successfully complete this project.

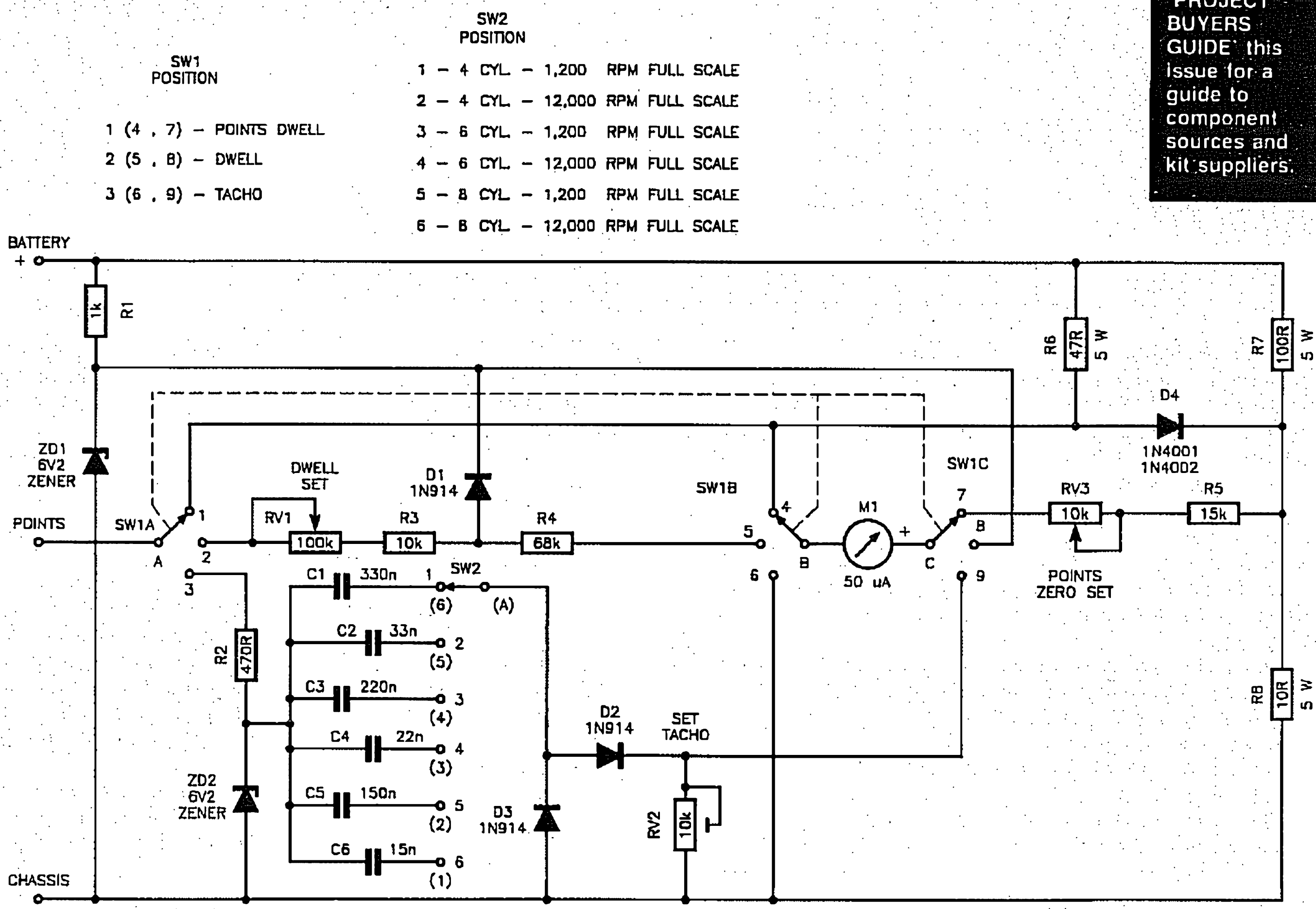
The project

This project incorporates the following:

- a *tachometer* so you can measure engine revs; important when setting the carburettor idle adjustment, timing, etc;
- a *dwell meter* so you can measure the points' dwell angle; important when setting the points gap; and

MAIN CIRCUIT DIAGRAM

See our 'PROJECT BUYERS GUIDE' this issue for a guide to component sources and kit suppliers.



The main circuit diagram. This "puts together" the sections shown in Figures 1, 2 and 5. Switch SW1 is a three-pole, three-position type and is shown here in the "points" position (fully anti-clockwise). The terminal designations relate to the actual switch contact markings, assuming a standard "Lorlin"-type fully-enclosed plastic switch is used. SW2 is a single-pole, six-position switch. The bracketed numbers here refer to the switch terminal markings, again for a Lorlin-type switch. Refer to the overlay.

• a *resistance checker* which is principally useful in measuring points resistance — a telling measure of their "health", but may also be used for checking leads and connections for continuity.

The readout employs a panel meter which, apart from being simple and comparatively low in cost as against a digital display, is ideal for showing varying quantities, which is what you get when tuning up an engine.

Functions are selected by a three position switch, which is seen on the front panel immediately below and to the left of the meter. The tachometer range switch is to the right of this, permitting selection for a 4-, 6-or 8-cylinder engine. Two tacho ranges are provided for each — 1200 rpm and 12 000 rpm. The lower range provides a suitable scale for engine idling revs adjustment.

The dwell scale is calibrated 0-90° and 0-60° for 4-and 6-cylinder engines. For 8-cylinder engines, all you need do is mentally halve the 0-90° scale reading in use. This avoids crowding of the meter scale.

The points function is for measuring the resistance of the points when closed, which will tell you a lot about their condition. It's just a resistance meter that can indicate very low values of resistance, which means you can also use it to check continuity of electrical wiring in the vehicle, particularly chassis connections. The resistance scale is the lowest one of the three and, you will have noticed, it is not calibrated. You don't need to know the *actual* resistance, just whether it's acceptably low, unacceptably high or in that vague area in between.

I have housed the project in a low-cost plastic "zippy" box, which is quite robust enough if you're not careless or over-rough in handling the instrument — which you shouldn't be for the sake of the moving-coil panel meter. It's robust enough to keep with your tools in the boot, if that's what you prefer, but you don't *throw* it in there with them! In any case, I envisage you'd keep the instrument in the garage or the house, for the most part. For a really robust case, use a diecast aluminium box.

All the small components are mounted on a printed circuit board, which gives reliability and simplicity of assembly. The switches, potentiometers and the meter are mounted on the front panel of the box and wired to the pc board with hookup wire. Connections to be made to the vehicle battery, chassis and points are taken on long, heavy duty "flying" leads with "alligator" clips on their ends.

The circuitry

Because the instrument has three functions, with three virtually separate circuits, the meter being switched between them, it's a bit hard to understand at first glance. So, the best way to explain it is to break it into its separate circuits and take them one at a time; tacho, dwell and points resistance.

THE TACHO

A tachometer counts the revolutions of the engine and displays the reading on a meter calibrated in revs per minute. In petrol engines, the input to the tacho comes from the points in the dis- ▷

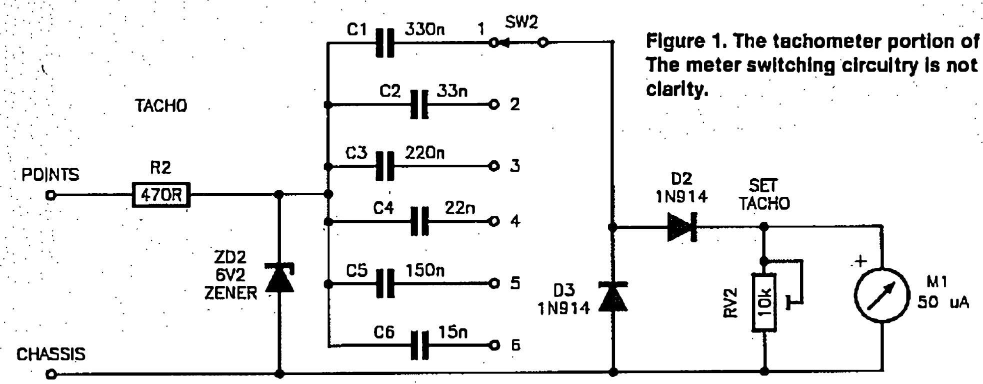


Figure 1. The tachometer portion of the Vehicle Test Set circuit. The meter switching circuitry is not included here for the sake of clarity.

tributor. When the points close, a circuit is completed from the battery positive through the ignition coil to the vehicle chassis and thus back to the battery negative terminal. When closed, there is no voltage across the points. When the points subsequently open, the battery voltage appears across them. That's a necessarily simple explanation, but for this purpose, it's the essence of what happens.

So, as the points open and close, you get a regular series of voltage pulses appearing across them. With increasing engine revs, the points will open and close more frequently, and vice versa. So, the *frequency* of the pulses is a direct measure of engine revs.

The tacho circuit is shown in Figure 1, minus the meter switching. The voltage or amplitude of the pulses that appear across the points is "clamped" or cut to 6 V by a zener diode, ZD2, and this voltage charges a capacitor (C1 to C6) selected by the range switch SW2. Resistor R2 just limits the maximum current through ZD2.

The short charging current pulse through the capacitor also passes through D2, RV1 and the meter, M1. The meter is deflected as the capacitor is charged. When the points close again the capacitor is discharged via R2, back through the points, the chassis and via D3, bypassing the meter.

This process is repeated each time the points open and close — many times a second. As the moving coil meter is slow to respond to the current pulse (because of the pointer's restoring spring and mass of the movement assembly) it cannot display the *peak* value of the current pulses, but rather reads the *average* value of the train of current pulses. In other words, it *fills in* the "spaces" between the capacitor charging current pulses.

As the engine is revved up, the pulse frequency increases and the meter reading increases. As the engine revs slow down, so the pulse frequency decreases as does the meter reading.

In a four-stroke engine, the distributor cam rotates twice each revolution of the engine. A four cylinder engine has four lobes on the cam, or four points openings; a six cylinder engine has six and an eight cylinder engine has eight.

Therefore, the pulse frequency to the tacho will be different for different types of engines. The capacitors C1 to C6 are selected to give the correct full-scale reading for each type of engine.

The circuit can be calibrated by the "trimming" potentiometer RV2 to give the required full-scale meter reading. While the tacho scale on the meter, in conjunction with the range switch, show full-scale readings of 1200 and 12 000 rpm, RV2 has enough range that you can reduce this to 1000 and 10 000 rpm if you wish, but you'll have to re-letter the scale and range switch. Calibration may be done by comparison against an existing tachometer (borrow one!).

DWELL ANGLE

This relates to the rotation of the distributor cam shaft and is a measure of the period for which the points remain closed during one revolution of the cam.

The gap between the points, when open, determines how long the points remain closed — or *dwell* — during rotation of the distributor cam. The narrower the gap, the longer they remain closed during rotation of the shaft, or in other words, they remain closed for a greater angle of one 360° rotation — the dwell angle.

As you well know, the points gap is adjusted by means of a small set screw and must be set accurately for correct timing of the engine and to give the ignition coil sufficient time to energize ready for each spark (which happens when the points open and the current through the coil is interrupted).

The manufacturer's specification for points gap sets the dwell angle fairly accurately when the points are new, but when they become worn, the dwell angle will be incorrect. A measurement of dwell angle is the only really *accurate* way to set the points.

Figure 2 shows the dwell angle portion of the circuit, without the meter switching. The battery voltage is regulated by a 6 V zener diode, ZD2, to provide a steady voltage reference for the metering circuit.

When the points close, current flows through the meter and the series resistors R4, R3, and RV1 to the chassis. The potentiometer RV1 is adjusted for full-scale reading on the meter with the points permanently closed. As the meter reads *average* current, it will accurately display the *ratio* of the time the points are closed to the time they are open, which is a direct measure of the dwell angle.

Diode D1 provides protection for the meter from the substantial negative voltage pulse that appears across the points just as they open, caused by the inductance of the ignition coil primary. Current from this pulse will flow via D1-R3-RV1. D1 will conduct, most of the current flowing through it rather than through R4 and the meter.

The meter calibration is different for each type of engine. A 4-cylinder engine has a maximum of 90° of cam rotation for which the points can be closed (because there are four lobes on the cam and 360° divided by four is 90°). For a 6-cylinder engine, with six lobes on the cam, it is 60°, and for an 8-cylinder engine it is 45° (which is why you can halve the 0-90° scale when measuring dwell on an 8-cylinder engine).

The manufacturer's specification for dwell angle will usually be between half and two-thirds of the maximum time the points can be closed.

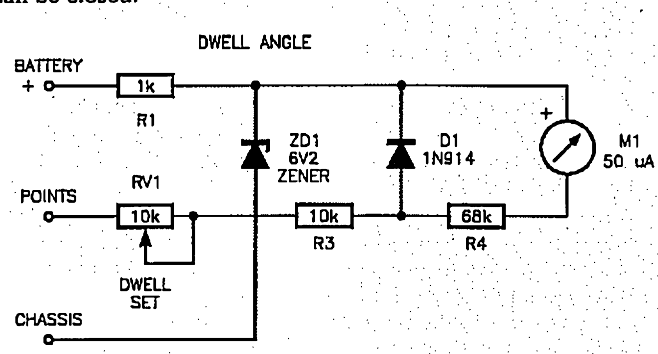


Figure 2. This is the dwell angle section of the circuit, again without the meter switching so it is more easily seen how it works.

POINTS RESISTANCE

As points become warn and dirty, their resistance increases, decreasing the energising current through the coil when the points are closed. For a healthy spark the resistance should be as low as possible and checked *each time* the points are adjusted.

The circuit for points resistance is a Wheatstone Bridge which can accurately measure the ratio of resistance values down to very low resistances. The circuit is an invention of Charles Wheatstone who, along with W.F. Cooke, invented the electric telegraph last century.

The concept of the Wheatstone Bridge is illustrated in Figure 3. There are two "arms", formed by R2-R3 and R1-Rx. Current from the battery will flow down both arms. Let us say R2 is 10 × the value of R3. Thus, the voltage across points C-D will be one-eleventh of the battery voltage (across A-D). Now, if the ratio of R2 is 8 × Rx, the voltage across points B-D will be one-ninth the battery voltage. Thus, the voltage at B, with respect to D, will be *higher* than the voltage at C, and current will flow through the meter.

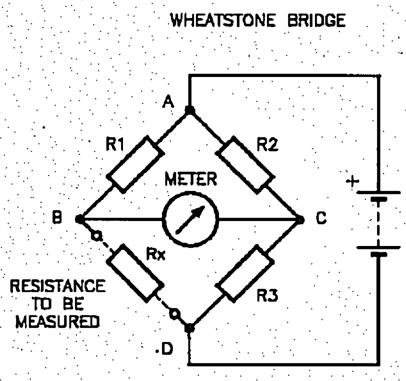


Figure 3. The basic circuit of a Wheatstone Bridge, which is employed in the points resistance section of this project. The text explains how it works.

In a measuring instrument, R1 is a precision variable resistance, or set of switched precision resistors, which you adjust until no current flows through the meter. In this condition, the bridge is said to be "balanced". Rx is then a direct proportion of R1. If R2 equals R3, then Rx equals R1. If R3 is one-tenth the value of R2, Rx is one-tenth of R1. If you want to measure or indicate very low resistance values, then the latter arrangement is a convenient one; which is why it has been used here!

Figure 4 shows the points resistance section of the circuit, minus the meter switching, arranged in Wheatstone Bridge fashion. As R7 is 100Ω and R8 10Ω, the bridge is balanced when the points resistance (or whatever you have it connected to) is one-tenth of R6; as R6 is 47Ω, the meter will read zero when the points resistance is 4.7Ω.

When the points resistance is *less* than 4.7Ω, the meter needle is deflected; full-scale is zero resistance. The meter is adjusted for full-scale deflection by RV3 when the leads to the points are shorted together. The diode, D4, protects the meter by "shunting" current past it if the points resistance is greater than about five Ohms. Otherwise, the meter starts to read "backwards.

Figure 5 shows this portion of the circuit, much as it appears in the main circuit diagram.

Assembling your Test Set

Construction of the project is quite straightforward if you follow an orderly sequence. If you've bought the project as a kit, first lay out and identify all the components — see that you

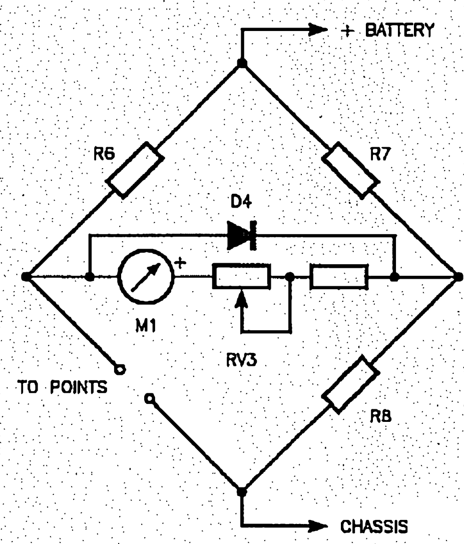


Figure 4. The points resistance section of the circuit, arranged Wheatstone Bridge fashion. You can readily relate this to Figure 3.

have everything! Even if you've bought all the components individually, you should do this.

Start with the printed circuit board. See that all the holes are drilled and are of the correct diameter, particularly those for resistors R6, R7 and R8. Check also the holes for the leads going to the battery and chassis, which should be a larger diameter than most of the component holes. Likewise, with RV2. If you have to drill-out any holes, use a drill bit slightly larger than the appropriate component lead and drill from the *copper* side. Carefully remove any burrs. If, or when, you're satisfied all's OK, put the board aside, we'll get back to it shortly.

Check that there are no small "fingers" of copper between closely-spaced track and pads on the board. A sharp hobby knife is ideal for removing offenders.

The potentiometers and switches may have shafts rather longer than required. Determine how much shaft is required to secure the knobs, clamp the excess length in a vise and cut through the shaft at the predetermined point. File the rough edges.

Now tackle the front panel of the box. Note that there are two ▷

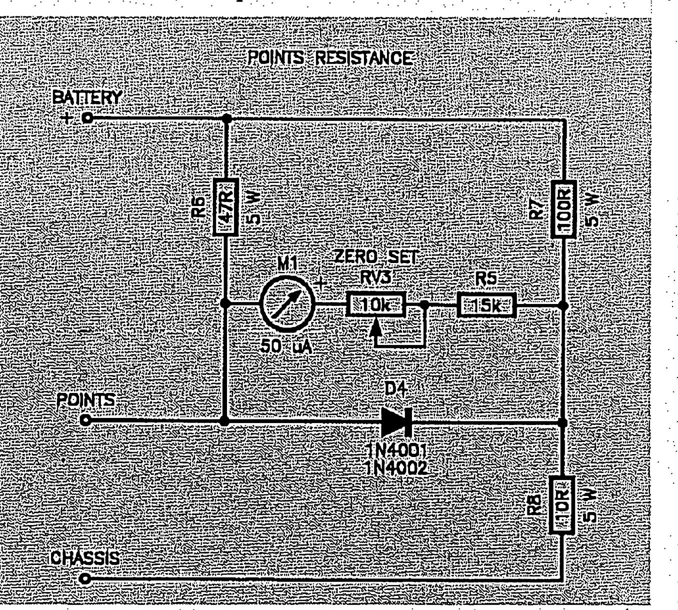
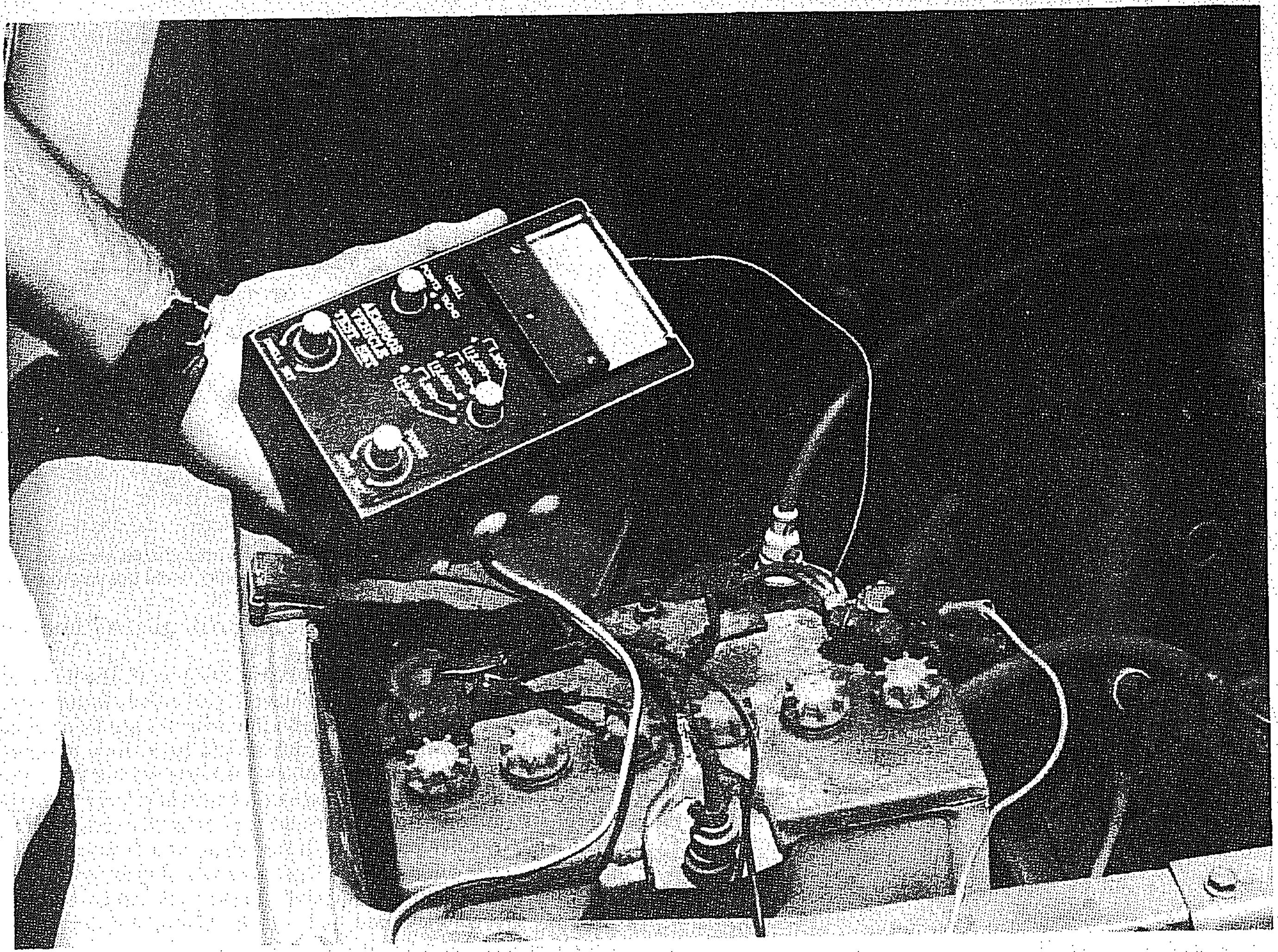


Figure 5. Here's the points resistance section of the Vehicle Test Set, arranged in more conventional fashion, much as it appears in the main circuit diagram.



"options" for the front panels of commonly available utility boxes: a plastic panel, made of the same material as the box, or an aluminium plate. The choice is yours. Use the front panel artwork reproduced here as a template to mark out all the hole centres. Use a centre punch or other sharp point to stop the drill bit wandering. For the 9 mm pot. and switch holes, drill a small (say, 2-3 mm) "pilot" hole first, then use successively large drills, finishing off with a hole reamer.

The meter hole can be drilled with a hole saw if your case has a plastic panel, or you can drill a series of holes just inside the circle and break out the inner piece. Use a half-round or rat-tail file to smooth the edges. The front panel artwork here has been drawn to suit the MU-45 meter. If you use an ST-670 meter, the box it comes in has a handy template — the part the meter sits in! Use that to mark out the cutout and mounting bolt holes.

You'll need to drill a hole (6.25 mm or ¼" is adequate) in one side or end panel of the box, for the flying leads to the battery, chassis and points. Put the rubber grommet in this hole to avoid chafing the insulation of the leads.

Your front panel can be "dressed" with a Scotchcal label (Scotchcal is a 3M product); if you bought a kit, this may be supplied, or the front panel may be screen printed as per our artwork. You can buy the necessary equipment to make your own Scotchcal label from some electronics retailers. There are two types — aluminium and plastic. The aluminium type is more durable, but costs more. Suit yourself. The "front" surface is sensitised and you transfer the image of the front panel artwork using a simple "photographic" process.

Whatever, when applying a Scotchcal label, there's a trick to it. The label has an adhesive back, covered in a special paper for protection during handling. The glue is water soluble, so the trick is to soak the panel in a shallow pan of water for 10-20 minutes before applying it. When the label is ready for application, use a sponge to squeegee some water onto the front panel. Then take the label from the water, carefully peel off the backing and put the Scotchcal in position. Used dry, you only get *one chance* to position your Scotchcal correctly.

The completed project provides for measurement of points resistance, engine revs and points dwell. It is housed in a common plastic "utility" box. A panel meter with a new scale is used for readout.

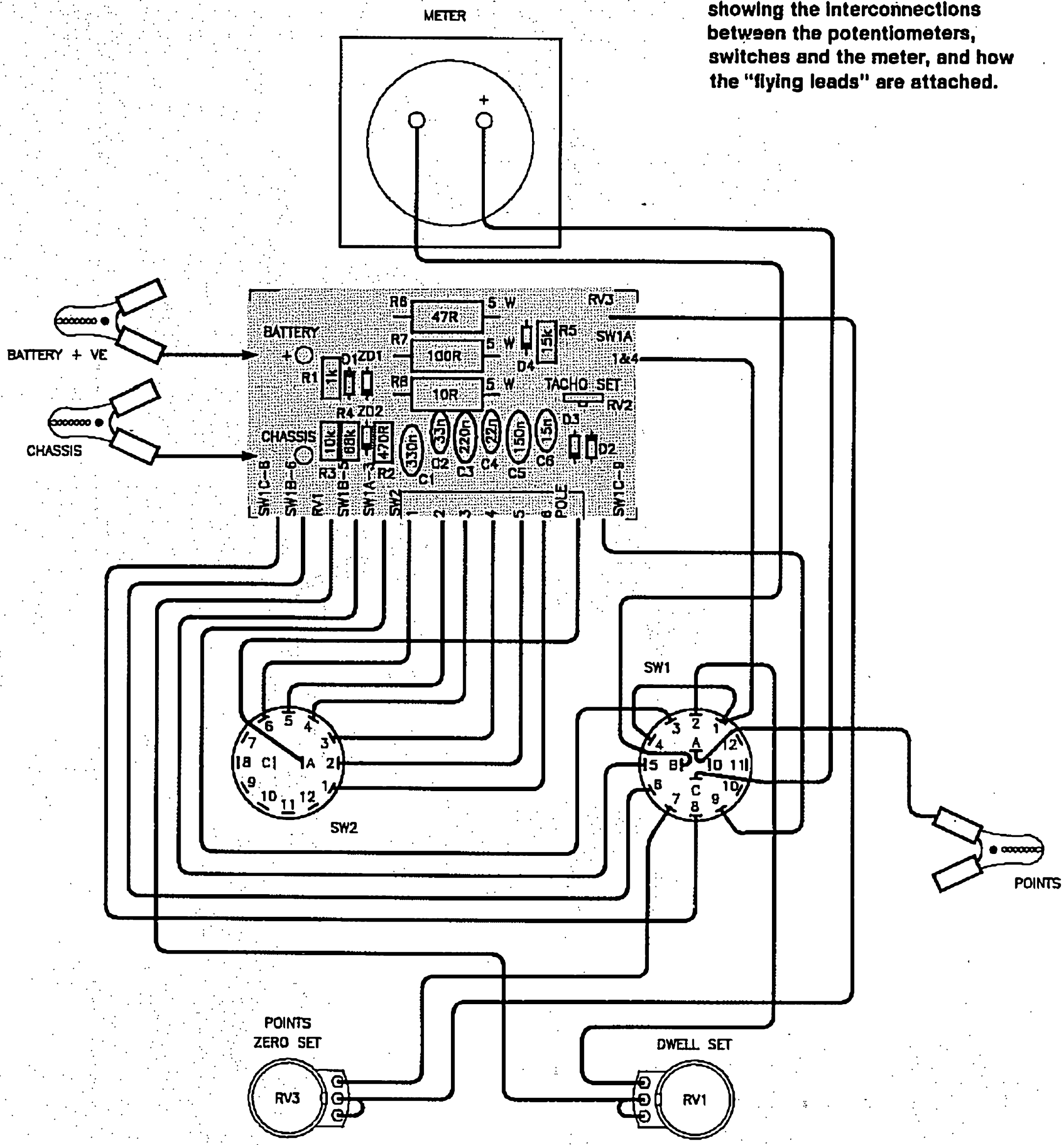
The water allows you to "slip" it accurately into place. Smooth the label down with the sponge, rubbing from the middle outwards, to push any bubbles to the edge. Set it aside to dry. Once dry, you can cut out the Scotchcal where it covers the holes using a sharp hobby knife or scalpel. Take care, so as not to damage the Scotchcal and spoil the appearance.

The new meter scale can be attached now. Carefully take off the meter front to expose the scale and movement. Two small screws hold the scale in place. Carefully undo these and slip the scale out, taking care not to bump the needle.

Attach the new scale. This may be Scotchcal, or you can photostat the scale printed here (use the one to suit your meter) and paste it that in place. Replace the scale in the meter, again taking care not to bump the needle. Reassemble the meter front.

Now you can assemble the switches, two pots and the meter to the front panel. The meter goes on last to reduce any likelihood of damage during handling. You will notice it has a small clip shorting the meter's terminal posts. Leave this on until you wire it in, it's for the meter's protection. Take care when tightening the securing nuts on the switches and pots, so that you don't spoil the Scotchcal. You will need to temporarily slip the knobs on the shafts to properly orientate the controls before tightening the nuts.

Wiring diagram for the project, showing the interconnections between the potentiometers, switches and the meter, and how the "flying leads" are attached.

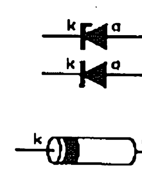


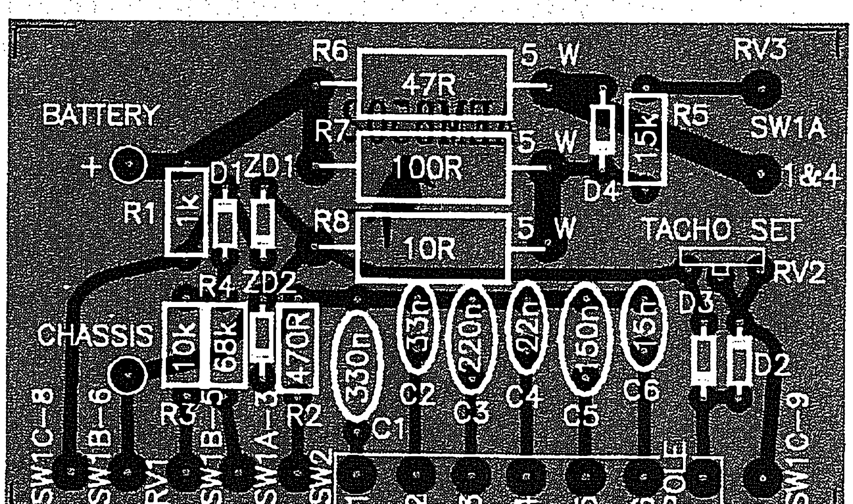
AEM8502 PARTS LIST

Semiconductors	
D1, D2, D3	1N914, 1N4148
D4	1N4001, 1N4002, etc.
ZD1, ZD2	6V2, 400 mW or 1 W zener diodes
Resistors	all 1/2 W, 5% unless noted
R1	1k
R2	470R
R3	10k
R4	68k
R5	15k
R6	47R, 5 W
R7	100R, 5 W
R8	10R, 5 W
RV1	100k linear pot.
RV2	10k vert. mtg trimpot.
RV3	10k linear pot.
Capacitors	
C1	330n greencap
C2	33n greencap
C3	220n greencap
C4	22n greencap
C5	150n greencap
C6	15n greencap
Miscellaneous	
M1	50 µA panel meter (MU-45 or ST-670)
SW1	4-pole, 3-position rotary switch
SW2	1-pole, 3-position rotary switch

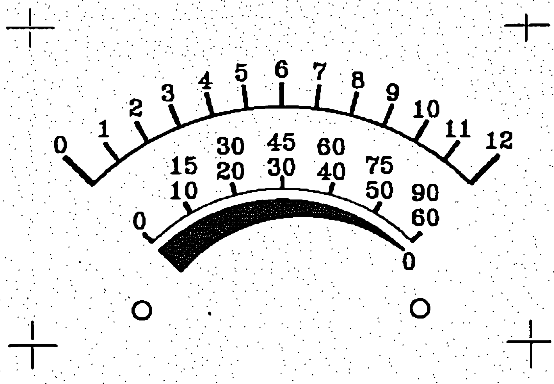
AEM8502 pc board; "zippy" box to suit — 160 x 90 x 50 mm, or near size; two to three metres of light duty hookup wire (10 × 0.12 mm); heavy duty hookup wire (23 × 0.2 mm), get three lengths (about 1.5-2 m) of different colour insulation; Scotchcal front panel and meter scale; three "large" or "giant" size alligator clips; one rubber grommet; double-sided sticky pad to secure pc board in the case; solder, etc.

Estimated cost: $38-$44

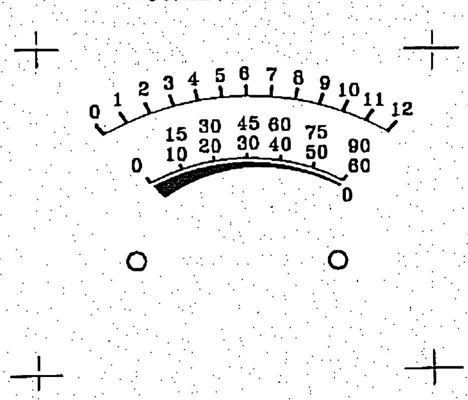




Component overlay diagram for the printed circuit board, showing placement of the components. Take care you get the four diodes (D1, 2, 3, 4) and the two zener diodes (ZD1 and ZD2) the right way round. Resistors R6, R7 and R8 are high power (5 watt) types and will get warm during use. Mount them a few millimetres above the board by putting a matchstick beneath them when you solder them in place. This will allow air to flow around them in use. All the other components may be mounted down on the board.

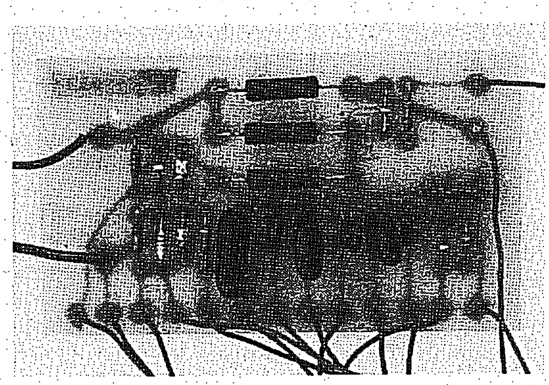


SCALE FOR ST-670

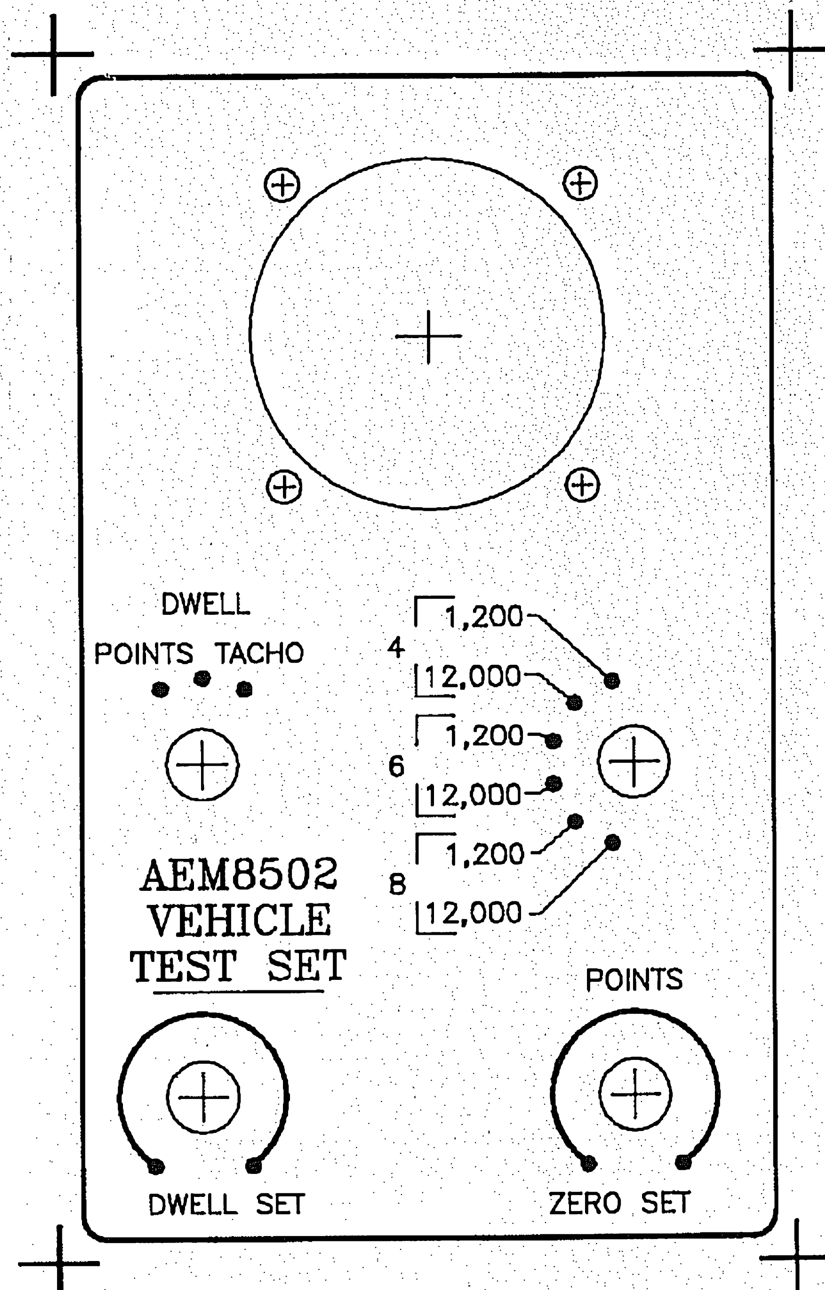


SCALE FOR MU-45

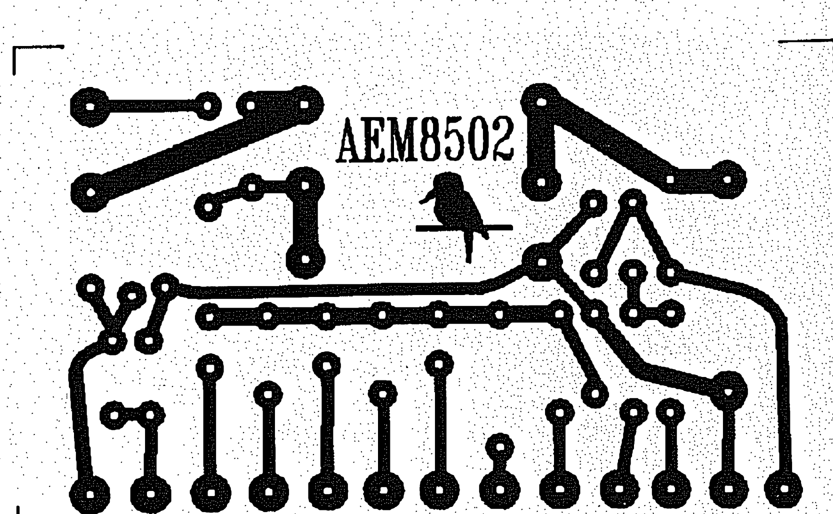
Full-size artwork for the meter scales to suit the Minipa type MU-45 and SEW type ST-670 meters.



View of the completed printed circuit board.



Full-size artwork for the front panel. This suits a standard plastic "zippy box", 160 x 90 x 50 mm.



Full-size artwork for the pc board.

Solder the components into the printed circuit board next. The component overlay diagram shows their placement. Start with the four diodes, D1 to D4, and the two zener diodes, ZD1 and ZD2. Carefully bend their leads by holding them with a small pair of needle-nose pliers just where the lead enters the diode's body. Take care you put all the diodes in the right way round, or your Test Set won't work as expected when you first try it out.

Next, solder the three large power resistors, R6-R7-R8, in place. Sticky-tape a couple of matchsticks to the board beneath where the resistor bodies will go. Bend their leads using small needle-nose pliers on the body side of the lead where you're bending it. Then put the resistors in place one by one and solder their leads to the pads. Slip the matchsticks out after the last of these resistors is soldered in place.

Fit the "trimpot", RV2, next and solder in place. Complete the pc board by soldering the rest of the resistors and capacitors in place. With the resistors, use the same principle to bend the leads as explained for the diodes.

Now, using the wiring diagram, cut suitable lengths of hook-up wire — 150 mm is a good length — and wire-up the switches and pots to the pc board. *Take it one lead at a time* and mark off each one on the wiring diagram as you do it, using a fluorescent marker pen. Take care you don't wire the meter back to front! Terminal C of SW1 goes to the meter positive; there will be a "+" symbol embossed on the meter's case adjacent to the meter's positive terminal.

Last of all, attach the flying leads. These require to be at least "heavy duty" insulated hookup wire, comprising 23 strands of 0.2 mm tinned copper wire. It's a good idea to use wires having different insulation colours, so they're more readily identified. I used the traditional red for the battery positive lead, black for the chassis lead and yellow for the points lead. You might splurge and get special, super flexible "test lead" wire. It's more expensive, but easier to handle.

Pass the flying leads through the grommeted hole in the box, tie a knot on the inside to prevent any pulling on the leads breaking the connections inside the unit, then attach the alligator clips.

Now make a *thorough* check of everything (don't forget to take the shorting clip from the meter's terminals!). Correct any mistakes. Temporarily assemble the case (leave the pc board loose inside for the moment). You're ready for a test run!

First tests

You will need to use a source of 12-14 volts (dc!) for this; your vehicle battery's ideal, but you may wish to use a small "bench" power supply capable of delivering up half an amp, for convenience if you have it.

Try the points resistance function first. Set SW1 to the "points" position. Take the flying leads and connect your "battery" lead to the positive terminal of your 12 V battery or power supply, and the "chassis" lead to the negative terminal. Turn the "points set zero" control fully anticlockwise. If you're using a power supply, you will notice that, during this test, the project will draw about 400 mA of current.

Now take the "points" flying lead and clip its alligator clip to the "chassis" lead's clip. The meter needle will move to the right hand end of the scale. Adjust the zero set control and you'll be able to set the meter needle on the resistance scale's zero, which is the right hand end of the scale. If you don't get these indications during this test, disconnect the project and look for a fault in the wiring or pc board assembly.

Now, leaving things as they are, turn the "dwell set" control fully anticlockwise, then switch SW1 to "dwell". The meter needle will give some reading well up the scale. Adjust the dwell set knob so that the meter reads full-scale. Again, if this doesn't behave as expected, disconnect the project and look for assembly faults.

To check out the tacho function, you'll need to fire-up your vehicle's engine.

Adjust the "tacho set" trimpot to centre position. With the engine running at idle, connect-up your project's chassis and battery leads, set SW1 to "tacho" and hook up the "points" lead's alligator clip to the points terminal on the distributor or ignition coil (mind the fan!). Set SW2 to suit your engine, choosing the low (1200 rpm) range and switch to tacho. You should get a reading on the meter.

If either of these tests don't go as described, disconnect the project and check for a wiring or pc board assembly error.

When you've got your Test Set going to this stage, you can calibrate the tacho scale.

Tacho calibration

You can calibrate it using the tacho in a friend's late-model vehicle which sports a tacho, providing the engine's the same; e.g: if yours is a 4-cylinder engine, your friend's should be the same. The calibration will differ slightly for 4-, 6-and 8-cylinder engines. Or, you can take the project to your friendly local garage and ask if you can calibrate it against what instruments they may have for measuring rpm.

However you do it, calibrate the project on the 1200 rpm range. Just adjust the "tacho set" trimpot RV2 so that the meter reads full-scale when the reference tacho reads 1200 rpm.

USING YOUR TEST SET

It's an easy instrument to use. Although operation is generally self-evident, let's go through the steps so as to avoid any pitfalls.

POINTS RESISTANCE

To check points resistance, the engine must be stopped, hand brake on, gears in neutral and the ignition off. Hook up the Test Set: "chassis" clip to a convenient point on the coil support or distributor, "battery" clip to the battery positive terminal. Short the "points" clip to the "chassis" clip and adjust the "points zero set" to zero the meter (RH side of the scale, remember!). Then attach the "points" clip to the points terminal on the distributor. You may not get a reading; turn the motor over by hand until the points close.

The meter needle should be over to the right hand end, in the last fifth of the scale, if the points are in good condition. If the needle reads half-scale, your points need cleaning or replacing.

You can check the resistance of joints and leads which run to chassis using the "points" clip at the "far" end of a lead, but note that it should not be part of a circuit which is energised while you're taking the reading.

TACHO

With the engine running, just hook up the "chassis" clip to a convenient connection to the chassis, say on the coil support, and the "points" clip to the points terminal on the distributor. Set the tacho range switch to suit your engine and the range you wish to measure, and read the revs from the top meter scale.

You multiply the reading by 100 for the 1200 rpm range and by 1000 for the 12 000 rpm range.

DWELL

Set up this measurement as described for the "points resistance". Switch SW1 to "dwell" and hook up the "points" clip to the points terminal on the distributor. Close the points by turning over the motor, if need be. Adjust the "dwell set" control to zero the meter.

Start the motor and the Test Set will show a reading for dwell.

AEM Project 3515

A low-cost amateur colour TV transmitter

Part 2

Bob Reid VK3AWL
Howard Rider VK3ZJY

This month we get down to the business of construction and alignment, tackling the exciter, the wavemeters, the video and audio boards.

SIMPLICITY is the essence of this project; it helps ensure repeatability. While it has been designed to be simple to assemble, we urge that you follow the procedures set down here to ensure success.

However, before proceeding, let us clear up a few errors and omissions concerning the circuits published in Part 1, which are listed in the accompanying panel.

Constructing the RF probes

Start with the easy bits! The RF probes are the most easily built items and should present no problems. Note that Probe 1 is not tuneable and is purely to detect the exciter oscillator in operation. Probes 2 and 3 are tuneable and the initial trimmer settings shown in the accompanying diagrams approximately identify where they should tune. Although not exact, these positions are near enough to prevent any ambiguity with other harmonic output — which is most unlikely to occur with this exciter design.

After measurable output has been achieved when tuning the exciter, the tuning on Probes 2 and 3 can be peaked if it is felt necessary.

Build each probe separately by mounting all components on the respective board as shown in the component overlay diagrams here. All the component leads are fully pushed through the pc board with as little lead length above the board as possible; the component's bodies sit on the board. Make sure you get the OA91 diode the right way round.

Solder a couple of flying leads (red and black) on the end of

LEVEL: We rate this construction project as suitable for constructors of:

INTERMEDIATE

experience, between beginners and experienced constructors, with experience in building a number of projects of differing complexity.

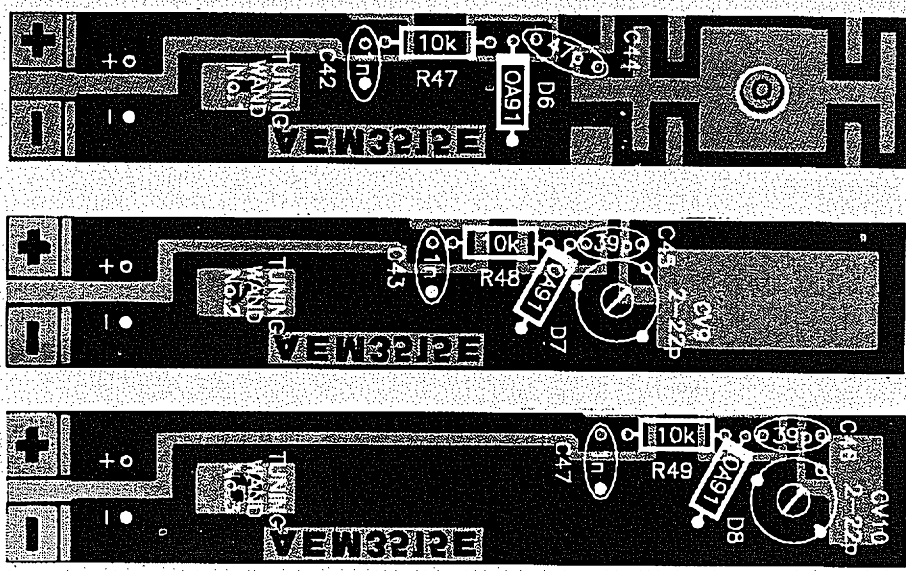


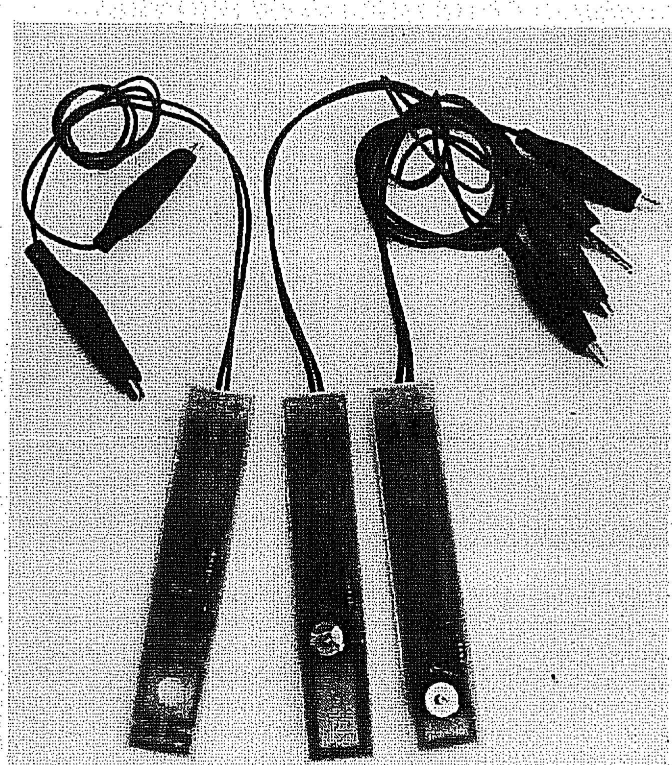
Figure 1. Component overlay diagrams showing parts placement on each of the RF probe pc boards.

each probe where the polarities are shown (red positive, black negative, is the convention). Add an alligator clip to the end of each lead — these will connect to your multimeter leads when testing the exciter. Preset the trimmers on Probes 2 and 3 by setting them to the positions as shown on Figure 2.

The probes are now ready to use. Put them aside until the exciter has been completed and is ready to be aligned. These probes are great pieces of test gear and they are usable for many other amateur radio applications.

The exciter board

This is the board that requires the greatest attention to detail on the part of the constructor and the authors *plead* that the constructional details be *fully read* before building is commenced. In the worst case this will be boring but it is more likely that following the construction details will ensure a neat trouble-free



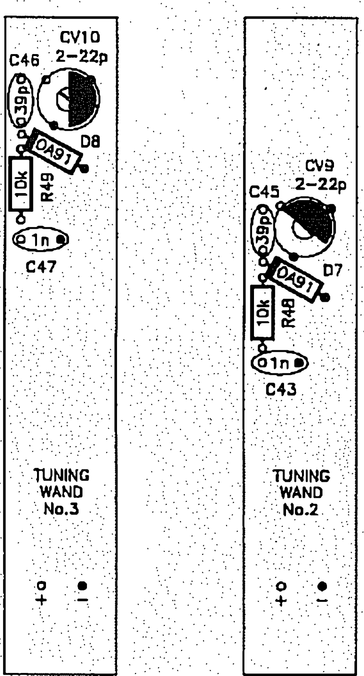
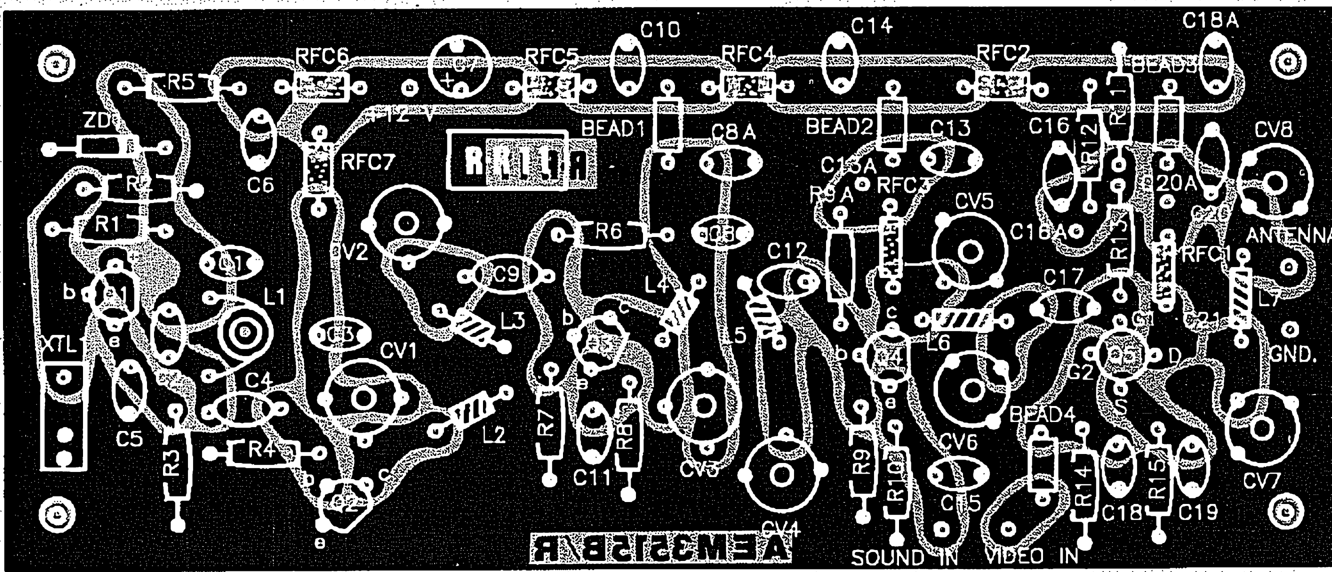


Figure 2. Trimmer settings for pre-tuning RF Probes 2 and 3.

exciter that works exactly as it should. Only a multimeter is needed for tuning to produce the vital 70 cm output.

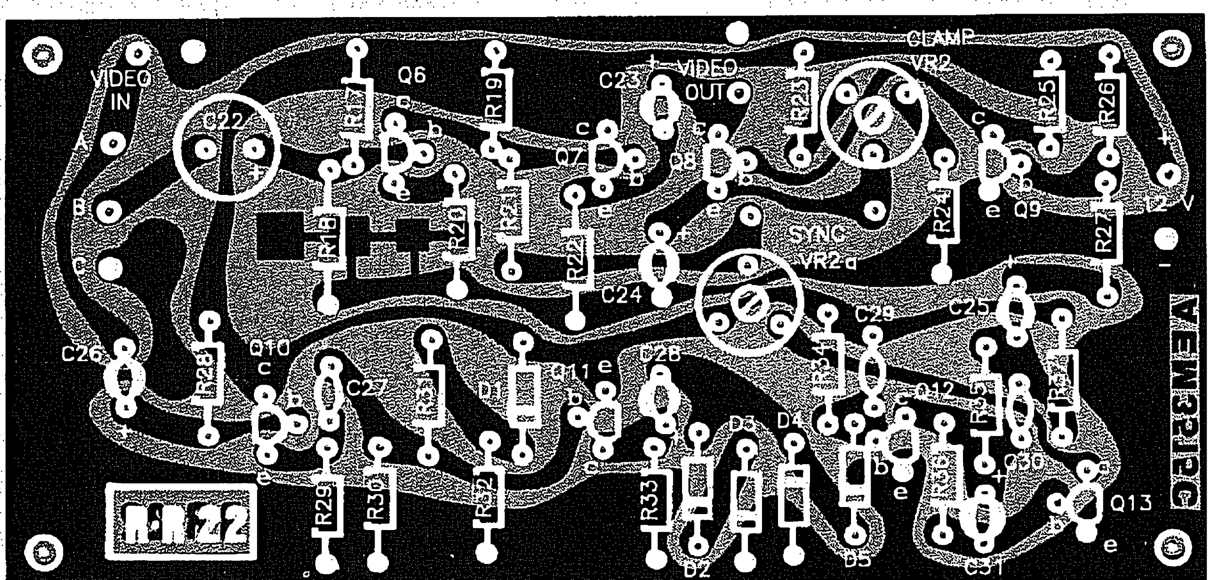
While it is critical that it be done correctly, the board is quite easily constructed. The wavemeter probes make it simple to tune up for maximum power on the correct frequency. One thing we omitted to mention in Part 1 is the use of ceramic "chip" capacitors as UHF bypasses in parallel with C13, C16 and C20, and for the output dc blocking capacitor, C21. These have no leads and a construction which reduces self-inductance to an absolute minimum, very necessary at these frequencies. (See *Component Considerations in VHF and UHF Construction*, by Roger Harrison VK2ZTB, AEM Feb. '88, p.72).

Give the board a thorough visual check first. Make sure all holes are drilled and of the right diameter to fit the components. Note that the component side of the board is a "groundplane", with holes to clear component leads that pass through to the track side. Some component leads will have to be soldered on both sides of the board, in which case there's no clearance hole in the copper on the component side of the board. ▷



△ **Figure 4. Component placement for the exciter board. The orientation for transistors Q1 to Q4 are for PN3563 types. Check the pinouts for other types as they will be different.**

▽ **Figure 6. Component overlay diagram for the video module. Note the b-c-e orientation for the transistors. Compare these with the pinouts of your types if they differ (see the panel showing transistor pinouts). Also note which way round the diodes are placed. The points marked A B C connect to the video gain control.**



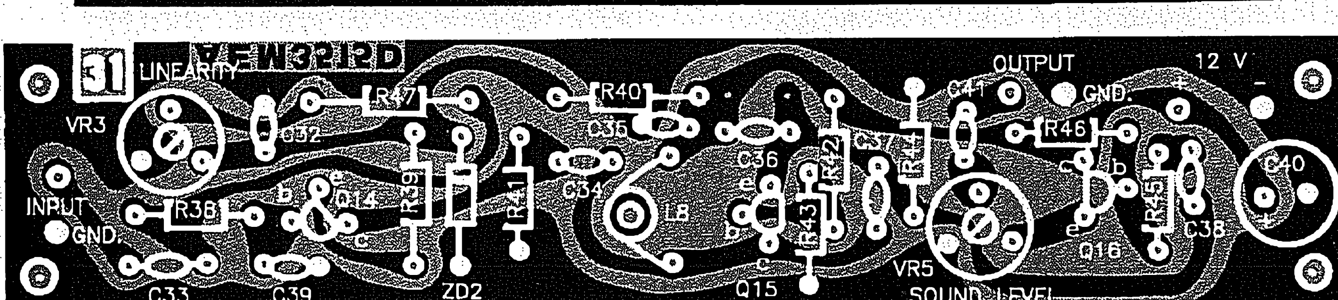


Figure 7. The sound module pc board component overlay. Note that the transistor b-c-e connections are for 2N types. Note that there are extra holes adjacent to C37 on the board for a capacitor to be parallelled with C37 should the oscillator not come within range.

The first step in assembly is to solder in the chip capacitors - see Figure 3(a) for the position of these components. Start by tinning around the edges of holes A, B, and C on top and underneath the board. Also, tin either side of gap D.

Lay the board component side down on a flat surface with a white sheet of paper beneath it. The chip capacitors come in an envelope. Open it and empty the capacitors onto the sheet of white paper — this is to make them easy to see as they are quite tiny. Note that they have an area of solder on each "end" — these are the connections.

Place one of the capacitors in hole A, one "end" up, and sol-

AEM3515
COLOUR ATV TRANSMITTER
EXCITER BOARD
AEM3515B

Semiconductors

Q1	PN3563
Q2	PN5363
Q1, 2, 3, 4	PN3563
Q5	BF960

Resistors all ¼ W, 5%

R1	10k
R2	1k8
R3	390R
R4	15k
R5	330R
R6	22k
R7	2k2
R8	220R
R9	2k2
R10	220R
R11	39k
R12	100k
R13	220k
R14	22k
R15	27R

Capacitors

C1	1n ceramic
C2	22p ceramic
C3	1n ceramic
C4	8p2 ceramic
C5	15p ceramic
C6	1n ceramic
C7	10u/25 V tant.
C8, C8A	1n ceramic
C9	4p7 ceramic
C10	1n ceramic
C11	100p ceramic
C12	8p2 ceramic
C13, C14	1n ceramic
C15	56p ceramic
C16	100n ceramic
C17	39p ceramic
C18	47p ceramic
C19	150p ceramic
C20	1n ceramic
C13A, C16A, C20A, C21	1n ceramic chip capacitors
CV1-CV8	2-22p Philips film trimmers

Miscellaneous

AEM3515B pc board; coil winding wire; Neosid 5 mm former with F29 slug; ten FX1115 beads; crystal to suit output frequency; length of RG178 Teflon dielectric coax.

Cost: $97

(inc. Tuning Wands)

VIDEO BOARD
AEM3515C

Semiconductors

Q6	2N3646
Q7	BC183
Q8, Q9, Q10	BC548
Q11	BC557
Q12, Q13	2N3904
D1-D5	1N4148, 1N914

Resistors all ¼ W, 5%

R16	330R *
R17	4k7
R18, R19	820R
R20	100R
R21	10k
R22	750R
R23	2k2
R24	470R
R25	2k2
R26	22k
R27	2k2
R28	10k
R29	1k
R30	1M
R31	22k
R32, R33	1k
R34	27k
R35	470R
R36	10k
R37	330R
VR1	500R log. pot (front panel control)
VR2	1k hor. trimpot
VR2a	5k hor. trimpot

* not on board

Capacitors

C22	220u/16 V RB electro.
C23	2u2/16 V RB electro.
C24	47u/16 V RB electro.
C25	4u7/16 V RB electro.
C26	10u/16 V RB electro.
C27	100n greencap
C28	4u7/16 V RB electro.
C29	56p ceramic
C30	220p ceramic
C31	2u2/16 V RB electro.

Miscellaneous

AEM3515C pc board.

Cost: $39

SOUND BOARD
AEM3515D

Semiconductors

Q14	2N4249
Q15, Q16	2N3564
ZD2	9V1 zener

Resistors all ¼ W, 5%

R38	10k
R39	5k6
R40	330R
R41	56k
R42	33k
R43	22k
R44	1k
R45	5k6
R46	10k
VR3	20k hor. trimpot
VR4	1k log. pot (front panel control)
VR5	1k hor. trimpot

Capacitors

C32	10n ceramic
C33	47n ceramic
C34	220p ceramic
C35	1n ceramic
C36	220p dipped mica
C37	150p dipped mica
C38	220p ceramic
C39	330p ceramic
C40	470u/16 V RB electro.
C41	10n ceramic

Miscellaneous

AEM3515D pc board; 5 mm Neosid former with F29 slug.

Cost: $29

TUNING WANDS
AEM3515E

Semiconductors

D6, 7, 8	OA91

Resistors all ¼ W, 5%

R47, 48, 49	10k

Capacitors

C42, 43, 47	1n ceramic
C44	47p ceramic
C45, 46	39p ceramic
CV9, CV10	2-22p Philips film trimmer

Miscellaneous

AEM3515E pc boards (3); hookup wire (red and black); three black-insulated and three red-insulated alligator clips.

See our 'PROJECT BUYERS GUIDE' this issue for a guide to component sources and kit suppliers.

TRANSISTOR IDENTIFICATION

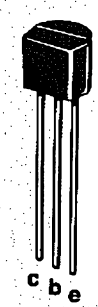
Although there are 16 transistors used in the complete ATV transmitter, these are of only nine different types. It is important to verify that the transistors supplied are the ones listed on the circuit drawings.

However, because of component shortages, a transistor of the 2N variety may be replaced by another with a different prefix but with the same suffix figures. For instance, a transistor type 2N4249 may be replaced with another marked PN4249. In such a case, the actual transistors are identical BUT, the pinouts are reversed — the centre pins (base) are in the same place but the outer pins (c — e) are swapped. In this case the transistor must be turned around 180° before inserting it into the board. If there is ever a doubt, keep in mind that the connections as written on the circuit board layouts are correct.

Mention is made of this every time a description of pc board assembly includes transistor placement. The pin layout of each of the semiconductors used (and their possible substitutes) are given below.

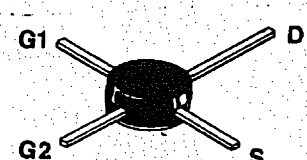
If transistors other than those listed are used, the b-c-e lead identification as per the pc board layouts should be used as a reference.

TRANSISTOR PINOUTS



2N3563 BC182
2N3564 BC183
2N3646 BC548
2N4249 BC557
PN3904

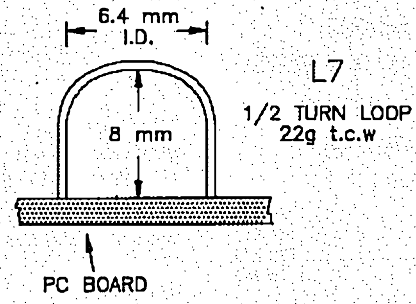
2N3904
PN3563
PN3564
PN3646
PN4249

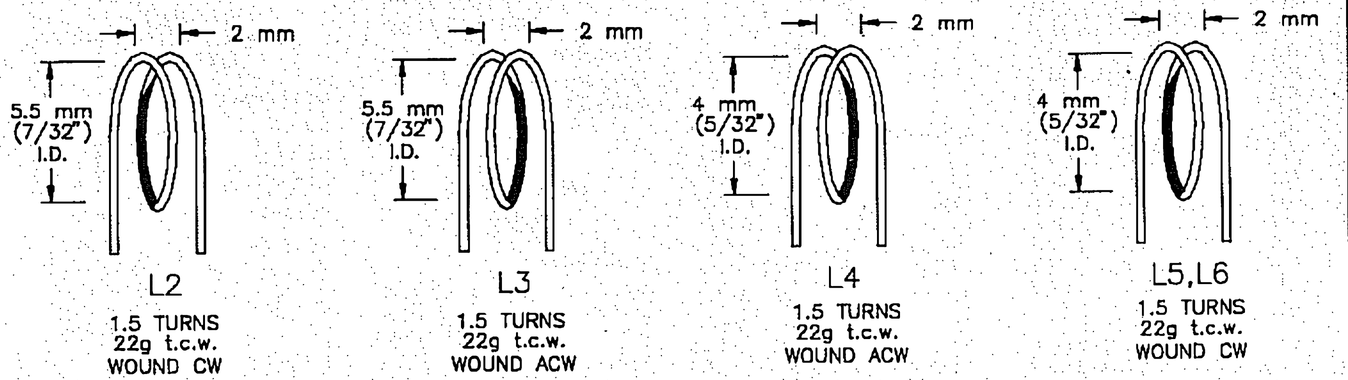


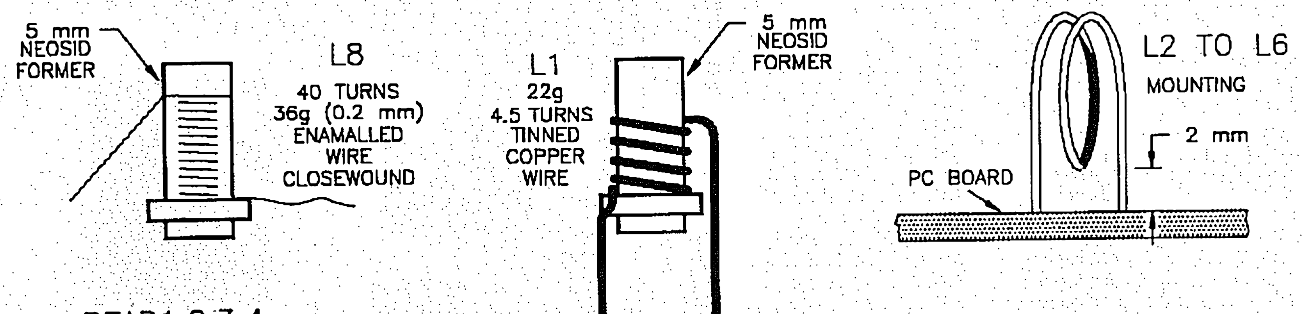
BF960
(viewed from beneath)
Writing on other side

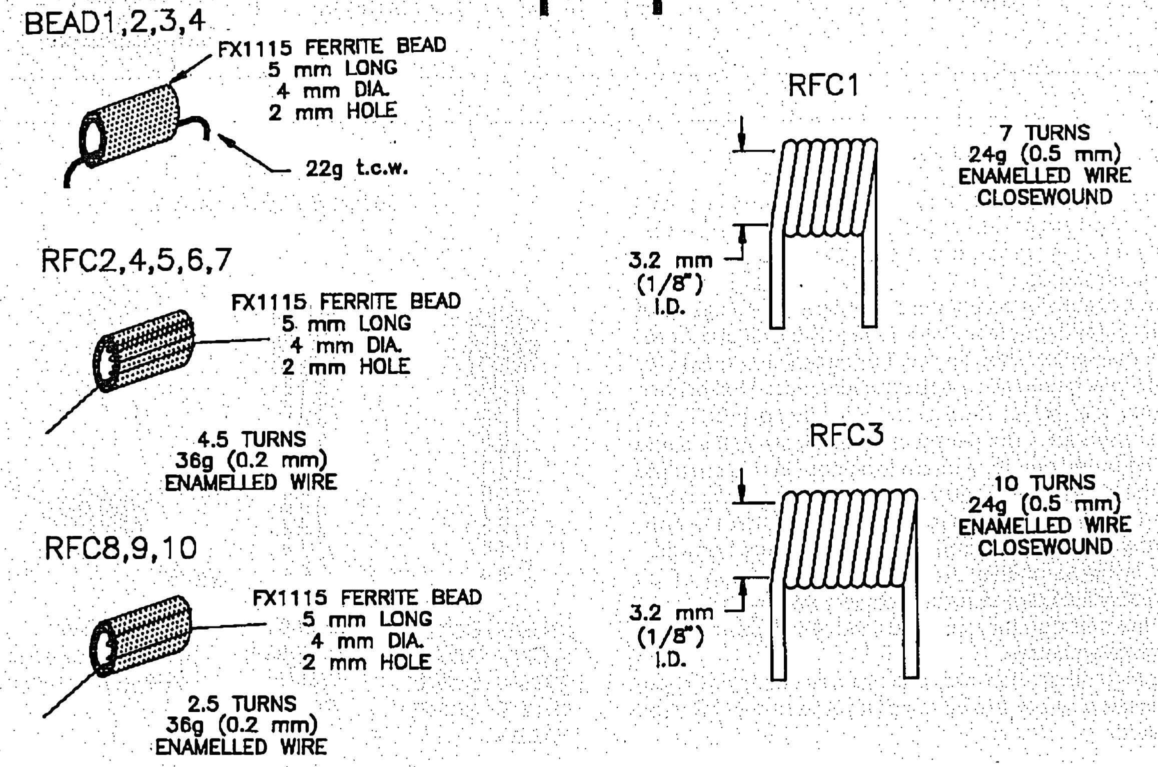
COILS, RF CHOKES AND BEADS

Coils L2 to L6, plus RFC1 and RFC3 are wound on a suitable former – a drill shank is ideal! – and then slipped off. They are self-supporting. Take care to spread the turns of L2 to L6 as shown and keep them 2 mm above the board when mounted. When winding RFC2, RFC4 and RFC5 to RFC10 on the beads, pass the wire through the centre hole, then around the outside and back through the centre hole to make each turn.









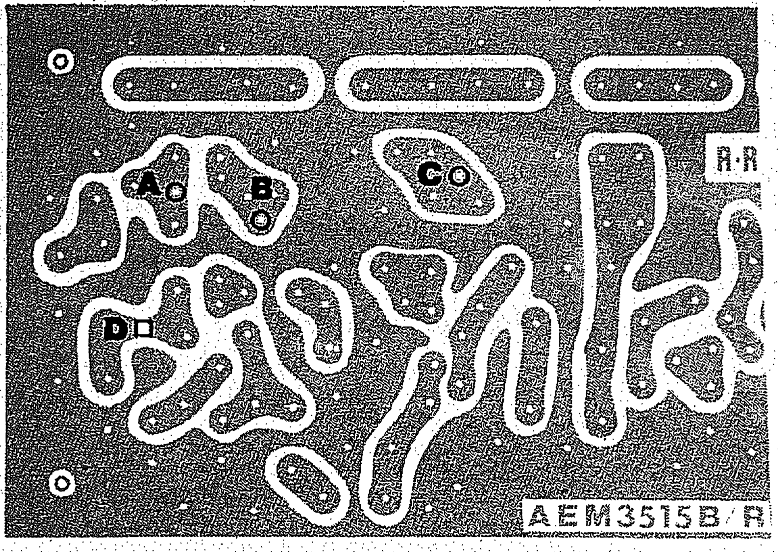


Figure 3(a). Where the ceramic chip capacitors are placed.

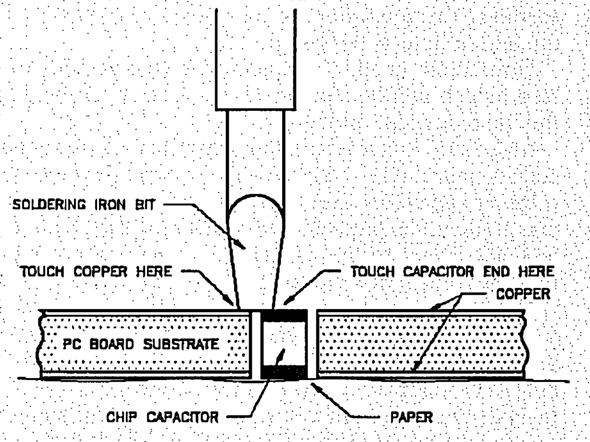


Figure 3(b). here's how you solder the chip capacitors in place, with the exception of C21 which is laid across the gap at D.

der the visible side to the board. Use a fine-tipped iron for this. Proceed likewise with holes B and C. Note: When soldering, make sure that the heat is applied to both the capacitor's "end" and the board — see Figure 3(b) — and only use as much solder as is needed to make a positive joint. The main point to avoid is solder running down the hole and shorting the top and bottom of the board. That would prove disastrous.

Now turn the board over and solder the capacitors on this side of the board using the same technique with the application of heat (this is a normal technique when soldering at any time, but it is worth emphasising here because of the fine work).

When this work has been completed, check with an ohmmeter between top and bottom of the board to verify that there are no shorts across the capacitors. If there are, find and repair it (or them) carefully using a solder sucker. Take care not to damage the chip capacitor.

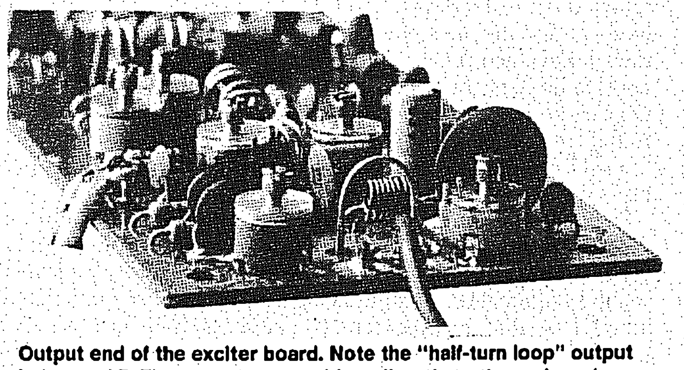
Place the board, component side down, on the paper and position the remaining chip capacitor across gap D. Lay a screwdriver (or something similar) on the capacitor to hold it in place — or, if possible, have someone else hold it in place while solder is applied. When soldered, check with an ohmmeter to verify that there is no short across it.

Having completed installation of the chip capacitors, the next stage is to mount all the other components. It is suggested that this be carried out in the following order. Note the positions by referring to Figure 4 (component overlay). NOTE: Transistors Q1 to Q4 are PN3563 types.

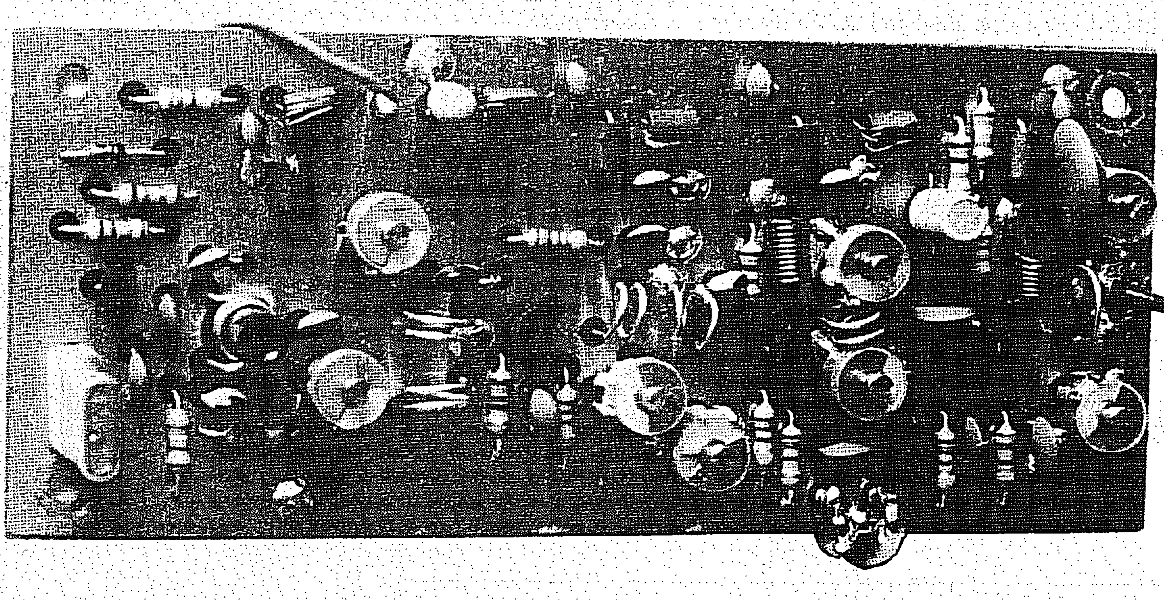
Firstly, install all the resistors. Push these down so that their bodies are flush with the board. Two safeguards that will pay dividends in terms of neatness and accuracy are:

(1) to measure each resistor with an ohmmeter before installing it, and

(2) face all resistors in the same direction so that the colours can be easily read without continually turning the board around. ▷



Output end of the exciter board. Note the "half-turn loop" output inductor, L7. The output coax solders directly to the pc board.



Topside view of the exciter board. The coils, RF chokes and trimmer capacitors are all clearly seen. Notice the crystal in the bottom left hand corner and the output coax leading from the centre of the right hand side of the board.

Whilst not essential, for any resistors that have one side earthed, it is good practice to solder the earthed side on both top and bottom of the board.

Now solder in all the capacitors. Leave one end of C12 (8p2) free, which will be connected to L5, so it can be joined when the inductors are installed.

Make sure that the tantalum capacitor, C7, is connected with correct polarity, i.e: with negative to earth. It is essential that all trimmer capacitors that have one side earthed have the earth tags soldered on both sides of the board. Take care not to apply too much heat to the capacitors, or to prolong the soldering time, so as to avoid damaging them.

Take the 0.5 mm enamelled wire and the ferrite beads. Wind these as shown in the accompanying inductor assembly diagrams and install them in positions RFC2, RFC4, RFC5, RFC6 and RFC7. Now wind chokes RFC1 and RFC3, as shown, and install them. These are "air wound" and self-supporting, and need to be mounted about 2 mm above the board surface.

With all the above chokes, make sure that the ends of the wires have been scraped clean and are tinned before finally soldering in position.

Now make up Beads 1, 2 and 3 using short lengths of 22 gauge tinned copper wire passed through the remaining ferrite beads. Bend the wires carefully else you risk breaking the beads. Solder them in place as indicated on the overlay diagram.

The transistors and zener diode are next to be installed. Verify the polarity of the zener diode. Check that the transistors are inserted in the correct positions and around the right way. The accompanying panel on transistor identification and pinouts will assist you. Verify there placement against the overlay diagram and again be particularly careful of the differences between the 2N and PN variety. The overlay diagram specifies which one the board is designed for. If the semiconductors you have are not the ones mentioned on this diagram, be careful to make allowance for it. Note that the leads for the BF960 (Q5) need to be bent *down* (writing on the case uppermost). Do this very carefully, to avoid damaging the leads or straining the internal connections.

Installation of the remaining inductors is almost the last operation, but it does require careful work.

Wind L1 on the Neosid former and stick this assembly in place, preferably with "Super Glue". Araldite or some other form of epoxy resin is fine but it takes longer to dry and there will be a temptation to continue before it dries. Use only a small amount of glue, making sure that none is spilt on the inside thread that caters for the ferrite slug. Note that the slug is installed with a short, narrow strip of plastic which acts as a "binder" to keep the slug in position.

Wind the other coils exactly as specified and mount them in place. In all cases they are to be mounted with the underside 2 mm above the top surface of the circuit board. The free end of C12 can now be soldered to the mid-point of L5 (this is at the bottom of the loop). It is essential that the earthed ends of coils L3 and L5 be soldered on *both* sides of the board.

The remaining items to complete the exciter are the installation of the output coax, three circuit board pins and the crystal socket. The output coax is a 200 mm length of 2.5 mm diameter Teflon dielectric coaxial cable (RG178). It is soldered directly to the pc board and not connected via circuit board pins — this is quite important. The three pins provide connections for the audio and video input and the power supply positive rail.

Getting the exciter going

A lot of thought has gone into the procedure for tuning the exciter and it is strongly recommended that it be followed closely to avoid causing unnecessary problems.

The design of this module makes it extremely reliable and it will tune with no mysteries. The kit is supplied with probe type wavemeters, or "tuning wands", for this purpose. The only additional test equipment needed is a multimeter — preferably not a digital type, although if that is all that is available, it can be used.

PREPARATION FOR TUNING

The exciter is most easily tuned prior to installation in the case. Only a final "tweak" is then required.

While undergoing this initial tune-up, the module is best supported by nuts and bolts through its mounting holes. This will keep the underneath clear of the surface on which it is resting. The surface does not have to be metal, in fact it is probably better if it is not.

Solder a 47 Ω resistor across the end of the coaxial cable from the output of the board to act as a dummy load. Temporarily connect a 33k resistor between Video In and +12 V (for adjustment only).

Solder red and black wires to the positive pin and earth to allow for the connection of a 12 volt supply. Measure across these wires to check that there is no short between supply and earth - if there is, correct it before proceeding.

When all is well, connect the power supply wires to a 12 volt supply and see that the unit draws between 20 to 40 milliamps. If by the remotest chance the initial trimmer and slug settings are in the correct positions, then the current will be nearer 80-100 milliamps.

Initially set the trimmer capacitors to the positions shown in Figure 5. Keep in mind that the final positions will never be far from these. If they are not in similar positions, be suspicious (although keep in mind that apart from maximum and minimum settings there are always two positions that will give the same capacitance).

Set the wavemeter trimmers on Probes 2 and 3 to the initial calibration positions as shown in Figure 2.

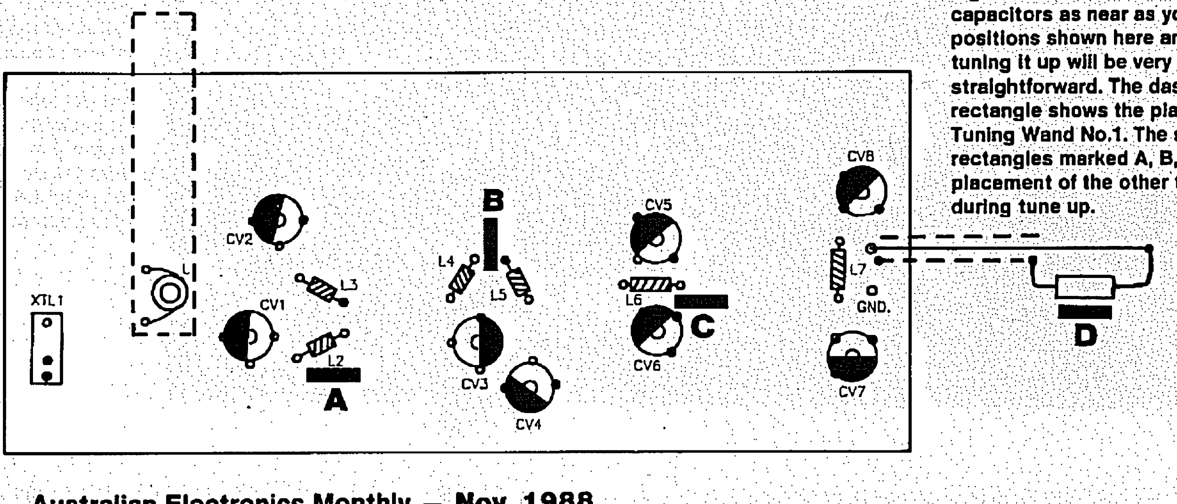


Figure 5. Set the exciter's trimmer capacitors as near as you can to the positions shown here and you'll find tuning it up will be very straightforward. The dashed rectangle shows the placement of Tuning Wand No.1. The solid rectangles marked A, B, C, D — show placement of the other tuning wands during tune up.

TUNING

Connect Probe 1 to your multimeter and select either a low voltage or low current range to give good sensitivity. Any range less that 2.5 V or 2.5 mA would be marginal as the meter deflections may by initially minute. If the meter concerned does not have this ability, it would be worth begging or borrowing one that does.

Place the probe over L1 as shown in Figure 5 (the hole in the probe allows this). With 12 volts applied to the board, tune the slug in L1 for maximum reading on the multimeter. Use a proper tuning tool to do this. It's a plastic rod with a small metal screwdriver tip inset in the end that fits the slot in the slug. This meter reading indicates that the crystal is operating.

Leave the probe in place but disconnect it from the multimeter. Now connect the meter to Probe 2. Place Probe 2 in position A as shown in Figure 5, vertical to the board, loop downwards facing L2, and tune CV1 for maximum meter reading. Whilst in this position, retune the probe trimmer for maximum reading also. This new setting should be quite close to the initial position.

Probe 1 can now be removed from L1 and the slug re-peaked for maximum multimeter reading from Probe 2. (The reason Probe 1 was not removed earlier was that, in doing so, this may have detuned L1 to the point of stopping oscillation).

After L1 has been re-peaked for maximum, it should be detuned very slightly by rotating the slug *anticlockwise* by the smallest amount. This is a standard oscillator tuning technique to allow reliable start-up.

With Probe 2 still in position A, tune CV2 for minimum deflection. After achieving this, retune C1 for maximum (this allows for any detuning effects by the tuning of CV2).

To this stage the oscillator is operating and the tripler is producing a signal which is in the 220 MHz range.

Next, connect Probe 3 to the multimeter, place the probe at

CORRECTIONS

Here we correct a number of errors and omissions concerning the circuit diagrams in Part 1.

VIDEO BOARD

The 'SYNC' trimpot is relabelled VR2a as the 'LINEARITY' trimpot on the sound board is labelled VR3. R24 is 470R, not 500R.

SOUND BOARD ▷

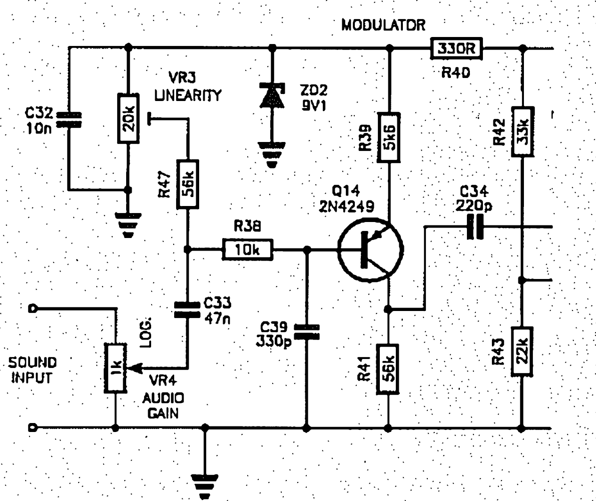
Resistor R47 was omitted and C39, shown originally as a 1n supply rail bypass, is actually a 330p capacitor from the base of Q14 to ground.

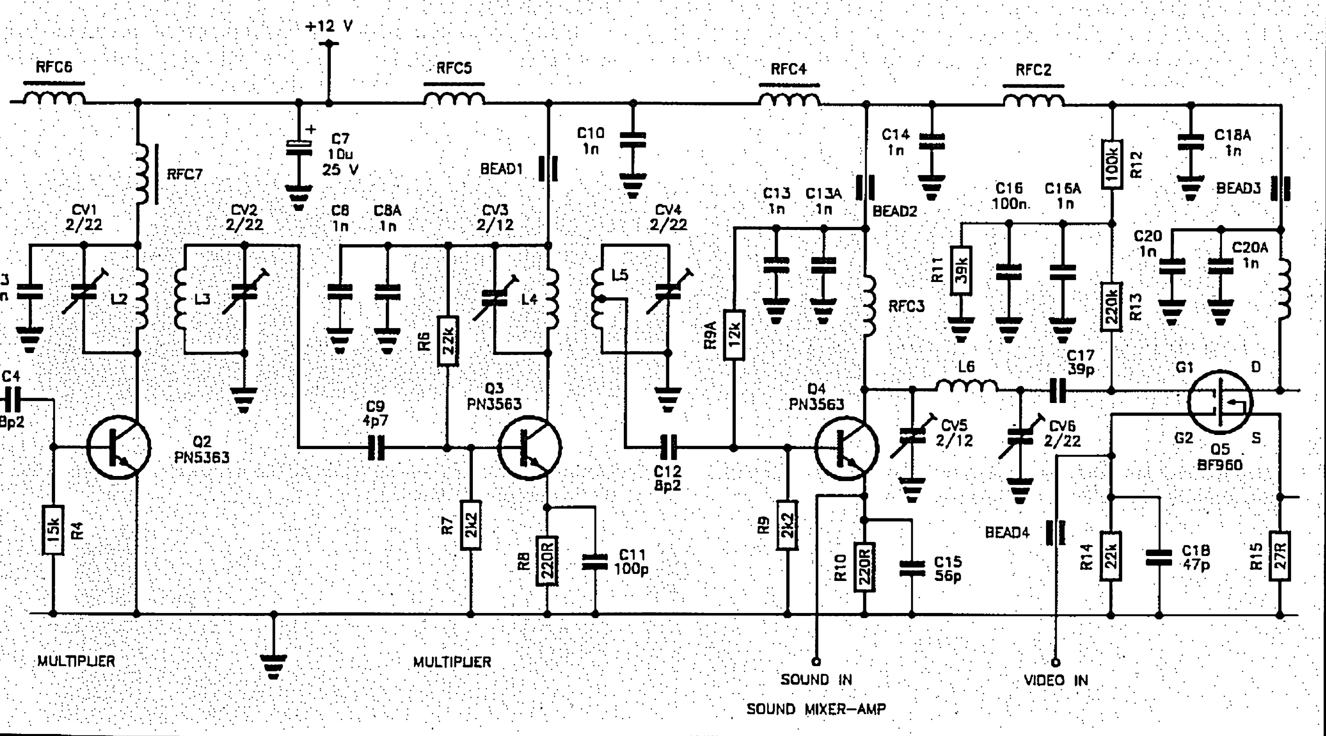
Extra holes are provided on the pc board so that another capacitor may be parallelled with C36 should the oscillator not come within range. It should not be necessary.

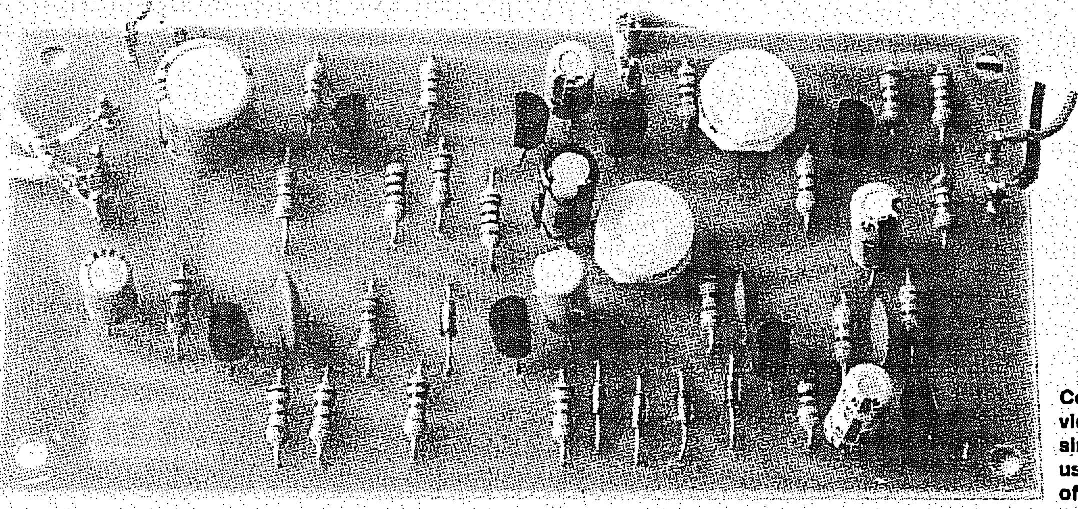
EXCITER ▽

Choke RFC7 attaches to the supply rail on the +12 V side of RFC6, not the other side at the junction of R5-C6-RFC6.

Capacitor C21, the output dc blocking capacitor between L7 and Q5's drain, is a chip ceramic type, as are C13A, C16A and C20A. An extra 1n ceramic (C8A) bypasses the collector circuit of Q3.







Component-side view of the video module, which is also simple to construct. Note the use of pc board pins for the off-board wiring.

position B; as with Probe 2, vertical to the board. Tune CV3 for maximum plus CV4 for minimum. Whilst Probe 3 is in this position, repeak the trimmer on the probe for a maximum reading on the multimeter. This setting should also be quite close to the initial setting.

Now move Probe 3 to position C and tune CV5, then CV6, for maximum reading on your multimeter.

Finally, Probe 3 is held near the 47 Ω dummy load resistor at position D and CV7 is tuned, followed by CV8 — both for a maximum reading.

Leaving Probe 3 in this position, all the trimmers can be finely tuned to eliminate any loading effects the probes may have had. All trimmers are tuned for a maximum with the probe in this position — even those that were previously tuned for minimums. These final adjustments must be very slight, so avoid being heavy handed.

Final checks

There are now two important checks that should be done to verify that the exciter is stable and operating on the correct frequency:

(1) Short the crystal pins together and see that there is no output from the exciter as measured by Probe 3 in position D. If there was output with the crystal shorted it would mean that the exciter was self-oscillating and would need investigation. All power produced must be crystal controlled.

This is a very sound design so there should be no problems in this area. However if there is, check for soldering or component mistakes and carry out the tuning procedure again.

(2) Using Probe 3 at point D (near the dummy load), check that the output from the probe peaks near the probe trimmer's initial setting. If it does not then the energy generated is at some other frequency and the tuning procedure should be started again.

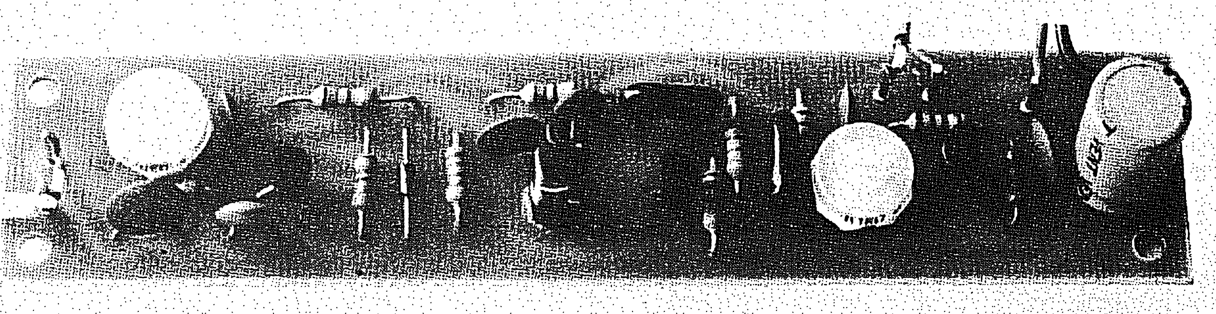
Although the probes should peak on their initial setting points, don't worry if they are not precise. They are mass produced and there will be minor variations; however, they should be very close.

The probes are mainly to ensure that the output is on the correct harmonic — accurate frequency control is achieved by the crystal.

If any other test gear is on hand, such as a frequency counter or a spectrum analyser (for the chosen few), now would be the time to touch up the tuning — this will really only confirm what has already been done.

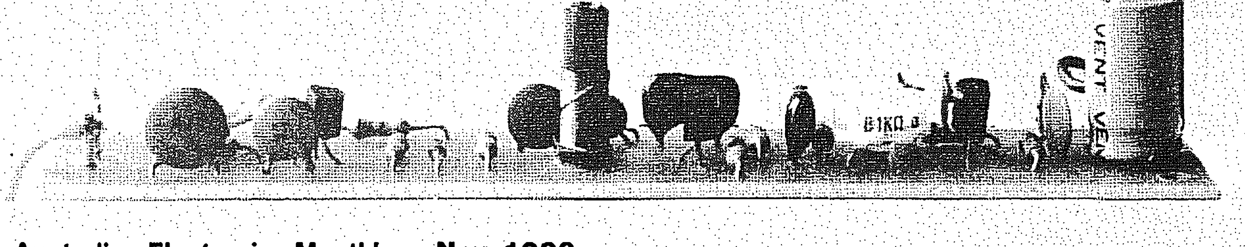
After the exciter is installed in its final resting place only a touch on the last two trimmers may be required, but this will be discussed later.

This has completed the most skilled part of the whole project and having reached this stage, you will most probably have become more knowledgeable in the process.



△ The sound module is the simplest to build, with only a handful of components required. Note the two trimpots.

▽ Side-on view of the sound module. The oscillator coil is seen in the centre of the board.



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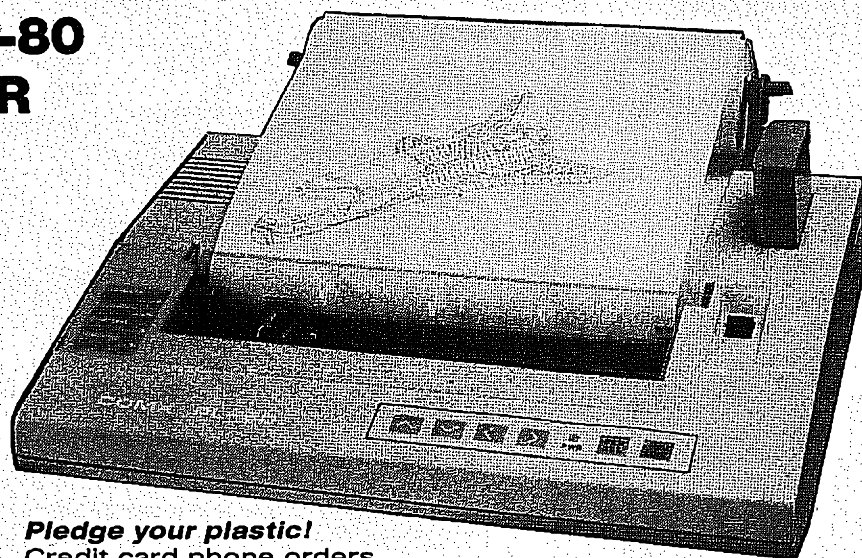

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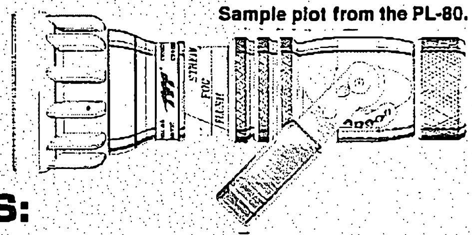

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Step size	: 0.2mm
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No. of pens	: 4 (black, red, green, blue)
Panel Control	: Up, Down, Left, Right, Pen Select, On line
Indicators	: Power, On Line
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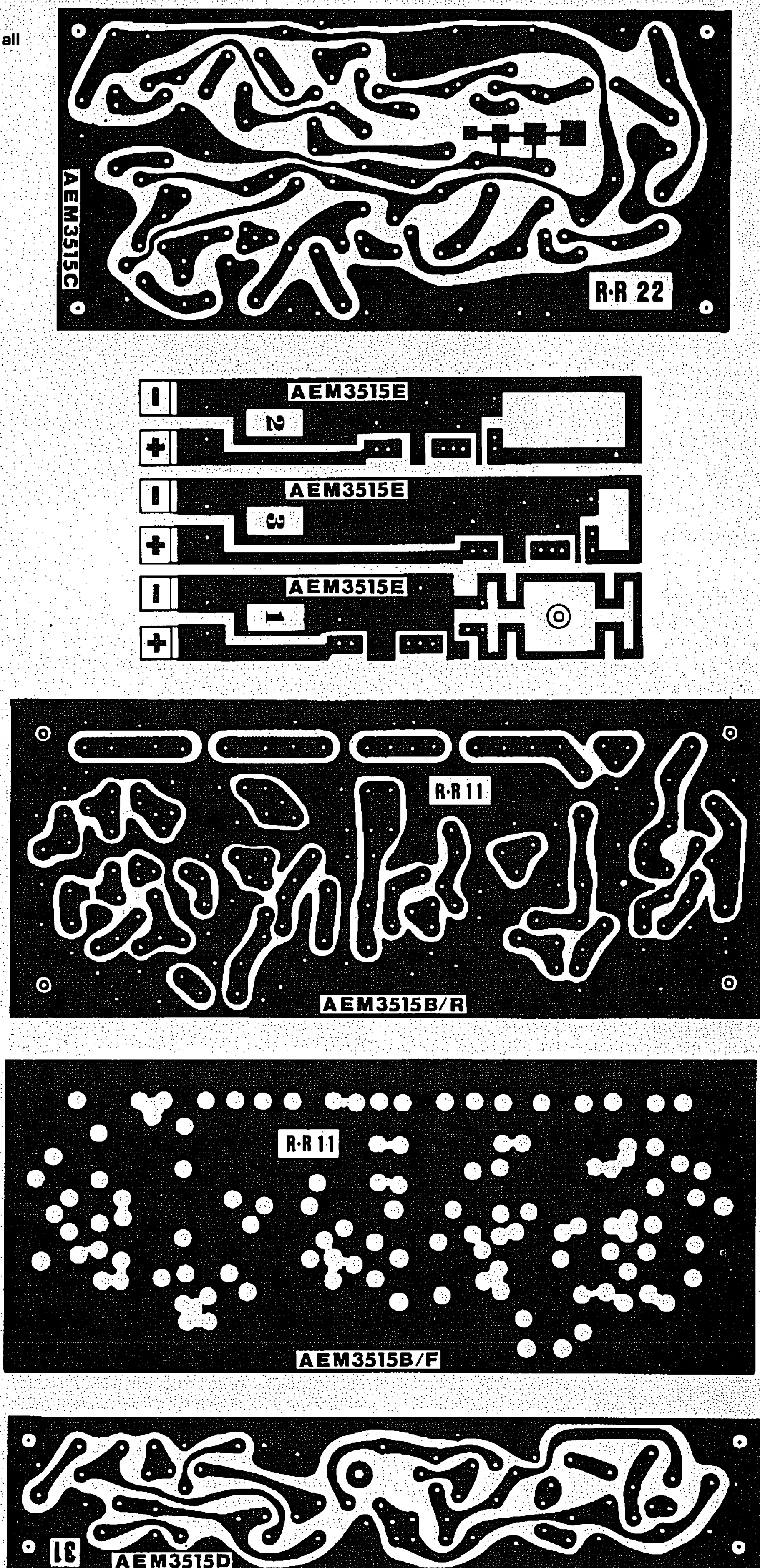

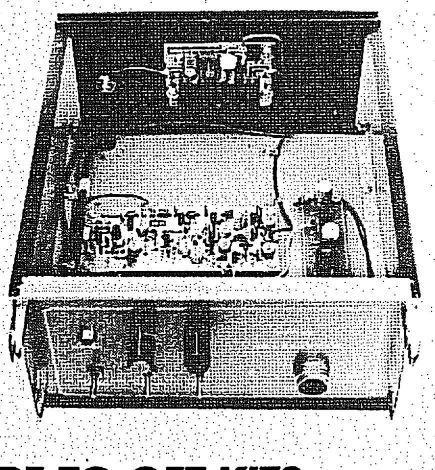

WHERE TO GET KITS

The authors are assembling and marketing kits for the AEM3515 Colour ATV Transmitter. You can buy the project module by module or as a complete set of modules.

The kits are available from:

Bob Reid
12 Gemini Close
East Doncaster Vic 3109

Prices quoted are inclusive of postal charges within Australia.

Readers may also obtain the kits through AEM, at 1st Floor/347 Darling St, Balmain NSW 2041.

70 cm Exciter Module: A complete kit of parts to build the exciter which produces 100 mW of RF. The kit includes parts to build tuning wands which enable it to be aligned accurately using only a standard analogue multimeter. Specify the output frequency you want: 426.25 MHz, or 444.25 MHz.

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Case Kit: All the hardware required to complete the transmitter. This kit includes case, heatsink, front panel label, switches, LEDs, video socket, etc. With this kit, your transmitter becomes an attractive finished unit and will relieve you of the worry of thinking out the final mounting and housing details.

$95.00

The video module

The video modulator may appear to be more complicated than other simple designs that are published but it is a much better performer and has two major advantages. These are:

(1) the size of the synchronising pulses can be adjusted, and

(2) once set they stay the same size regardless of varying picture brightness.

The above has the effect of keeping the picture stable under greatly varying conditions — a much desired situation!

There is no particular preferred order for loading the components on this board — probably resistors first followed by capacitors and semiconductors.

The most likely pitfalls would be putting the transistors in the wrong way or in the wrong place. Check to see if your transistors are 2N or PN types as their pin connections are different. The base-emitter-collector connections are shown on the overlay diagram in Figure 6. Not all the diodes face the same way so be careful that they are the correct way round. The cathodes are marked on the overlay diagram with a bar at one end, where the diodes have a ring marked around the body.

As is mentioned in the other construction articles, it is good practice to face all the resistor colour codes in the one direction. The two trimpots, VR2 and VR2a, are of different values so make sure they are placed in their correct positions.

With the exception of the transistors, all components should be mounted flush down against the pc board. The transistors should be as close to the board as practicable, without straining the leads. Solder pc pins in place where leads are required for the off-board connections — Video In, Video Out, A B C and power supply.

The sound module

The 5.5 MHz sound module is quite small, with only a handful of parts. There is no particular order in which the parts should be mounted but a word of advice is perhaps worthwhile.

As with the other boards, it is wise and good practice to mount all resistors with their colours in the same direction. Make sure that the electrolytic capacitor (C40) is correctly polarised.

Verify the transistor pinouts before putting them in the board - whether of the 2N or PN variety as their pinouts are different even though they are electrically identical. The correct component number is shown on the drawing below — if the ones supplied happen to be of the other variety then reverse the transistor as mentioned previously.

As the oscillator is free running, pay particular attention to winding the coil L8. Wind 40 turns of 0.2 mm enamelled wire tightly around the former and glue them in position so that there is no possibility of the wire moving. "Super Glue" is fine for this. When it's dry, glue the Neosid former into place, again using Super Glue, so that it is mechanically stable.

The other critical components are the 220 pF and 150 pF capacitors (C36 and C37, respectively) which are connected across this coil. These are high stability dipped mica types, as noted previously. Don't confuse these with the other disc ceramic type capacitors or you may find that the sound frequency will drift greatly.

Be careful of the trim potentiometers. Although they look the same they are of vastly different values. Lastly, make sure that the zener diode is installed with correct polarity.

And next —

Next month we get to make a trial hook-up and adjustment before assembling the project in a chassis, followed by the description of the linear amplifier and how it's assembled into the system. keep your soldering irons warm!

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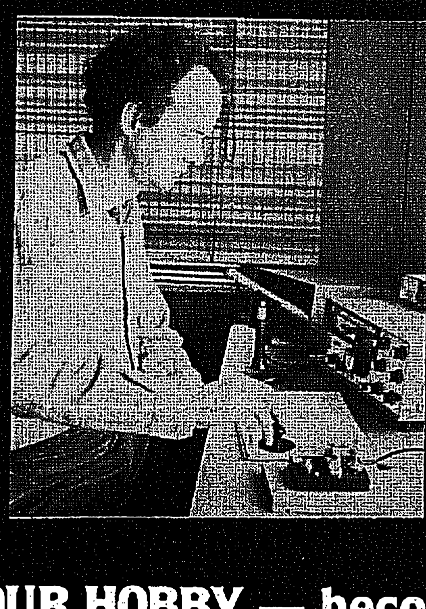

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Confounding the hackers

Inadequate and obsolete security systems for computers can be replaced by developing an international data encryption standard, having almost total security with fewer complications.

Technical director of Data Bridge Communications, Mr Alan Gray, said security systems had been designed for one building where staff had been screened but were inadequate with present day distributed data systems and expanding interconnection.

Mr Gray said encryption completely scrambled data between sender and receiver, making it meaningless to any interceptor and protecting the system from outside callers.

Called DES Encryption, the system has been approved by the Commonwealth Defence Department and the Australian Finance Industry Association.

Data Bridge has released an encryption solution based on this international standard, using an encryption algorithm based on the full 64 bits.

Mr Gray said a corporation with 50 PCs, for example, could use DES to keep data private by issuing individual keys to users, the controller holding a master key.

Keys were manually c during configuration and passed through a "one way" function which ensured it could never be revealed.

Since the code was destroyed when the key was entered, the password was re-entered every time a session began.

"Using remote key management, the controller can change the key codes of all his operators any time he wishes, as often as he likes, thus maintaining security," Mr Gray said.

"Each network has its own unique master key, ensuring that no other network can access it."

For a security bar against unwanted calls, Data Bridge had released Time Delay Security, a callback system accessed only with a password and identity codes.

This specifically foiled the latest hacker technique which overcame the "dial back" security system in many current modems.

"Our system programs the modem to manipulate the local exchange in terminating the connection and stop all procedures for 90 seconds," Mr Gray said.

"It then calls back to the user-designated number to verify a personal identification number which has been issued for that specific session before allowing access to the host computer."

He said the crucial feature was the 90 second delay. There was no attempt to dial the operator back in that time, and therefore when the hacker tried to reconnect the host computer he gets an engaged signal. This procedure would continue until the unauthorised caller gave up.

Data Bridge Communications is fighting off the hackers from **604 North Rd, Ormond, 3204 Vic.**

New Wyse terminal is flicker-free

A flicker-free 78 Hz refresh rate is only one of several features in the WY-120 36 cm general purpose computer display terminal from Wyse Technology.

It has a borderless (overscan) display, high resolution character call, a choice of three phosphors, multiple keyboard layouts, a tilt and swivel screen and an optional height adjustable arm.

It claims to be the advanced terminal in its price range, offering compatibility with three standard display personalities, with the user selecting the keyboard appropriate for the application: WY-50 or ASCII; VT-100/52 or ANSI; and PC terminal.

The phosphors offered to the buyer are paper-white, amber or green. The user chooses positive, negative or neutral presentations.

With the paper-white phosphor the display will appear as a printed page with dark letters on a white screen.

The unit's borderless capability allows the user to view a screen without dark borders, making it easy for the viewers' eyes to read copy.

Adjustments made frequently are convenient with clustered power, brightness and contrast controls. An optional height-adjustable arm allows the unit to take up less desk space.

The terminals feature up to 66 user-programmable function keys that let operators create their own key definitions to reduce keystroke errors and improve productivity.

A terminal can simultaneously show 512 programmable "soft" characters, permitting multiple language displays or special symbols on the same screen so the user may design custom logos, characters, or icons.

Memory capability to store up to seven display pages lets the user store menus and "help" screens while viewing information from different sources.

Hidden visual attributes are also a standard feature. It can have a 10 x 16 character call in a 60 Hz refresh mode; in the 78 Hz mode it automatically selects a 10 x 13 cell.

The WY-120 is priced at $1 182, including keyboard, before sales tax.

Further information from **Wyse Technology, Unit 7, 112-118 Talavera Rd, North Ryde, 2113 NSW.**

I spy with my — optical I/O boards

Eight optically coupled inputs and eight relay outputs on a board 240 x 100 mm designed for applications in industry, the home or school.

The digital PC-IO-NR board for "real-world" can be "daisy-chained" to provide 120 inputs and outputs using a special 8-bit bi-directional card (PC-BD-IO), inserted into a single card slot on any IBM PC/XT/AT computer or compatible.

The board comes complete with demonstration software and instructions.

Interface with **Procon Technology, PO Box 43, Essendon, 3040 Vic.**

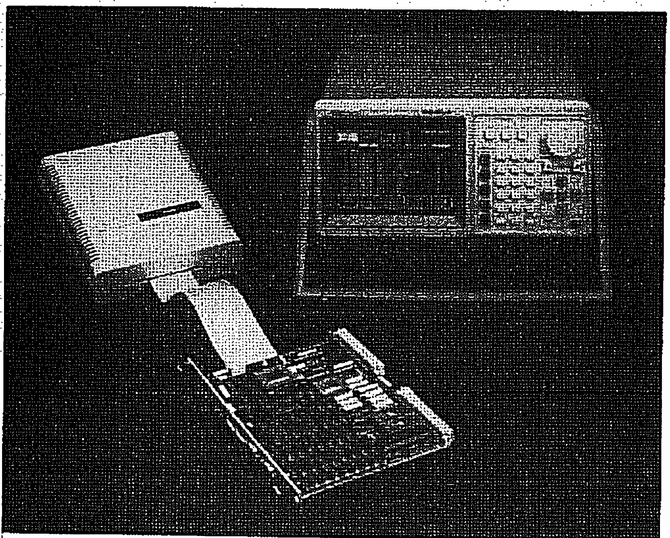
Desktops seek publishers

Compatible with Schlumberger Technologies' Bravo 3 CAD/CAM software, the desktop publishing package Interleaf supplements their CAD/CAM system by supplying a technical documentation and word processing capability.

The program is said to feature an icon-based user interface that is simple and intuitive to use, shortening the training curve. It has full windowing capabilities, a full range of editing functions with text and font formatting.

CAD created graphics created with Bravo 3 can be incorporated into Interleaf documents. Drawings appear as icons that can be pasted anywhere into a document, and these graphics are fully editable.

Details from **Schlumberger, 382 Wellington Rd, Mulgrave, 3170 Vic.**



Microprocessor support

Said to be a quick and convenient interface between a Motorola 25 MHz 68030 on the Tektronix 1240/1241 logic analysers, the 68030 support consists of a 12RM33 68030 mnemonics ROM pack and the PM205 68030 personality module.

The 12RM33 provides instrument setup and disassembly post-processing of acquired 68030 data. It marks executed 68030 instruments by automatically tracking the 68030's 3-stage instruction pipeline; it also decodes the 68030's dynamic bus sizing mechanism and displays only the 68030 data that was actually transferred.

The device is said to turn a 1240/1241 logic analyser into a powerful microprocessor analyser focused on 68030 applications to debug hardware and software, integrate hardware and software, and optimise system performance.

For more about the support get on line to **Tektronix, 20 Waterloo Rd, North Ryde, 2113 NSW.**

Making dumb programs print smart

Any program, no matter how limited, can be supplemented to command any printer to write various fonts, sizes and a large range of symbols and characters with the Flashpoint Plus program, of six disks in all.

The first disk — Flashprint Plus — allows two character commands to send a sequence of bytes to control the printer, and up to 8000 bytes can be sent with a single command.

Disk 2 (Flashprint Translation) can create a table where one character being printed can be changed to another character or string of characters.

Said to be ideal for foreign languages and other applications. Flashprint Images, the third disk, prints any of 80 images from any program.

Flashkey, disk 4, does the same for the keyboard as Flashprint does to printing. Disk 5, Flashprint Toolbox, has customised utilities that make Flashprint work better and for designing images.

Disk 6, Flashprint Image Manager, has useful utilities that complement Flashprint, allowing the user to design or modify an image, from the 400 supplied.

All Flashprint printing programs will work with any program and will control any printer.

Flash your inquiries to **JRT Software, 42 Turners Ave, Coromandel Valley, 5051 SA.**

Low-cost cards played

Two low-cost AD/DA cards for IBM pcs and compatibles claim to provide a "real world" interface, for precisely measuring and recording any "analogue" parameter.

In a single channel card, at $215, the D-A conversion claims: 12-bit precision; adjustable output voltage, 0-9; uni or bipolar; settling time 500 ns; and nonlinearity, 0.2 per cent. A-D conversion: unipolar; conversion time 60 µs; and input voltage 0-9 adjustable. Software included.

A dual channel 14-bit AD/DA conversion card, at $599, offers: 14-bit resolution; 16 input channels; uni or bipolar input and output levels; conversion time <42 µs; and relative accuracy of ±LBS maximum.

More details from **Electronic Solutions, Box 426, Gladesville, NSW 2111.**

PALS, GALs and PROM programmer

Using proprietary pin driving architecture, the System 3000 is a programmer where on one universal programming station more than 1600 device types can be programmed.

Programmable ICs include PLA, EPLD, GAL and IFL devices as well as PROM, EPROM, EEPROM and microcomputer technologies. The system has 2M of on-board RAM that is expandable to 64M so that high density devices are supported.

Pinouts from 16 to 40 pins, 0.3 to 0.6 inches wide in pitch, are accommodated and the latest PLCC and LCC devices for surface mounting in 20, 28, 32, 44, 52 and 68-pin packages can be programmed with the SMD chip station.

All device libraries and programming algorithms are held on a removable IC memory card, providing instant access to selecting any device type, rather than slower times of floppy disk based systems.

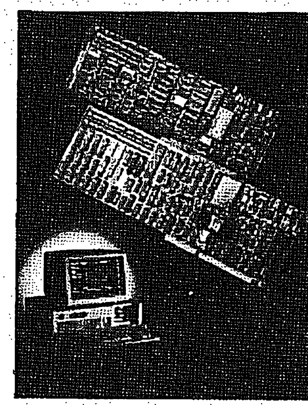
Easily interchanged, these memory cards will be continually updated as new devices and technologies evolve. All programming algorithms in the system are said to be approved by semiconductor makers.

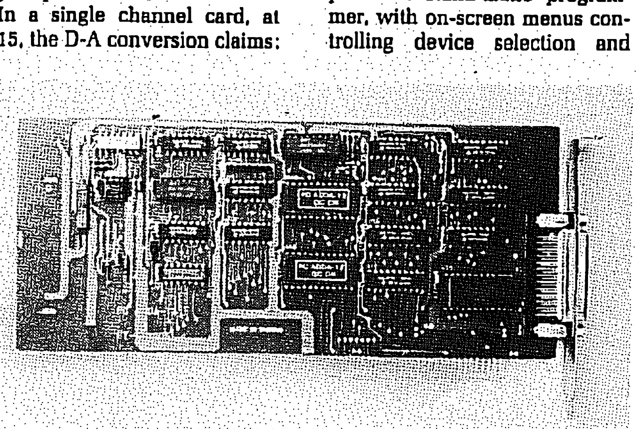
The system has its own CRT display and keyboard, and is a powerful stand-alone programmer, with on-screen menus controlling device selection and other functions.

It can connect to other equipment by four communication ports, including two RS232C interfaces for a host computer, an IEEE-488 port and a parallel interface for automated handler equipment.

Complete remote control of all functions from a host computer system is also supported as well as the ability to download data in any of MDS formats.

Get full details from **Anitech, 1-5 Carter St, Lidcombe, 2141 NSW.**





Two boards, two bauds, or too bored?

Two new high performance analogue input boards from Analog Devices, one featuring 14-bit resolution, the other 12-bit, are designed to operate with the IBM PC/AT.

The RTI-850 provides eight channels of differential analogue input with an ADC resolution of 16-bits and an accuracy of 14-bits, or 0.003 per cent of full scale.

For high speed use the RTI-860 features a 250 kHz throughput with 16 channels of single-ended analogue inputs and 12-bit resolution.

Applications include medical and analytical instrumentation, robotics and precision machine control, test equipment and others. The RTI-860 is aimed at spectral, correlation, and vibration analysis, and machine monitoring and test equipment.

In addition, the company offers Snapshot *Storage Scope*, an easy-to-use, menu-driven data acquisition system and digital storage oscilloscope software package for the IBM PC/XT/AT and the Analog Devices' RTI-800 series of analogue I/O boards.

It can include digital or analogue triggered acquisition of 32 channels, display of any eight channels along with dual cursor readouts, time and magnitude readouts in engineering units, X and Y zooming and offset.

Also there is the Snap-Filter Software Package which provides digital filtering on the IBM-PC.

It works within the Snapshot Storage Scope data acquisition program and the Snap-Calc analysis and monitoring program to offer a totally integrated solution to data acquisition, storage, analysis, decision making and filtering.

Check it all out at **Parameters, Centrecourt, 25-27 Paul St North, North Ryde, 2113 NSW.**

SRAM for cache controller

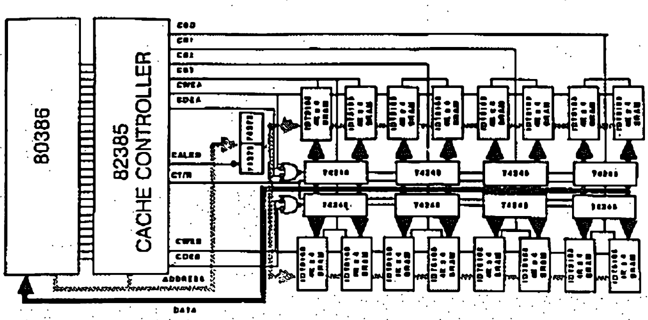
Featuring a 35 ns access time with an on-chip address latch, a 4K x 16 SRAM has been optimised to work with Intel's 82385 cache controller in 80386 systems.

The cache SRAM, the IDT 71586's on-chip address latch improves speed by reducing interchip delays and eliminating the need for external glue logic, while reducing board size by 57 per cent.

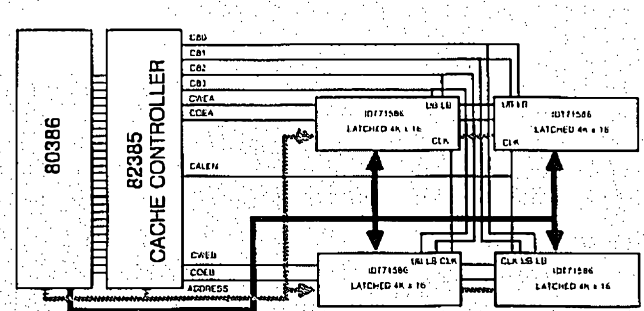
In an Intel 80386-based system using an 82385 cache controller, four IDT 71586 SRAMs replace 27 memory and logic chips and use only ⅓ of the power to do the same work.

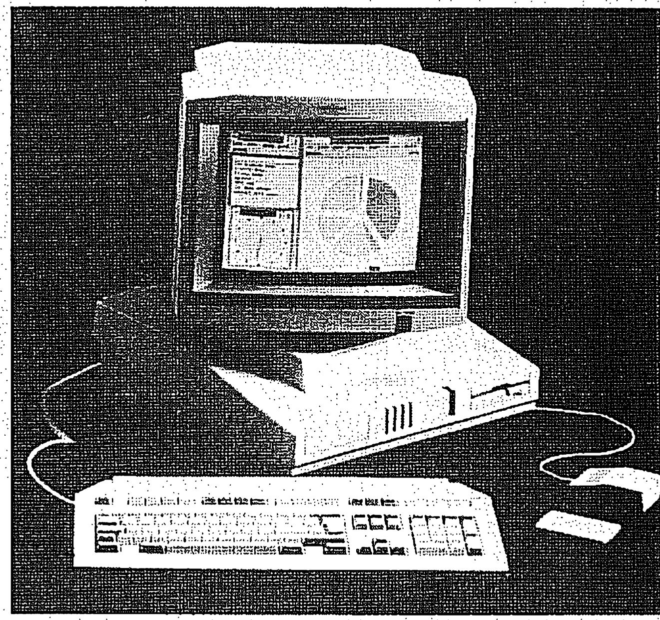
Full details from **The George Brown Group, Marketing Division, 456 Spencer St, West Melbourne, 3003 Vic.**

INTEL'S SUGGESTED CONFIGURATION WITHOUT THE IDT71586



CONFIGURATION USING IDT71586





Fruitful release for Apricot?

Apricot's latest is a range of six microcomputer systems incorporating the IBM Micro-Channel Architecture (MCA). Curiously, they're named the Apricot "Qi" (pron. — Key) range. The six systems also conform fully with the systems application architecture (SAA).

The Qi personal workstations are based on 80386 and 8036SX computer processors, claiming faster running than IBM or Compaq equivalents, built-in Ethernet, VGA graphics as standard, on-board communications, integrated security, MS windows presentation manager, full multitasking facilities within MS/DOS or OS/2, and fixed disks claiming to work 50 per cent faster than equivalents.

Also released is the Qi Environment, an integral software solution for personal workstation computing.

More details from **Barson Computers, 335 Johnston St, Abbotsford, 3076 Vic.**

Logic analyser

Timing of ultra-high speed logic circuits using digital signal processors and application-specific ICs is analysed as well as the state of microprocessor systems, by the TR4726 Logic Analyser, from AWA.

There are two modules for analysing timing: the 300 MHz Option 75 and the 100 MHz option 70. The 300 MHz module has asynchronous sampling resolution of 3.3 ns and can sample synchronously at 100 MHz, so it can analyseultra-high speedlogic circuitry and evaluate high speed A-D converters which needs synchronous analysis.

With 64K bits of memory at each channel, a compressed-display view of all data simultaneously is possible, so that analysing the most complex system is made easy.

For state analysis there are personality kits for 16-and 8-bit processors, including dissemblers, as well as general purpose kits. By combining the timing and state analysis capabilities of the TR4726, simultaneous multi-fact analysis is becoming more possible.

The unit has a 3½" floppy disk drive built-in to file analysis results and comparison data, measurement conditions and procedures, thus easily automating the process.

Arrange for an analysis from **AWA Distribution, 112-118 Talavera Rd, North Ryde, 2113 NSW.**

PolyFORTH supplier

Brisbane now sees PolyFORTH products for industrial and process control on mini and microcomputer systems represented locally by Energy Control.

Several PolyFORTH-based software and hardware products for DSP, embedded systems development, high speed processing and multiprocessor control applications using microcomputers are also in the range.

Access **Energy Control, 26 Boron St, Sumner Park, 4074 Qld.**

A basic users' guide to driving the AEM4624 SUPERbis modem

Jamye Harrison

No matter whether you've assembled a kit or bought your SUPERbis ready-made, when it comes to actually *driving* the beast, everyone needs a little guidance; some more than others, depending on whether or not you've used a Hayes-compatible modem before.

IF YOU'RE NEW to the world of dial-up data communications, and you have only a vague idea of what it's all about, I'm sure I'll have a few surprises. If the SUPERbis 2400 ZXR (AEM Project 4624) is not your first modem, or if you bought it for specific purposes, you may want to skip this preamble.

The great thing about modems and data communications, unlike other applications in the computer world, is that **what** you can do is not so much limited by the equipment you've got, but rather by your imagination and persistence.

First, I'll discuss Bulletin Board services, commonly referred to as BBSs. These systems are setup by people with a computer system, perhaps not unlike your own, who place their system *'on-line'* for other people to call in and access the information on the system (the "board").

Some boards belong to a BBS Network, FIDO-Net for example, which allows them to communicate with and access or swap information on other boards in the network (this is generally done on an automated, or semi-automated, basis — the boards call each other in a sequence at some godforsaken hour of the morning and exchange various files of information).

A great many bulletin boards use an IBM/compatible computer, mainly because BBS software for PCs is so widely available. There are also BBSs using Amigas, Commodores, Microbees and Apples, it's just that IBM/compatibles predominate. But let this not discourage you! As I said, what you are able to do is not really limited by your computer equipment. These boards, no matter what computer system the service uses, will usually have files and information regarding other types of computers.

The information available from BBSs is generally of two types, messages and files. Users are able to post and receive messages relating to a variety of subjects, not just relating to computers.

Many people feel, including BBS users, that the message areas merely contain idle chit-chat which is of no real importance. This could not be more false! Quite a number of people use the message facilities of bulletin boards as an alternative to Australia Post, keeping in contact with other people who have similar interests to themselves. Advice can be sought; you may be surprised at the number, and how quickly, people are willing to offer advice or a solution to a problem. Just the thing for that late night perplexity. Have a go, you might be pleasantly surprised!

If a board is on a network you can post and receive messages in what are called **conference areas** . This means that any message you post will be "echoed" (that is, repeated) on other boards in the network within a few days. This permits other people, right across the country, or the world, to read your message and possibly reply.

Secondly, most BBSs have a group of files for *'downloading'*. These are programs and information files which are categorised for easy searching. Of course, these are available for free and are thus public domain or shareware programs.

Hmmmm, that is all very well. However, there is life beyond BBSs. Your modem can be used to communicate with a friend or colleague of yours to transfer information between computers which are geographically separated. This is especially useful for transferring text files from one make of computer to another, rather than paying the nominal forty-odd bucks for a disk conversion.

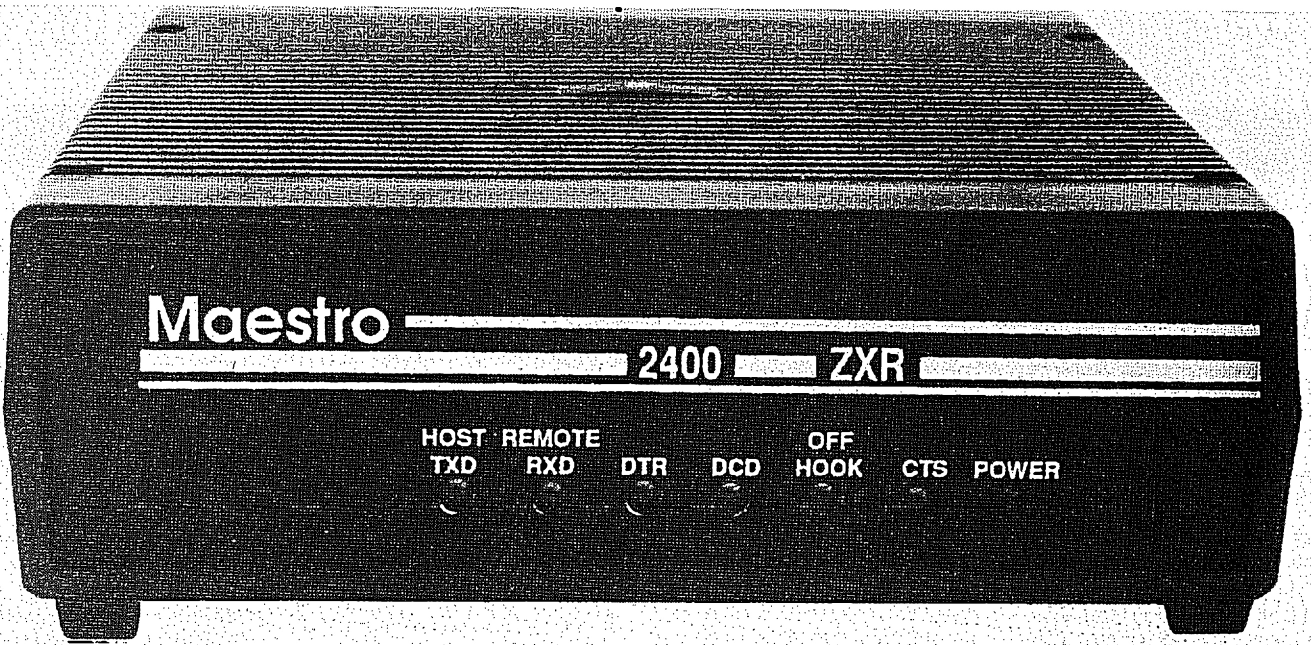
No doubt you've heard of the subscription database services like Telecom's Viatel and the Elders' service. There are even dial-up horse racing form guides available!

These are only a few of the varied applications for modems. Ourselves? — we have been using modems for the past year or so to transfer text files for typesetting the magazine articles. We keep a regular "weather eye" on the BBS networks, both locally and overseas, and transfer articles from correspondents.

The concepts

To refresh you: A software controlled modem like this is a machine that responds to a set of "commands" sent to it from your computer. Just the one set, no others. Speak its "language", and it will "do your bidding". US modem manufacturer Hayes developed the set of commands that have become the erstwhile "standard" for "smart" modems. The commands are merely strings of characters — letters and numbers — that the modem's software "recognises".

In addition, Hayes compatible modems have something called *S-Registers*. These are "places" in the modem's system, some of which contain important information or "settings" which the modem refers to for its operation, while others store



statistical information which you can refer to. That is, some registers are like multi-way switches, in that they are used to select a required operating function from a group. Other registers are like message pads, or pigeon holes in which useful data are stored.

This article does not replace the manual supplied with your modem, it must be read in conjunction with it.

How to do things

OK, now you know **what** you can do, **how** do you do it? It's simple really, like learning a language with very limited vocabulary. To explain them, I have set them out with the command, or the "form" of the command, at the left of the line followed by its function, then any "parameters" which must be specified, usually a number or numbers, indicated by a lower case 'x'. After the command and function of the command, where applicable, I have specified what range of numbers is valid for that command, and the default parameter when the modem is reset. (Not all commands require parameters). The command's explanation and how it is used, then follows.

The effect of some commands can be altered by a "modifier", usually a letter or character. The use of these is also explained. You get the modem to do your bidding by stringing together the required commands and modifiers.

Note that, wherever you see this symbol — ↵ — it means you hit the "enter" or "carriage return" key.

ATA *Answer mode*

This command immediately places the modem in answer mode. The modem will 'grab' the line, go into data mode and will transmit an "answer carrier" (a standard frequency tone) to which the modem at the other end of the line will respond.

The ATA command is similar to operating a manual modem. It is usually only used where you are currently on a voice call and wish to switch the modem into answer mode while the person at the other end switches theirs to 'originate' mode.

A/ *Execute last command again*

Unlike other AT commands, this one doesn't require 'AT' preceding it or even a ↵ afterwards, immediately you finish keying 'A/' the modem will carry out ("execute") your previous command. This is useful for re-dialling engaged numbers.

ATBx *Select Bell/CCITT* 0-9 0

This command is quite powerful. It allows you to 'mask' baud rates. That is, it turns off the modem's automatic baud rate scanning. For instance, by issuing an 'ATB3' command your modem will *only* connect in CCITT V.21 mode (300 bps). Here, as in following commands, the '0-9' gives the range of values that may be used, while the '0' at the end of the line gives the default value.

Some selection parameters specify Bell standards; at the time of writing, the Bell protocol standards were not supported and so only those referring to CCITT are applicable.

ATB0	*All CCITT speeds supported.*
1	All Bell speeds supported.
2	All CCITT except V.23 (1200/75).
3	CCITT V.21 (300 bps) ONLY.
4	Bell 103 (300 bps) ONLY.
5	CCITT V.23 (1200/75 — 75/1200) ONLY.
6	CCITT V.22 (1200 bps) ONLY.
7	Bell 212A (1200 bps) ONLY.
8	CCITT V.22bis (2400 bps) ONLY.
9	BELL 2400 (2400) ONLY.

Probably the best use of these commands is when you have trouble connecting to another person's modem which scans differently to the 2400 ZXR. Often, this will result in your modem connecting at a speed you don't want it to, say 300 bps, when both modems are actually capable of 2400 bps. In this case you would issue the 'ATB8↵' command.

ATDxx *Dial command*

This command is most likely to be the one you will use the most. It's format is relatively simple. For instance, if you wanted to call a bulletin board whose number is 555 1212 you would issue the following command:

ATD5551212↵

The modem would seize the line, wait two seconds for a dial tone and commence pulse-dialling the number.

However, there are a number of ways to modify the dialling command to suit your needs. Below I've listed the dialling command modifiers and their use.

T — Use DTMF Dialling

This is for people who have "touch tone" dialling available on their exchange (DTMF stands for "dual-tone, multi-frequency"). The modifier needs to be embedded in the ATD command, thus:

'ATDT5551212↵'. (See note 1)

P — Pulse Dialling

This is the opposite to the 'T' modifier. It instructs the modem to use decadic, or pulse, dialling and is used in the same way as the 'T' modifier.

W — Wait for a dial tone

'W' is used in the same way and place in the ATD command as the T or P modifiers, although it serves a different purpose. When the SUPERbis finds the 'W' in an ATD string it will pause and wait for a dial tone. If none is found in the time period specified in the S7 register (the setting of which we'll come to later), then the dialling command aborts.

— to p.121 ►

Compact, broadband precision RF wattmeter

A new portable, bi-directional RF power monitor from Telewave, the model 44A, measures forward and reflected power in a coaxial transmission line under any load conditions and over a broad frequency range from HF to UHF.

The instrument covers 25 to 1000 MHz with a power range of 1 to 500 W. The meter movement can be turned off to protect it from rough handling when the instrument is not being used, and a leather carrying strap helps the 44A's portability.

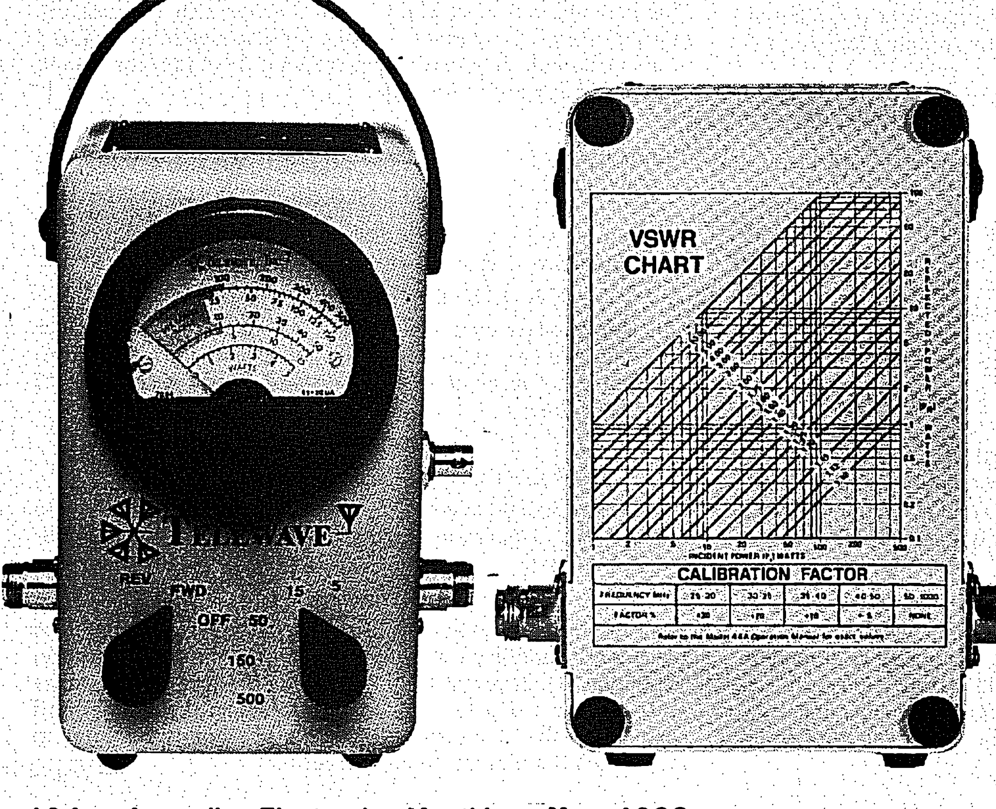
An optional RF sampling probe accurately extracts a low level of RF power as it passes through the instrument. This port is made available to a BNC connector on the unit's side. It allows for injecting an input signal into the unit under test or it can be used for in-line spectrum analysis and frequency measurements without affecting the meter's operation.

The instrument has built-in precision directional detectors which sample forward and reverse CW power flow in a specially-engineered section of transmission line. The sampled current is scaled to drive the 20 µA taut band meter.

Forward and reflected power can be directly measured by rotating the FWD-REV switch. VSWR is easily determined by comparing these measurements and using the convenient chart on the back of the instrument.

There are five power scales. The 500 W scale will test most high power transmitters, while the 5 W scale makes it simple to tune low power portables. The excellent stability of this unit and its facility of switching from one power range to another to check the calibration does away with the need for a secondary standard to verify calibration.

More information from ACL **Special Instruments, 27 Rosella St, East Doncaster, 3109 Vic.**



New mobile and a handheld from Icom

Two new dual-band VHF/UHF rigs, a mobile and a handheld, are offered from Icom, providing operation on 2 m and 70 cm.

The IC-3210A dual-band VHF/UHF mobile allows transmission on one band and reception on the other, if you want this. Frequency ranges are 144-148 and 430-440 MHz on transmit and 138-174 and 430-440 MHz on receive. There are two sets of 20 memory channels, one for each band, storing frequency, offset and tone data.

It can be set to scan between the band edges, or between preset limits, or through only the memory channels relevant to a particular band.

It delivers 25 W on both bands and a receiver sensitivity of <0.18 µV for 12 dB SINAD, according to the specs. There is an optional Tone Squelch Unit available for it.

The IC-32AT handheld FM transceiver operates over both the 144-148 and 430-440 MHz bands and can transmit on one band while receiving on another. Each band has 20 memories, and an advanced priority watch function allows the user to monitor the call channel memory, any selected memory channel or all memory channels every five seconds — including while operating.

The IC-32AT generates 5.5 W on 2 m and 5 W on 70 cm. Water-resistant rubber seals on all joints make it safe to operate even in marine service.

Contact Icom at **7 Duke St, Windsor, 3181 Vic.**

Transcending transceiver

A new precision-engineered "air band" VHF transceiver from Icom has full 108 to 136 MHz band coverage with 16 user-programmable channels.

The IC-A20 has 720 COM channels and 200 NAV channels, and VOR decoder. VOR readings can be taken directly from the front panel LED, showing frequency of the VOR station and the bearing to or from the station, and flight path deviation can also be read at the touch of a button in 2° increments.

The 121.5 MHz emergency frequency can be called up instantly at the touch of a button.

Its case is weatherproof, dust-tight and designed to withstand rough handling. Size: 65 x 198 x 35 mm.

Icom frequents **7 Duke St, Windsor, 3181 Vic.**

Broadband power divider

A range of compact stripline two-and four-way power dividers used to distribute or combine RF power from signal sources in the 2 to 18 GHz range has been released by A.P. Imports.

An in-phase power divider from this family, connected to a signal source, will distribute the input signal equally to each output port with low VSWR and high isolation.

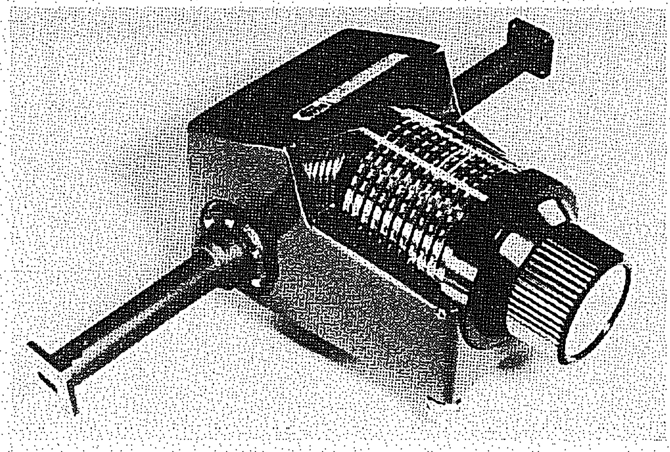
More details are available from **A.P. Imports, 61 Aero Rd, Ingleburn, Nsw 2565. (02)829 1555.**

Rotary vane attenuators

Claimed to be the best commercially available attenuators in the world, a line of microwave precision rotary vane attenuators from Flann provide high accuracy in direct reading, the company claims, when measuring attenuation from 0 to 60 dB within the waveguide bands covering 1.14 to 170 GHz.

However, the greatest attenuation possible exceeds the calibration range limit of 60 dB, the additional attenuation permitting scale alignment beyond the basic range requirement. This contributes to the enhanced accuracy specification of 0.1 dB or one per cent of scale reading, whichever is greater. The SWR for most models is <1.15.

A feature of these Flann attenuators is a "user check" to verify the symmetrical attenuation characteristic's alignment with the direct reading drum scale.



In a series of waveguide couplers, developed for laboratories for quality network analyser or reflectometer systems, more than 50 dB directivity is said to be available.

They are in all rectangular waveguide sizes between 2.6 ands 40 GHz, with models being developed to 140 GHz. The three port design incorporates a precision load in the terminated fourth port. Coupling sensitivity of better than ±0.5 dB is maintained over the full waveguide band.

Standard coupling values are 3, 10 and 20 dB but other values can be considered.

Contact **Anitech at 1-5 Carter St, Lidcombe, 2141 NSW.**

SAPS foretells future

Shortwave (high frequency) radio users can produce their own frequency predictions with SAPS, the "stand alone prediction system" offered by the Ionospheric Prediction Service.

The program is a PC software package produced by IPS Radio and Space Services and its MS-DOS version, with a comprehensive SAPS users' guide, is retailing at $250.

Recommended hardware is the IBM PC XT/AT or compatible, EGA, Hard Disk. (CGA/Hercules Graphics and dual floppy disk systems also supported).

SAPS is distributed on seven 360K floppy disks.

The program produces HF predictions for circuits anywhere in the world, and it is easily installed. Its user-friendly interface includes on-screen help, graphics and colour.

Databases are managed simply. They contain ionospheric indices, terminals, circuits and predictions, and frequency sets and antenna details. Predictions can be easily computed for a new month or ionospheric index.

SAPS prepares useful reports including GRAFEX frequency predictions, daily frequency management and antenna selection information.

A monthly bulletin from IPS updates ionospheric indices.

Bounce your request for more about SAPS to the **IPS Radio and Space Services, P.O. Box 702, Darlinghurst, 2010 NSW.**

Do-it-yourself HF propagation predictions using a PC

Part 2

Leo MacNamara and Roger Harrison VK2ZTB

In Part 1, we described how the basic MUF of the ionosphere is calculated. But that information in itself is not particularly useful. This article describes a program, and how to use it, which gives practical HF propagation predictions that provide a wealth of information for the professional or enthusiast with an IBM PC or close compatible.

THE PROGRAM DESCRIBED HERE, known as MINIFTZ4, generates a printout of very useful, detailed HF propagation predictions for a given frequency or a range of frequencies, and a given path between any two points on the Earth's surface, providing the following information:

- the maximum usable frequency (MUF)
- the optimum frequency to use (FOT)
- the lowest usable frequency (LUF)
- signal strength
- the number of 'hops' via the ionosphere
- the angle of elevation
- the path bearing (azimuth) at each end
- the path distance, and
- all of this for *each hour* of the day!

The program employs a method which is tailored (by making some simplifying assumptions) for use on a microcomputer such as the ubiquitous PC. MINIFTZ4, like the program described in Part 1, was written by T. Damboldt and P. Suessmann of the West German Post Office (7).

MINIFTZ4 requires 24K of memory, and is based on measured field-strength data and on a field strength formula developed by B. Beckmann (Ref. 1). The accuracy of the results compares very favourably with that of mainframe field strength prediction programs, with an average error of about 0 db and an RMS error (that is, the mean range of the error) of about 11 dB. Fading is often more than that!

The method

The prediction method employed in MINIFTZ4 involves four basic steps:

- determination of the basic MUF (see Part 1)
- determination of the upper frequency limit
- determination of the lower frequency limit, and
- and estimate of the variation in field strength with frequency within these limits.

Now let's look at some of the details on how these are calculated.

Finding the basic MUF

For the path (or circuit) which you specify, several "control points" are determined in order to determine the basic MUF for the path. For single-hop paths, this is the mid-point, assuming a single hop via the E-layer is less than 2000 km, for the F-layer, less than 4000 km — note these simplifying assumptions. For multi-hop paths the control points are the midpoints of the first and last hops.

For long, multi-hop circuits, particularly where they pass through the auroral zones (which ring the north and south magnetic poles), it was found necessary to take into account a third control point, at the path mid-point.

The hop length is calculated by dividing the great circle distance into hops of a maximum of 2000 km for the E-layer, and into hops of a maximum length of 4000 km for F2-layer propagation. The elevation angle is determined for the given hop length and a reflection height of 100 km (E-layer) and 300 km (F2-layer), respectively. If the elevation angles are below the wanted minimum elevation angle, the number of hops is increased by one and the calculation of elevation angles repeated until until the wanted minimum elevation angle is exceeded.

Each of the twenty four hourly values of the F2-layer MUF (F2(4000)) are determined in the sub-program FTZMUF2 described in Part 1 (see also, Ref. 6). These hourly values are converted into the F2 basic MUF by applying the simple formula:

$$F2(D)MUF = F2(4000)MUF.F_D$$

where F_D is a function of the hop length.

The critical frequencies for the E-layer ($f_C(E)$) are determined from a formula derived by Karl Rawer (Ref. 4) and depend on the geographical latitude, the Sun's zenith angle and the 12-month running mean of the Sunspot number. Then the twenty four hourly values of the E-layer MUF, E(D)MUF, are determined by applying this formula:

$$E(D)MUF = f_C(E).5.E_D$$

where E_D is a function of the hop length.

The basic MUF for the whole circuit is chosen by taking the *higher* value of the E-or F2-MUF for each control point, and then taking the *lowest* value for all three control points.

HF-FIELD STRENGTH ESTIMATED BY MINIFTZ4.1

CIRCUIT : CANBERRA - HONSHU JAPAN
LOCATION: 35.5S 149.2E 36.0N 138.0E
AZIMUTH : 350.5 DEG. 170.4 DEG.
DISTANCE: 8035 KM
MIN-ANG. : 3.0 DEG.

MONTH : DEC. 88
SSN : 102
POWER : 0.400 KW
TX-GAIN: 2.2 DB

FIELD STRENGTH IN DB ABOVE 1 UV/M FOR 90 PERCENT OF TIME

UTC	MUF	DBU	FOT	3.0	4.0	5.0	6.0	8.0	10.0	12.0	15.0	18.0	22.0	26.0
1	24.4	-21	19.6	....	....	....	....	....	....	....	-28	-20	-19	-23
2	25.0	-21	18.8	....	....	....	....	....	....	....	-29	-20	-18	-22
3	25.4	-20	20.4	....	....	....	....	....	....	....	-29	-20	-17	-21
4	25.1	-20	20.6	....	....	....	....	....	....	....	-27	-19	-17	-21
5	24.8	-19	20.3	....	....	....	....	....	....	....	-25	-18	-17	-21
6	24.2	-18	19.8	....	....	....	....	....	....	-36	-20	-15	-16	-21
7	23.8	-16	19.4	....	....	....	....	....	....	-25	-14	-11	-13	-21
8	23.4	-12	19.4	....	....	....	....	-27	-12	-4	-1	-2	-9	-18
9	22.8	-9	18.4	....	....	-35	-20	-5	2	6	5	2	-7	-17
10	22.4	-9	18.0	....	-35	-18	-8	3	7	9	7	2	-8	-18
11	22.0	-8	17.6	....	-19	-7	0	7	10	11	8	3	-8	-18
12	22.0	-8	17.5	-23	-8	1	6	11	13	13	9	3	-8	-18
13	21.7	-7	17.1	-6	4	9	11	14	15	14	10	3	-8	-19
14	21.2	-8	17.2	-6	4	9	11	14	15	13	9	2	-10	-20
15	20.0	-9	15.7	-6	3	8	11	14	14	12	6	-2	-16	-25
16	18.9	-10	14.6	-6	3	8	11	13	13	10	3	-7	-20	-31
17	17.7	-11	13.7	-6	3	8	11	12	11	8	-1	-12	-26	-39
18	16.2	-14	12.4	-6	3	7	10	11	8	3	-8	-22	-36	....
19	13.1	-14	10.1	-6	2	7	8	7	1	-8	-24	-36	....	....
20	12.4	-18	9.6	....	-39	-22	-13	-7	-9	-16	-29	....	....	....
21	16.8	-22	13.1	....	....	....	....	-32	-19	-15	-17	-26	-35	....
22	23.5	-19	18.3	....	....	....	....	....	....	-25	-15	-12	-16	-24
23	23.8	-19	18.8	....	....	....	....	....	....	-36	-21	-16	-17	-23
24	23.9	-20	19.2	....	....	....	....	....	....	....	-26	-19	-18	-24

TABLE 1. Typical field strength/frequency prediction produced by MINIFTZ4. The text explains the details.

MODES AND ELEVATION ANGLES ESTIMATED BY MINIFTZ4.1

CIRCUIT : CANBERRA - HONSHU JAPAN
LOCATION: 35.5S 149.2E 36.0N 138.0E
AZIMUTH : 350.5 DEG. 170.4 DEG.
DISTANCE: 8035 KM
MIN-ANG. : 3.0 DEG.

MONTH : DEC. 88
SSN : 102
POWER : 0.400 KW
TX-GAIN: 2.2 DB

MODES AND ELEVATION ANGLES

UTC	MUF	MODE	FOT	3.0	4.0	5.0	6.0	8.0	10.0	12.0	15.0	18.0	22.0	26.0
1	24.4	3F09	19.6	....	....	....	....	....	....	....	3F09	3F09	3F09	3F09
2	25.0	3F10	18.8	....	....	....	....	....	....	....	3F10	3F10	3F10	3F10
3	25.4	3F10	20.4	....	....	....	....	....	....	....	3F10	3F10	3F10	3F10
4	25.1	3F09	20.6	....	....	....	....	....	....	....	3F09	3F09	3F09	3F09
5	24.8	3F09	20.3	....	....	....	....	....	....	....	3F09	3F09	3F09	3F09
6	24.2	3F09	19.8	....	....	....	....	....	....	3F09	3F09	3F09	3F09	3F09
7	23.8	3F09	19.4	....	....	....	....	....	....	3F09	3F09	3F09	3F09	3F09
8	23.4	3F09	19.4	....	....	....	....	3F09	3F09	3F09	3F09	3F09	3F09	3F09
9	22.8	3F09	18.4	....	....	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09
10	22.4	3F09	18.0	....	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09
11	22.0	3F09	17.6	....	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09
12	22.0	3F09	17.5	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09	3F09
13	21.7	3F08	17.1	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08
14	21.2	3F08	17.2	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08
15	20.0	3F08	15.7	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08
16	18.9	3F08	14.6	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	....
17	17.7	3F08	13.7	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	3F08	....
18	16.2	3F07	12.4	3F07	3F07	3F07	3F07	3F07	3F07	3F07	3F07	3F07	3F07	....
19	13.1	3F07	10.1	3F07	3F07	3F07	3F07	3F07	3F07	3F07	3F07	....	....	....
20	12.4	3F07	9.6	....	3F07	3F07	3F07	3F07	3F07	3F07	3F07	....	....	....
21	16.8	3F07	13.1	....	....	....	....	3F07	3F07	3F07	3F07	3F07	3F07	....
22	23.5	3F07	18.3	....	....	....	....	....	....	3F07	3F07	3F07	3F07	3F07
23	23.8	3F08	18.8	....	....	....	....	....	....	3F08	3F08	3F08	3F08	3F08
24	23.9	3F09	19.2	....	....	....	....	....	....	....	3F09	3F09	3F09	3F09

TABLE 2. Typical modes/angles predictions produced from the same set of input data as used for Table 1, also explained in the text.

The upper frequency limit

The basic MUF denotes the highest frequency that can be propagated by a particular mode (that is, reflections via the E- and/or F-layer) between specified points (or terminals) on the Earth by ionospheric refraction.

However, experience has shown that reception is possible above the basic MUF. The receiving field strength (that is, signal strength) does not abruptly fall off when the basic MUF is exceeded (Ref. 3) — something which every DXer knows from experience — the signal strength decreasing gradually with increasing frequency. Therefore, the "operational MUF" increases with increasing transmitting power.

In most cases the operational MUF can be substantially higher than the basic MUF. This is the consequence of of several mechanisms which are not taken into account by prediction techniques based on the theoretical considerations of effective propagation modes. The efficiency of these mechanisms increases with increasing beamwidth of the transmitting and receiving antennas.

Since, at present, it is not possible to determine quantitively all influences using suitable formulae, empirical "corrections" or adjustments are applied by this program to each of the 24 hourly values of the basic F2(D)MUF in order to get the "upper frequency limit, whic here is a special case of the "operational MUF".

The dynamics of the ionosphere manifest themselves in the diurnal (daily) and seasonal variations of the basic MUF. On the other hand, ionospheric irregularities become more apparent the more the height of the F-layer increases and its critical frequency decreases. Consequently, greater corrections are made for winter nights when the MUF values are lowest.

The lower frequency limit

After the upper limit of the transmission frequency range has been determined, the ionospheric absorption which influences the lower limit of the transmission frequency range, is computed.

Towards the lower frequency end of the HF range, the non-deviative D-layer absorption — where the radio wave travels directly through the D-layer without deviating (Ref. 5) — plays a decisive rôle. The lower frequency limit is calculated using a formula for non-deviative absorption which depends on factors which include the Sun's zenith angle, the angle of incidence at the D-layer, the number of hops and a variety of ionospheric parameters.

One formula is used to determine the lower frequency limit for the daylight hours, and another to determine it during the night. During the night, the lower frequency limit is assumed to be dependent only on the distance between the transmitter and receiver. For a distance of 3000 km, the night-LUF turns out to be 1 MHz. As there is a certain lag between the time of sunset and the decrease of region ionisation, the decay from day-LUF to night-LUF is supposed

- to last for three hours
- to begin at double the night-LUF, and
- to drop exponentially.

During the three-hour "twilight zone" interval, the LUF is obtained using a simple formula which decays the day-LUF exponentially.

After the upper and lower frequency range have been determined, the next step is to compute the field strength as a function of the frequency within these maximum and minimum frequency limits.

Signal strength versus frequency

Field strength recordings made by the Deutsche Bundepost for many years clearly show that the field strength of trasmissions propagated via the ionosphere steadily increases from the lower frequency limit to the higher frequency limit After a maximum value is reached, the field strength decreases steadily until it reaches the upper frequency limit. The basic MUF lies on that part of the curve *after* the maximum field strength value. Up to this frequency, propagation takes place by refraction from the ionosphere. Above the basic MUF, propagation by off-great-circle and scatter mechanisms occurs.

As a consequence of these observational facts, Beckmann (Ref. 1) developed a formula for calculating field strength, which is used in this program. The formula takes into account the transmitted power, the antenna gain, the distance between the transmitter and receiver, absorption and the upper and lower frequency limits previously determined. In addition, allowance is made for the influence of the Earth's magnetic field on the ionosphere.

Beckmann's formula, it should be stressed, empirically comprises all the different factors affecting propagation. Propagation modes, polarisation loss, "blanketing" (of the F-layer by the E-layer) and other phenomena are not dealt with separately as is done in the more complex analytical field strength prediction methods. These phenomena are partly accounted for in determining the frequency range (upper and lower frequency limits).

At short distances, the operational MUF can be substantially higher than the upper frequency limit, leading to higher field strengths than those calculated by the formula. This is taken into account by an additional correction factor which increases the field strength above the basic MUF for ranges up to 4000 km. This correction factor is a function of distance of the ratio (f/basic MUF). It is zero for distances ≥4000 km.

MINIFTZ4 works out the field strength with respect to a one megawatt (1 MW) transmitter, then subtracts 30 dB because, in practice, the transmitter powers are normalised to 1 kW effective radiated power (erp). The figure of 1 MW is used is because the lower and upper frequency limits are defined here as the frequency where the field strength of a 1 MW transmitter is 1 µV per metre (1 µV/m). That's quite a weak signal. You'll get more of a "handle" on how field strengths relate to signal strengths a bit later.

Input and output

The program requires the following information:

- month
- year
- Sunspot number (SSN)
- transmitter "name"
- transmitter latitude and longitude
- receiver "name"
- receiver latitiude and longitude
- transmitter power
- transmitter antenna gain (in dBi)
- percentage of days prediction holds
- short or long path
- minimum elevation angle
- option for elevation angle/mode printout
- frequencies (maximum of 11)

We'll go through the requirements for the input data with a few real-life examples shortly.

For output, the program calculates hourly values of the basic MUF, the field strength at the basic MUF, the optimum frequency to use (which here is the 90 percent basic MUF) — known by its French acronym, FOT — and the field strength for any specified frequencies up to a maximum of 11 frequencies. The printout of field strength is suppressed when it goes below -40 dB with respect to 1 µV/metre. The sort of output you get is shown in Table 1.

This is for a path between Canberra and the island of ▷

HF-FIELD STRENGTH ESTIMATED BY MINIFTZ4.1

CIRCUIT : CANBERRA - ADELAIDE
LOCATION: 35.5S 149.2E 34.7S 138.6E
AZIMUTH : 272.2 DEG. 98.3 DEG.
DISTANCE: 968 KM
MIN-ANG.: 10.0 DEG.

MONTH : JAN. 89
SSN : 105
POWER : 0.400 KW
TX-GAIN: 1.2 DB

FIELD STRENGTH IN DB ABOVE 1 UV/M FOR 90 PERCENT OF TIME

UTC	MUF	DBU	FOT	1.8	3.6	7.1	10.1
1	13.2	13	13.2	...	...	10	17
2	13.5	13	13.5	...	...	9	16
3	13.4	13	13.4	...	...	9	16
4	13.2	13	13.2	...	...	10	17
5	12.7	13	12.7	...	-37	11	17
6	11.9	14	11.9	...	-30	13	17
7	11.1	15	10.7	...	-20	16	17
8	10.8	17	9.1	...	-8	20	18
9	10.3	20	8.4	-27	12	26	21
10	9.9	21	8.0	-9	19	27	19
11	9.4	21	7.6	-1	22	28	17
12	9.1	22	7.3	5	25	28	15
13	8.8	22	7.0	9	26	28	13
14	8.5	22	6.9	9	26	27	12
15	8.2	22	6.5	9	26	26	10
16	7.8	22	6.1	9	26	25	9
17	7.5	22	5.8	9	26	23	7
18	7.4	22	5.7	9	26	23	6
19	7.7	22	5.9	9	26	24	8
20	8.6	18	6.9	-39	8	21	9
21	9.7	15	9.4	...	-10	17	13
22	11.0	15	11.0	...	-22	15	16
23	12.0	14	12.0	...	-32	13	17
24	12.8	13	12.8	...	-38	11	17

MODES AND ELEVATION ANGLES ESTIMATED BY MINIFTZ4.1

CIRCUIT : CANBERRA - ADELAIDE
LOCATION: 35.5S 149.2E 34.7S 138.6E
AZIMUTH : 272.2 DEG. 98.3 DEG.
DISTANCE: 968 KM
MIN-ANG.: 10.0 DEG.

MONTH : JAN. 89
SSN : 105
POWER : 0.400 KW
TX-GAIN: 1.2 DB

MODES AND ELEVATION ANGLES

UTC	MUF	MODE	FOT	1.8	3.6	7.1	10.1
1	13.2	1E11	13.2	....	....	1E11	1E11
2	13.5	1E11	13.5	....	....	1E11	1E11
3	13.4	1E11	13.4	....	....	1E11	1E11
4	13.2	1E11	13.2	....	....	1E11	1E11
5	12.7	1E11	12.7	....	1E11	1E11	1E11
6	11.9	1E11	11.9	....	1E11	1E11	1E11
7	11.1	1F33	10.7	....	1E11	1E11	1E11
8	10.8	1F33	9.1	....	1E11	1E11	1F33
9	10.3	1F33	8.4	1E11	1E11	1F33	1F33
10	9.9	1F33	8.0	1F33	1F33	1F33	1F33
11	9.4	1F33	7.6	1F33	1F33	1F33	1F33
12	9.1	1F34	7.3	1F34	1F34	1F34	1F34
13	8.8	1F34	7.0	1F34	1F34	1F34	1F34
14	8.5	1F34	6.9	1F34	1F34	1F34	1F34
15	8.2	1F34	6.5	1F34	1F34	1F34	1F34
16	7.8	1F34	6.1	1F34	1F34	1F34	1F34
17	7.5	1F34	5.8	1F34	1F34	1F34	....
18	7.4	1F34	5.7	1F34	1F34	1F34	....
19	7.7	1F34	5.9	1F34	1F34	1F34	1F34
20	8.6	1F33	6.9	1E11	1E11	1F33	1F33
21	9.7	1F33	9.4	....	1E11	1E11	1F33
22	11.0	1E11	11.0	....	1E11	1E11	1E11
23	12.0	1E11	12.0	....	1E11	1E11	1E11
24	12.8	1E11	12.8	....	1E11	1E11	1E11

TABLE 3.

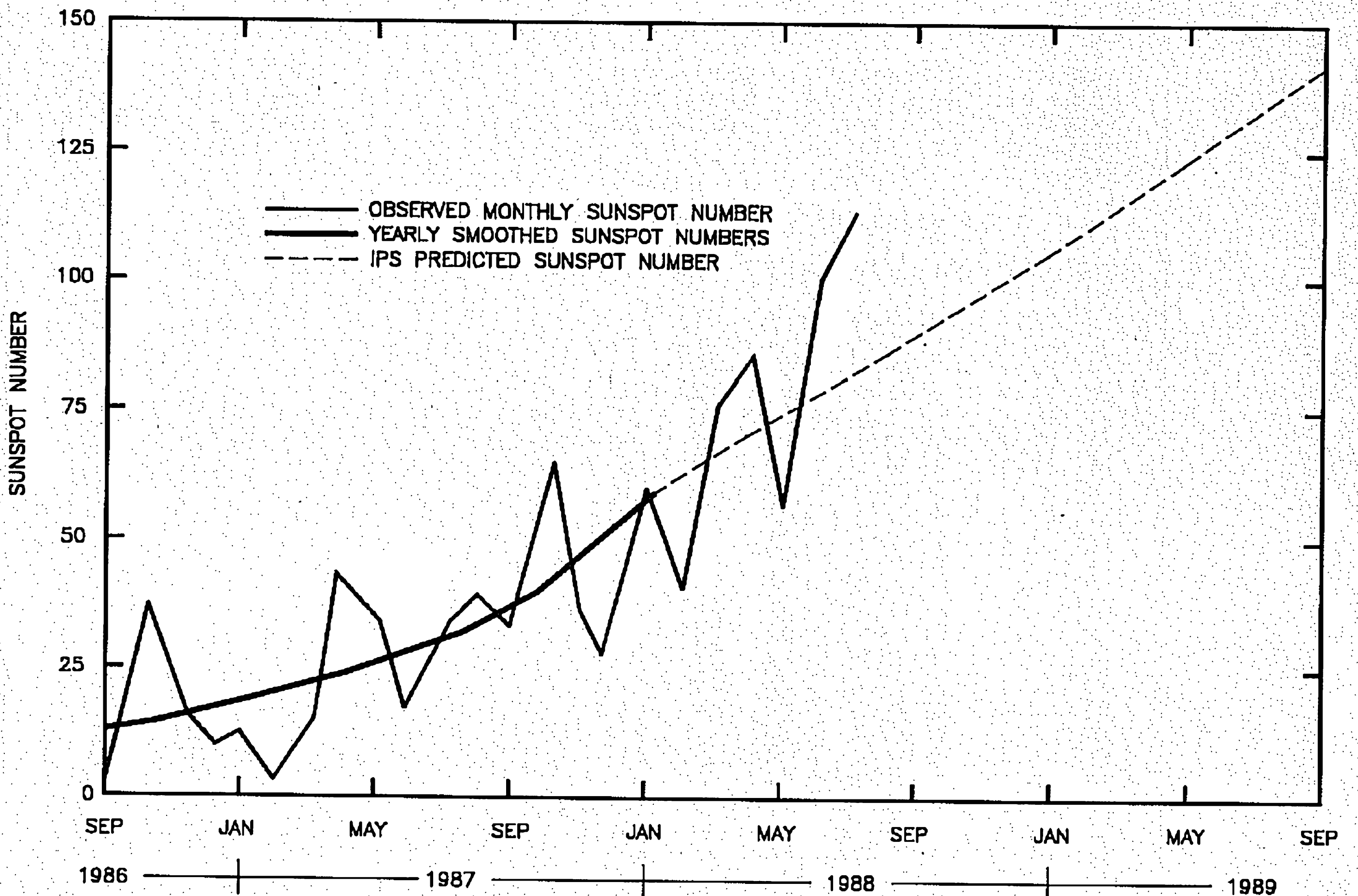


Figure 1. You can use the dashed curve here to derive predicted Sunspot number up to September 1989. This chart is taken from that produced by IPS Radio and Space Services in their monthly geophysical summary. We will be publishing updates in the magazine from time to time.

Honshu, Japan. At the receiving end, the signal will cover a wide area with little variation in field strength, so the latitude and longitude here have only been specified within 1°. The Sunspot number of 102 has been taken from the IPS Radio and Space Services graph shown here in Figure 1. A transmitter power of 400 W has been arbitarily chosen, while the antenna gain ("TX-GAIN"), given as 2.2 dB, represents a dipole antenna. The "default" minimum angle of 3° was taken and the default range of 11 frequencies used. The prediction is calculated for the path being available for 90% of the time. You get options of 10, 50 and 90 per cent.

The left-most column of Table 1 gives time in UTC; you have to add or subtract the required number of hours for the time zone appropriate to the transmitter and receiver time zones to determine local time. The next column to the right lists the predicted MUF, while the DBU column next to it shows the field strength at the MUF. The FOT column shows the optimum working frequency. The field strengths for each hour at each of the 11 default frequencies is plotted to right. If you rotate the table 90° anticlockwise, you can see the form of the old MUF-ALF curves in vogue 10-20 years ago.

The program includes an option to print out propagation modes and elevations angles, producing a similar table to that for field strength versus frequency in Table 1. This is shown in Table 2 for the same path. As in Table 1, UTC is on the left, followed by the MUF, then the mode and FOT. The modes and elevation angles for each hour and the 11 default frequencies are plotted to the right.

The mode is in 'hops' and 'elevation angle'; '3F' tells us that the signal arrives via three hops and the '08', '09' and '10' following tell us that the signal's angle of elevation is variously 8°, 9° and 10°. Scanning Table 2, you can see that the predicted angle of elevation varies from 7° to 10°.

Now, what to make of the field strength figures predicted? Well, the conversion of field strength to volts delivered to your receiver's antenna terminals is not a simple matter, and beyond the scope of this article. Even so, it's not a simple matter of signal volts at the antenna, but the *signal-to-noise ratio*. On the HF bands below 30 MHz, atmospheric and man-made noise predominate so the signal arriving at the antenna must compete with the noise arriving at the antenna.

In "quiet" suburban or rural locations, atmospheric noise from electrical discharges in the atmosphere is dominant, rising from 1 MHz and peaking around 9-10 MHz, falling sharply above 15 Mhz. It's worse in summer, least in winter and varies with geographic location, being worse in the tropics than at high latitudes. Man-made noise in and around cities will generally override atmospheric noise, peaking in industrial areas and around central and regional business districts. It rises steadily with decreasing frequency.

So, how much noise, in µV/m do you have to compete with? In a quiet location, where atmospheric noise predominates, it might range from under 0.5 µV/m to about 2 µV/m. In urban and suburban regions, where man-made noise predominates, the local noise field strength may range from around 1-2 µV/m to 10 µV/m provided you're not "next door" to a source of RF noise. These figure relate to measurements with a short vertical antenna over good ground. Any gain in the antenna will reduce the noise pickup accordingly.

Now, a 9-10 dB signal-to-noise ratio is a fairly "noisy" signal, but quite "readable" for voice communications. Much lower signal-to-noise ratios can be tolerated for Morse, radioteletype and other narrowband "digital" modes. For quiet locations, field

HF-FIELD STRENGTH ESTIMATED BY MINIFTZ4.1

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CIRCUIT : NORTH QLD    - STHN JAPAN            MONTH   :   MAR. 89
LOCATION: 20.0S 149.0E   34.0N 134.0E          SSN     :       125
AZIMUTH : 345.0 DEG.      162.9 DEG.           POWER   :  0.400 KW
DISTANCE:  6211 KM                             TX-GAIN:     9.0 DB
MIN-ANG.:   3.0 DEG.
```

FIELD STRENGTH IN DB ABOVE 1 UV/M FOR 50 PERCENT OF TIME

UTC	MUF	DBU	FOT	14.2	21.3	28.5
1	32.8	3	26.7	-13	6	7
2	31.9	2	26.4	-15	4	5
3	31.6	2	26.6	-15	4	5
4	31.8	3	26.5	-14	5	5
5	32.1	3	26.5	-10	7	6
6	32.9	4	26.9	-5	9	8
7	33.0	6	26.8	2	13	10
8	32.7	8	26.3	15	18	13
9	31.8	9	25.4	24	22	14
10	31.0	9	24.7	26	22	13
11	30.0	10	23.9	28	22	12
12	29.7	10	23.6	29	23	12
13	30.3	10	24.1	31	24	13
14	30.2	10	24.1	31	24	13
15	28.0	10	22.0	30	21	9
16	26.1	10	20.4	28	19	4
17	23.6	10	18.4	26	15	-3
18	20.2	10	15.7	23	7	-17
19	18.4	9	14.2	20	0	-28
20	16.9	8	12.9	16	-8	...
21	20.6	3	15.7	10	2	-18
22	29.0	3	22.4	2	9	3
23	34.5	5	27.2	-4	11	10
24	34.3	4	27.5	-10	8	9

MODES AND ELEVATION ANGLES ESTIMATED BY MINIFTZ4.1

```
CIRCUIT : NORTH QLD    - STHN JAPAN            MONTH   :   MAR. 89
LOCATION: 20.0S 149.0E   34.0N 134.0E          SSN     :       125
AZIMUTH : 345.0 DEG.      162.9 DEG.           POWER   :  0.400 KW
DISTANCE:  6211 KM                             TX-GAIN:     9.0 DB
MIN-ANG.:   3.0 DEG.
```

MODES AND ELEVATION ANGLES

UTC	MUF	MODE	FOT	14.2	21.3	28.5
1	32.8	2F07	26.7	2F07	2F07	2F07
2	31.9	2F07	26.4	2F07	2F07	2F07
3	31.6	2F07	26.6	2F07	2F07	2F07
4	31.8	2F07	26.5	2F07	2F07	2F07
5	32.1	2F07	26.5	2F07	2F07	2F07
6	32.9	2F07	26.9	2F07	2F07	2F07
7	33.0	2F07	26.8	2F07	2F07	2F07
8	32.7	2F07	26.3	2F07	2F07	2F07
9	31.8	2F07	25.4	2F07	2F07	2F07
10	31.0	2F07	24.7	2F07	2F07	2F07
11	30.0	2F07	23.9	2F07	2F07	2F07
12	29.7	2F06	23.6	2F06	2F06	2F06
13	30.3	2F06	24.1	2F06	2F06	2F06
14	30.2	2F06	24.1	2F06	2F06	2F06
15	28.0	2F05	22.0	2F05	2F05	2F05
16	26.1	2F05	20.4	2F05	2F05	2F05
17	23.6	2F05	18.4	2F05	2F05	2F05
18	20.2	2F05	15.7	2F05	2F05	....
19	18.4	2F05	14.2	2F05	2F05	....
20	16.9	2F04	12.9	2F04	2F04	....
21	20.6	2F04	15.7	2F04	2F04	....
22	29.0	2F05	22.4	2F05	2F05	2F05
23	34.5	2F05	27.2	2F05	2F05	2F05
24	34.3	2F06	27.5	2F06	2F06	2F06

TABLE 4.

HF-FIELD STRENGTH ESTIMATED BY MINIFTZ4.1

CIRCUIT : ADELAIDE - W.GERMANY
LOCATION: 34.7S 138.6E 54.0N 7.0E
AZIMUTH : 315.2 DEG. 80.1 DEG.
DISTANCE: 15722 KM
MIN-ANG.: 5.0 DEG.

MONTH : JAN. 89
SSN : 105
POWER : 0.400 KW
TX-GAIN: 2.2 DB

FIELD STRENGTH IN DB ABOVE 1 UV/M FOR 50 PERCENT OF TIME

UTC	MUF	DBU	FOT	3.5	7.1	10.1	14.2	21.3	28.5
1	9.0	...	7.1	...	...	-34	-26	...	...
2	8.2	...	6.5	...	...	...	-40	...	...
3	8.0	...	6.3	...	...	...	...	...	...
4	9.3	...	7.3	...	...	...	...	...	...
5	12.0	...	9.6	...	...	...	-30	-29	...
6	15.6	-31	12.4	...	...	...	-36	-25	-37
7	19.1	-23	15.3	...	...	...	-39	-21	-28
8	21.6	-19	17.4	...	...	...	-40	-19	-22
9	22.6	-15	18.7	...	...	...	-35	-15	-18
10	21.6	-10	17.4	...	...	...	-23	-10	-16
11	20.7	-4	16.6	...	...	-20	-5	-4	-17
12	19.8	1	15.8	...	-13	2	6	-2	-19
13	19.3	3	15.4	-39	4	11	10	-1	-21
14	18.8	4	14.8	-20	10	14	11	-2	-23
15	18.2	1	14.7	-7	14	15	10	-7	-33
16	16.3	0	13.2	-2	14	13	6	-16	...
17	14.0	1	11.2	-2	12	10	0	-29	...
18	12.0	0	9.5	-3	10	6	-8	...	...
19	10.5	0	8.3	-3	8	2	-16	...	...
20	9.7	0	7.6	-4	6	-1	-21	...	...
21	9.2	-2	7.2	-18	1	-5	-25	...	...
22	9.2	-14	7.4	...	-20	-14	-25	...	...
23	9.5	-23	7.4	...	-38	-21	-24	...	...
24	9.5	-31	7.5	...	...	-28	-25	...	...

MODES AND ELEVATION ANGLES ESTIMATED BY MINIFTZ4.1

CIRCUIT : ADELAIDE - W.GERMANY
LOCATION: 34.7S 138.6E 54.0N 7.0E
AZIMUTH : 315.2 DEG. 80.1 DEG.
DISTANCE: 15722 KM
MIN-ANG.: 5.0 DEG.

MONTH : JAN. 89
SSN : 105
POWER : 0.400 KW
TX-GAIN: 2.2 DB

MODES AND ELEVATION ANGLES

UTC	MUF	MODE	FOT	3.5	7.1	10.1	14.2	21.3	28.5
1	9.0	....	7.1	....	....	6F08	....	....	....
2	8.2	....	6.5	....	....	....	....	....	....
3	8.0	....	6.3	....	....	....	....	....	....
4	9.3	....	7.3	....	....	....	....	....	....
5	12.0	....	9.6	....	....	....	6F08	....	....
6	15.6	6F08	12.4	....	....	....	6F08	....	....
7	19.1	6F08	15.3	....	....	....	6F08	6F08	....
8	21.6	6F08	17.4	....	....	....	6F08	6F08	....
9	22.6	6F08	18.7	....	....	....	6F08	6F08	....
10	21.6	6F08	17.4	....	....	....	6F08	6F08	....
11	20.7	6F08	16.6	....	....	6F08	6F08	6F08	....
12	19.8	6F08	15.8	....	6F08	6F08	6F08	6F08	....
13	19.3	6F08	15.4	6F08	6F08	6F08	6F08	6F08	....
14	18.8	6F08	14.8	6F08	6F08	6F08	6F08	6F08	....
15	18.2	6F08	14.7	6F08	6F08	6F08	6F08	6F08	....
16	16.3	6F08	13.2	6F08	6F08	6F08	6F08	....	....
17	14.0	6F08	11.2	6F08	6F08	6F08	6F08	....	....
18	12.0	6F08	9.5	6F08	6F08	6F08	6F08	....	....
19	10.5	6F08	8.3	6F08	6F08	6F08	....	....	....
20	9.7	6F08	7.6	6F08	6F08	6F08	....	....	....
21	9.2	6F08	7.2	6F08	6F08	6F08	....	....	....
22	9.2	6F08	7.4	....	6F08	6F08	....	....	....
23	9.5	6F08	7.4	....	6F08	6F08	....	....	....
24	9.5	6F08	7.5	....	....	6F08	....	....	....

TABLE 5.

HF-FIELD STRENGTH ESTIMATED BY MINIFTZ4.1

CIRCUIT : CANBERRA - HONSHU(JA)
LOCATION: 35.5S 149.2E 36.0N 138.0E
AZIMUTH : 350.5 DEG. 170.4 DEG.
DISTANCE: 8035 KM
MIN-ANG.: 5.0 DEG.

MONTH : DEC. 88
SSN : 102
POWER : 0.400 KW
TX-GAIN: 9.0 DB

FIELD STRENGTH IN DB ABOVE 1 UV/M FOR 50 PERCENT OF TIME

UTC	MUF	DBU	FOT	3.5	7.1	10.1	14.2	21.3	28.5
1	24.4	-2	19.6	...	...	...	-19	-2	-5
2	25.0	-2	18.8	...	...	...	-20	-2	-4
3	25.4	-1	20.4	...	...	...	-20	-2	-3
4	25.1	-1	20.6	...	...	...	-19	-1	-4
5	24.8	-1	20.3	...	...	...	-15	0	-4
6	24.2	0	19.8	...	...	...	-10	1	-4
7	23.8	3	19.4	...	...	-26	-3	4	-4
8	23.4	7	19.4	...	-23	2	12	10	-2
9	22.8	9	18.4	...	4	16	19	12	-3
10	22.4	10	18.0	-32	13	21	21	12	-4
11	22.0	11	17.6	-12	20	24	22	12	-5
12	22.0	11	17.5	2	24	26	23	12	-5
13	21.7	11	17.1	16	28	28	24	12	-6
14	21.2	11	17.2	16	28	28	24	11	-8
15	20.0	10	15.7	16	27	27	22	7	-16
16	18.9	9	14.6	15	27	25	20	2	-24
17	17.7	8	13.7	15	26	24	17	-4	-34
18	16.2	5	12.4	15	24	21	12	-15	...
19	13.1	5	10.1	14	21	15	0	-39	...
20	12.4	0	9.6	-38	5	6	-6	...	...
21	16.8	-3	13.1	...	-23	-6	0	-14	...
22	23.5	0	18.3	...	...	-27	-4	2	-8
23	23.8	0	18.8	...	...	...	-11	1	-5
24	23.9	-2	19.2	...	...	...	-16	-1	-6

MODES AND ELEVATION ANGLES ESTIMATED BY MINIFTZ4.1

CIRCUIT : CANBERRA - HONSHU(JA)
LOCATION: 35.5S 149.2E 36.0N 138.0E
AZIMUTH : 350.5 DEG. 170.4 DEG.
DISTANCE: 8035 KM
MIN-ANG.: 5.0 DEG.

MONTH : DEC. 88
SSN : 102
POWER : 0.400 KW
TX-GAIN: 9.0 DB

MODES AND ELEVATION ANGLES

UTC	MUF	MODE	FOT	3.5	7.1	10.1	14.2	21.3	28.5
1	24.4	3F09	19.6	....	....	....	3F09	3F09	3F09
2	25.0	3F10	18.8	....	....	....	3F10	3F10	3F10
3	25.4	3F10	20.4	....	....	....	3F10	3F10	3F10
4	25.1	3F09	20.6	....	....	....	3F09	3F09	3F09
5	24.8	3F09	20.3	....	....	....	3F09	3F09	3F09
6	24.2	3F09	19.8	....	....	....	3F09	3F09	3F09
7	23.8	3F09	19.4	....	....	3F09	3F09	3F09	3F09
8	23.4	3F09	19.4	....	3F09	3F09	3F09	3F09	3F09
9	22.8	3F09	18.4	....	3F09	3F09	3F09	3F09	3F09
10	22.4	3F09	18.0	3F09	3F09	3F09	3F09	3F09	3F09
11	22.0	3F09	17.6	3F09	3F09	3F09	3F09	3F09	3F09
12	22.0	3F09	17.5	3F09	3F09	3F09	3F09	3F09	3F09
13	21.7	3F08	17.1	3F08	3F08	3F08	3F08	3F08	....
14	21.2	3F08	17.2	3F08	3F08	3F08	3F08	3F08	....
15	20.0	3F08	15.7	3F08	3F08	3F08	3F08	3F08	....
16	18.9	3F08	14.6	3F08	3F08	3F08	3F08	3F08	....
17	17.7	3F08	13.7	3F08	3F08	3F08	3F08	3F08	....
18	16.2	3F07	12.4	3F07	3F07	3F07	3F07	3F07	....
19	13.1	3F07	10.1	3F07	3F07	3F07	3F07	....	....
20	12.4	3F07	9.6	3F07	3F07	3F07	3F07	....	....
21	16.8	3F07	13.1	....	3F07	3F07	3F07	3F07	....
22	23.5	3F07	18.3	....	....	3F07	3F07	3F07	3F07
23	23.8	3F08	18.8	....	....	....	3F08	3F08	3F08
24	23.9	3F09	19.2	....	....	....	3F09	3F09	3F09

TABLE 6.

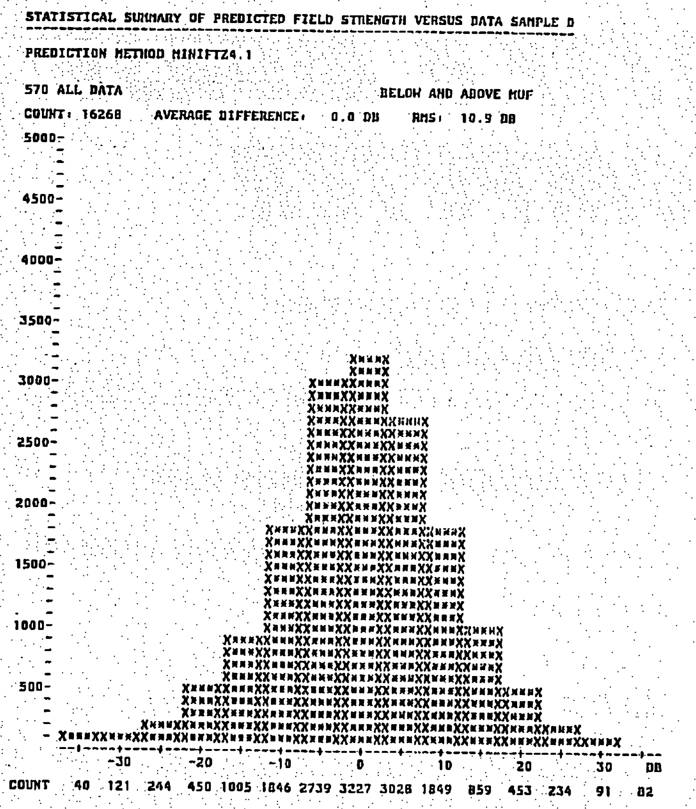


Figure 2. Comparison of predicted field strength produced by MINIFTZ4 versus observations published in CCIR Data Bank D for results below and above MUF.

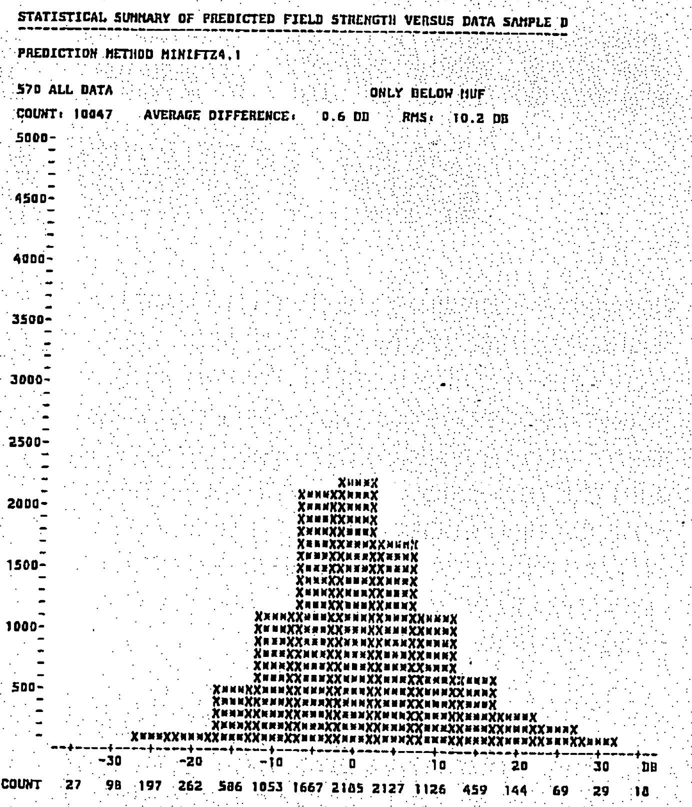


Figure 3. As per Figure 2, but for results only below the MUF.

strength predictions (as in Table 1) in the range 10-15 dB above 1 µV/m should give good results on voice signals.

Driving MINIFTZ4

The program requires an IBM PC XT/AT or close compatible and runs under GWBASIC or BASICA. For output, you will need a printer hooked up to the parallel printer port. When you load and run the program, it will ask for input in the order given above. For MONTH you enter the month's number (Jan. = 1, Feb. = 2, etc); for YEAR you enter the last two digits of the year (88 for 1988, 89 for 1989, etc). The SUNSPOT NUMBER you can take from Figure 1, using the dashed line. Keep your transmitter and receiver names short and to the point, otherwise the program asks you to do it again!

Note that, with the latitude and longitude coordinates, north and east are positive, south and west are negative. You don't need to enter a with north and east, but you *do* need to enter a — with south and west (no spaces!). While you can enter the coordinates accurate to one decimal place, it's not essential that you do, except perhaps for paths with a low elevation angle.

The transmitter power is normalised to 1 kW, so powers under a kilowatt are entered as a decimal fraction (0.4 for 400 W, 0.1 for 100 W, etc). You enter the antenna gain in dB referred to isotropic (dBi). A dipole has a gain of 2.15 dB over isotropic; use 2.1 or 2.2. Only one decimal place accuracy is required. A modest beam, say a three element Yagi or a cubical quad, might have a gain of 7-9 dBi.

You get three choices for percentage of days — 10, 50 and 90. A choice of 10% gives higher MUFs, 50% represents the median, while 90% gives "conservative" predictions (allowing 10% for disturbances, etc). When you come to short/long path, keep in mind the path you're considering. For example, with circuits that pass through the auroral zones on the short path, the long path may give better results.

When it comes to the mode/angle option, remember you can opt for a straight field strength/frequency prediction. Elevation angles may help in antenna choice. Next, the minimum angle need only be specified to one decimal place. In any case, accuracies of 0.5° would only be necessary under 10° elevation. If you're unsure of what elevation angle to use, just go for the default value of 3° (hit the ↵ key to select a default value).

Last, the program calls for the frequencies for which predictions are required, with a maximum of 11. The default frequencies are shown in Table 1. To enter your own frequencies, start with the lowest, enter that and press ↵ ; enter the next, and so on. After you've entered the last, enter 0 ↵ (zero). If you enter frequencies that exceed the MUF, where the field strength drops below -40 dB (wrt 1 µV/m) the program will exclude it from the printout.

The program will then respond with CALCULATING...... and some 6-10 minutes later, your printer will fire up and commence printing the output tables. The program also calculates and prints out the azimuth (or bearing) for each station or terminal, and the distance in kilometres.

Accuracy

An extensive comparison of MINIFTZ4 field strength predictions with observations shows that the average error is about

— to p.123 ▷

The programs FTZMUF2 and MINIFTZ4 are available together on one 5.25" disk to run under PC-DOS/MS-DOS, from:

AEM Software Service
1st Floor, 347 Darling St
BALMAIN NSW 2041

The cost is $22, which includes sales tax, post and handling. Payment may be made by cheque or money order, or you may quote your credit card details (name, no. & expiry date).

Novices! Welcome to two metres – a primer, Part 4

Ben Furby VK2XNZ and Roger Harrison VK2ZTB

Two metres FM is ideal for mobile operation. The nature of FM modulation and detection, and the widespread use of repeaters, provides signals of good quality undisturbed by electrical noise generated by your own and other vehicles. And many other advantages accrue from those characteristics.

IF YOU ARE squashed up in a ground floor flat in a 10-storey apartment block, mobile operation lets you indulge in ham radio without hassles trying (a) to get an aerial on the roof and (b) getting a feeder from the roof down to your home. As a passenger, 2 m mobile allows you to sit back and let your partner/spouse/friend do the driving while you enjoy yourself making contacts as you go along.

You can practise your hobby when you go away on holiday, and get advice on local points of interest, detours, stopping points etc. You mightn't be able to call for help if you break down 200 km from Alice Springs on the Birdsville Track, unless the sporadic E is running well at the time (hah! — hope is a slim diet). It's usually in the more populous areas that 2 m mobile is useful for emergencies.

Even though you are restricted to 10 W on 2 m while you are operating on a Novice licence, you can still have plenty of fun on a Sunday drive, sitting up in the Blue Mountains overlooking Sydney, or the Dandenongs if you are in Melbourne, and the Adelaide Hills for hams in the capital city of the "5" prefix state, with a whole city to aim at.

Despite 10 W (5 W on some rigs) being low power, if you're within range of a repeater and can successfully trigger it, you're then as good as those with full licences. If you can't get out any other way, mobile is the solution.

First steps

Your first problem will be to decide where to put the antenna on your car. Drill a hole in the roof, so as to get the antenna central and as high as you can? Or don't go drilling holes, but accept a less efficient mount? The choice is yours — influenced by a host of things perhaps, like the car's age (and perhaps re-sale value), objections to its appearance (who could possibly object? Huh!), if you have a soft-top (a wee problem), etc. At least in a car you don't have to worry about great lengths of lossy feeder lines.

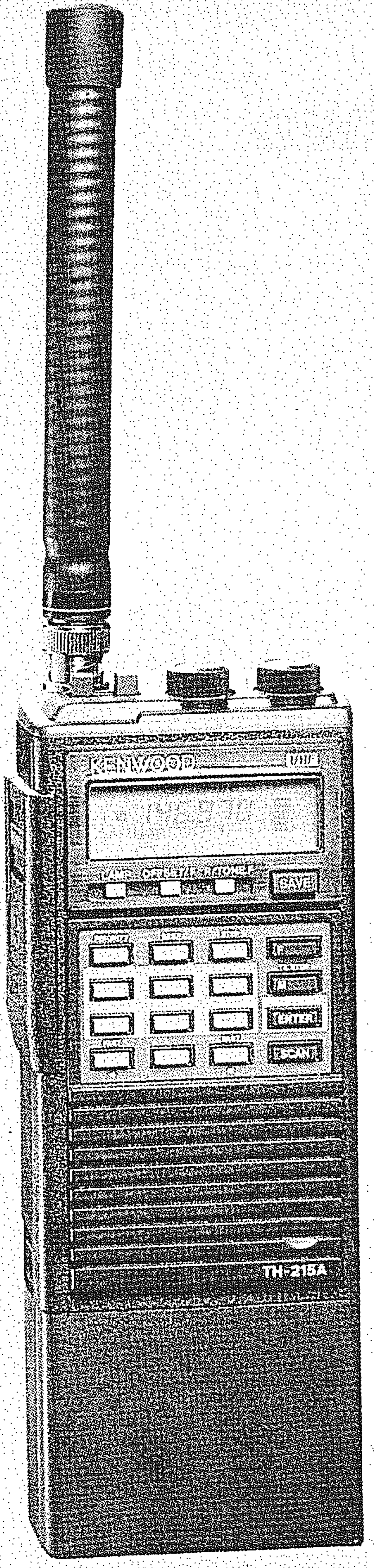
By far the most popular mobile antennas in use are the $\frac{1}{4}$-wave and $\frac{5}{8}$-wave whips. The former are around 480 mm high, while the latter are a bit over 1.2 m. Naturally, you have to consider above-roof clearance when considering the installation of a $\frac{5}{8}$-wave whip. So, you need to make arrangements so that the aerial bends, folds, unclips or does something self-effacing if it is likely to collide with your garage door lintel, service station overhangs, low tree branches etc.

One way out of the drill/don't drill the car dilemma, is to buy a roof rack and mount the antenna on that. Incidentally, one of the advantages of 2 m is that you don't have to go to all sorts of compromises and contortions squeezing an 80 m wavelength into a short aerial for a car, with resulting radiation losses. You get full efficiency from your 2 m whip.

While we are about it, we should mention that we belong to the school of thought that believes never to leave a stone unturned to pass on the safety message.

This refers to mains power. While you don't have an extension lead to the 240 Vac mains when you are driving around, in your ambition to get a signal out as well as you can, don't get carried away in your search for height. Don't put your antenna on the roof of the articulated trailer on your truck. This would be where it gets height all right: like, enough height to hit power lines. Such an event may prove terminal, and you'll never get ▷

The Icom IV-μ2A is the tiniest handheld rig on the market, but sports features found on many of its bigger-brother mobiles.



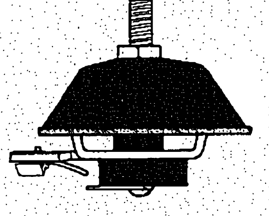
Handheld rigs are a low-cost solution to getting on 2 m. This Kenwood TH-215A is typical of many rigs on the market.

MOBILE ANTENNA MOUNTING

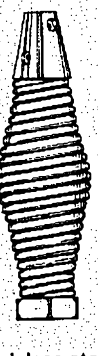
Mounting a 2 m antenna on your vehicle throws up a number of considerations, RF-wise, as well as mechanical and aesthetic. But one of the main considerations is the effect on the antenna's radiation pattern according to its location on the vehicle. Knowing something of how the antenna radiation pattern might be affected according to where you locate it may assist your choice on placement, or at least give you some idea of what to expect according to where you have to place it.

There are five basic locations and several different ways you can mount a 2 m whip on your vehicle. The accompanying pictures and diagrams illustrate them all.

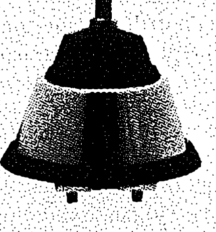
A gutter-mount bracket allows you to mount a whip high on your vehicle's roof without drilling a hole — but not all vehicles have roof gutters these days! The unit here is the model 02723B from Benelec, which incorporates the mounting bracket and an 02720 standard VHF base.



If you're unafraid to drill a hole in your vehicle, or decide to use an existing broadcast antenna mounting hole, then a "standard" VHF base like this is what you need. This one is the 02720 from Benelec and features coax cable termination and clamp in the underside along with a chassis clamp that provides good "grounding" to the vehicle's metal body. The 5/16" 26 tpi threaded bolt takes a "standard" coax cable termination and clamp in the underside along with a chassis clamp that provides good "grounding" to the vehicle's metal body. The threaded bolt takes a "standard" whip ferrule (female 5/16", 26 tpi thread) and the insulator is a durable, low profile plastic cone. A rubber ring gasket provides sealing on the top surface.

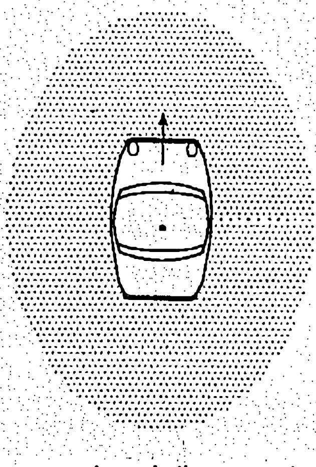


If you use a stainless steel whip (they're very durable!), it's advisable to install a light duty spring, like the one shown here, on your antenna base mount so that your whip and mount won't come to grief should the whip strike anything. (Illustration courtesy of Benelec).

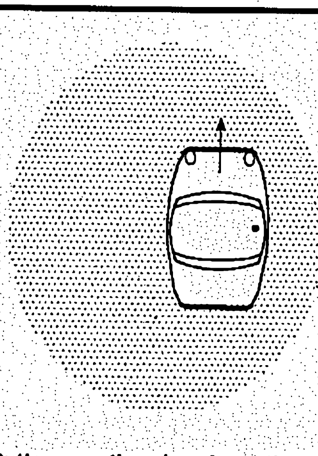


A trunk-lip mount permits attaching the whip to the lip of a car boot or trunk. The assembly provides grounding to the car body via the mount. (Benelec model 02729).

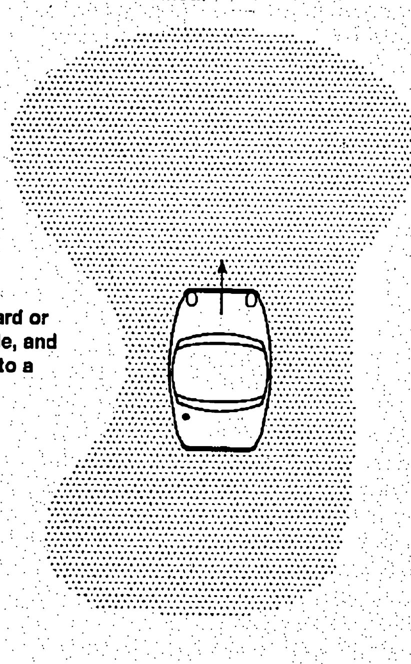
One popular way to mount a whip on a vehicle without drilling a hole is to use a magnetic base to which you mount the whip and its base mount. This employs a large, powerful ring magnet housed in a plastic and metal assembly, constructed to provide strong but scratch-proof mechanical contact with the vehicle and 'capacitative' coupling to the vehicle body for a 'groundplane'. Magnetic bases can be obtained as a 'naked' component, like this one — model 0274K from Benelec — or complete with antenna mount and coax lead.



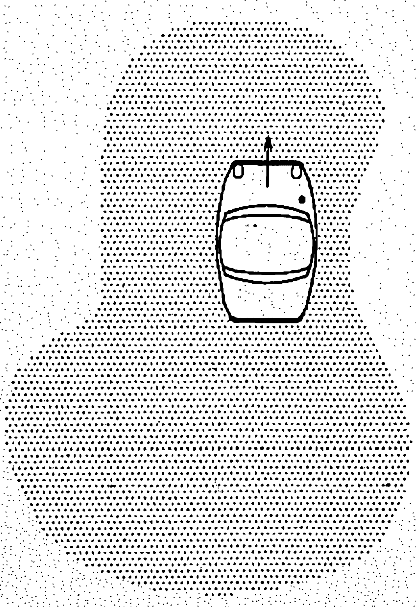
Mounting your antenna in the centre of your vehicle roof gets the antenna in the highest position and provides about the 'best' radiation pattern. Signals are somewhat stronger forward and rearward compared to off the side of the vehicle. While the radiation patterns here are 'smoothed' for the sake of clarity, in reality they are a mass of small 'lobes' with minor peaks and troughs in all directions. If you don't want to drill a hole in your vehicle, use a roof rack and mount the antenna to it (adding some groundplane elements if you can).



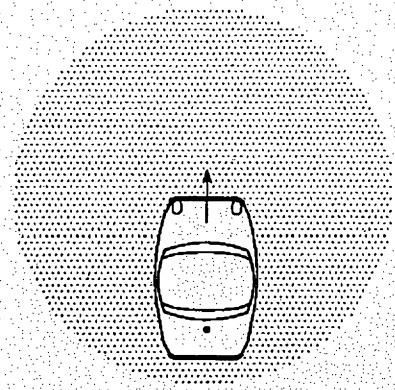
Gutter mounting also places the antenna high up, but the radiation pattern is distorted, being enhanced where it passes across the vehicle, degraded where it doesn't. Good signals front and rear are obtained.



Mount your whip on a rear mudguard or cowl, or on the trunk lip to one side, and the radiation pattern may break into a peculiar figure-8 shape, like this.



With the whip mounted on a front guard or cowl, you get quite a distorted radiation pattern with deep 'nulls' either side of the vehicle, similar to a rear-guard mounted whip. Unless it's unavoidable, don't put your 2 m whip where the traditional broadcast antenna is mounted.



A trunk-mounted antenna positioned on the vehicle centre line favours the forward direction — provided the whip is not too near the passenger roof rise, which may break up the radiation pattern. The message is, keep your whip away from other vertical structures on the vehicle (broadcast and other antennas included).

out of the Novice class if that happens to you!

No matter how you mount your antenna, you should also pay some attention to routing of the coax lead-in. If you employ a mount that attaches to the vehicle body rather than a hole-mounted type and decide to pass the coax in through a door, route it such that it does not get crushed when the door is closed, but is cushioned by the door seal. However, keep in mind the purpose of the door seal — to keep water and dust out!

If you pass the coax into the vehicle via the boot, here too you need to see the cable is not crushed. If the cable has to pass through the engine bay, ensure that it is routed well away from any component that carries engine heat, the exhaust for example, and away from moving parts. The same applies if you need to route the cable under the vehicle — keep it well away from the tail shaft and exhaust.

However you mount your antenna, it is essential to check the SWR and tune or prune the whip if necessary. Inefficiency in a mobile is counterproductive.

Let's look at some gear

You can investigate the gutter mount antenna, which biases the propagation by not having the antenna centrally mounted. The same argument goes for rear mounting by the boot, or over a front mudguard.

Take a look at the Scalar range of antennas, now marketed by Vicom. There is a range of 2 m antennas, from a basic ¼-wave whip through fibreglass and stainless steel variants to a steel whip featuring 3 dB gain. However, one interesting — if expensive — mobile antenna is the 140-174 MHz "on window" model OW 150.

This does not need any drilling to mount it. It fits to a car window, and is easily "snapped" on or off. The transmitter couples to it through the window by induction, and thus when you sell the car you don't have to patch up any holes.

OK, we've got the antenna on the car (somehow, somewhere): now you have to drive it (the antenna, not the car).

If you've got something like $615 left in change after forking out for the antenna, take a look at the Kenwood TM-221A, which is as good as any as an example of a 2 m FM mobile transceiver.

On high power, which you cannot use until you move out of the Novice class, you'll be pumping 45 W into that antenna you somehow got on to the car. Looking forward to higher power operation will be an inducement to working towards the day.

But for Novice and limited transmission and to save cluttering up the band you set the transceiver to transmit about 5 W, which is well within your legal limit and can get you some exciting results on occa- ▷

sions. Your car's battery as well as the Department of Transport and Communications likes you to operate on low power, because on high power 45 W RF takes something just a little less than 9.5 A. There's no problem keeping the receiver on while you're driving because under no signal conditions the receiver takes less than 400 mA.

The transceiver weighs 1.2 kg, so you won't have to adjust the car's suspension for extra weight. Size is compact: 140 × 40 × 179 mm.

But now to look at some of the features of this example of a modern 2 m mobile. It receives 138 to 173.995 MHz in several steps (5, 10, 15, 20 and 25 kHz). The transmitter covers only the actual amateur band: 144 to 148 MHz. This unit has a microprocessor pre-programmed for automatic simplex or a ±600 kHz offset in accordance with the 2 m band plan.

There are 14 memory channels to store frequency, repeater offset, and other information not generally used in Australian amateur practice. Memories A and B establish the upper and lower limits for programmable band scan. Memories C and D store transmit and receive frequencies independently for operating repeaters having standard and odd offsets. The 14 memories can be scanned.

Using memories A and B, the upper and lower limits of a band of frequencies to be scanned may be set, for greatest efficiency in band scanning. When memory frequency A = B, the transceiver scans the whole band.

A new amber, multifunction backlighted, semi-penetration type LCD gives best visibility in direct sunlight or after dark. It shows frequency, memory channel, scan, repeater offset, REV, CTCSS, TONE, S and RF meter, CALL, ON AIR and BUSY. Among several other features the transceiver has a rugged diecast chassis and large heatsink.

If you're in the bigger spender class, $1380 will get you a Kenwood all mode TR-751A 2 m 25 W (5 W on "low power") transceiver. It will also dangle the delights of unrestricted operation before you, as an added inducement to work your way out of the Novice class.

This rig offers FM, SSB and CW. Just select the appropriate mode key, and the mode chosen is signalled by the first letter of the mode sounding in Morse. When "auto" is keyed, the mode is automatic, depending on frequency. The built-in dual digital VFOs tune independently, including mode selection, frequency step and repeater information, for maximum operator convenience. There are 10 memories to store frequency, mode, repeater offset and tone information.

Kenwood national sales manager Sandy Brucesmith, VK2AD, told AEM that the Kenwood transceivers were small, compact and reliable.

Start with a rig like this and you won't need to upgrade when you upgrade your licence. This is Kenwood's TR-751A all-mode rig featuring both 2 m and 70 cm operation.

"FM is the most reliable in any production radio range," he said.

Kenwood transceivers, he told us, began as amateur gear but after exhaustive field use they would be adapted for commercial application.

"So the mass market means good quality," Mr Brucesmith said. "And the acceptance of the product shows its quality."

Yaesu, distributed by Dick Smith Electronics, also caters for the 2 mobile enthusiast, with its FT-2700RH. This transceiver covers 70 cm as well as 2 m, so it promises further delights when you have progressed beyond your Novice licence.

It has a programmable memory scan, 10 memory channels and priority channel scan. It has dual independent front ends, independent local synthesisers and IFs in the receivers and independent transmitter RF stages — two independent transceivers in the one box, they just share the audio and control blocks!

When you get a higher grade of licence you can go on 70 cm and use the full crossband duplex facility.

The FT-2700RH transmits 25 W on both bands, against the day you get your full licence, and until then you would switch it to the 5 W low power mode when you use . The transceiver has two CPUs for complete control and a wide angle LCD readout. The microphone incorporates scanning buttons and a mounting bracket.

If you find the DSE catalogue price of $1299 for the FT-2700RH a bit off-putting, stay on the same page (72) and cast your eyes to the left and take a look at the Yaesu 2 m mobile FT-270RH. This has quite a lot going for it, in addition to its price of $799.

The FT-270RH has a power output of 45 W, against the day you stop being a Novice, but you can get your hand in operating at the 5 W low power setting in the meantime. Features include 10 memories, dual VFOs and scanning facilities, in a 140 × 162 × 40 mm package.

If you haven't got a car, you can still go mobile with a handheld. These days they are small enough to fit in a purse, coat pocket, or briefcase, or on a belt. Rechargeable batteries take the cost problem of battery replacement out of the "ouch!" area. Some are supported by optional mobile-mounting accessories.

While a handheld will not do some of the things the more powerful car mobiles will, you do not have the installation and aerial fitting problem.

The Yaesu FT23 2 m handheld from DSE is a good example. It covers the complete band and has 10 memories for commonly used channels in your area. It has a six digit LED, and up to 5 W output with 12 V internal battery (NiCad). The FT23 measures 60 × 150 × 30 mm. It is listed at $599.

Kenwood's handhelds for 2 m are the TH-215A and TH-25A/AT. The latter is slightly smaller and lighter than the TH-215A, but to make up for that, there is a price difference: $500 for the TH-215A, against $560 for the TH-25A. Measurements are: TH-215A, 67 × 173 × 37 mm and 540 g; and TH-25A/AT, 58 × 137.5 × 29.5 mm and 400 g.

Both offer a choice of NiCad battery packs, which govern the output power. For the TH-215A, you get 5 W from the 12 V, 800 mA/h pack; 2.5 W from the 8.4 V, 500 mA/h pack, and 1.5 W from two packs, both 7.2 V, but differing with capacities of 800 and 1600 mA/h.

The TH-25A/AT offers 5 W with a 12 V, 600 mA/h battery, and 2.5 W with three 7.2 V battery packs offering 200, 600 and 1100 mA/h.

For both there are optional rapid, compact and wall chargers and a battery case that will hold AA primary cells. A filtered adaptor powers both transceivers from a car or boat cigarette lighter socket. They have LCD readouts of frequency, memory channel, scan and scan stop modes. The LCDs are back lit for night use.

For the latest in 2 m gear, keep your eye on the *Spectrum* page in AEM every month.

Happy DXing, and enjoy your voyage on the airwaves of 2 m. Anyone in Sydney, please give me a call if you hear me on 2 m.

• from p.103.

If you're operating the modem on a PABX, use this to ensure a dial tone is present before going ahead; otherwise, you don't normally need it.

I — Hook Flash

The modem will go on-hook and off again for a ½-second. Most of you want use this as it is usually employed to grab a line in some of the older PABX systems.

/ — Pause for ⅛ seconds

After encountering a '/' in a dial command the modem will suspend operations for ⅛th of a second (125 milliseconds).

, — Pause for S8 seconds

When the SUPERbis modem discovers a comma in the dialling command it will suspend operations in the same way as the '/' modifier, but this time for a time period determined by the value in register S8.

Both of the two pause commands are often useful. I use the ',' mostly.

Often, when calling a BBS with a Netcomm Trailblazer at the other end I get problems. This is because the 'Blazer will first scan it's own special "PEP mode" carriers and then continue with the normal CCITT scan.

This causes a problem as the communications package I use, (Telix V.3), occasionally times out due to the extra scans and some modems will get a bit upset with the PEP carriers. By issuing the following command the problem is overcome.

ATD5551212,,,,,,,↵

This instructs the modem to dial the number and then suspend operations for a while, hopefully until the PEP carriers have been scanned.

; — Return to command mode

If a ';' is appended to a dialling command the modem will complete dialling the number, leave the modem on-line and return to command mode.

Although I don't use this feature, you may find it useful when some parameters need to be in a certain state during and at the beginning of the dialling command, but need to be changed as, or after, the modem connects to the other computer.

ATEx *Command Echo* 0-1 1

The echo command is quite powerful and should be used only as long as you know what you're doing. Many people have fallen into the trap of disabling command echoing and being stuck as the modem will appear dead when it's not echoing commands.

For the more enlightened among you, this is similar to full/half duplex operation of a terminal. Essentially you will usually need the command echo enabled and the echo in your comms package disabled, like this:

ATE1↵

ATG *Alternate Operating System* - -

This command is not a standard Hayes string and is for *advanced computer users only.* I have not discussed its operation here as it is beyond the scope of this article.

ATHx *On/Off-Hook Command* 0-1 0

The ATH command directly controls the line relay, switching it on-hook or off-hook, exactly like picking up the receiver on your telephone. Sometimes I have needed to use this command to connect to a caller who is already on-line or to hang up a call which has "hung". Most communications packages for PCs and clones use this method for disconnecting a call.

There are two other ways of disconnecting the modem from the line. Firstly, the more technical way, is to pull the plug out of the wall. Alternatively, you can force the modem into command mode, (see later), and issue the following command:

ATH0↵

ATI *Modem I.D.* - -

After you issue the ATI command, the SUPERbis will return its Vers. number. This is helpful when you need to know which revision you have for upgrade purposes.

ATLx *Loudspeaker volume* 0-1 1

Basically, the ATL command is a software switch. It allows you to switch between loud (1) and soft (0). For instance, to achieve low volume operation you would execute this command:

ATL0↵

ATMx *Speaker Control* 0,1-2 1

To change the operation of the speaker, use the ATMx command.

Three methods of operation are available. By executing an ATM0 command the speaker is permanently switched off. 'ATM1' will allow you to monitor the call until the carrier is detected, this is probably the most useful. And, as expected, an ATM2 command will leave the speaker on, from the beginning of the dial command to the point of "NO CARRIER!"

ATOx *Commence On-Line/Originate Mode* 0-1 0

How this command affects the operation of the modem is dependant on the current state of the SUPERbis. If the modem is in command mode, i.e: not on-line or in data mode, then an ATO command will cause the modem to go on-line and commence the originating handshake sequence; this should be preceded by an ATH1 command to connect the modem with the phone line.

If however, the modem was on-line at the time it received an ATO command, it will return to data mode.

This command is often used when you and a friend are currently on the phone, on a voice call, and you both wish to switch-over and start "modeming". The person who has decided to originate should use the following sequence:

ATH1↵

(wait)

ATO↵

The person at the other end would, of course, go on-line in answer mode. This would be achieved thus:

ATA↵

ATQx *Result Codes, Yes/No* 0-1 0

This command allows you to decide if result codes are to be sent to the computer or not. By typing 'ATQ↵' or 'ATQ0↵', result codes will be enabled. An 'ATQ1↵' command will disable result codes from being sent to the host computer.

Commands such as this one and the ATEx command, are generally only used once to set up the modem's initial operation. Usually, command echo and result codes are left on, unless the modem is being used in, say, a stand-alone, automatic setup, where human intervention isn't often required, or where the host software doesn't require command echo or result codes.

Often, people forget that they have turned the result codes off and then think their modem is broken or not responding. Always check this sort of thing first, before suspecting a hardware failure.

ATXx *Response code types* 0-4 4

The issue of an ATX command will affect the types of response codes that you will receive from the modem. Further on in this article you will see a list of response codes; this is a useful reference for setting up a communications software package.

Some software packages require certain types of responses, i.e: some need to know when a busy signal is detected at the other end of the line, and others do not. If you are not sure what you are doing it is best to leave it as it is (ATX4↵).

Below are listed the various ATX commands and their effect.

ATX0 — Enables result codes 0-4
ATX1 — Enables result codes 0-5,10
ATX2 — Enables result codes 0-6,10
ATX3 — Enables result codes 0-5,7,10
ATX4 — Enables result codes 0-10

▷

ATZ *Modem parameter reset* - -

This resets the modem and restores all the default settings in the non-volatile RAM. Be careful under what mode you issue this command as it will terminate your call if you are presently on-line. After issuing this command it will return to command mode.

The SUPERbis has a series of AT&y commands. These are fairly common amongst most 'Hayes-compatible' modems. Although most people will not need to use these, it is best to get to know them; they are especially useful when troubleshooting hardware and software anomalies.

AT&Cx *Control of DCD (Data Carrier Detect)* 0-1 1

This command basically controls the status of the Data Carrier Detect (DCD) line on the RS-232 interface. By using the command you are able to force it high, or allow it to follow the true data carrier. To force it high:

AT&C0↵

To allow it to follow the true status:

AT&C1↵

AT&Dx *Data Terminal Ready (DTR) Control* 0-3 0

The DTR (Data Terminal Ready) line on the RS-232 interface may be controlled by the use of the AT&Dx command. It is issued in much the same way as the AT&C command although you have more options as to what happens when a change in DTR status is detected:

AT&D0 — DTR always ignored.

AT&D1 — When DTR is low, modem reverts to command state.

AT&D2 — Modem hangs up phone line and reverts to command state when DTR low.

AT&D3 — Modem re-initialises when DTR low.

I find it is best to leave the setting to AT&D0, unless your communications package supports DTR control, in which case it would be safest to issue an AT&D2↵ upon initialisation of the modem.

AT&F *Return S-registers to factory settings* - -

When the modem receives an AT&F command it returns the S-registers to the default settings, the state they were in when the SUPERbis was shipped to you.

This is *especially useful* when you, or somebody else, has stuffed up the settings in the modem and you just want to start again from scratch!

AT&Gx *Guard Tone Control* 0,2 0

This is rarely used. The guard tone is generated by the modem chip and is used by the hardware at each end to secure data communications. At least now you know how to invoke it on the rare occasion it might be called for.

AT&Nx *Australian or New Zealand Dialling* 0-1 0

The Australian and New Zealand pulse dialling standards are reversed in the number of pulses attributed to the various numbers. As a rule, if you are using the modem in New Zealand and you use pulse dialling, issue the following commands.

AT&N1↵
AT&W↵

Otherwise, don't bother yourself with the AT&Nx command as it is useless to you.

AT&Tx *Test Procedures* 0-8 0

The AT&Tx test commands are used to start or stop various tests available to you. They are as follows:

AT&T0 — Terminate the test in progress.
AT&T1 — Start Local Analogue Loopback (ALB) Test.
AT&T3 — Start Digital Loopback (DLB) Test.
AT&T4 — Enable Remote DLB Response.
AT&T5 — Disable Remote DLB Response.
AT&T6 — Initiate Remote DLB.
AT&T7 — Initiate Remote DLB with self-test.
AT&T8 — Initiate ALB with self-test.

This is something for "technical types" only. Local loopback effectively connects the modem's own output to its own input. Remote loopback does it via the external line.

AT&W *Write Set-up into Non-Volatile RAM* - -

This command will write the current modem set-up (S-registers) into non-volatile RAM (that is, battery-backed memory, if you have the option fitted).

It is best to use this command after you have arrived at the optimum settings for your modem and have made sure that the modem operates correctly first.

S-Registers

There are two ways you use the S-registers. Firstly, you can *enquire* about a particular register to find out what value it is presently set to, and secondly, you may *set* the register to a particular value. To enquire:

ATSr? *Enquire as to the value of Register r* 0-27 0

This command will return you to the decimal value of the S-register concerned. For instance, to enquire about the status of register 1:

ATS1?↵

The modem should then return the value contained in S-register 1, which should be 0.

ATSr *Set Register r to the value n* r, 0-27 n, 0-255

This command is used to write a value to a particular S-register. Probably the best way to explain this is through illustration.

ATS1=3↵

By executing this command, S-register 1 would be set to a value of 3. This happens to cause the modem to enter auto-answer mode and answer the phone, when it rings, after three rings. To cancel this, type the following:

ATS1=0↵

Practicalities

Like all equipment of the computing genre, the SUPERbis modem, when in use, will not always appear to obey a series of commands in the manner thought it would. This is due to one simple rule which people working with computers must always remember. *"A machine will do* **exactly** *what you instruct it to do,* **not** *what you would like it to do".*

For instance, if you get up in the middle of the night to burn a bit of midnight oil with your new modem and you don't want to wake your wife — or partner/family/budgie as applicable — (for obvious reasons), you issue an ATM0 command to turn the speaker off permanently. That's fine.

So, next morning, about ten — just after you have woken up - you return to the scene of the crime to dial up your favourite BBS to download the latest version of Space Invaders, just out from the States. Great! You boot up your comms package and get it to dial the board. To your horror you don't hear the usual **CLICK — (dial tone) — click, click, click .... — RING RING — BEEP, BOOP, BAHHHH,** — CONNECT 2400!

Instead, you hear nothing, not a peep out of your modem. (No points for guessing why!)

A little quirk I run into sometimes when I dial up a board which has a Netcomm Trailblazer at the other end. Often my modem will attempt to answer the couple of PEP answer tones which are characteristic of the 'Blazer. I thought 'OK, I'll issue it an ATB8 command', in order to mask out the PEP tones. This did not work because the SUPERbis thought the PEP tones were a 2400 bps carrier in any case. Fine.

This problem was easily rectified by getting the modem to dial the number and get it to wait for a few seconds until the

PEP answer tones were over and done with. First, I cancelled my previous ATB command by issuing an ATB0↵ . Then I gave the modem this sequence:

ATDT8684347,,,,↵

This told the modem to dial the number of the board and wait for a few seconds, enough time for it to ignore the PEP answer tones. Some people might say that this same thing could have been done by altering the value in register S7. I agree, except I only needed to alter the waiting time for just one number, not globally, as altering S7 would have achieved.

Also, occasionally some modems which answer the phone and commence answering will have a pause between some of the answer tones. This may upset some modems in that they have recognised one of the previous tones, the carrier drops out and doesn't restart for a while. If you are having problems of this sort I recommend the following:

ATS10=35↵

This allows the carrier to drop out for a maximum of 3½ seconds before the SUPERbis will give up and hang up. If included in an initialisation string in a communications package, it will make the modem less susceptible to line drop-outs and the like.

Some people might have come across S-register 11, this alters the duration of the DTMF tones used for dialling. Those of you who are lucky will have your phone on an exchange capable of 'Touch Tone' Dialling. If you are not sure whether or not your exchange will accept this, call your local Telecom Business Office (God help you!. . .) and ask about this, giving them your phone number. If your exchange will support DTMF Dialling ask for this service to be added to your line, (this is free of charge), and in a few days you will be able to use the T modifier for your dialling — rather than ATDP, use ATDT.

Once this has been done you could experiment, as I have done, altering the value in register S7 until you can achieve the minimum dial time. By default, this is set to cycle the tones at 95 milliseconds. I have been able to get this value down to approximately 35 ms. Thus, with a value of 35, a seven-digit number can be dialled in 490 ms, less than half a second, compared to the default of 1.33 seconds!

Admittedly, this adjustment isn't that crucial, it's really only a cosmetic feature of the modem. But nonetheless, a fun adjustment to make and experiment with — why not get the best of the Telecom technology you and I pay dearly for!

Software

To wrap this up I'll discuss some communications packages for IBM-PCs and compatibles (users of other computers may want to skip this section).

There are a number of very good communications packages around for the PC. Many of these are available on the market for an amount of money in the vicinity of $400, or less in some cases CrossTalk, SuperCom are just a few and are widely available, just look in some of the computer journals, However there is also an equally large range of public domain and Shareware packages available through the various BBSs and computer user groups. These are either available for free, in the case of public domain software, of for a small charge, in the case of Shareware programs.

The concept of Shareware is that you have a limited license to obtain the program and evaluate it for a limited period of time. After this period, if your intention is to use the package on a regular basis you must register yourself as a user and pay a nominal fee, usually fifty or sixty dollars.

Some of the excellent Shareware programs around are, Qmodem, Telix, Procomm, GT-Powercomm, Pibterm, to name a few. Personally, I use Telix (v3.10 is the current version). The advantage of using one of these packages is they make most functions any regular modem would need transparent and automatic.

For instance, to dial a particular number you are able to select from a list of names and numbers you have entered yourself. After selecting which name or number you wish to contact, the software will issue the modem with the appropriate dial command and lead you smoothly through the process of connecting with a board or other dial-up service.

These programs do require some setting up, informing the software what speeds your modem can support and some general information about the setup of your computer system. The configuration of any one of these programs is beyond the scope of this article, although I will recommend an appropriate 'Initialisation String' which you could put in the proper area of the comms package if you wish.

ATE1M1Q0V1X4S10=35S11=35

This will enable command echo (E1); allow the speaker to be on until a carrier is detected (M1); allow result codes to be sent to the computer (Q0); set result codes to be verbose (full words, not numeric) (V1); allow the full set of response codes to be issued (X4); make the modem less sensitive to line dropouts (S10=35) and optimise the DTMF Dial Cycling time (S11=35).

Conclusion

Right, this article should at least help get you "on the air". From there on in, it's up to you, your imagination and a little experience. I haven't covered every single command here, the use of some is a little obscure anyway. But those I have covered should enable you to do most things you might require.

• from p.115.

0 dB, with an RMS error of about 11 dB. These errors are about the same as for mainframe computer field strength predictions. Histograms of the errors are plotted in Figures 2 and 3.

Conclusion

MINIFTZ4 is a very useful, low-cost tool for producing HF predictions of high accuracy for the amateur or shortwave enthusiast who owns, or has access to, a PC or compatible.

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Using the 555 and its dual, the 556

Part 3

Roger Harrison

By now you should have had a little practice with a few circuits and starting to get the "hang" of 555 circuit techniques. Having covered some practical timer applications, here are some interesting oscillator applications and a useful workshop instrument.

A SIMPLE, PRACTICAL astable oscillator application of the 555 was introduced in Part 2, Figure 6 — a Morse practice oscillator. While the basic astable oscillator circuit (Figure 4, Part 1) uses a resistor between the THRESHOLD and DISCHARGE pins, as in the Morse practice oscillator, you can actually tie these two pins together. The output pulse is very narrow as the discharge time now depends on the on-resistance of the collector-emitter junction of the discharge transistor (Q1) inside the 555.

Electronic "chocolate wheel"

Such an oscillator is used in the circuit of Figure 12 here. This is an electronic "chocolate wheel", or "spin the bottle".

The 555 oscillator operates at a high frequency, near 6 kHz. Its output drives the CLOCK input of the 4017, a decade counter with 10 outputs which go high in turn from the first incoming pulse. Press the 'spin' pushbutton and the oscillator starts up. It will oscillate for a period depending on exactly how long you hold the pushbutton down. The 4017's outputs will go high in turn, very rapidly (about 700-800 times per second), until the last pulse is received and one of the LEDs will be lit.

Because the oscillator runs at such a rapid rate, the number of pulses sent to the 4017 cannot be determined; human reactions are too slow. Hence, you won't know which LED it will stop on.

In detail, the circuit works as follows. The oscillator frequency is determined by:

$f = 1.44/R1.C1$

where R1 is 10k and C1 is 33n

Thus, $f = 1.44 \times 100\,000/33$

$= 4364$ kHz (near enough).

As there's no resistor between pins 6 and 7, this doesn't figure in the frequency equation we explained in Part 2.

The 4017 is a decade counter and 1-of-10 decoder all in a single package. It has ten outputs ('0', '1', '2', etc), only one of which goes high (to the positive supply rail, 9 V here) at a time; meanwhile, all the others are low (0 V). The 4017 has a CLOCK ENABLE pin which is active low, so it's tied to ground. It also has

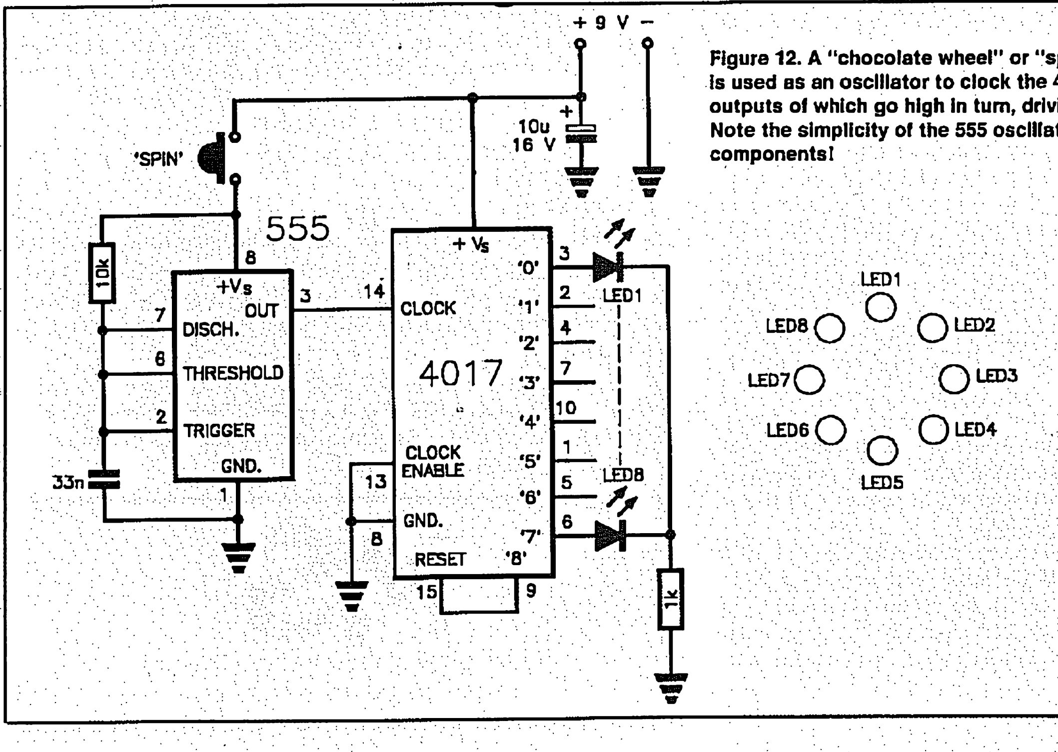


Figure 12. A "chocolate wheel" or "spin the bottle" circuit. The 555 is used as an oscillator to clock the 4017 decade counter, the outputs of which go high in turn, driving the LEDs on in sequence. Note the simplicity of the 555 oscillator here — just three components!

a RESET input pin. When this pin is taken high, the device is set "back to the start" where the first output ('0') is high.

With the 555's output driving the clock input of the 4017, every time there is a pulse from the 555, the last output of the 4017 which was high will go low and the next output in turn will go high, providing the RESET input remains low. Thus, each output of the 4017 goes high in turn: 0 — 1 - 2. . . etc, the high shifting through the outputs at the same rate as the pulses coming in from the 555. The sequence of ten outputs re-cycles whilst the input pulses continue.

You could have a string of ten LEDs if you like, but as it's easier to divide a circle into eight segments, we have to arrange for the 4017 to count by eight, rather than ten. Now, when the 4017 is clocked such that the high transfers from the eighth output to the ninth output, the high on the ninth output is used to reset the 4017. Hence you see pin nine (output '8', which is actually the ninth output as the first one is '0') tied to the RESET pin.

Once the 4017 counter is reset, the high transfers from the eighth output to the first output and the cycle repeats. The 4017 is counting by eight. This happens *very* fast (in about 100 nanoseconds) so if you try to look for it with an oscilloscope hooked to pin 15 (or 9), you'll have difficulty seeing the reset pulse unless you have a very wide bandwidth oscilloscope.

The eight outputs of the 4017 each connect to the anode of a LED, the LEDs being arranged in a circle to replicate your "chocolate wheel" or "spin the bottle" compass points. All the LED cathodes are tied together and a single 1k current limiting resistor sets the LED current (as only one LED at a time is actually on). You can see the action by using a very high value resistor in series with pin 7 of the 555, instead of the 10k. Try a value of 4M7.

There are a couple of interesting points to note about this oscillator. Firstly, the frequency is very quickly and easily determined, as I showed above. You can use the Figure 5 nomograph in Part 1 to roughly determine the frequency, the slanted resistor lines being taken as the value of the resistor in between pin 7 of the 555 and the supply rail.

Secondly, the output pulses are very short, a few microseconds here as the collector-emitter junction resistance of the discharge transistor in the 555 (as mentioned earlier) is very low, about 100 Ω.

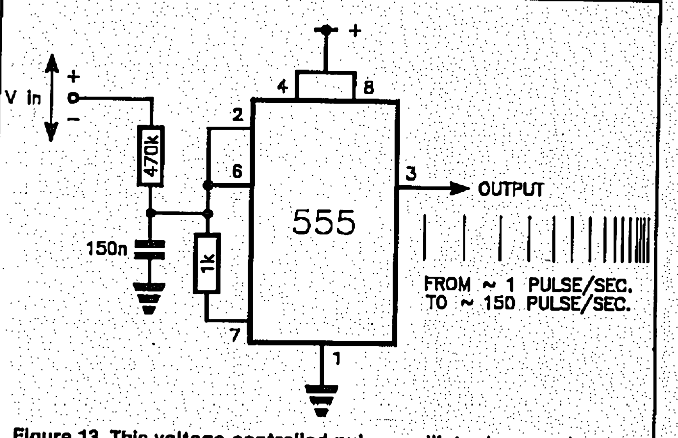


Figure 13. This voltage-controlled pulse oscillator has good linearity and operates over a very wide range. And it's so simple!

A wide range voltage-controlled pulse oscillator

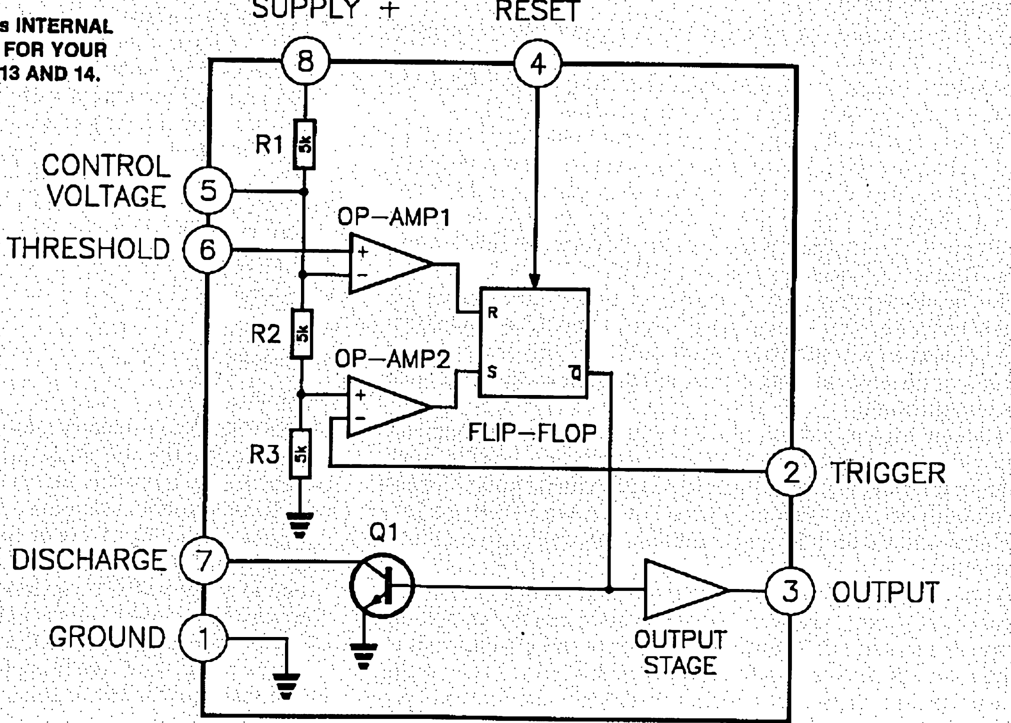
An oscillator whose frequency can be controlled by applying a variable voltage — a voltage-controlled oscillator, or VCO — is a very useful circuit in many applications. A remarkably simple, but very versatile voltage-controlled oscillator can be made using a 555 in the manner illustrated in Figure 13. This circuit is capable of being varied over two-to-three *decades* by varying the control voltage, "Vin", over a range of several volts.

By returning the 470k capacitor charging resistor to a variable input voltage, you're varying the trigger *and* threshold voltages (pins 2 and 6) simultaneously, but the supply voltage is fixed, hence the period it takes the capacitor to charge (and thus the oscillation frequency) will no longer be independent of the supply voltage.

This circuit has good voltage-to-frequency linearity and, as mentioned earlier, a very wide range. With the values given here, the output frequency ranges from about one pulse per second to about 150 pulses per second swinging Vin over several volts (but not higher than the supply rail).

This circuit was employed in the AEM5504 Electromyogram ▷

BLOCK DIAGRAM OF THE 555's INTERNAL CIRCUITRY, REPEATED HERE FOR YOUR REFERENCE IN FIGURES 12, 13 AND 14.



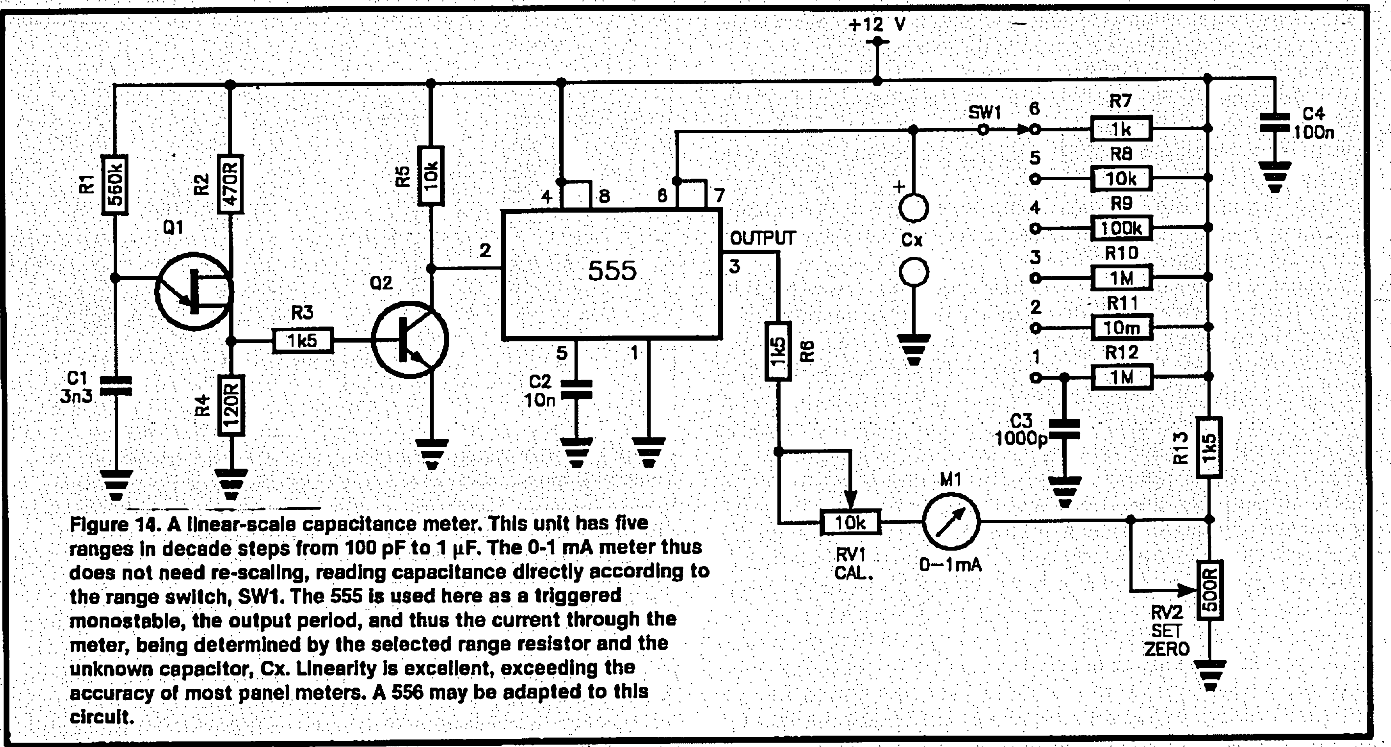


Figure 14. A linear-scale capacitance meter. This unit has five ranges in decade steps from 100 pF to 1 µF. The 0-1 mA meter thus does not need re-scaling, reading capacitance directly according to the range switch, SW1. The 555 is used here as a triggered monostable, the output period, and thus the current through the meter, being determined by the selected range resistor and the unknown capacitor, Cx. Linearity is excellent, exceeding the accuracy of most panel meters. A 556 may be adapted to this circuit.

as the audio output oscillator, providing variable frequency "clicks" according the level of muscle activity measured by the input circuitry of the Electromyogram. The output pulse width here is "stretched" by the 1k resistor between pins 6 and 7 in order to provide reasonably audible clicks from the loudspeaker. In other applications, you could dispense with this resistor, reducing the component count.

A linear-scale capacitance meter

A very handy instrument to have around the workshop is a "capacitance measurer". You might want it as a stand-alone instrument or as an adjunct to your multimeter. A capacitance measurer is the sort of device that, once you have it around, it finds uses for itself!

You can measure capacitance to very good accuracy using the circuit of Figure 14. Here, the 555 is used as a triggered monostable, triggered by pulses of a set frequency which are generated by the unijunction transistor oscillator (Q1).

The circuit works like this: Q1 is a simple "relaxation" oscillator, C1 charging via R1 until the voltage across C1 reaches Q1's emitter threshold voltage; the emitter then conducts, discharging C1 via R4. A short pulse of about 1 µs appears across R4 each time C1 discharges, which is about every one millisecond here. That is, Q1 oscillates at about 1 kHz.

The positive-going pulses across R4 drive the base of Q2 which turns on with every pulse. Thus, short (1 µs) negative-going pulses appear at the collector of Q2. As this is connected to pin 2 of the 555, the TRIGGER input, the 555 is triggered once every millisecond.

Between trigger pulses, pin 2 of the 555 is held high (at +12 V) by R5. This sets the 555's internal flip-flop (see the block diagram reproduced here), turning on Q1, which applies a short circuit between pin 7 (actually pins 6 and 7, which are connected here) and ground. In this condition, the output (pin 3) is at zero volts.

When a trigger pulse is received, the short across pins 6-7 is released, allowing whatever capacitor is connected across the terminals marked "Cx" (for the capacitance to be measured) to charge via whichever resistor is selected by SW1. The voltage across Cx then increases exponentially for a period that depends on the value of Cx. That period is determined from the following formula:

$$t = 1.1\ Rr.Cx$$

Where "Rr" is the range resistor (selected by SW1).

At the end of the period, the 555's comparator resets the flip-flop, which in turn causes Q1 to turn on, discharging the unknown capacitor Cx. The output, pin 3, goes low once again. This cycle repeats each time the 555 is triggered.

Thus, as the range resistor is fixed, the on-to-off ratio of the output pulse will be determined by the value of Cx. This ratio is independent of Q1's frequency of oscillation.

The output from pin 3 of the 555 drives current through R6, RV1 and the meter, M1. The meter then "averages" the current pulses through R6, deflecting according to the on/off ratio. As the 'low' to 'high' voltage from pin 3 does not swing from 0 V to the positive supply rail, the resulting dc offset being compensated by returning the other end of M1 through a small positive voltage developed across RV2, the "set zero" control. Full-scale meter deflection is simply calibrated by RV1, which determines the maximum current through the meter.

Position 1 on the range switch is for calibration. Capacitor C3 is a 1% or 2% high stability, high accuracy silver mica type, allowing setting of the calibration control for full-scale deflection, calibrating the unit at 1000 pF (or 1n) full-scale. The other range switch positions are as follows:

- 2 100 pF
- 3 1 nF
- 4 10 nF
- 5 100 nF
- 6 1 µF

The SET ZERO control only really needs to be used on the 100 pF range. To reduce the stray input capacitance, any leads between the Cx terminals, IC1 and the range switch have to be kept to an absolute minimum.

If you use a 500 µA meter for M1, full-scale deflection will then be from 50 pF to 500 nF.

Astute readers will have already noticed that a 556, the dual-555, may be adapted to this circuit, using one half as the trigger oscillator, replacing Q1 and Q2 and associated components.

That's it for now, we'll explore some more applications in Part 4 that use the 555 in somewhat more complex, yet subtle, ways.

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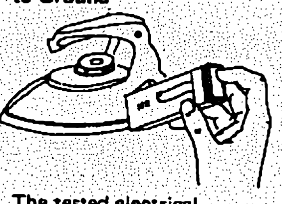
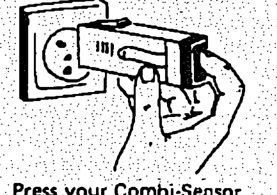


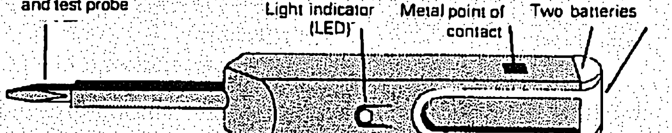
The tested electrical appliance should be switched on. Press your Combi-Sensor slightly to the appliance's surface and push the button. If the tested appliance is not grounded, Combi-Sensor will indicate it immediately by glowing test light and by continuous buzzer.

C — Wall Outlets and Switches



Press your Combi-Sensor slightly to the surface of the tested outlet or switch. Push the battery button. If the outlet or switch is live, Combi-Sensor will indicate it by continuous response of test light and buzzer.

TESTER PLUS $14.95



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AEM pc boards available through Sydney supplier

Sydney circuit board manufacturer JWD Electronics is able to supply readers' requirements for printed circuit boards. If they don't have it in stock, then the required board can be made to order.

The magazine has supplied JWD with film masters of a range of projects and will supply film masters for future issues in advance.

JWD supplies only quality epoxy glass boards.

The company can also supply prototype boards in small quantities, made up from artwork supplied by you. Cost for single-sided epoxy boards is 10 cents per square cm; hole drilling costs 3 cents per hole. Artwork reduction costs $22 per negative; a simple reversal costs 3 cents per square cm. delivery may be by post or overnight courier.

JWD also offer an artwork design service for pc boards, as well as board assembly. Proprietor, John Jansen, says JWD Electronics is dedicated to producing the best possible quality at the lowest possible prices.

Further details from **JWD Electronics, 293 Windsor Rd, Baulkham Hills NSW 2153 ☎ (02)639 1252.**

Snazzy tranny a bargain!

Our grapevine tells us that Perth-based retailer and mail order specialist Altronics has a fantastic bargain on a little multi-tap pc board mounting transformer at present.

Priced at $3 in quantities 1-9, the transformer is Japanese manufactured, has a 240 V primary and three secondaries of: 15 V at 300 mA, 9 V at 800 mA and 24 V at 300 mA.

Normally priced at $15, at $3 it's a real bargain. In quantities of 10-24 at $2.50 each, it's a steal! For quantities over 25, cost is $1.80 each. Read it again.

Trammel the tracks to **Altronics, PO Box 8350, Perth Mail Exchange WA 6000 ☎ 008 99 007.**

Multi-turn pc mount trimmers

Spectrol turn out a nice line in quality pc-mount trimpots. Stocked by Rod Irving Electronics, the 64Y vertical mounting, top-screw type are perfect for many applications requiring an on-board trimmer — and you get the advantage of fineness of control.

Rod Irving Electronics stocks them in the 1-2-5 values each decade starting at 10 Ω and going through to 1M.

Cost, in quantities of 1-9, is $3.50 each; in quantities of 10-up, they're $3.20.

Trip over to RIE for your trimpot requirements. **Rod Irving Electronics, PO Box 620, Clayton Vic 3168 ☎ 008 335 575.**

Solderless circuit breadboards

If you're "fiddling" with the circuits in our currently running series on the 555 & 556, then one of the best ways to lash up a circuit is to use "solderless breadboard."

These consist of a series of sockets interconnected in rows, spaced so that you can plug in most DIL package ICs, resistors capacitors and wire links to make a trial circuit.

A comprehensive range is stocked by David Reid Electronics in Sydney. They range from small units that will take 3-4 ICs, up to monsters on which monumental circuits can be assembled. The larger ones include a metal baseplate and terminals for convenient supply rail connections.

Slip on down to Sydney's Silicon Alley, York Street in the City. **David Reid Electronics, 127 York St, Sydney NSW 2000 (02)267 1385.**

PROJECT BUYERS GUIDE

The **AEM6511 30 W Audio Power Amp Module** should prove popular as it's *so simple* and so cheap! It's ideal for hi-fi amps, PA applications, as a small guitar amp — you name it! Original design comes from Graham Dicker of PC Computers in Adelaide, who market a kit. They're at 36 Regent St, Kensington SA 5068 ☎ (08)332 6513. Kits will also be stocked by Dick Smith Electronics stores. The LM1875 is available off the shelf from Geoff Wood Electronics of Lane Cove in Sydney. For pc boards, contact All Electronic Components in Melbourne or JWD Electronics in Sydney.

The **AEM8502 Vehicle Test Set** will repay its owner many times over. At press time, we knew of no retailers who were to supply kits. However, components are widely obtainable. The MU-series meters are stocked by many retailers, while you'll have to hunt around a bit for the ST-series meters, which are probably better for this application.

Kits for the **AEM3515 Colour ATV Transmitter** are being marketed by the authors; see the panel on page 97 of the article. They may also be ordered through the magazine in Sydney.

Rod Irving moves

Melbourne-based retailer Rod Irving Electronics is opening a news store in Sydney. Located in the inner-western suburb of Stanmore, the new store will stock the full line of RIE products. Address details are: **74 Parramatta rd, Stanmore NSW 2048 ☎ 519 3134**

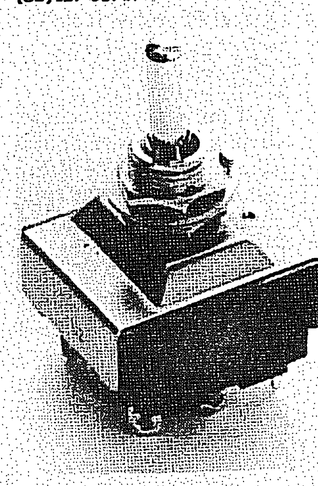
Late news to hand advises that Rod Irving himself has departed the business he started in the late 1970s, handing over to Greg Boot, who has been running the Software Express side of the business for some years. Enjoy the break, Rod!

SEW panel meters

Geoff Wood Electronics in Sydney's leafy Lane Cove stocks a comprehensive range of "Standard" brand panel meter movements, ideal for many projects.

These meters have a good width-to-height ratio, giving an easy to read, wide scale. They are available in full-scale sensitivities ranging from the microamp region to the multi-amp region and are competitively priced.

Check them out at **Geoff Wood Electronics, 229 Burns Bay Rd, Lane Cove NSW 2066 (02)427 1676.**



Floggle twitch!

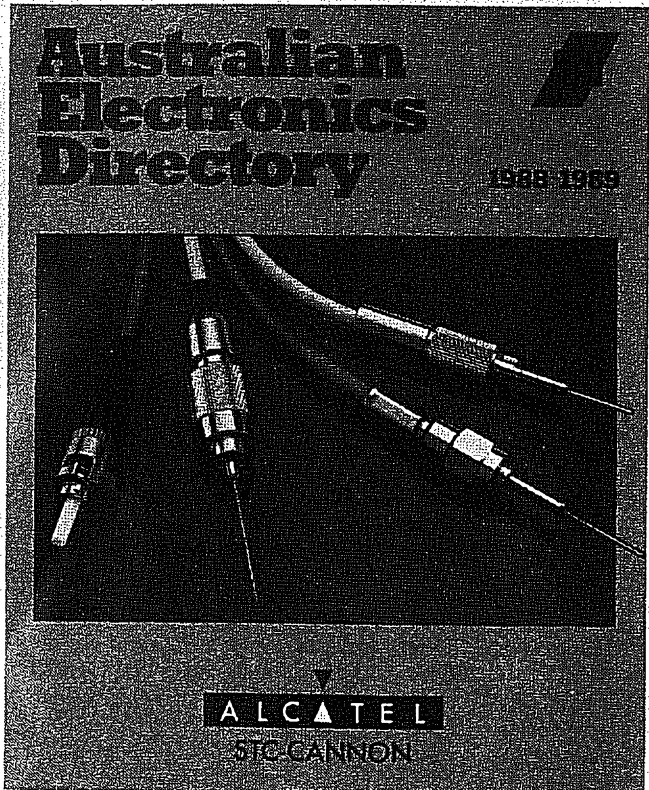
Sometimes even we get confused! All Electronic Components in Melbourne have a great bargain in an interesting centre-off, spring-loaded 3-pole, double-throw toggle switch.

It's ideal in control applications where you only want the switch to operate while it's being held in position; in a garage door opener control, for example.

It's rated to carry 6 A at 250 Vac, has sturdy lugs and costs but 50 cents. Read it again — 50 cents!

Flip on over to **All Electronics Components, 118 Lonsdale St, Melbourne Vic 3000 ☎ (03)662 1381.**

ELECTRONICS BUYERS GUIDE



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The 20th Edition of the Australian Electronics Directory (Australia's only true directory to who's who in the electronics industry) has had many thousands of company information changes since last year including:— agencies and overseas principals represented, address, telephone, fax etc., along with management sales and technical staff.

There are also 124 additional product headings, including 2 new charts on SURFACE MOUNT TECHNOLOGY. The 5 major product categories covered in this unique directory are: • Electronic Components • Construction Materials • Measurement & Test Equipment • Systems and Sub-Systems • Services.

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"Great science nobly laboured to increase people's joys, But every new invention seemed to add another noise."

A.P. (Sir Alan) Herbert.

Tourism and GAS

Yes, tourism is said to have a great future in Australia. But how can electronics help tourism? Well, Last Laugh has its suggestion.

In Katoomba in the Blue Mountains behind Sydney, there is a shop with a fish tank in its window, and the legend: "Invisible Tibetan Fighting Fish". A *now you don't see them, now you still don't see them* sort of tourist gimmick. Like canned "pure air" from such and such a place. Or the containers from Tasmania of "Pure Mountain Water". A reverse "something for nothing".

But offering nothing for something is exactly what electronics can do for Australian tourism, and offer something more enduring than tins of water or air: sell audio cassette tapes of silence! The Great Australian Silence (GAS to the cogniscenti).

Think of the Japanese worker, returned from his two weeks in Australia, squeezed in a Tokyo commuter train, regimented and stressed, with worries over high rents and rising rice prices. To opt-out, he or she listens to the quiet, relaxing hiss of silence from the souvenir tape in the Walkman, reviving visions of that carefree holiday at Cairns.

Or the harassed New Yorker in a traffic jam, calmed by the quiet hiss of GAS on his Kenwood or Pioneer car system, as recorded in Surfers Australia, and carried home as a valued souvenir.

Notice that GAS is truly international. You don't have to understand English to understand GAS. Even the French could pretend not to understand it, so we wouldn't have to make a French version.

Our politicians could publicise GAS as a cause to help Australia. Imagine our Minister for Foreign Affairs, Senator Gareth Edwards, arriving at some international talkfest conference.

Instead of a boring speech which would have been totally predictable to the other foreign ministers at the conference, suppose our minister were to offer a valuable contribution: a half-hour of pure silence, just standing there saying not a thing. No more foot-in-mouth problems for our Gareth! Then as a goodwill gesture he could hand out C120 tapes of GAS to the other delegates, recorded in Canberra.

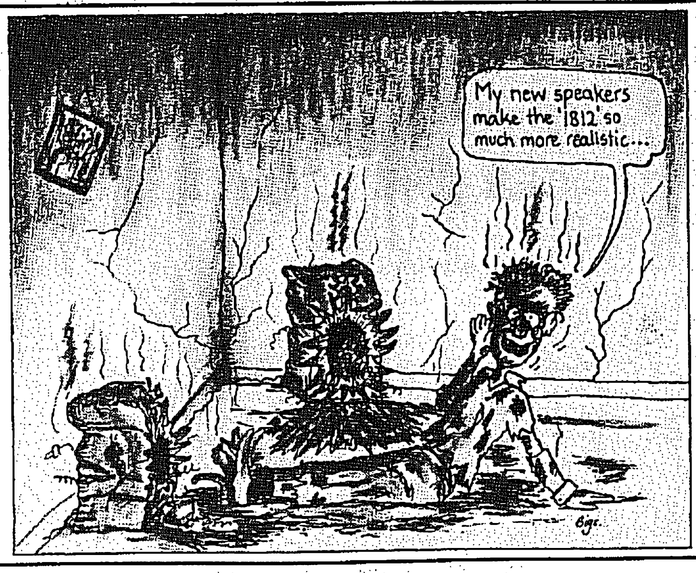
It shouldn't be hard to get all our capital cities into the act either, popularising regional features: all part of the tourist dollar drive.

"Mister! Wanna buy a tape of Melbourne silence to take home?" you would hear the barker in Kings Cross call to a tourist.

"Ah so, you are most kind, but already have Great Barrier Reef GAS to take home to Osaka."

"Ah, have a listen to this, mate. This Sydney Silence will sound better back in Osaka than Great Barrier Silence! Notice the hiss is sharper, with less bass than the Barrier? You don't want to be the same as all your friends with just another Great Barrier Reef tape — try our Sydney Harbour Bridge Silence, or for another half dollar, there's the latest Darling Harbour with the silent, broken-down Monorail!"

Actually, the ramifications of GAS are enormous. You could range all the way in prices from a cut-price C30 on el cheapo tape, to the full bit of a C90 metal, in Dolby B.



Think of all the duty free stores offering tapes galore of GAS. Signs of "Don't leave Australia without a GAS!" we envisage. Perhaps even, "OZ is a GAS".

Complaints about our tourist shops being closed over weekends would be an opportunity to advertise the tapes. Imagine a sign outside each shop: "Shut Up. Australia". Tourists would see it as an advertisement for GAS.

Maybe a GAS tape would be a tactful hint for a garrulous spouse. Or a gentle hint to a loquacious alderman, disc jockey, the religious fundamentalists who knock on your door, or some of those TV people.

AATEC should leap at the idea, as being an opportunity to sell more Australian-made tape. And you should count on Allsop, Amaray and Arena helping kick it along in the interests of selling more tape cleaners. You won't get the right GAS without clean heads, you know! Perhaps they'll hold a public competition to see which cleaner preserves the GAS best.

Don't let the imagination stop here. There could be a buy, swap and sell industry in GAS tapes, like there is for stamps. "Swap: 10 John Howard GASes for 1 Bob Hawke GAS. Also 1 Thursday Island GAS wanted. 2 Sydney Opera House and 20 Melbourne Yarra GASes offered." I can see those ads in the *Trading Post* papers now.

Australia has a CD factory in Melbourne. This means the Great Australian Silence, Digital (GASD) recording: not only a chance to put more work in the way of a local industry, but an opportunity for diversifying and extending the basic concept.

Our revered prime minister, Bob Hawke, on his next visit to the UK, could give Mrs Thatcher a ceremonial present: a full 30 cm, LaserDisc size CD, made in Australia — of silence.

So all GAS needs is some entrepreneurial initiative, and it's all go!

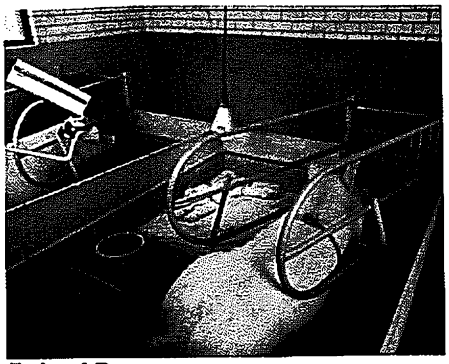
Now I must see if I can talk Roger into one of his competitions. Like, you send in your tape of local silence, and we judge which town, city or country place has the best silence. Just imagine Roger and his panel of experts sampling the silences.

"Hmm, from the Left Bank of the Yarra — a distinctive aroma, once sampled, never forgotten?" Or: "Just outside Boroloola, heading for the Berkley Highway, post wet period — the highs are fine but the lows seem a bit muddy".

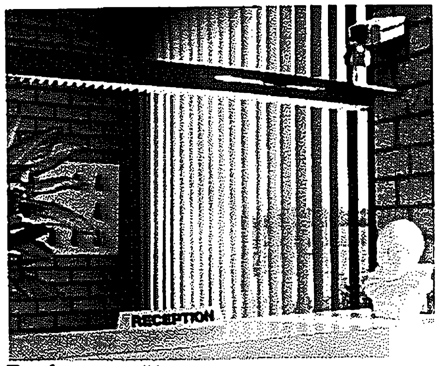
But perhaps you'd better wait and see if we can talk a tape company into giving us some prizes first...

Ben Furby

THE COMPLETE OBSERVATION SYSTEM...



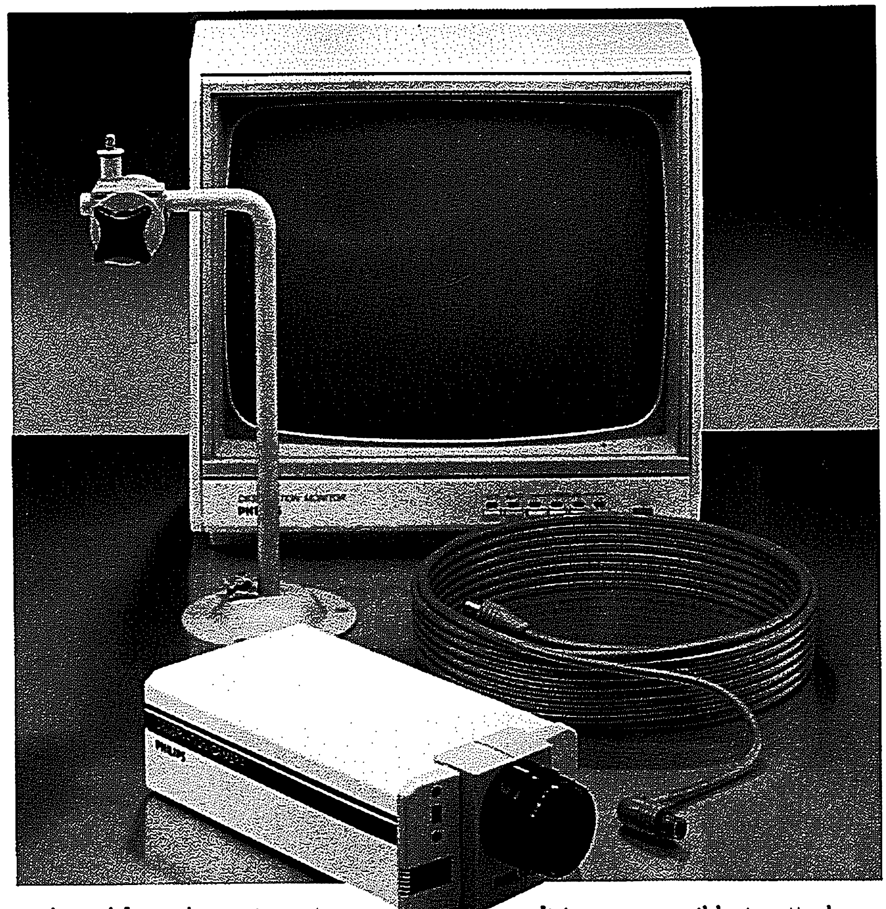
Animal Pens



Business or Home

Outdoors

FOR EVERY SITUATION



The Philips Observation System comprises a camera, a black-and-white monitor, and all the equipment and fittings needed for rapid installation.

The basic system comprises: camera, 12-inch (31 cm) black-and-white monitor, mounting brackets with plugs and screws, and 10 metres of coaxial connecting cable.

As well as offering simple installation, the Philips Observation System is easy to operate. Almost every adjustment is taken care of automatically, ensuring an optimum picture at all times.

The camera is supplied as standard with a multi-way support allowing it to be aimed in exactly the right direction. A choice of interchangeable lenses with standard C-mount fittings lets you choose the correct field of view for each situation.

The microphone built into the camera picks up sound from the area under observation. This can alert the operator to unusual events, even when full attention is not being paid to the picture.

For a more extensive system, it is possible to add up to three extra cameras. The 'active' camera is selected from the main system monitor, and can be either manual or automatic. In automatic mode, images from all connected cameras are selected in sequence.

Convenient positioning is provided by adjustable mounting brackets.

Extra 'slave' monitors can simply be added.

It is even possible to attach a video cassette recorder to this system.

The system is low in cost and ideal for installation anywhere observation may be needed: around the home, in business, in research, in education — every situation your imagination can dream up!

☐ **Please rush me more details on the Philips Observation System.**

Name..

Address..

.... Postcode ....

Tel:..

Send coupon to:
Philips S&I, 25 Paul St North, North Ryde 2113 NSW.
or phone (02)925-3367.

PHILIPS

PHILIPS

GOLDSTAR SERIES 7000 "AT."

High speed stand alone or fileserver system.

SYSTEM MOTHER BOARD.

8/10 MHz 80286 CPU.
1 Mb RAM standard.
Six 16 Bit I/O Slots and two 8 Bit I/O Slots.
7 Channel DMA Controller.
Low Power CMOS Technology.
200 Watt Switch Mode Power Supply.
Dual Floppy Controller (1.2Mb or 360k).
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Monochrome and Colour Graphics Card.
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Two RS232 Serial Ports.
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1.2Mb and 360k Disk Drives (3½" or 5¼").
20 to 600 Mb Hard Disks.
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20 to 150 Mb Tape Backup Units.

MAIN FEATURES.

Extremely fast CPU operation (Switchable 8-10 MHz).
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Dimensions: 46 x 40 x 15cms.
Weight: 17.5kg.
Environment: 10C to 40C.
Humidity: 20 to 90% (Non Condensing).

*IBM is a Registered Trade Mark.