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New loudspeaker test technique — world scoop for ETI !

Expanded-scale vehicle ammeter

SCOOP REVIEWS
B&W 801 speakers
Nakamichi 1000 ZXL cassette deck

Sequential touch switch
Apple II Plus reviewed

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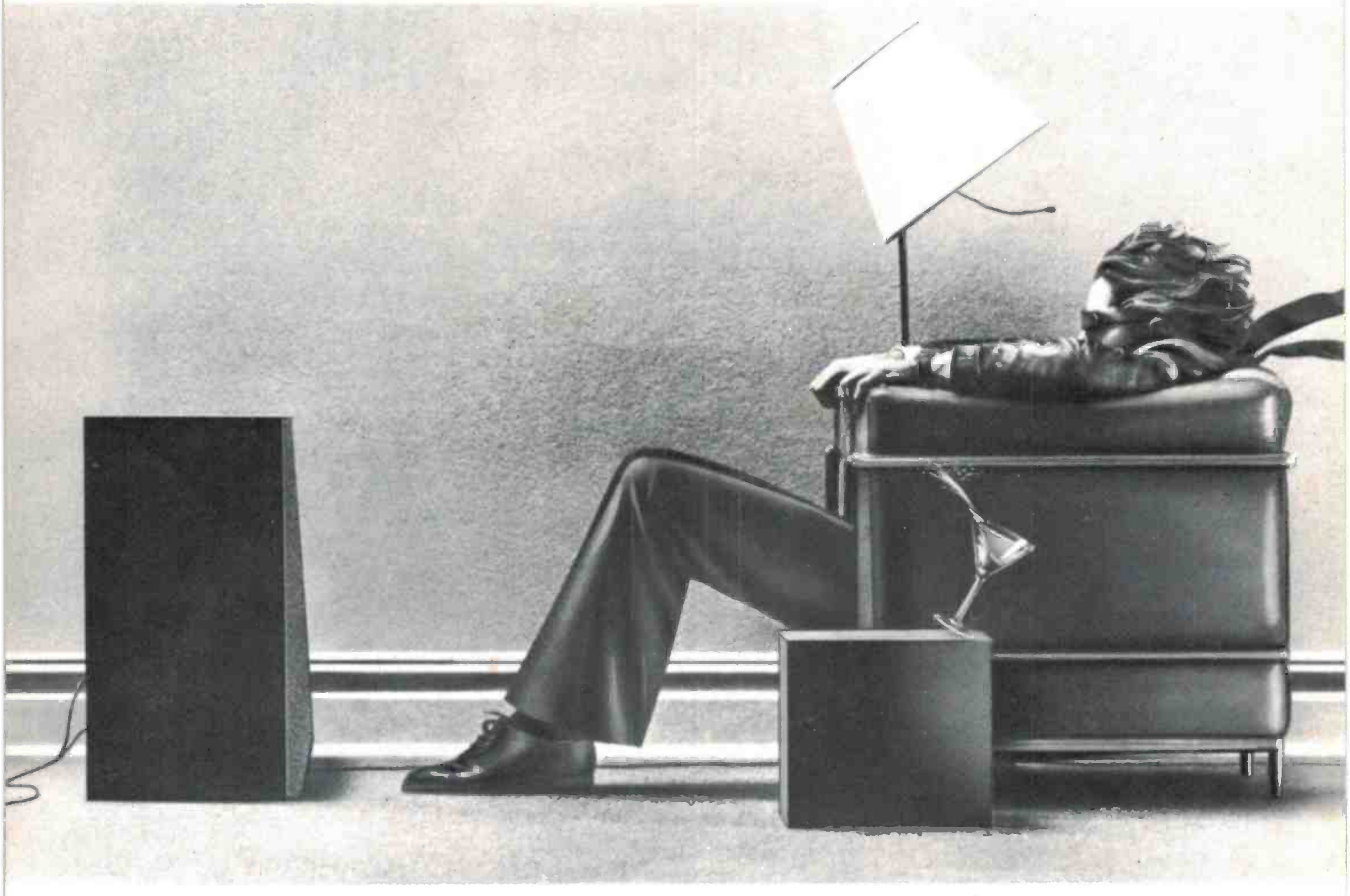

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ELECTRONICS TODAY INTERNATIONAL

QUICK INDEX

FEATURES:

SOUND SECTION:

PROJECTS & TECHNICAL

CHANNEL 0, CHANNEL 28: AD LIB, AD HOC, AD INFINITUM!

JUST WHAT has the Government snuck upon us with the introduction of 'multicultural broadcasting'? Here, a newly-introduced service has been given the privilege of simulcasting on two channels — a unique action — only to have it taken away in the same breath by having to plough its way against the technical difficulties of the frequency allocations accorded to it.

Before getting into the meat of my argument, I should review the significant events that preceded the introduction of 'ethnic TV'. The P & T Annual Report for 1978/79, in mentioning this proposed service, said:

"These stations, planned for late 1980, will operate on the UHF frequency band". (Page 18).

This made it pretty plain. Over the years, the P & T Department had held meetings with broadcasters, manufacturers and service organisations, to discuss the introduction of UHF television. Local industry was pressed to produce TV receivers equipped with UHF tuners. Stations in Adelaide and Sydney took up options to install UHF translators to improve coverage in existing 'difficult' areas (these are now in operation). A committee even produced a standard for UHF down-converters.

Then, on 23 April 1980, the then P & T Minister, Mr Staley, in speaking on the Broadcasting and Television Amendment Bill, referred to multicultural television. He said:

"For an interim period, the service will be simulcast on the VHF and UHF bands". (Hansard, 23 April 80, p. 2183).

Somewhere along the way the Government changed its mind. There has *never* been an explanation as to why they changed their mind, nor any statement on what the 'interim' arrangements are to be. Will Channel 0 be 'interim' just as the 27 MHz CB band was 'interim'? Viz: will it transfer from 'interim' to permanent as a fait accompli because of user demand?

In October last year, a story in the *Financial Review* reported that Mr Staley had said:

". . . with a combination of UHF (ultra-high frequency signal) and Channel 0 we believe we will be able to put out a good signal for the public." (*Financial Review*, 8-10-80).

Experience belies that fond hope! In Sydney, so few people have Channel 0 antennas, or are aware that they need them, that reception difficulties are legion.

The *Sydney Morning Herald* of 10-1-81, page 1, reported "Difficulties at Channel 0", saying that no solution had ". . yet been found to Channel 0/28's transmission problems.

"Since the new . . . station went to air last October, viewers in some areas of Sydney have complained about poor reception.

"Mr Gyngell (of the IMBC . . . Ed.) said that the station's engineers, Telecom and the Department of Post and Telecommunications were all trying to locate the problem."

Any number of people could supply the answers! From ex-ATV-0 personnel to P & T personnel: the *ad hoc* allocation of Channel 0. Mr Gyngell isn't helping matters by promoting Channel 0, either. Their logo says it all!

It seems to me the Government tried to *ad lib* some ethnic votes, then pressured the P & T for an *ad hoc* frequency allocation. Will this silliness continue *ad infinitum* ?

Roger Harrison
Editor

advertisers

ELECTRONICS TODAY INTERNATIONAL

COVER

Shown against its spectral decay plot (see Louis Challis' article on page 122) is B&W's Model 801 speaker which is reviewed in this issue (page 144) — an ETI scoop! Composition and photography by Ivy Hansen.

*Recommended retail price only

features

news

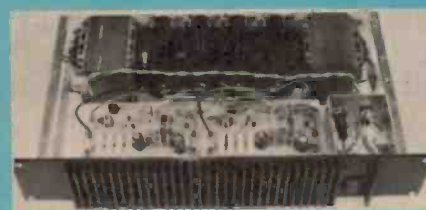
projects

sound

general

next month

COMPUTING TODAY!
Starts tomorrow! . . . well, next issue, really. In response to the booming interest in hobby computing, we're providing a coordinated section in ETI for readers largely interested in the subject — whether professionally, or just as a hobby. To kick off, we have a beaut feature article on *Bubble Memories* explaining all the ins and outs, plus circuit techniques. We also have a project — an S100 PROM board. Plus — we have Part 4 of Back Door Into Basic and our regular Printout news columns.



SERIES 5000 STEREO POWER AMP
This is it! The finest stereo power amp you can build. Naturally, it uses two ETI-477 MOSFET power amp modules and it features the exclusive ETI Front Panel/Heatsink. You can use it 'stand alone' or rack mount it.

S100 PROM BOARD
Another masterpiece from Craig Barratt. It's almost a 'universal' PROM board. It will carry 2708s, 2758s, 2716s (+5 V) and 2732s. The board is arranged as two totally independent banks of eight PROMs each and you can have different types in each bank. And there's more goodies . . . don't miss the March issue!

POLICE RADAR
There's been plenty of controversy over this subject in the press of late. Can police radars give 'false' readings? How do they work? How do different vehicles 'look' to the radar (radar cross-section)? This report answers the questions, investigates the facts and raises some provocative issues . . . don't get caught without your March issue!

Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.

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Playmaster Mosfet Amp

YES! Contains the genuine components specified by Electronics Australia. Beware of other kits with non-standard parts: especially the transformer!

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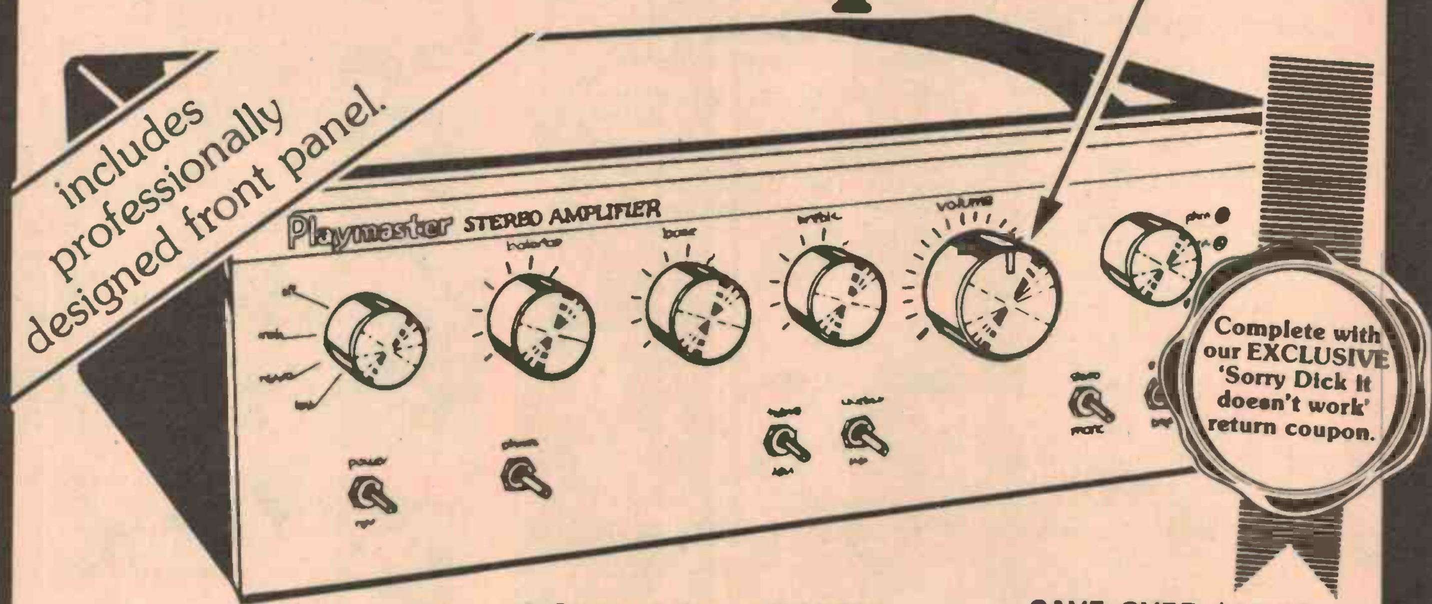

This is it: the new Playmaster Power Mosfet Stereo Amplifier, as described in the current issue of Electronics Australia. It's the latest in the incredibly successful series of Playmaster amplifiers (over 10,000 Twin 25's & Forty/Forty's built!) but this one really has everything:

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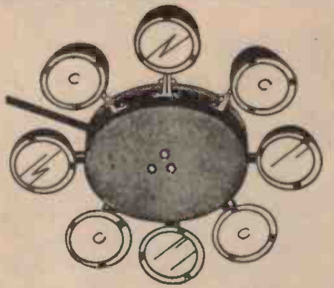

A stunning effect — 4, 8, or 16 PAR 36 pinspots, all rotating, sending sharp beams of light spinning in different orbits. Each lamp head is adjustable in any direction, and colour filters may be fitted. Space Beacons — made in Australia by Rock Industries.

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3 CHANNEL AUDIO CHASER — with built-in mic.
4 CHANNEL AUDIO CHASER — with built-in mic.
CHASER 4 — Colourgan and Audio Chaser in one.
PHASER — 3 CHANNEL DIMMER and CROSSFADER.
COLOURGAN — 3 CHANNEL colourorgan, built-in mic.

All above units 10 amp maximum load (up to approx. 1000 watts per channel in some cases).

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104 Deep Amber
105 Orange
106 Primary Red
107 Light Rose
109 Light Salmon
111 Dark Pink
113 Magenta
115 Peacock Blue
116* Medium Blue Green
117 Steel Blue
118 Light Blue
119 Dark Blue
120* Deep Blue
121 Lee Green
122 Fern Green
124 Dark Green
126 Mauve
127 Smokey Pink
128 Bright Pink
130 Clear
132 Medium Blue
134 Golden Amber
136 Pale Lavender
137 Special Lavender
138 Pale Green
139 Primary Green
141 Bright Blue
142 Pale Violet
143 Pale Navy Blue
144 No Colour Blue
148 Bright Rose
152 Pale Gold
153 Pale Salmon
156 Chocolate
157 Pink
158 Deep Orange
159 No Colour Straw
161 Slate Blue
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164 Flame Red
165 Daylight Blue
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174 Dark Steel Blue
176 Loving Amber
179 Chrome Orange
180* Dark Lavender
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806 Medium Lemon
807 Dark Lemon
809 Straw
810 No Colour Amber
811 Flame
813 Light Amber
815 Golden Amber
817 Dark Amber
818 Orange
819 Orange-Amber
821 Light Red
823 Medium Red
825 No Colour Pink
826 Flesh Pink
827 Bright Pink
828 Follies Pink
829 Bright Rose
830 Medium Pink
832 Rose Pink
834 Salmon Pink
835 Medium Salmon Pink
837 Medium Magenta
838 Dark Magenta
839 Rose Purple
847 Surprise Pink
842 Special Lavender
843 Medium Lavender
846 Medium Purple
849 Pale Blue
850 No Colour Blue
851 Daylight Blue
854 Steel Blue
855 Azure Blue
856 Light Blue
857 Medium Blue
858 Light Green Blue
859 Green Blue (Moonlight)
861 Surprise Blue
863 Medium Blue
866 Dark Urban Blue
869 Pale Yellow Green
871 Light Green
874 Medium Green
877 Medium Blue Green
878 Yellow Green

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NEWS digest

Your car becomes your office . . .

Increasingly over the last few years, computer technology and advanced communications techniques have been linked to provide sophisticated systems for commerce and industry.

These systems have taken many forms, and have usually been used by large companies, notably in the mining industry. The marrying of computers with communications has arisen in many cases from the need to combine telemetric data with normal voice channel capability.

Recently, a Queensland-based company, Personal Communications Company Pty Ltd, applied the same technology to produce a computerised message-handling service operating from a user's vehicle — a service which has some unique features.

Known as Carphone, it operates 24 hours, seven days a week, and enables users to make and receive telephone calls from their vehicles through an operator who handles any such calls. Although Carphone does not provide direct telephone connection from the car, the speed and accuracy of the transfer of messages, utilising computers, more than compensates for this deficiency.

The mobile radiotelephone equipment being used is the AWA RT-80 Carphone, one of the most sophisticated units available in Australia and one of the only units capable of supporting such a sophisticated system.

Each Carphone is equipped with a Sepac Command Module, which provides not only selective calling facilities, but also full identification and status of every unit. The control equipment is based around a Sepac status and identification console which itself uses an 8085 based microprocessor to provide the following functions:

1. Selective calling of up to 10 000 units.
2. Individual identification of each unit.
3. The status of each calling unit up to 11 designations.
4. Automatic verification of each unit called by answer-back tone with appended status.
5. Queuing up to 10 units in strict calling order with full operator manipulation of queue.
6. Automatic upgrade in queue in an emergency situation, according to status.
7. RS-232 porting directly to computer,

The computer system is a stand-alone unit supplied by Index Computers of Sydney. This system enables any messages being held for users to be automatically displayed, along with all customer file data, when the user calls the control centre. It obviates the need for the user firstly to identify, and then to request any messages awaiting him. Thus a lot of time is saved, both for the user and from an operational point of view. Less air-time usage also means that more subscribers can be accommodated on one system.

The use of computer-based files also means that data security can be maintained at a high level, something which is most important to companies who require a maximum of discretion.

The Computer, an Onyx 2000, uses a 10 M Winchester hard disk for storage of data, this being backed up by a 12 M 3-M cartridge. The operating system is the Oasis Multi-user system, supporting two televideo terminals and the status and identification unit.

The software was written by Personal Communications Co. staff programmers Ian Smith and Barney Huttley in OASIS Multi-user BASIC, the drives for the status and identification unit being in Z-80 MACRO.

The entire communications and computer system was configured by the Personal Communications Company for Carphone Pty Ltd, the communications network operating from a base-site at the AMP Centre in Sydney. The Sydney operations of Carphone began on November 1, 1980, and Personal Communications plan to expand the Carphone service to include printers in vehicles and direct computer data links early in 1981.

Carphone Pty Ltd plan to expand operations to all states, beginning in Melbourne, early in 1981. At present, the service is available only in Sydney, but plans are in hand to open a Carphone service in the major regional centres of NSW, such as Wollongong and Newcastle.

GOES-4 in good health

A new weather-watching GOES (Geostationary Operational Environmental Satellite) was launched from Cape Canaveral, Florida, on September 9th, 1980.

Although it was originally planned that this satellite would be the first meteorological satellite to be placed into a geosynchronous orbit by the Space Shuttle, problems with the Shuttle resulted in the satellite being launched by a three-stage Delta 3914 booster.

Originally known as GOES-D, the satellite was renamed GOES-4 after its successful launching. GOES-E is scheduled for a launch early in 1981, while GOES-F will be kept on the ground as a spare. The new satellites have a design life of seven years and will take over the work of the GOES craft currently operating in geosynchronous orbit. They have been built by Hughes Aircraft Company at El Segundo, California, each satellite weighing nearly a ton (837 kg at launch, 398 kg in orbit).

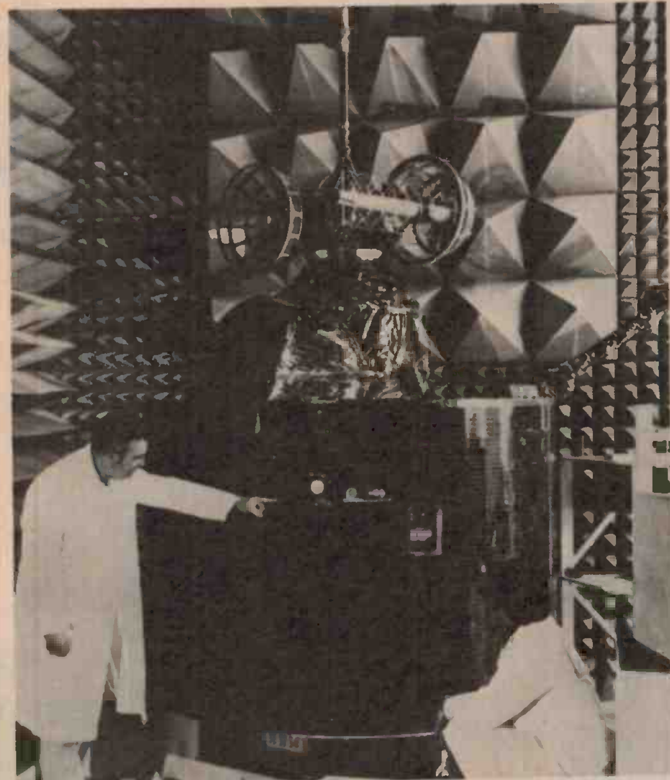
These GOES craft are each 3.66 m in height and are equipped with a cylindrical array of solar cells 2.13 m in diameter which can supply a constant 450 W initially, falling to 320 W at the end of the seven-year life. There is battery back-up power for use during eclipses by the earth.

The visible and infra-red scanning radiometer on board GOES-4 will deliver cloud pictures of the earth every 30 minutes, day and night, from its position 35 600 km above the equator at about 98°W longitude. The resolution of the visible images is 0.9 km and that of the infra-red images 6.9 km.

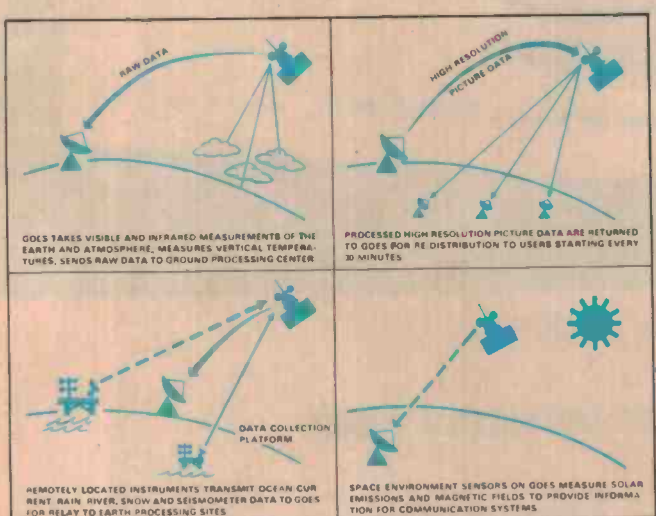
GOES-4 transmitted its first picture of the earth's cloud cover on September 24, 1980, as raw data to the National Oceanic and Atmospheric Administration ground station at Wallops Island, Virginia. This picture includes a clear image of virtually the whole of South America together with storms over North America and hurricane Kay approaching the Hawaiian Islands.

The raw data returned by GOES-4 is processed on the earth before being returned to the satellite as high resolution picture data. The satellite then re-transmits the picture data to users' earth stations. In addition, GOES-4 receives signals from transmitters at ground stations in remote locations and relays the data back to earth; this data includes rain, snow, river measurements, etc. The satellite also provides information on the magnetic fields and solar emissions in space.

Transmissions from the satellite are in the S-band region. The satellite has been purchased by NASA and will be operated by the National Oceanic and Atmospheric Administration of the USA.



ABOVE: Final test for GOES-D in anechoic chamber. LEFT: First image from GOES-4; note South America at bottom right.



GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE (GOES)

Tecnico's 'current gun plus'

Tecnico Electronics recently announced the development of a new hand-held non-contact current meter giving fast and safe operation.

The F.W. Bell Model CG100D 'Current Gun Plus' is an evolutionary model of the CG100A Current Gun probe originally introduced two years ago for use with DVMs, multimeters and scopes. It reads both ac and dc as well as ac-on-dc currents to 200 amps, from dc to 400 Hz.

Using a Hall generator, the CG100D has a 3½-digit LCD readout located in its handle, directly in the line of sight. The unit can be clamped round conductors up to 19 mm in diameter and can read through any non-magnetic insulation. Jacks are provided for use with a scope.

Since the circuit is not disturbed, the operation is fast and safe, and there is no external disturbance of the current being measured.

The CG100D is available from Tecnico Electronics, P.O. Box 50, Lane Cove 2066 NSW; or P.O. Box 520, Clayton 3168 Vic.

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New connectors

Tecnico Electronics recently announced an additional range of Belling & Lee Bleecon connectors.

The L1904A/-/PCS is an IEC 130-9 professional multipole connector, designed for straight pc board mounting or for fitting to a panel with a pc board mounted behind. Mating faces comply with DIN 41524, 45322 and 45329. All plastic parts are manufactured from flame retardent materials meeting U.L. requirements, and the connector is available in five, six or seven-pole configurations.

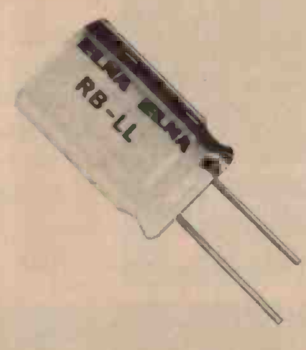
The L1904A/-/CSN is a nut-mounted version of the L1904A series sockets, providing convenient single-hole mounting.

Finally there are the L1904A/-/MFP, MCS and MFS, which are moistureproof IEC 130-9 multipole connectors providing drip-proof protection to IEC 529 Class 4 (when mated or capped with the socket protection cap). They are suitable for occasional immersion in water when mated (free pair) with IEC 529 Class 7.

For complete information on Belling & Lee's Bleecon connectors, contact Tecnico Electronics, P.O. Box 50, Lane Cove 2066 NSW; or P.O. Box 520, Clayton 3168 Vic.

New electrolytic caps to substitute for tantalums ?

Elna, the world-renowned capacitor manufacturer, has developed an advanced etching technology for their new low leakage electrolytic capacitors that can be substituted for tantalum types in many applications.



Dubbed their "RBLL" series, the capacitors are available in values from 100n to 100u, in the E6 series, and voltage ratings of 25, 35 and 50 volts dc (working), for the 'standard' range. Models obtainable on indent can be supplied in values of 220u, 330u, 470u, 1000u and 2200u.

The new series are quite small too; values from 100n to 3u3 measure 5 mm in diameter by 11 mm long. Larger values range in size from 6.3 mm diameter by 11 mm long up to 10 mm diameter by 16 mm long.

The RBLL series are specified to operate over the temperature range of −40°C to +85°C with leakage current below 0.05 uA initially, falling to less than 0.02 uA after several hundred hours operation. This is better than a factor of 10 improvement over Elna's common RB series capacitors.

Further information can be obtained from Soanar Electronics Pty Ltd, 30 Lexton Rd, Box Hill Vic. 3128. (03)89-0661. In Sydney, (02)789-6733; Brisbane, (07)52-5421.

Turn over, Mr. Bell

When Bell invented the telephone, it's a fair bet he had no idea it would ever become quite such a versatile instrument as it is today.

Now, by means of Telefax, a new system by STC which has been described as a 'high speed electronic mail service', letters, plans, drawings, layouts, orders, accounts, memos, stock lists, price lists, charts, schedules, sketches . . . you name it . . . can be sent and received by telephone — and all for the cost of a telephone call.

Documents may be transmitted by Telefax to any point within Australia or overseas in just two or three minutes. Much of the possible error caused by the copying of documents for despatch by courier or mail is eliminated, since the original may be used for transmission.

Financial statements, annual reports, planned promotions, urgent information — all may be passed swiftly and safely between head offices and branches of both national and international companies. A spokesman for Gilbeys Australia, a member of the International Distillers and Vintners Group, which has 13 offices worldwide, claimed that Gilbeys even received the advertising material for Telefax via their installation before STC, and were able to lend it to STC until its own literature arrived from overseas!

One user, the Odyssey House Drug Rehabilitation Centre in Sydney, is testing Telefax as a means of cutting phone bills by a possible 75%. As they put it, with regular daily contact between Odyssey centres in Sydney and Melbourne, there is a danger that telephone calls become opportunities to discuss the weather and the state of the cricket; Telefax would cut out such pleasant but expensive socialising, whilst at the same time probably conveying the required information more clearly and concisely than would be possible in a telephone conversation.

For further information contact Standard Telephone & Cables Pty Ltd, 280 Botany Road, Alexandria 2015 NSW. (02) 699-0044.

New SAA Chairman

The Standards Association of Australia recently announced the election of Mr R.W. Mitchell, ASTC, FIE Aust, FAIM, as its new chairman. He succeeds Mr F.M. Mathews who retired on 20 November after serving 15 years as chairman.

Mr Mitchell is the former general manager of the Sydney County Council. He retired from this post in 1979 having joined SCC as an apprentice in the early 1930s. During the war years, Mr Mitchell served in the RAAF as a squadron leader, involved with air and ground radar.

Mr Mitchell has served as chairman of the Electrical Standards Board and is chairman of the Mark committee, the Association's committee responsible for activities pertaining to the AS (Australian Standard) mark.

Mr Mitchell has served SAA as a vice-chairman of Council, and the place he vacates will be taken by Mr A.L. Rigby. The other vice-chairmen are Mr J.G. Ritchie, OBE, and Mr E.D. Waldie.

BWD ELECTRONIC TEST INSTRUMENTS

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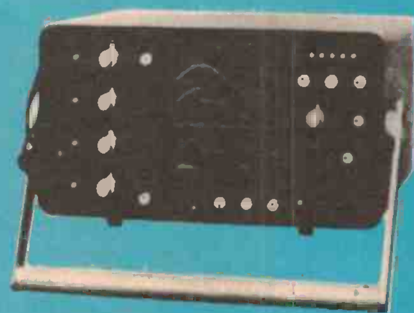
BWD 845

A remarkable field portable AC or battery-operated variable persistence storage oscilloscope $<$1cm/μSec writing speed, auto erase and store. 1mV/div sensitivity, 30MHz bandwidth.

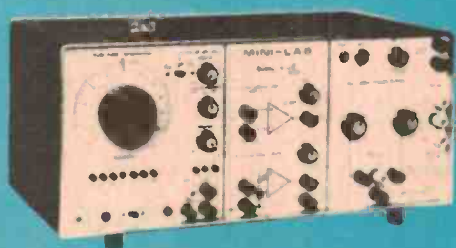


BWD 880

POWERSCOPE. A powerful tool for direct-in-line measurements. Four independent differential channels. 100mV to 200V/cm sensitivity. Digital phase measurement from 0° to 359°.

BWD 820

Economically priced 25 MHz dual-trace or differential operation oscilloscope, 2mV sensitivity, 40MHz. Triggering. DC coupled X-Y-Z operation.



BWD 603B

A portable laboratory instrument. Look at its facilities. Function generator + amplifiers + multiple power supplies in one complete unit.

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B.W.D. test instruments have increased production to speed delivery time of their equipment and the George Brown Electronics Group have stocks available now from their national network.

B.W.D. instruments are manufactured in Melbourne by a wholly Australian owned company, B.W.D. Instruments Pty. Ltd., which was formed to continue and expand the B.W.D. range.

B.W.D. instruments are known and respected in the Electronics industry and are supplied to Government Departments, Defence Services, Hospitals, Research and Industrial Laboratories and exported worldwide.

Each Instrument is entirely designed and manufactured in Australia and incorporate features which make them unique amongst worldwide competition.

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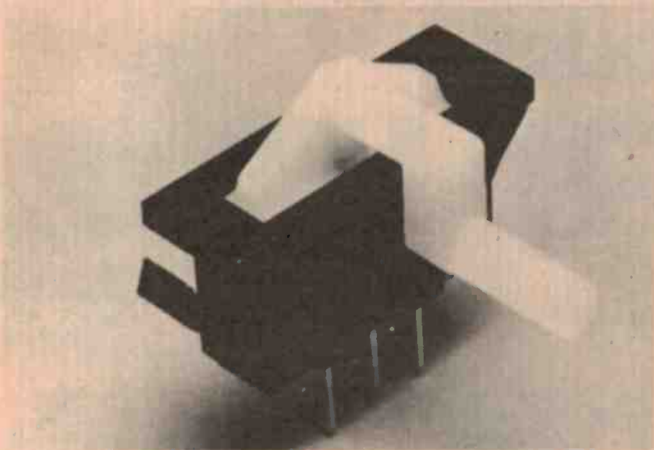
S.A.:	Protronics Pty. Ltd.	Ph. 212 3111	Telex AA88261
W.A.:	Protronics Pty. Ltd.	Ph. 362 1044	Telex AA93883



Splash-proof switches

Splash-proof switches are an important safety aspect in bathrooms and such household appliances as washing machines and dishwashers.

Swann Electronics is at present designing switches to pass new shower and splash tests with various electrical safety bodies, and their splash-proofing tests actually involve simulations of ordinary household conditions, such as where a switch might be splashed by soapy and very electrically conductive water.

Many of Swann's switches already hold approvals in Australia and several other countries, and with their new splash-proof series — the 41 series rocker, 70 Series Rotary, 91 Series Rotary and 475 Series Toggle — they hope to gain widespread success in this area as well. The 475 Series, for which Swann has great hopes, will feature a rubber gasket seal. The 91 Series Rotary is a multiple function switch available in 2, 3, 4, 5, and 6 position. It operates as two independent single pole double throw switches. Various shaft-cams can be supplied to make the switch operate in the sequences required.

The 91 Series switch will also incorporate a multiple stacking design to couple any number of bodies together. These will be available as Series 92, Series 93, etc.

The contacts are silver to silver for up to 15 amps (25 amps on request), voltages of 12 to 250 V ac or dc, and the contact resistance 5 milliohms. With a temperature rating of 100°C to S.A.A., Swann believe they have found the answer to the problem of safely mixing switches and water.

Laser superhet receiver

Tokyo-based scientists have developed in prototype what is claimed to be the world's first fibre-optic laser-driven superheterodyne receiver.

They have tested it both as a 300 MHz analog device and as a 100 megabit-per-second digital device. The superhet approach permits the laser to be frequency-modulated, opening the way to multilevel coding schemes, and such optical superhet systems can also select carriers spaced only a few MHz apart and thus fully exploit the fibre's bandwidth.

Though still only an imperfect prototype, the Japanese system is good enough to show the advantages of frequency-modulation superhet circuitry for fibre-optic receivers, enhancing both selectivity and sensitivity.

New Dialight LEDs

Two new bicolour discrete LED indicator lamps are now available from Philips Electronic Components and Materials division.

They are available in two configurations: part no. 521-9177, two-leaded for polarity indication; and part no. 521-9178, three-leaded to replace two conventional LED indicators. They are ideal for use in high-density packaging where space is at a premium.

Extremely useful as a polarity indicator, part no. 521-9177 is a two-leaded device with a red and a green GaP chip mounted in parallel (with polarities inverted) in a single package, providing a typical luminous intensity of 1.8 mcd at 10 mA maximum. Power dissipation is 115 mW.

Part no. 521-9178 is a three-lead device particularly suited to replace two conventional LED indicators. It consists of two integral chips, one red and one green, that operate independently in a common-cathode configuration. Luminous intensity is 1.5 mcd at 10 mA maximum; power dissipation is 35 mW for the red anode and 95 mW for the green.

Both devices are IC-compatible, exhibit solid-state reliability, are vibration and shock resistant and have a lifetime measured in years. They are available in a T-1¾ type package with clear diffused dome lens.

For further information please contact Philips Electronic Components and Materials, 67 Mars Road, Lane Cove 2066 NSW. (02) 427-0888.

New power amp from NS

The LP2878P, National Semiconductor Corp's latest stereo power amplifier, is claimed to be not only versatile but to have improved heat dissipation.

According to National, this amp is suitable for use with stereo record players, tape recorders, AM-FM stereo receivers and stereo TV sound systems, and can also serve as a power op-amp, power comparator or servo amp.

The high voltage stereo power amplifier has a unique 11-lead single-in-line package (SIP) with exceptional heat dissipation characteristics, allowing more power to be applied to the device. It is capable of delivering 5 W per channel continuously into 8 ohm loads, and is ideal for use with low regulation power supplies because of its superior power supply rejection, National claim.

National also claim an extremely wide operating range (6 V - 32 V) for the LP2878P, along with excellent channel separation and input noise voltage.

The unit was designed to minimise external component count, and also features 60 dB ripple rejection, low crossover distortion, internal current-limiting short circuit protection and internal thermal shutdown.

You can get further information on the LP2878P by ringing (02) 729-6333 or (03) 439-6865.

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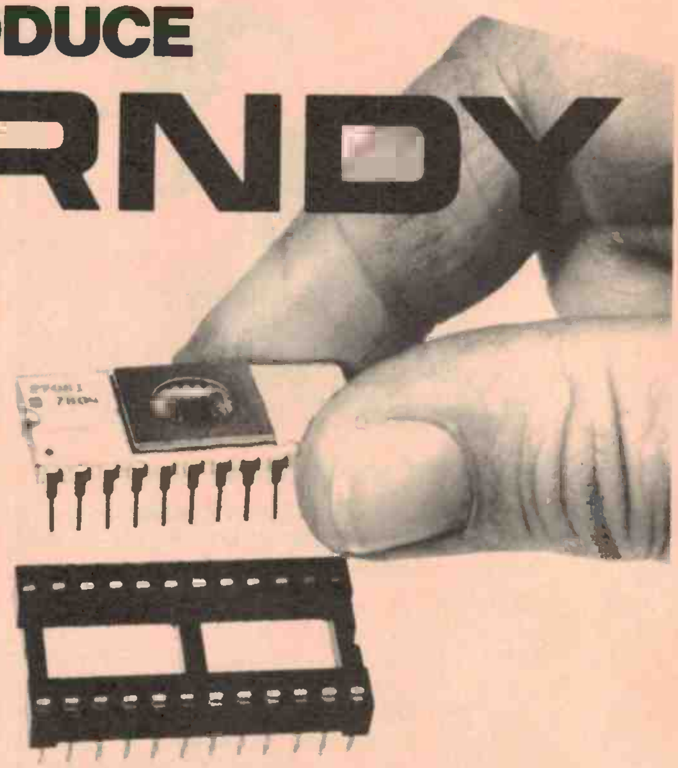

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$2 billion invested in solar energy

More than 100 delegates from 13 countries attending a London conference last December on investment and marketing opportunities in solar energy, heard that governments have invested more than $2 billion in devices to harness the power of the sun.

Dr Cleland McVeigh, from Brighton Polytechnic in southern England, said that although some of the immense energy reaching earth from the sun was reflected back into space the direct heating available was many orders of magnitude greater than the total world energy used.

Averaged over the year, the world's best conditions offered about 300 watts of solar power per square metre. At its most intense the sun offered one kilowatt of energy per square metre at mid-day in clear sunny conditions at low latitudes.

Dr McVeigh said that, until recently, the high latitude of the UK was regarded as being unsuitable for solar power applications, but meteorological statistics surprisingly revealed that during the summer months the daily solar energy levels were close to the best in the world. The UK average was just over 100 watts per square metre and it was now accepted that solar water and space heating was technically possible.

The conference was told that up to half of the total primary energy used was in the heating, cooling and provision of other services in buildings. The key to successful space heating applications was the development of suitable heat storage systems.

Dr McVeigh said there was already evidence in Britain, the United States and Federal Germany that successful storage systems had been perfected.

He added that with these systems, the combination of good insulation and heat storage would enable up to 80 per cent of the total space heating of a house to be met with solar panels.

"Buildings have been designed which can provide all their space heat from solar energy, even in the UK climate," he continued, "and it is reasonable to expect that such buildings will become quite common over the next 50 years.

"The economics of long-term heat storage using water systems become more attractive when large heat stores can be shared between a number of buildings. It is difficult to predict how rapidly these techniques could be introduced, but the earliest monitored UK experiments are now showing considerable promise.

"A storage system using salt hydrates and suitable for a single dwelling has successfully completed trials simulating 25 years of continuous operations."

New Fluke DMM

Fluke's latest release into the digital multimeter market, the 8024A, features temperature, peak-hold and logic level detectors and an audio alarm for continuity checking.

The peak-hold facility permits measurement of transients or the peak value of sinusoidal and non-sinusoidal signals. Acquisition time is 10 ms for a square pulse and accuracy is quoted as 3% of reading +10 digits, positive pulses.

Input impedance on dc is 10M, on ac it's 10M in parallel with 100 pF. The 3½-digit LCD display includes a 'low battery' warning and a Δ symbol for the level detector mode of operation. In the latter mode, the instrument's reference level is +0.8 Vdc nominal and the display indicates Δ for inputs above the reference, ∇ for inputs lower than the reference and Δ/∇ for inputs toggling above and below the reference. With ∇ levels, you can switch in the 'beeper' audio prompt.

The temperature measurement facility requires a K-type thermocouple and displays directly in °C.

The range for each function has full autopolarity, overrange indication, and effective protection from overloads. The instrument employs the dual-slope integration technique. Long term stability is quoted as one year. The 8024A requires a 9 V alkaline battery providing up to 100 hours of operation. The low battery warning (BT) appears on the display when there's about 10 hours' operation left.

The instrument is light (about 480 g) and convenient to use, the probes have finger guards and the newly-incorporated features give the instrument many advantages. Further details from the distributor, Elmeasco, P.O. Box 30, Concord NSW 2137. (02)736-2888; in Melbourne (03)233-4044.

NOTES & ERRATA FOR RECENT PROJECTS & ARTICLES

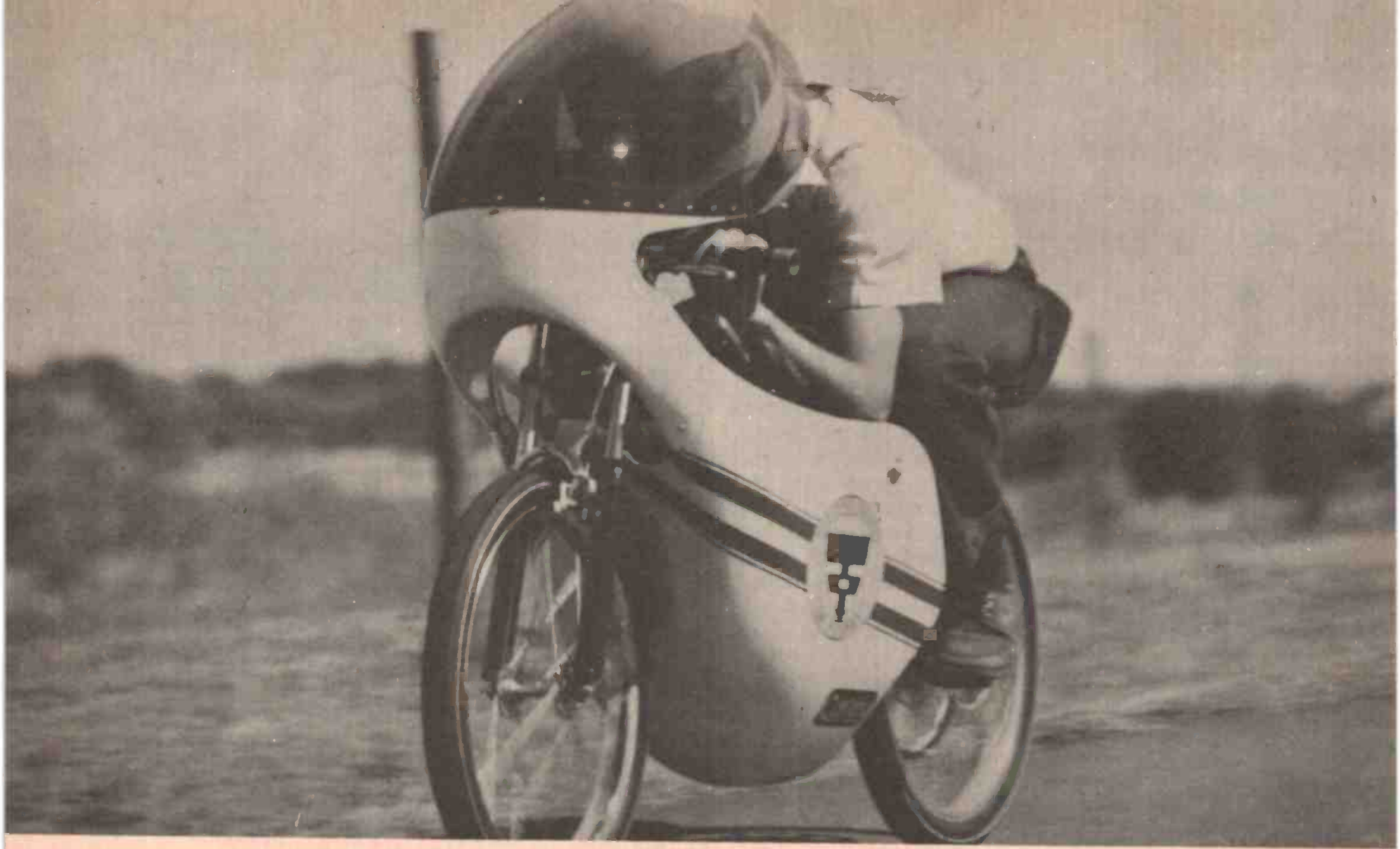
November 1980. In the *Series 3000 Compact Stereo Amplifier*, there is an error in How It Works on page 28. Under the sub-heading 'Power Amplifier', third paragraph, there is a sentence which reads . . . "This leaves a total of 0.6 V to be dropped across the two 27 ohm resistors R27 and R28." It should read ". . . 100 ohm resistors R27 and R28." In the *Electronic Temperature Meter* (ETI-255), the meter in the circuit diagram, page 39, was shown the wrong way round. The negative terminal of M1 goes to pin 2 of the LM3911. In the *Soil Moisture Indicator* (ETI-247), in How It Works on page 52, the circuit in Figure 3, lower right, shows the zener the wrong way round.

December 1980. As ETI staff are generally more electronic enthusiasts than amateur horticulturists, gardeners etc, we boobed in the *"pH — the acid test"* article. Several readers kindly and quickly pointed out the error of our ways. Firstly, on page 19, following 'Neutrality and activity', the third sentence reads . . . "In pure water at room temperature only about one water molecule in ten million dissociates into ions." This should read ". . . about one water molecule in 600 million . . ." Later, the section on 'Soils' (page 21) became entirely mixed up! K.A. Handreck, from the CSIRO Division of Soils in South Australia, advises that camelias and azaleas thrive at pH 4 - 5, while they're sure to die at pH 8 - 9, or even 6 - 7. R.J. Talbot of the Queensland Agricultural College's Department of Biology says the camelias and azaleas thrive at pH 5 - 6 and would die quickly at pH 8 - 9. He also says the vast majority of plants flourish at pH 6 - 7 and few will make normal growth at pH 9 and that, while potatoes and tomatoes will do reasonably well at pH 5 - 6, they'll produce more at pH 6 - 7. Mr Handreck also pointed out that bone meal will increase soil pH and phosphates do little for it. Mr Talbot says an efficient pH reducer is sulphate of ammonia, or for very acid soils, alum. So far as we know, the rest of the article is OK.

The CSIRO has available a small booklet that may be of interest, called "What's Wrong With My Soil?". (Cost: $1.50). This is number five in a series of eight in the CSIRO's 'Discovering Soils' booklets. They are available from Australian Government Publishing Service Bookshops in every state capital, or from the CSIRO Editorial and Publications Service, P.O. Box 89, East Melbourne 3002 (post free in Australia).

In the *Metal Detector* (ETI-1500), there are a number of designation errors on the circuit on page 42. Firstly, terminals T and V, which go to the volume pot RV5, are shown the wrong way round on both the circuit and wiring diagram. Transpose them and the pot will work in the usual manner. Secondly, the pin numbers to IC2a are shown incorrectly. The gate is actually pin 6 (not pin 3). The drain and substrate are connected (internally) to pin 14 which goes to +10 V. The source is pin 13 (not pin 1). Pins 1 and 2 of IC2a are unused. Pin 3 goes to 0 V. The overlay is correct.

January 1981. In the circuit diagram for the ETI-477 *MOSFET Power Amp Module*, page 24, capacitors C7 and C8 were shown connected between the gates of Q9 and Q11 respectively, and the feedback line. In fact, they connect between the gate and source of each device, as shown in the circuit this month.



1980 Electric Moped Race

One Saturday afternoon in October last year saw a group of dedicated electric bicycle enthusiasts — or a bunch of nuts closely affiliated to birdmen and hang-glider fliers, depending on your point of view — get together in Sydney for the Australian Electric Vehicle Association's (AEVA) 1980 Electric Moped Race.

THERE WERE prizes of $300, $150 and $50 for the three top prizewinners, plus trophies for winners of the various categories, but winning did not seem to be the prime motive of most race entrants; they came along for the challenge and the fun.

And there were certainly some strange and wonderful machines vying for the honours. Some used standard bicycle frames modified in various ways; some had custom-built frames; one resembled a racing motorbike. Some had friction drive, some chain; some were driven by car dynamos, while others had printed circuit motors.

According to the AEVA, the motive for holding the race was to stimulate public interest in electric vehicles. The AEVA's main aims are to bring together people interested in electric transportation and to make information on the subject readily available. Whereas an electric car is out of most people's do-it-yourself price range, an electrically assisted bicycle is more easily affordable, and thus brings the race within the range of a sufficient number of people.

Electrically assisted bicycles are not a new idea, and they are sufficiently fascinating and potentially useful to appeal to anyone with some basic electric vehicle interest, but although they have been available commercially for some years, they have never been common or popular.

The main reason for this is that the technology is not yet quite up to the task required. Electric bicycles are not yet economical, nor is there enough technical backup in the form of maintenance and repair companies. In addition, in order to avoid the hassles of registration, the mopeds must develop less than 300 W of power, which does not afford enough power to do away completely with the manual effort part. It is therefore not too appealing to pay out for a heavy engine and battery when you may end up carrying it occasionally! However, the 1980 Electric Moped Race may have been a sign of things to come.

Points were awarded in five categories: 60 for performance, 10 for ease of control and safety, 10 for ingenuity, 10 for workmanship, and 10 for appearance and cleanliness, giving a total of 100. Each moped was allowed up to 25 kg of batteries and an adjustment factor for weight was included in the calculation of the scores. Performance was determined by allotting the moped which travelled the farthest, in integral numbers of ½ km laps of the track and after the adjustment for weight, 60 points. The other competitors then scored proportionately. The weight factor was calculated by dividing

100 kg by the sum of the weight of the rider and the machine complete with batteries, and multiplying the result by the number of laps to get the 'corrected' number of laps.

The winning vehicle did 130 laps (uncorrected), performing almost twice as well as any other contender. This winning machine also took the trophies in all but one of the categories. It was moulded after a racing motorbike, with its rider wearing a crash helmet and crouching behind the tinted perspex windshield, and it lapped all the other competitors time after time with dogged persistency.

In appearance it was mechanical and professional and, compared with the string-and-sticky-tape appearance of many of the other competitors, rather unfriendly. With a low-slung black custom frame, a multitude of cogs, pulleys and black boxes, and the neatly painted fibreglass fairing with various stickers, it *looked* the superb technical and professional monster it proved itself to be.

The racing motorbike's rider, Paul Hinds, proved to be far friendlier than one would have expected from the cold, professional appearance of his vehicle. Joking that, "The look really demoralised the enemy," he explained the success of his machine.

Designed and built by Paul Hinds and Jonathan Scott (from ETI's design staff) at Sydney University, the bike was the result of "careful, meticulous overall design sense". The two started by choosing the batteries, experimenting with alkaline dry batteries, lithium, and various other kinds before settling on Century car batteries.

For the motors they chose printed circuit types, but had to use three to get enough power. High efficiency toothed belts were used to interconnect the motors, with a chain drive to the wheel. The bike was suspended with springs to ease out the worst of the bumps, and they put on the finishing touches with the fairing, the electronic speedo and other fancy additions.

The winners! — Paul Hinds and Jonathan Scott (on bike). Lead picture at left shows the machine in action.

Jonathan described the philosophy of the controller design: "We used power HEX FETs in a rather conventional switchmode scheme . . . because they have several advantages in this application. They have astonishingly high power gain and are easy to drive and control; you wind up with a very efficient system overall — in fact, each controller dissipates no more than 1.4 W, which is about ¼% of their total capacity, or ¾% of the capacity limit imposed by the engines on the bike. Oh yes, and the speedo uses a magnetic sensing system, just so it doesn't produce any drag!"

Efficient and highly successful Paul and Jonathan's bike might have been, but it didn't carry the day for eccentricity. Vying for those honours were perhaps two bikes, one of which actually came third. It had a custom frame with an extra-long wheel base, giving a comfortable, spacious riding position. This was filled by a casual, confident rider with an indelible smile, who rode on through the race unperturbed by all the mishaps of jettisoned batteries, discarded riders and general chaos going on around him. The final wheel of this bike sported an *enormous* cog, which the rider assured had been laboriously fabricated by means only of a drill press and files. A large dash panel and a noisy idler wheel on the drive chain combined with all the other features to impart an air of a jovial gentleman taking an antiquated, but friendly old car for a Sunday cruise through the countryside.

The other particularly noticeable entry was a lightweight bicycle which appeared to have a kind of conversion kit attached. It weighed in complete with rider at 87 kg, with only one battery which must have weighed well under the maximum 25 kg. It also had a pair of pc motors the size of pancakes driving a cunning friction wheel type of arrangement which gave two speeds, the slower automatically being selected when the pulling got tough enough. The upshot of this was that each time this bike negotiated the hill of the track it slowed down so much that riders and spectators alike were on the edge of their seats awaiting the crash. But its lady rider coped with this so often and so skilfully that no one even noticed when the battery finally did give out and she fell (gracefully) over.

So that was the AEVA 1980 Electric Moped Race — eccentric and full of oddities perhaps, but at least the enthusiasm for experimentation with electric vehicles is still obviously alive, and such meetings can only foster the interchange of ideas and the possibility of development. ●

The 'conversion kit' moped. The engine, visible at the top of the rear wheel beneath the driver's seat, applies friction drive to the rear wheel.

'The smiler'. The giant hand-made cog can be seen attached to the back wheel. A chain drive arrangement couples power from the motor.

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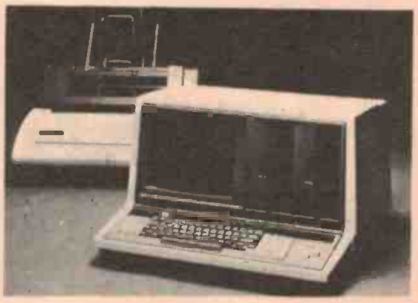

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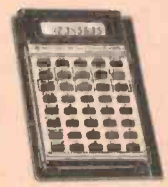

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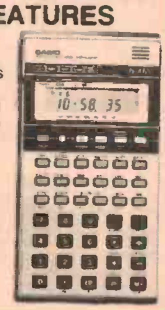

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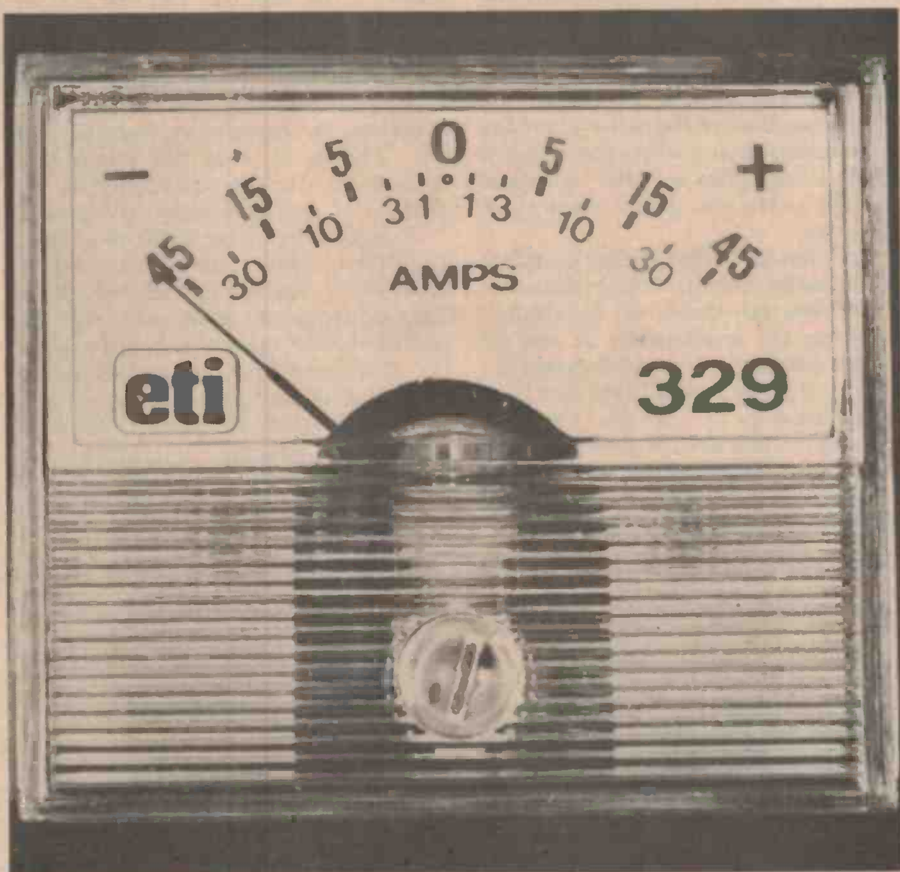
Jonathan Scott



THE CONVENTIONAL current meter, usually a moving iron type, has long been one of those instruments included in the better-equipped 'up market' vehicles. It indicates charging system or other electrical faults more quickly than any other device and warns the perceptive driver of any abnormal currents — even momentary variations.

However, the conventional vehicle ammeter has two main disadvantages: (1) In order to provide a full-scale deflection (FSD) of, say, 30 or 40 amps, it sacrifices the sensitivity necessary to show small currents that might completely discharge the battery in one or two days if the vehicle is left standing for any short or long period. (2) If you wish to install one in a vehicle that does not already include the instrument, it is necessary to interrupt the heavy, main current carrying cables and either install a 'current shunt' and cables to the ammeter, or divert the cables to the ammeter in the dashboard. This may require adding heavy cables (as they will be called upon to carry current up to 40 amps or so). One hardly need point out the inconvenience, not to mention the electrical drawbacks. In addition, off-the-shelf instruments are usually rather expensive for the function they provide because of their rather specific nature and the general cost of automotive bits.

In addition, moving iron types have a cramped scale at the low current end.

This project overcomes these problems. Our instrument offers a non-linear ('expanded') scale so that currents as low as one amp or as high as 45 A can be easily seen. It employs the earth strap of the battery as a current shunt, thus avoiding use of any cable thicker than hookup wire and not requiring the car's current path to be disturbed at all. In addition, it uses readily available components and features a centre-zero scale employing either a centre-zero meter or conventional meter movement. It may be installed in 12 V or 24 V systems and incorporates reverse-polarity protection in case you connect it the wrong way round or try to destroy it by some devious automotive electrical fault. (I recently had the unpleasant experience of momentarily disconnecting a wire on my car which resulted in the *instant obliteration* of every semiconductor in the vehicle.)

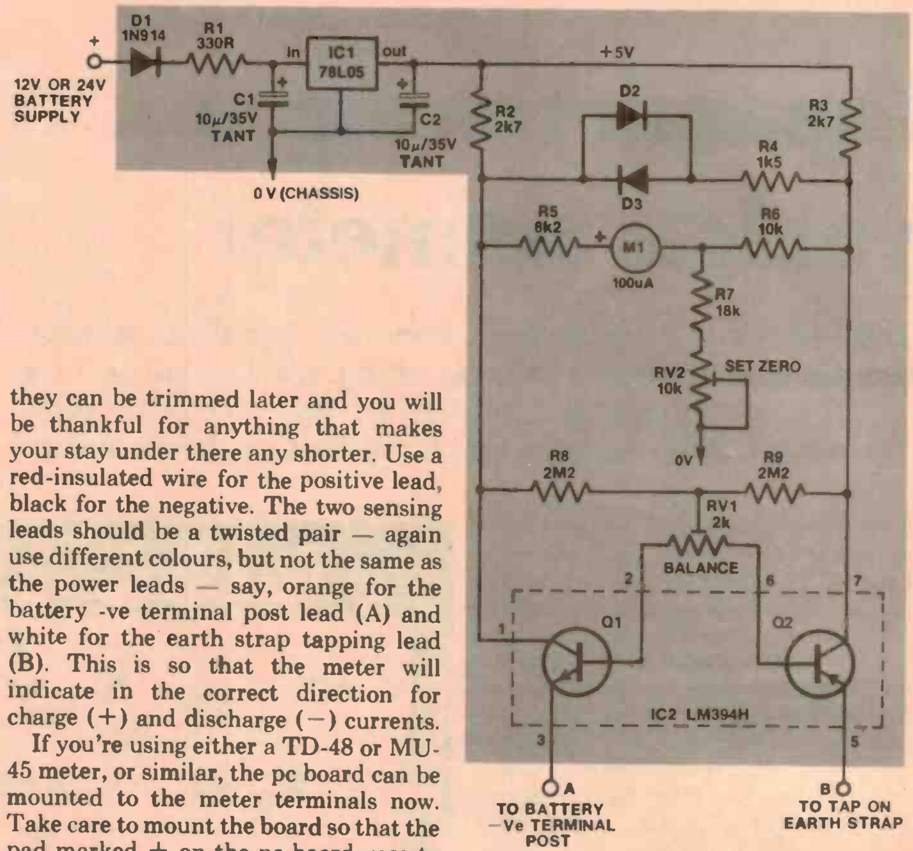
Meters and scales

We have provided artwork of scales to suit several commonly available meters: the University types TD-48 (45 mm face width) and TD-66 (62 mm face width) plus the Minipa MU-45 (51 mm face width).

As mentioned earlier, either a conventional meter movement (100 uA), with zero on the left of the scale, or a centre-zero movement (50-0-50 uA) may be used. The pc board has been laid out to suit the TD-48 meter and it mounts ▶

directly on the meter's terminals. However, the board can be fitted to the MU-45 by drilling the mounting holes through the pads on the board to suit the differently spaced terminals. If you use a larger meter, the pc board will have to be mounted separately.

Obviously, a 50 uA movement can be used provided a shunt equal to the movement's coil resistance is connected in parallel with the meter terminals.



Construction

Before commencing the construction of the electronics, the wisest move is to prepare the dash mounting place for the meter movement. As this is rather a matter for the individual vehicle owner, we will have to leave the details to you. First, though, a word of caution — choose a position for the meter where the rear is accessible and where the pc board will fit if you plan to have the board mounted on the rear of the meter as we have done.

Next step is to drill the pc board to suit the meter chosen. Having taken care of that, you can tackle the electronics. Mounting the components on the pc board is a simple job — which means it's easier to make mistakes! Take care with the orientation of the two tantalum capacitors as well as with the ICs and the three diodes. Attach power supply leads more than long enough to reach suitable termination points under the dash — they can be trimmed later and you will be thankful for anything that makes your stay under there any shorter. Use a red-insulated wire for the positive lead, black for the negative. The two sensing leads should be a twisted pair — again use different colours, but not the same as the power leads — say, orange for the battery -ve terminal post lead (A) and white for the earth strap tapping lead (B). This is so that the meter will indicate in the correct direction for charge (+) and discharge (−) currents.

If you're using either a TD-48 or MU-45 meter, or similar, the pc board can be mounted to the meter terminals now. Take care to mount the board so that the pad marked + on the pc board goes to the meter's positive terminal. If you're using one of the larger meters, attach leads to the pads and connect them to the meter terminals — again, use differently coloured insulated wire to identify each lead so that the meter is connected the right way round.

Setting up

If you have a bench supply that can deliver 12 V or 24 V, it can be used to set up the instrument initially. If you don't have one, then you'll have to do this with

HOW IT WORKS - ETI 329

The circuit senses the voltage drop across a section of the vehicle battery's earth strap, amplifies it and displays the result on a meter having a centre-zero scale so that both charge (+) and discharge (−) currents are indicated.

Heart of the circuit is a transistor differential pair contained on a single slice of silicon, IC2 (Q1-Q2). This ensures that the two transistors, though electrically separate, have closely-matched characteristics. The differential pair is operated as a common-base amplifier, the two emitters being connected across the vehicle battery's earth strap.

The differential pair requires a well-regulated supply and this is provided by IC1, a low power three-terminal regulator. Output is 5 V. Diode D1 protects the unit against the ravages of reverse polarity connection, while R1 and C1 remove supply line transients. Capacitor C2 prevents oscillation of IC1.

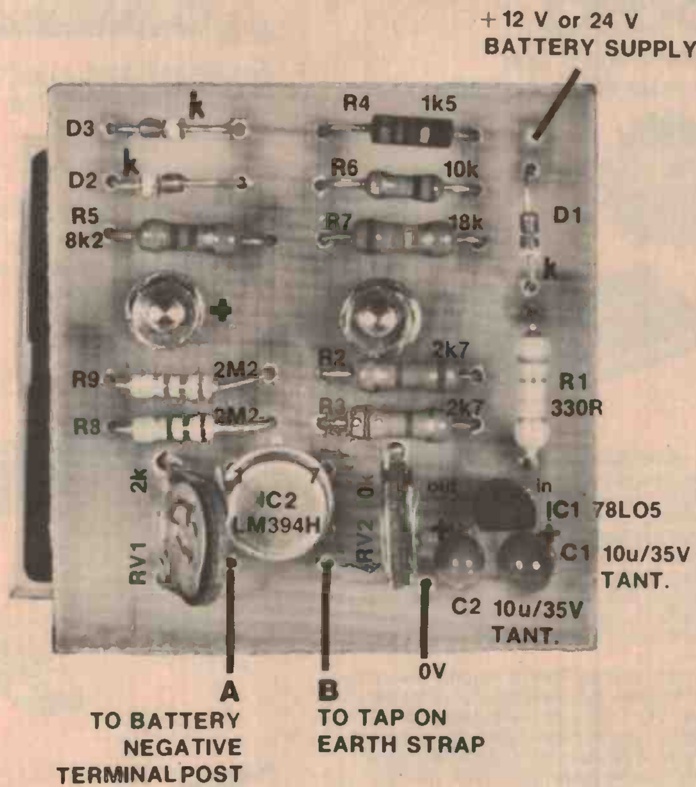
The meter is connected between the collectors of Q1 and Q2 from IC2. The centre-zero function (regardless of which type meter you use) is obtained by shunting some current to the common (0 V) rail via R7 and RV2. The latter provides a zero-point adjustment. Scale-linearity is achieved by the addition of R4 and D2-D3, which effectively shunt the meter circuit. Let's look first at the circuit as if these weren't connected.

When no current is being drawn from or passed into the vehicle battery, the emitters of Q1 and Q2 will be at the same voltage. As the base-emitter voltages of these two transistors will be very nearly identical, each will draw very nearly the same collector current. Only a small amount of base current is applied to each, via R8 and R9, with RV1 serving to balance the base currents, and therefore the emitter-collector currents, of the two transistors to compensate for the differences which inevitably occur. This trimpot is capable of compensating for more than twice the expected maximum error.

With the values chosen, Q1 and Q2, when balanced, will each have around 3 V on their collectors (with respect to 0 V). Now, when the battery is being charged, the current through the earth strap will raise the emitter of Q1 to a slightly higher voltage than the emitter of Q2. Thus Q1 will draw less current, Q2 will draw more, and the collector voltage of Q1 will rise to a higher value than the collector voltage of Q2 (with respect to 0 V). The current will therefore flow through the meter from the positive terminal to the negative terminal and the meter will indicate the current on the + side of the scale (i.e: charge). The reverse happens when current is drawn from the battery.

Now let's have a look at what happens when R4, D2 and D3 are in circuit. When the voltage between the collectors of Q1 and Q2 rises to a value greater than about 0.6 V, either D2 or D3 will conduct, depending on which collector is at the higher voltage. When one of these diodes conducts, some of the meter current will be diverted through R4, reducing the effective reading on the meter for further current increases. The result is a meter scale which is 'compressed' at the higher currents.

Resistor R7 and RV2 are arranged so that equal quiescent currents will flow through R6, R5 and the meter (M1), allowing centre-zeroing of the meter without upsetting the balance of the differential pair. These two components can be deleted if a centre-zero meter is used.



Component overlay for the pc board. Trimpot RV1 is for BALANCE while RV2 is for ZERO SET. The latter, along with R7 are left out if you use a centre-zero meter.

PARTS LIST - ETI 329

Resistors	all ½W, 5%
R1	330R
R2,R3	2k7
R4	1k5
R5	8k2
R6	10k
R7	18k
R8,R9	2M2
RV1	2k min. vertical mount trimpot
RV2	10k min. vertical mount trimpot
Capacitors	
C1,C2	10u/35 V tantalum
Semiconductors	
IC1	78LO5, or similar 5 V reg.
IC2	LM394H supermatch pair
D1,D2,D3	1N914, EM401 etc silicon diode

Miscellaneous
ETI-329 pc board; M1 - 100 uA conventional meter or 50-0-50 uA centre-zero meter (see text); meter scale; hookup wire etc.

Price estimate

We estimate that the cost of purchasing all the components for this project will be in the range:

$15 - $17

Note that this is an estimate only and not a recommended price. A variety of factors may affect the actual price of a project, whether bought as separate components or made up as a kit.

the unit connected in the vehicle, but not mounted.

Connect up the power supply leads, join leads A and B (the sensor leads) and connect them to zero volts. Adjust both trimpots and see if they both have some affect on the meter reading. This will confirm correct operation, and you can proceed with the setting up. If the meter goes hard over in either direction you have a wiring fault. Disconnect the unit *immediately* and trace the fault before proceeding.

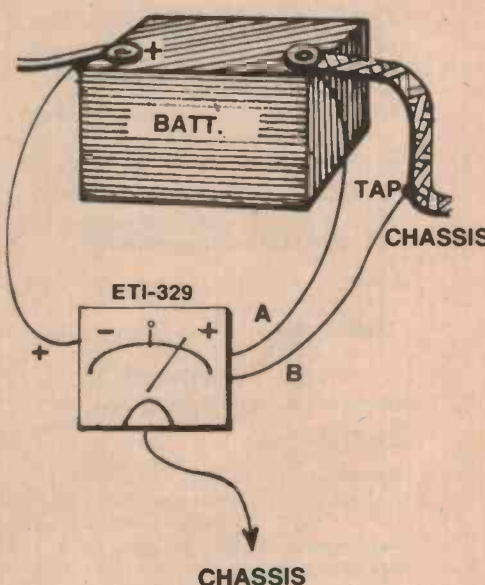
With a multimeter, measure the voltage on the collector of each transistor in the differential pair IC (pins 1 and 7). Adjust RV1 so that these voltages are equal. If you do not have a multimeter, remove R7 and short out R5 and R6. Then adjust RV1 for zero meter reading (i.e: centre scale). This last method is not recommended as accuracy is affected to some extent, but it will suffice in the absence of a multimeter. Restore the circuit when you've finished.

When doing this initial setup, whichever method you use, allow a couple of minutes (with the unit still connected) and check the circuit balance again as it may drift briefly after initial switch on.

When you are confident that the balance is correct, adjust RV2 for exactly half-scale deflection on the meter — zero on the scale. This trimpot functions as a 'set zero' adjustment. If you wished, you could have a scale zero at some position other than centre scale — there is no reason why you couldn't have the zero at quarter-scale, to the left or the right. However, if you're using our meter scale and component values, you can only have zero at centre-scale, and that settles it.

If you cannot achieve balance within the range of RV1 (equal voltages on pins 1 and 7 of IC1), proceed as follows: if you're only a short way off balance then you possibly have an IC and resistors that are all on the edge of their specifications. In this case, reduce the value of R8 and R9 to 1M5 or so and try balancing the circuit again. If there is a gross imbalance you are almost certainly using a meter of the wrong coil impedance. It may be possible to rectify the situation by halving the value of R8 and R9 and substituting a 5k trimpot for RV1, sacrificing some sensitivity.

When you have the unit correctly set up, install it in your vehicle. Be careful to ensure that the sensor leads (from A and B) are of equal length. If all is well, next step is to calibrate the unit. You can leave it connected permanently to the battery (i.e: not via the ignition switch) as it draws very little current. Lead A should be securely connected to the battery negative terminal connector. It is best to solder it to the copper strap just as it terminates at the clamp which attaches to the battery post. Temporarily connect the other sensor lead (B) about 200 mm down the earth strap, toward the chassis termination. ▶



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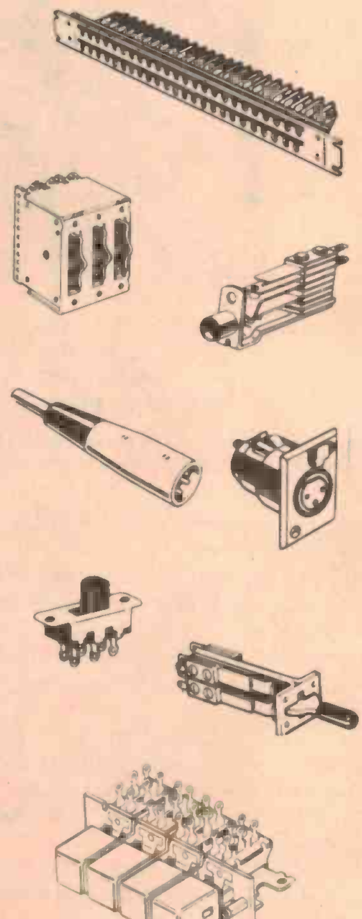

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Calibration

To calibrate the ammeter you will either need to have a 'load' of known resistance and a multimeter or temporarily connect an ammeter (say, 10 A or 15 A FSD) between the battery's positive terminal post and the positive terminal clamp.

In the former case, connect the known load between the positive supply rail and *vehicle chassis*. Measure the voltage across the load and calculate the current through it. Note the reading on the meter (it should read in the negative portion of the scale) and adjust the position of sensor lead B on the battery earth strap so that the meter reads the correct current. Move it *towards* the battery terminal to *decrease* the reading, *away* from it to *increase* the reading.

If you don't have a known load, then the series ammeter method will be necessary. With the ammeter connected in series with the battery positive lead, turn on a few accessories until you are drawing a current of say 5 A or 10 A. As before, move sensor lead B along the earth strap until the project indicates the correct current.

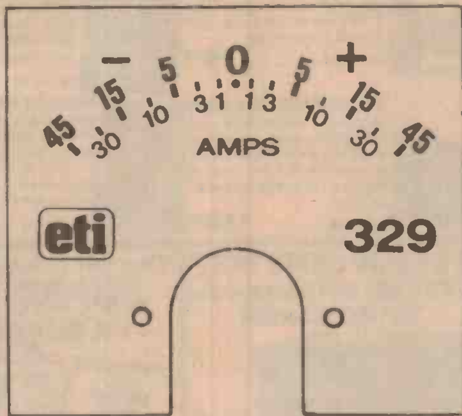
Once the unit is calibrated, permanently connect sensor lead B to the position determined. The length of strap between this point and the battery negative terminal has a resistance of around 1½ milliohms!

Some vehicles have insulation on the earth strap. Small sections may be removed with a sharp penknife or lino cutter.

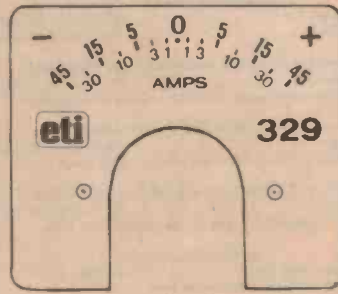
Finished? — that's it!

Once operational, you will notice that your vehicle has characteristic charge and discharge patterns under the usual driving conditions. Get used to them — you can then quickly tell at a glance if and when something may be going wrong.

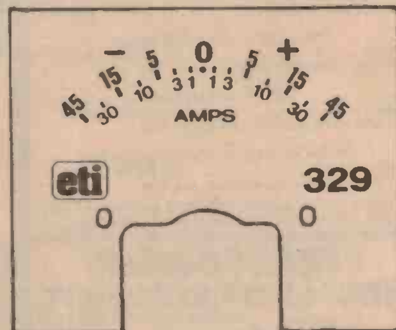
Illumination of the meter scale is useful, although we haven't included details. This will depend on the individual situation and the particular meter used. A hole may be drilled in the rear of the meter case and through the scale panel so that a small 'pea' or bayonet type globe can be fitted. (Be careful!) These lamps can be obtained in 12 V (or 24 V) ratings; lower voltage types will require a series resistor. If the light is too bright, reduce the current through the globe with a series resistor. ●



Scale for the University TD-66



Scale for the University TD-48



Scale for the Minipa MU-45

METERS, SCALES AND SHUNTS

We have provided artwork of scales to suit several commonly available meters: the University types TD-48 (45 mm face width) and TD-66 (62 mm face width), plus the Minipa MU-45 (51 mm face width).

As mentioned in the text, either a conventional meter movement (100 uA) with zero on the left of the scale, or a centre-zero movement (50-0-50 uA) may be used. The pc board has been laid out to suit the TD-48 meter and it mounts directly on the meter's terminals. However, the board can be fitted to the MU-45 by drilling the mounting holes through the pads on the board to suit the differently spaced terminals. If you use a larger meter, the pc board will have to be mounted separately.

Obviously, a 50 uA movement can be used provided a shunt equal to the movement's coil resistance is connected in parallel with the meter terminals. For some types, meter impedance is 1400 ohms, while for others (particularly the University models) it is 2000 ohms. Resistors having a 1% or 2% tolerance can be used (E48 or E96 series), and values of 1k4 and 2k are available. Alternatively, a parallel combination of standard value, 5% tolerance resistors can be used and will result in sufficient accuracy in this application. For a 1k4 shunt, parallel a 1k5 and a 22k. For a 2k shunt, parallel a 2k2 and a 22k.

LM394

general description

The LM194 and LM394 are junction isolated ultra well-matched monolithic NPN transistor pairs with an order of magnitude improvement in matching over conventional transistor pairs. This was accomplished by advanced linear processing and a unique new device structure.

Electrical characteristics of these devices such as drift versus initial offset voltage, noise, and the exponential relationship of base-emitter voltage to collector current closely approach those of a theoretical transistor. Extrinsic emitter and base resistances are much lower than presently available pairs, either monolithic or discrete, giving extremely low noise and theoretical operation over a wide current range. Most parameters are guaranteed over a current range of 1μA to 1 mA and 0 to 40V collector-base voltages, ensuring superior performance in nearly all applications.

To guarantee long term stability of matching parameters, internal clamp diodes have been added across the emitter-base junction of each transistor. These prevent degradation due to reverse biased emitter current—the most common cause of field failures in matched devices. The parasitic isolation junction formed by the diodes also clamps the substrate region to the most negative emitter to ensure complete isolation between devices.

The LM194 and LM394 will provide a considerable improvement in performance in most applications requiring a closely matched transistor pair. In many cases, trimming can be eliminated entirely, improving reliability and decreasing costs. Additionally, the low noise and high gain make this device attractive even where matching is not critical.

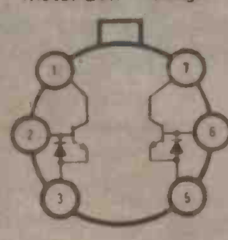
The LM194 and LM394/LM394B are available in an isolated header 6-lead TO-5 metal can package. The LM194 is identical to the LM394 except for tighter electrical specifications and wider temperature range.

features

- Emitter-base voltage matched to 50μV
- Offset voltage drift less than 0.1μV/°C
- Current gain (h_{FE}) matched to 2%
- Common-mode rejection ratio greater than 120 dB
- Parameters guaranteed over 1μA to 1 mA collector current
- Extremely low noise
- Superior logging characteristics compared to conventional pairs

connection diagram

Metal Can Package



TOP VIEW

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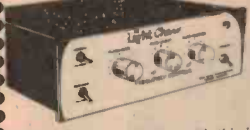

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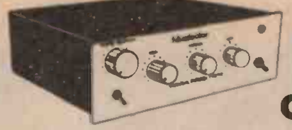

EA MUSI-COLOR

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Cat X-3501 OUR PRICE: **95¢!!!**

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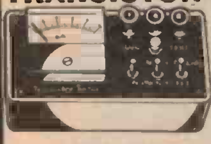

This one tests bipolar transistors, diodes, FET's and even SCR's & PUT's. It's a low cost and practical instrument simple enough for a beginner to build. Ideal also for the serviceman. A valuable piece of test equipment you can't afford to miss!

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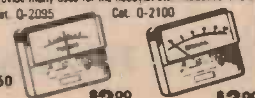

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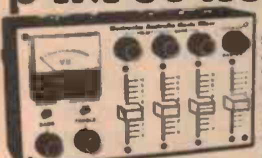

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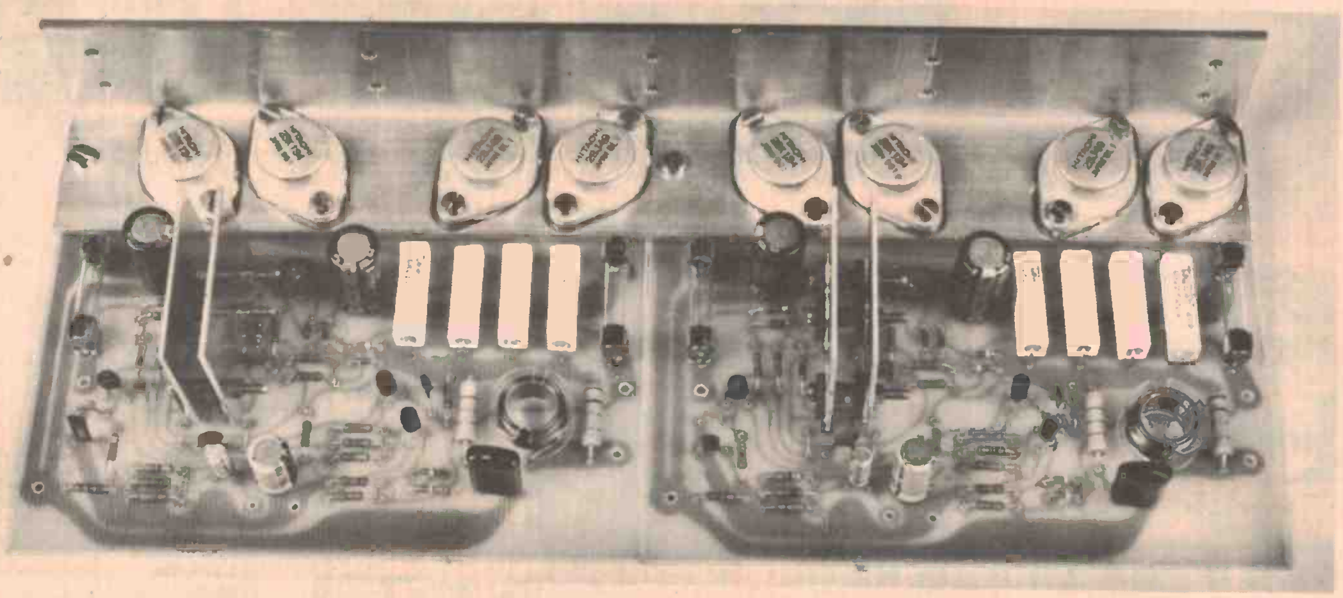


MOSFET power amplifier Part 2.

David Tilbrook

This month we continue with the discussion on the amplifier's design, followed by further construction details to enable you to build a stereo power amplifier using two modules.

LAST MONTH we decided on the use of the MOSFET output devices, and can now proceed with the design of the rest of the power amplifier. The biggest problem is the reduction of distortion in the output stage. In most power amplifiers this is accomplished with negative feedback.

There is a trend at the present away from amplifiers with large amounts of overall negative feedback. Claims have been made that negative feedback is the cause of transient intermodulation distortion and results in amplifiers with dubious stability characteristics. The anti-negative feedback purists have suggested that 10-20 dB of overall negative feedback should be considered the maximum in a high-quality audio amplifier. To my knowledge, however, and on the basis of numerous experiments into the problem, there is no sound engineering basis for this position. So long as a good stability margin is maintained and providing the amplifier is designed so that the feedback loop will not saturate on any input signal, with the exception of an amplitude overload, there is no reason why 40-60 dB *or more* of negative feedback could not be applied.

In order to understand the relationship between negative feedback and distortion it is necessary to look at some of the fundamentals of feedback amplifiers.

The modern transistor power amplifier is similar to the IC op-amp. Both have an input difference amplifier, followed by a voltage gain stage or stages. The output from the voltage gain stage is fed to the output stage that provides a sufficiently low output impedance to drive the expected load. Figure 11 is a block diagram of a typical power amplifier.

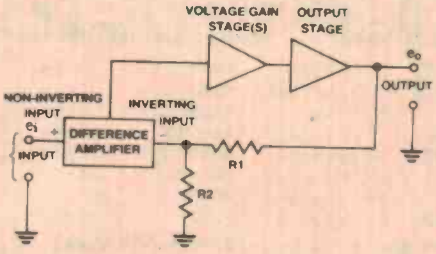


Figure 11

The difference amplifier has two inputs. A signal applied to the *non-inverting* input will be amplified and *appears at the output with the same phase as the input signal.* A signal applied to the *inverting* input is also amplified but *appears at the output with the oppositve phase to the input signal.* The non-inverting input is sometimes referred to as the positive input and is generally marked on diagrams with a '+', while the inverting input is sometimes referred to as the negative input and is marked on diagrams as a '−'.

If identical signals are fed to both inputs simultaneously, the result at the output is 0 V. i.e: only the difference between the two input signals will appear at the output.

In Figure 11 the input signal, e_i, from the output of the preamplifier, is applied to the non-inverting input of the difference amplifier. The output signal voltage, e_o, is attenuated by the resistive potential divider formed by R1 and R2 and then fed to the inverting input of the difference amplifier. If we assume that the input impedance of the inverting input is high, the output signal voltage, e_o, will give rise to a signal current through R1 and R2 to ground. So:-

$$i_o = \frac{e_o}{R1 + R2} \text{ by Ohm's law.}$$

The signal voltage developed across R2, which is the signal voltage seen by the inverting input, is given by:-

$$i_oR2, \text{ or } \frac{R2e_o}{R1 + R2}$$

Now, if the output signal e_o is at 0 V while the input e_i is taken slightly positive, the input stage will amplify the difference between the two voltages and feed this signal to the voltage amplifier where it is further amplified. The output signal from the input stage is proportional to the difference between the input and the output of the power amp and is therefore often referred to as an *error* signal. In this case, the error signal is a positive-going voltage that will cause the output stage to drive in the positive direction until the voltages on the two inputs of the differential amplifier are identical. To do this it must take the output signal voltage to a higher voltage than the input in order to compensate for the attenuation in the potential divider.

Specifically, $e_o = e_i \cdot \frac{R1 + R2}{R2}$

The factor (R1 + R2)/R2 defines the relationship between the input and output signal voltages and therefore is the gain of the power amp — sometimes called the *closed loop gain.*

The total voltage gain in the difference amplifier, voltage amplifier and output stage is called the *open loop gain* since this is the gain the amplifier would have if the negative feedback were not there. If the open loop gain was infinite, then no matter how small the error voltage became, the feedback loop could reduce it still further. Real amplifiers always have a finite open loop gain and so the equation for the closed loop gain gives us really only an approximation. Nevertheless, this is the biggest single advantage of feedback amplifiers. The gain, and therefore the transfer characteristic, is ostensibly a function of the ratio of resistors R1 and R2, provided that the open loop gain is high enough.

Consequently, feedback amplifiers are capable of extremely good performance and it is significant that almost any power amplifier available today uses this basic technique.

There are of course disadvantages to the negative feedback approach. If, for any reason, the output signal e_o cannot follow the input signal e_i, the error voltage will increase dramatically. Since the amplifier has access only to a limited supply rail (even the national power grid is a limited supply rail !), the feedback loop will clip if the error signal becomes too great. Once the amplifier overloads in this way it will remain 'latched up' for a period before recovering. The ability of the circuit to recover from overload is simply referred to as *overload recovery* and is another factor contributing to the difference in sound between amplifiers.

It is important that the amplifier can recover quickly and cleanly from an overload situation. Some amplifiers actually burst into oscillation momentarily as they pass into and out of an overload situation. This can be difficult to see on an oscilloscope if the effect is relatively minor, but it will have a profound influence on the sound of the amplifier.

Although it is true that negative feedback amplifiers are more likely to suffer badly from this problem than open loop amplifiers, it should be realised that all amplifiers suffer from this problem. The two instances where this is likely to occur are *amplitude limiting* and *slew rate limiting.* When the output voltage reaches one of the supply rails and the amplifier 'clips', the feedback loop will swing hard against the opposite rail. Figure 12 is an oscilloscope picture showing the feedback loop of the ETI-477 MOSFET power amp module trying to correct for a 100 W RMS, 1 kHz sinewave that is being clipped slightly on peaks. Notice that the feedback loop comes out of overload quickly and with no sign of oscillation.

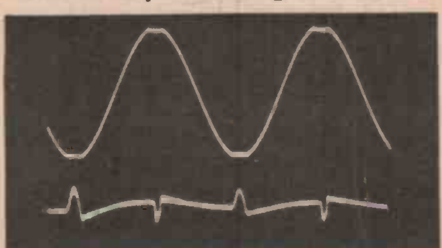
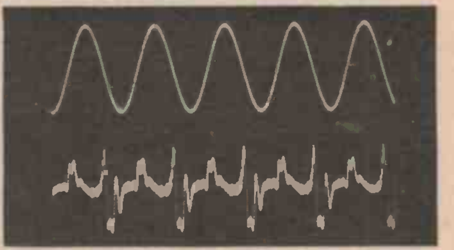


Figure 12

Transient intermodulation distortion

The second instance that leads to saturation of the feedback loop occurs when the signal slope of the input exceeds the slew rate of the amplifier. That is, when the signal rises or falls faster than the amplifier can. In this case, the feedback loop simply cannot 'catch' the input signal and the amplifier will be momentarily operating without feedback (open loop). As I mentioned earlier, this is one of the more controversial aspects of feedback amplifier techniques.



A bad case of TIM. Upper trace — 25 kHz power output sinewave. Lower trace — distortion. Notice that the distortion is greatest for the middle portion of the sine wave, where slew rate is highest.

The claim is made that negative feedback makes an amplifier susceptible to transient intermodulation distortion. Since a bipolar output stage is usually the slowest stage in the amplifier, it will take the longest to react to a transient input signal with high input signal slope. The argument is that since the input signal is present on the non-inverting (+) input of the difference amplifier, but not on the inverting (−) input, since it has been delayed by the output stage, the error voltage will increase to the point of clipping, thereby overloading the driver stage and generating gross distortion.

It is easy to demonstrate by experiment that this effect *does in fact occur*, and it is true that beyond the slew rate limit, the presence of a negative feedback loop will make the problem worse. *It is equally true*, however, that the negative feedback loop worsens the distortion above the amplitude limit, or clipping point, and for *exactly the same reasons*. Once the feedback loop is overloaded, either by clipping or slew rate limiting, it will take a finite time to recover and this adds an audible form of distortion to the output signal.

The point is that no high quality amplifier should be operated above its slew rate limit.

The usual approach is to ensure that the slew rate limit is high enough in the first place and to precede the input stage with a low-pass filter to limit the ▶

maximum possible signal slope of any input signal. In this way, extreme slewing distortion *cannot occur,* since no signal at the amplifier's input can exceed the slew rate limit.

As the input signal approaches the maximum slew rate, the distortion will increase, just as it does when the signal amplitude approaches the clipping point. Under these conditions however, the negative feedback loop *may actually decrease* the amount of transient intermodulation distortion by generating the appropriate error signal.

A good qualitative indicator that an amplifier is free from TIM is its square wave response. Remember that a relatively high frequency square wave (about 10 kHz) passed through a low pass filter with a 3 dB point of around 30 kHz for example, should not look square. (See Picture I on page 28 of last month's issue.) The filter gives rise to the exponential shape of the rising and falling edges and clearly limits their signal slope. Furthermore, since the ear is roughly a 20 kHz low pass filter itself, you will perceive no difference in the sound of these two signals. A power amplifier that is free from TIM should produce a 10 kHz square wave that has exponential leading and trailing edges like the waveform in Picture I last month. There are several extremely fast amplifiers on the market at present whose square wave response will look square, even at 10 kHz. If their square wave response is analysed on a high speed CRO, however, the leading and trailing edges of a 10 kHz square wave would still have an exponential shape.

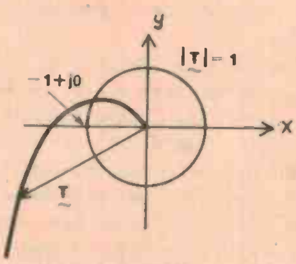
In this analysis of the TIM mechanism, the term slew rate has been used in reference only to the slew rate of the slowest active device. If the power amplifier has been designed for minimum TIM, and consequently has been fitted with an input filter to limit the maximum possible input signal slope, the filter will determine the slew rate of the amplifier. The slew rate specification quoted by most amplifier manufacturers is meaningless when it is not known whether this slew rate is determined by an active device or by a passive input filter.

Stability of feedback amplifiers

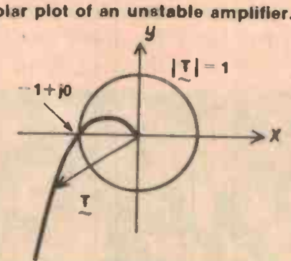
By far the biggest problem encountered with feedback amplifiers is the stability. The difference amplifier stage achieves its differencing effect by summing signals that are inverted with respect to each other; i.e: they have a 180°, or π rad., phase difference. If any reactive component in the load or the amplifier itself is allowed to cause a phase shift of more than ±90° ($\pi/2$ radians) the differencing function of the amplifier becomes a *summing* function and oscillation results. If the oscillation occurs it will invariably lead to gross distortion in the audible range, even if the oscillation itself is well above 20 kHz. In the worst case, full power output at these frequencies (typically between 50 kHz and 1 MHz) will lead to almost instantaneous heating, and possible destruction, of the output devices and perhaps the loudspeakers.

There are some amplifiers that destroy tweeters with monotonous regularity. These amplifiers are usually those with marginal stability characteristics and can be improved with some modification to their design.

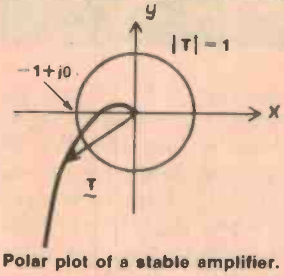
The basic rule for stability of a feedback loop is the *Nyquist Stability Criterion.* This says that the amplifier will be stable if the loop gain is less than unity when the phase shift of the loop reaches 180°. This is best shown as a polar plot like that in Figure 13. On the polar diagram, the loop gain is represented as a vector quantity, $\underset{\sim}{T}$. This is because both the phase and the magnitude of the loop gain change as a function of frequency. The phase is



Polar plot of an unstable amplifier.



Polar plot of a conditionally unstable amplifier



Polar plot of a stable amplifier.

Figure 13 Nyquist stability diagrams.

HOW IT WORKS — ETI 477

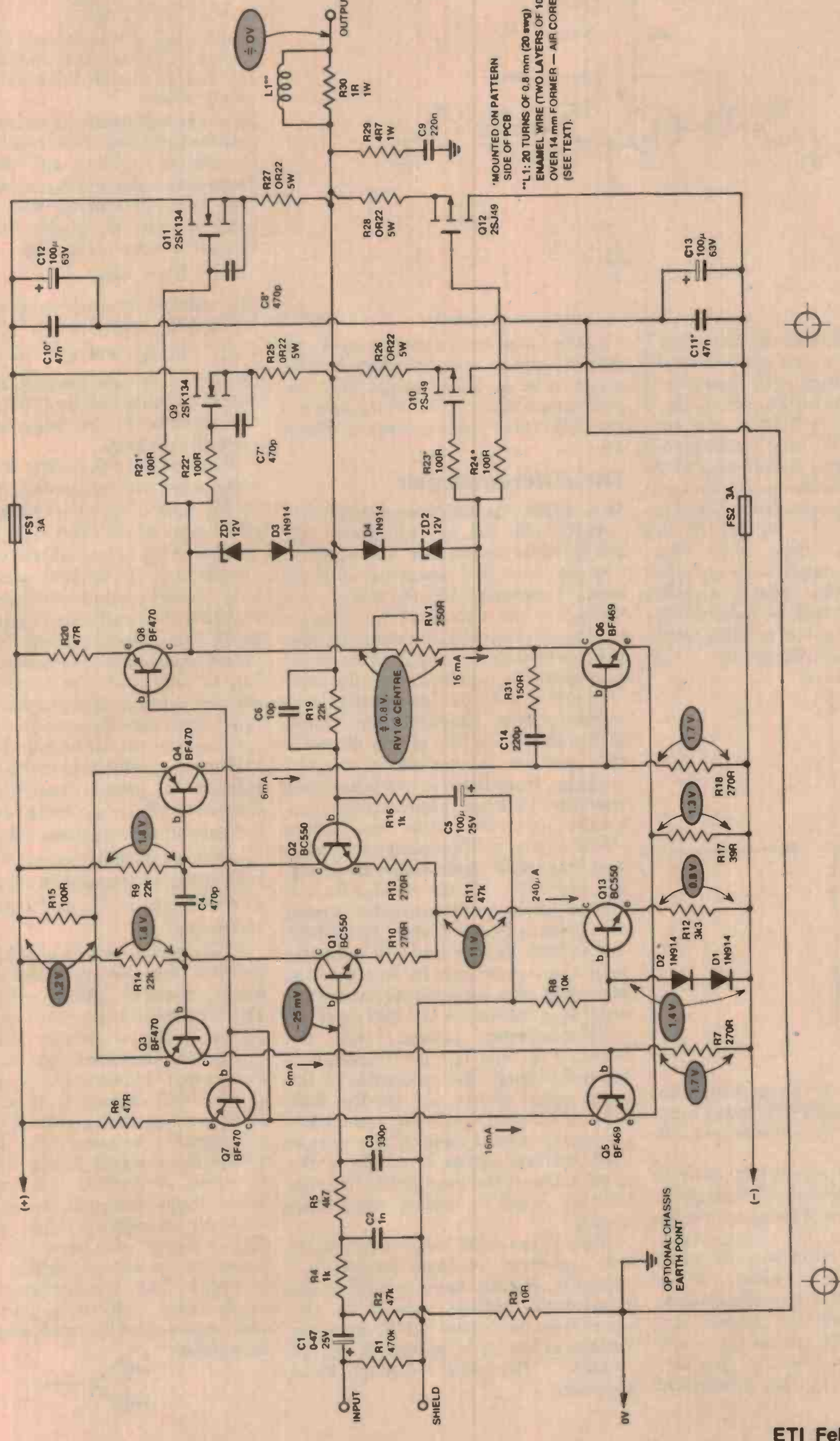
This description is confined to a dc analysis.

The input signal is fed to three RC filter sections formed by C1R2, R4C2 and R5C3. The C1R2 filter defines the low end 3 dB point of the amplifier at around 7 Hz, with an attenuation rate below this frequency of 6 dB/octave. The two sections R4C2 and R5C3 both have 3 dB points of around 30 kHz defining the top end response of the amplifier. This filter limits the maximum signal slope to less than the slowest stage in the amplifier. It also provides protection against RF interference. Resistor R1 ensures that the positive side of C1 always remains at the 0 V potential for reasons discussed in the main text.

Transistor Q13 and the associated components R8, R12 and D1, D2 form a constant current source (or sink), maintaining a final dc current through the differential pair Q1, Q2 of around 240 mA. Under no-signal conditions this current is shared equally between Q1 and Q2. The resistances of R9 and R14 are in parallel with the equivalent input resistances of the transistors Q3, Q4, decreasing the effective load resistance of the differential pair to around 15k. The voltage drop across R9 and R14 should therefore be 1.8 V approximately. This voltage, minus the 0.6 V drop of Q3 and Q4, will cause a voltage drop of 1.2 V across resistor R15, causing a current of 12 mA to flow in this resistor. This current is shared by Q3 and Q4 and causes a 1.7 V drop across resistors R7 and R18. Once again, the effective input impedance of Q5 and Q6 is in parallel with the resistors, but in this case the value of R7 and R18 is very much lower than the base impedances of Q5 and Q6, so this effect can be ignored in a dc analysis like this. The voltage across R7 and R18 minus the 0.6 V drop of Q5 and Q6 will cause 1.3 V to be dropped across the 39 ohm resistor R17, giving rise to around 32 mA through the resistor. Again Q5 and Q6 form a differential pair, and this current is shared equally by the two transistors. The load for these devices is formed by a current mirror, Q7-Q8, that ensures the current through Q5 and Q6 will remain the same. Transistors Q4 and Q5 therefore form the main voltage gain section of the amplifier and have a typical emitter-collector current of 16 mA. The preset RV1 will drop nominally 1 V across it when the output stage quiescent current has been set.

Diodes D3, D4 and zeners ZD1, ZD2 protect the MOSFET output devices from being overdriven, as described in the text. The RC-RL network on the output ensures that the amplifier has a correct load at all frequencies, thereby eliminating the problem of oscillation that could otherwise result.

This very brief analysis of the circuit is intended only to help the constructor rationalise the voltages quoted on the circuit diagram. The voltages are the result of averaging voltage measurements on a number of prototypes, and slight deviations from these should be expected. A more detailed description of the operating principles is given in the main text.



OUTPUT.
INPUT
SHIELD
0V
(+)
(–)
OPTIONAL CHASSIS EARTH POINT
*MOUNTED ON PATTERN SIDE OF PCB
**L1: 20 TURNS OF 0.8 mm (20 swg) ENAMEL WIRE (TWO LAYERS OF 10) OVER 14 mm FORMER — AIR CORE (SEE TEXT).
Q11 2SK134
Q12 2SJ49
Q9 2SK134
Q10 2SJ49
Q8 BF470
Q4 BF470
Q3 BF470
Q7 BF470
Q6 BF469
Q5 BF469
Q1 BC550
Q2 BC550
Q13 BC550
FS1 3A
FS2 3A
RV1 250R
0.8 V. RV1 @ CENTRE

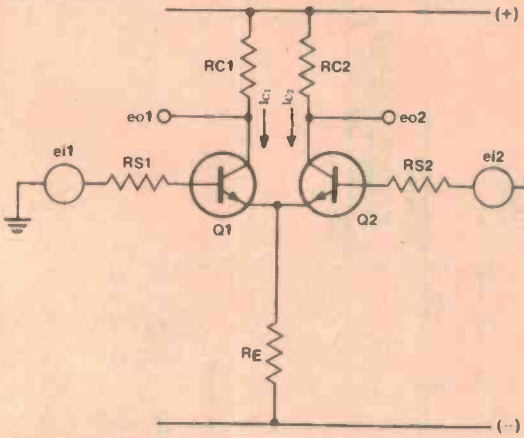


Figure 15

shown as the angle between the vector $\underset{\sim}{T}$ and the positive x axis and is written: arg $\underset{\sim}{T}$. The magnitude of the loop gain is represented by the length of the vector T and is written /T/ or T. Now, since both arg $\underset{\sim}{T}$ and T will vary as frequency varies, the terminal or end point of the vector will describe the curves shown in the Nyquist diagrams. If the curve encloses the point $-1 + j0$, then /$\underset{\sim}{T}$/ has not become less than unity when arg $\underset{\sim}{T} = \pi$ so the amplifier is unstable. An amplifier whose polar plot passes through $-1 + j0$ will be conditionally stable. The polar plot of a stable amplifier will not enclose the point $-1 + j0$.

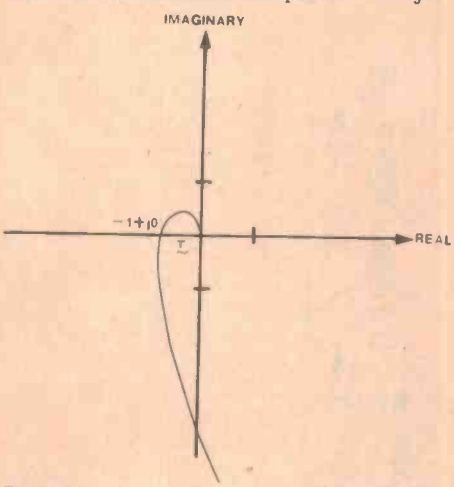


Figure 14

Figure 14 shows the Nyquist diagram for the ETI-477 MOSFET power amp. module. *Note that the curve passes well inside* $-1 + j0$.

We have looked very briefly at some of the advantages and disadvantages of feedback amplifiers of the general type shown in Figure 11. If negative feedback is to work effectively we must design a difference amplifier, voltage gain stage and output stage that will go together to provide the proper conditions of phase shift, open loop gain and slew rate so that a stable amplifier results. Since it is the differential amplifier that compares the input and output signals, it is necessary for this stage to be as linear as possible. The most common circuit for this purpose is the *differential pair* as shown in Figure 15.

The differential pair

Most differential pairs are symmetrical circuits with the two transistors (Q1 and Q2 in the circuit here) well matched and the resistance associated with the bases of approximately the same value. Similarly, the values of the collector resistors are usually the same. Ideally, the two devices forming the differential pair would be constructed on the same chip and it is for this reason that some semiconductor manufacturers make differential pairs that simply consist of two matched transistors in the one package. In practice it has been found however, that two good quality transistors can be made to operate effectively as a differential pair for the vast majority of applications. In the circuit of Figure 15, the resistor R_E will determine the emitter/collector current that flows in the two devices, Q1 and Q2. Since these two devices will normally have a dc current gain in the order of at least 200, the base-emitter current is roughly a maximum of 1/200 th of the emitter-collector current. Now the bases of Q1 and Q2 are connected to ground through the resistance of the input signal sources, R_{s1} and R_{s2}. Both Q1 and Q2 are therefore biased on, but in most practical circuits, the voltage drop produced across R_{s1} or R_{s2} by the small value of the base-emitter current will be neglible; seldom more than 50 mV.

The voltage at the bases of Q1 and Q2 will therefore be approximately 0 V (actually, slightly negative). Since the base-emitter voltage drop of the two transistors is around 0.6 V, then the voltage at the top of resistor R_E will be -0.6 V. The current through R_E is therefore

$$I_{RE} = \frac{V - 0.6}{R_E}$$

where I_{RE} is the absolute value of the current flowing in the emitter resistor R_E, and V is the absolute value of the negative supply voltage.

Since the voltage drops across the base-emitter junctions of the two transistors are almost identical, and the voltage drops across R_{s1} and R_{s2} are negligible, then both Q1 and Q2 will share the available current equally. The current in each collector is therefore

$$I_{C1} = I_{C2} = \tfrac{1}{2} I_{RE}$$

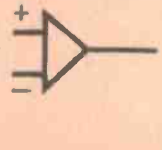
The voltage drop across the resistors R_{C1} and R_{C2} is given by

$$v_{C1} = I_{C1} R_{C1} \text{ and } v_{C2} = I_{C2} R_{C2}$$

So the dc voltage present on the two output terminals of the differential pair (i.e: between the two collectors) will be virtually the same.

Now, consider the effect if the input voltage generator e_{i1} causes the voltage on the base of Q1 to increase slightly, while e_{i2} remains fixed. The increased voltage on the base of Q1 will turn Q1 on harder than Q2. In fact, since there is only limited current available through R_E, Q2 will actually be robbed of current by Q1. The collector current I_{C1} will increase, causing the voltage drop across R_{C1} to rise, while the current I_{C2} decreases, causing the voltage drop across R_{C2} to decrease. Since the voltage drop across R_{C1} has increased the output voltage e_{o1}, which is measured with respect to ground potential (0 V), decreases while e_{o2} increases. So an increase in e_{i1} will cause a decrease in e_{o1}, but an increase in e_{o2}. By similar reasoning, an increase in e_{i2} gives rise to a decrease in e_{o2} and a consequent increase in e_{o1}.

This simple analysis of a differential pair has been made using dc signals but the argument is valid for ac waveforms also. Differential pairs are sometimes used with the two outputs as shown in Figure 15, but more often, only one of the output connections is used (i.e: single-ended output). In this case, the input terminal that gives rise to an output signal of the same sense (or phase) as the input signal is called the *non-inverting, or positive, input* while the other input terminal is called the *inverting*, or *negative* input, since the output signal will have the opposite phase to a signal applied to this terminal. This is sometimes called a single-ended differential pair and is often represented in circuit diagrams by the symbol:



This symbol could be used equally validly for the differential pair alone, an IC op-amp or the differential pair, voltage and current stages of a power amplifier. The essential feature is simply the presence of inverting and non-inverting inputs and a single output.

So far we have seen that it is the *difference* between the two base voltages that will give rise to an output. Ideally, if the signal voltages on both inputs are varied identically, then each transistor should still share half the available current and no output should result. Such an input signal is called a *common-mode* input signal. In real differential pairs common-mode signals are still amplified slightly. The ability of the differential pair to reject common-mode signals is called the *common-mode rejection ratio* and is normally given as the ratio of the differential voltage gain to the common-mode voltage gain. i.e:

$$\text{CMRR} = 20 \log \frac{A_d}{A_c}$$

where A_c is the common-mode voltage gain
and A_d is the differential voltage gain

In order to calculate A_c and A_d we first need look at the voltage gains for input signals e_{i1} and e_{i2}. In Figure 15 we will let the output associated with the e_{o2}signal voltage be the differential pair output. Then, the base of Q1 is the non-inverting (+) input and the base of Q2 the inverting (−) input. The signal e_{i1} first suffers attenuation due to R_{s1} and the base resistance of Q1. Furthermore, Q1 is acting as an emitter follower and therefore has a voltage gain of slightly less than unity. Finally, the input signal is fed to the emitter of Q2 which acts as a common-base stage and provides the voltage gain. If we let A_1 be the gain of the non-inverting input, i.e:

$$A_1\ (\text{definition}) = \frac{e_{o2}}{e_{o1}}$$

then it can be shown that:

$$A_1 = \frac{(R_E \parallel R_e)(R_{C2})}{(R_e + R_E \parallel R_e)(R_e)}$$

where A_1 is the voltage gain of the + input
R_E is the value of the emitter resistor
R_{C2} is the value of the collector resistor
R_e is the emitter resistance

The e_{i2} signal fed to the inverting input of the differential pair also suffers attenuation, in this case due to R_{s2}. The signal is then fed directly to the base of Q2. So for signals at the inverting input, Q2 acts as a common emitter amplifier. If we let A_2 be the gain of the inverting input, i.e:

$$A_2\ (\text{definition}) = \frac{e_{o2}}{e_{i2}}$$

$$\text{then } A_2 = -\frac{R_{C2}}{R_e + R_E \parallel R_e}$$

It is obvious at a glance that the expressions for A_2 and A_1 are not the same; it is this difference that causes the common-mode signal to be amplified.

Now, the output signal voltage e_{o2} is really a function of both the common-mode and difference signals.

$$e_{o2} = A_c e_{ic} + A_d e_{id} \quad \ldots\ldots\ldots\ldots (1)$$

where e_{ic} is the common-mode input signal
and e_{id} is the difference input signal

Now, $A_d = \frac{e_{o2}}{e_{id}}$: substituting in (1) gives

$$A_d = \tfrac{1}{2}(A1 - A2)$$

$$\text{Similarly, } A_c = \frac{e_{o2}}{e_{ic}}$$

$$\text{giving} \quad A_c = A_1 + A_2$$

Substituting the equations for A_1 and A_2 into the new equation for A_c gives:

$$A_c = A_1 + A_2$$

$$= \left(\frac{R_c}{R_e + R_E \parallel R_e}\right)\left(\frac{R_e}{R_E + R_e}\right)$$

Similarly, substituting the equations for A_1 and A_2 into the equation for A_d gives:

$$A_d = \tfrac{1}{2}(A_1 - A_2)$$

$$= \tfrac{1}{2}\left(\frac{R_c}{R_e + R_E R_e}\right)\left(\frac{2R_E + R_e}{R_E + R_e}\right)$$

The common-mode rejection ratio is given by:

$$\text{CMRR} = 20 \log \frac{A_d}{A_c}$$

$$= 20 \log \frac{\tfrac{1}{2}\left(\frac{R_c}{R_e + R_E R_e}\right)\left(\frac{2R_E + R_e}{R_E + R_e}\right)}{\left(\frac{R_c}{R_e + R_E \parallel R_e}\right)\left(\frac{R_e}{R_E + R_e}\right)}$$

Thus,

$$\text{CMRR} = 20 \log \frac{(2R_E + R_e)(R_E + R_e)}{2(R_E + R_e)(R_e)}$$

Now, if we assume that R_E is very much larger than R_e, this equation can be simplified to:

$$\text{CMRR} = 20 \log \frac{(2R_E)(R_E)}{2R_E(R_e)}$$

$$= 20 \log R_E/R_e$$

This simple equation shows that, in order to ensure a high CMRR it is necessary to make the value of the impedance R_E as high as possible. The problem is that Q1 and Q2 require a certain amount of emitter current to function linearly and with low noise. Remember that the differential pair will normally be used as the input stage in a power amplifier and is therefore handling small signal voltages, so noise generated in this stage will affect the signal-to-noise ratio of the amplifier. Since the negative supply voltage is fixed, and the amount of current required by the input is determined by factors such as noise and distortion, this automatically predicts a value of R_E, and so long as we are restricted to the use of a resistor to determine the emitter current, there is little that can be done to increase the CMRR.

These problems are solved, however, if R_E is replaced with a constant current source as shown in Figure 16.

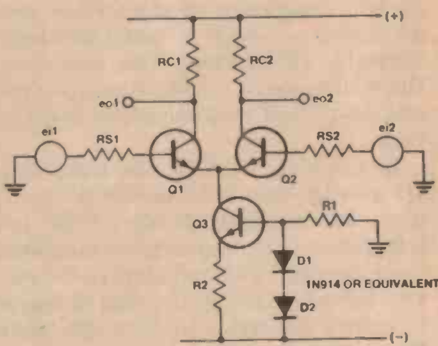


Figure 16

The resistor, R1, acts as a current limit between ground and the negative supply rail via the two diodes, D1 and D2. If the supply rail is around −50 V, for example, a 10k resistor will cause approximately 50/10k = 5 mA to flow through the diodes. The two diodes are turned on and the voltage drop across each of them at this current will be around 0.7 V. The base of Q3 is therefore held 1.4 V above the negative supply voltage (i.e: at −48.6 V.) The base-emitter junction of Q3 will drop roughly 0.6 V, allowing the remaining 0.8 V to be dropped across R2. This voltage across R2 will remain almost constant, regardless of variations in the negative supply voltage. If the negative rail is affected by a heavy transient current, from the output stage of the power amplifier for example, the supply voltage might change momentarily from −50 V to −40 V. The voltage at the base of Q3 will still be 1.4 V above that of the negative supply, so the 0.8 V drop across R2 will remain largely constant. Now we have a fixed voltage ▶

(0.8 V) across a fixed value of resistance (R2) and therefore the current flowing through R2 is fixed also. Since the current flowing in the base-emitter junction of Q3 is negligible in comparison to that flowing in the emitter, most of the current must be supplied by the emitter of the differential pair. That portion of the circuit associated with Q3 is known as a constant current source (or a constant current sink). The operating point of the differential pair is totally determined by the value of R2. Furthermore, since the emitter current is not affected by supply variations, ac mains ripple or signal voltages present on the negative supply rail are not connected to the emitters of the differential pair and a good negative supply rejection results. Now, since Q3 is really operating as a common-base amplifier, the impedance seen by the emitters of the differential pair is the output impedance of a common base amplifier — which is extremely high, typically 1M or more. This now forms the resistance R_E and its high value will ensure a good common-mode rejection ratio.

In practical circuits, the transistors Q1 and Q2 cannot be matched exactly with the result that one of the two transistors will often attempt to conduct more current. This unbalances the pair and increases the generation of second harmonic distortion in the input stage. The solution to the problem is to add resistors in series with the emitters of the differential pair. This, in effect, applies local negative feedback which increases the input impedance of the stage. The voltage gain becomes more independent of the parameters of the input transistors.

This linearises the input stage transfer characteristic and therefore decreases distortion considerably. Differential pairs are sometimes referred to as *transconductance amplifiers* since the output impedance of the stage is relatively high and the input signal voltage is really giving rise to a signal output current. If this current flows through a resistance such as R_{C2} the result is the signal output voltage e_{o2}. Generally however, the output of the differential pair will be loaded down by some degree of capacitance and the output signal voltage will no longer be linearly related to the input signal voltage. The differential pair is really a constant current source, capable of being modulated by the input signal. The rate of change of the output signal current with respect to input signal is called *transconductance* and is given the symbol 'g_m'.

One of the biggest advantages of the addition of emitter resistors to the input stage (sometimes called *emitter degeneration)* is that it allows control over the g_m of the differential pair and will prove invaluable later when considering stability and slewing distortion.

The voltage gain stage

As we saw in the section on feedback amplifiers, it is necessary to have adequate open-loop gain to enable the negative feedback loop to effectively linearise the output transfer characteristic. Since it is the main voltage amplifier stage that is responsible for most of the gain in the amplifier, it is necessary to calculate the required open-loop gain so that the gain of the voltage gain stage can be determined. In order to do this we must look again at the effect of negative feedback on the various paramaters of the amplifier.

In Figure 11, the power amplifier was represented as consisting of a difference amplifier, voltage amplifier and an output stage. All three of these stages can have voltage gains, depending on the particular design. The power amplifier can be represented by a block diagram based on the functions in the power amp, however, rather than the actual circuit. Such a diagram is shown in Figure 17.

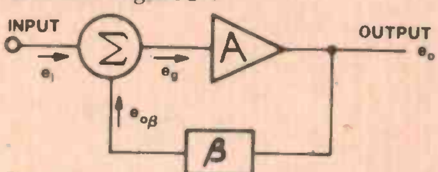


Figure 17

Symbolic representation of a feedback amplifier typical of most power amps.

The symbol 'A' represents the total open loop gain of the amplifier while block 'β' represents the feedback factor or that fraction of the output signal fed back to be summed with the input.

The voltage amplifier stage, A, simply sees an input signal voltage e_g which consists of the sum of the input signal e_i and that amount of the output, e_o, that is returned by the feedback circuit, i.e: $e_o\beta$

Therefore:

$$e_o = A\,e_g$$

$$= A(e_i + \beta e_o)$$

thus $e_o(1 - \beta A) = Ae_i$

or
$$e_o = \frac{A}{1 - \beta A} e_i \quad \ldots\ldots\ldots\ldots (2)$$

Since this is negative feedback, β is negative, so the equation becomes:

$$e_o = \frac{A}{1 + \beta A} e_i \quad \ldots\ldots\ldots\ldots (3)$$

This is now a general feedback equation for the simple feedback amplifier of Figure 17. It gives the overall closed loop gain with respect to the open loop gain A and the feedback factor, β.

The β here should not be confused with the β used to represent the gain of a transistor. In this context, β is a fractional quantity and this convention has been in use since long before the invention of the transistor. The β here is that fraction of the output signal fed back; it is given by:

$$\beta = \frac{R2}{R1 + R2}$$

where R1 and R2 are the resistors forming the negative feedback potential divider in Figure 11.

Equation (3) above therefore becomes:

$$e_o = \frac{A\,e_i}{1 + \left(\frac{R2}{R1 + R2}\right) A}$$

Multiplying both the numerator and the denominator by (R1 + R2) gives:

$$e_o = \frac{A\,(R1 + R2)\,e_i}{(R1 + R2) + AR2}$$

and dividing both through by A gives:

$$e_o = \frac{R1 + R2}{\left(\frac{R1 + R2}{A}\right) + R2} \cdot e_i$$

If we assume that the value of the open loop gain is large in comparison to (R1 + R2), then (R1 x R2)/A will approach zero and the equation approximates to:

$$e_o = \frac{R1 + R2}{R2} \cdot e_i$$

and this is the equation established from the simpler model examined earlier in this discussion. We can see that this is a convenient approximation for the closed loop gain assuming the open loop gain is very high. Notice also that this is equivalent to writing:

$$e_o = \frac{1}{\beta} \cdot e_i$$

or the closed loop gain is approximately 1/β.

It was stated earlier that the effect of the negative feedback was to linearise the transfer characteristic of the amplifier. It does this by decreasing the dependence on the gain of the individual transistors in the amplifier. We are now in a position to justify this statement.

First, consider the effect on the amplifier's closed loop gain by a substantial variation in the open loop gain. Suppose that the amplifier's open loop gain is 10^5, so $A = 10^5$, and let 1/100th of the output signal be fed back to the input by the negative feedback loop. So, $\beta = 10^{-2}$.

Using the general feedback equation, (3), the gain of the amplifier is:

$$\frac{10^5}{1 + 10^{-2}.\,10^5} = \frac{10^5}{1 + 10^3} = 99.9$$

If the open loop gain is now decreased by a factor of 100, which would be most improbable in a practical power amplifier design, the closed loop gain becomes:

$$\frac{10^3}{1 + 10^{-2}.\,10^3} = \frac{10^3}{1 + 10} = \frac{10^3}{11} = 90.9$$

The huge variation in the open loop gain has been reduced by negative feedback to a variation of only 10%. The gain of the amplifier is therefore greatly stabilised by the application of negative feedback.

Negative feedback and distortion

Negative feedback will also affect the input and output impedances and the small signal frequency response of the amplifier. It will also reduce distortion generally, and as stated earlier, is one of the few ways to reduce distortion in the output stage.

If a signal, e_i, were applied to the amplifier without negative feedback, the output would be the result of the loop gain, A, and a distortion component, D. If we let e_{o_o} be the open loop output signal voltage, then

$$e_{o_o} = A\,e_i + D$$

If negative feedback is applied, however, the input signal voltage must be increased to obtain the same output level since the gain has been reduced by the negative feedback. If we let e_{o_c} be the output signal voltage with the amplifier operating in closed loop, then e_{o_c} will be determined by the closed loop gain (call it a) and a distortion component, d.

$$e_{o_c} = a\,e_i + d$$

Now, the closed loop gain is given by:

$$a = \frac{A}{1 + \beta A}$$

$$e_{o_c} = \left(\frac{A}{1 + \beta A}\right) e_i + d$$

Now, since the relationship between the open loop output signal and the closed loop output signal is given by:

$$e_{o_c} = \frac{e_{o_o}}{1 + \beta A}$$

then, $$\frac{e_{o_o}}{1 + \beta A} = \left(\frac{A}{1 + \beta A}\right) e_i + d$$

Substituting for e_{o_o} from the equation

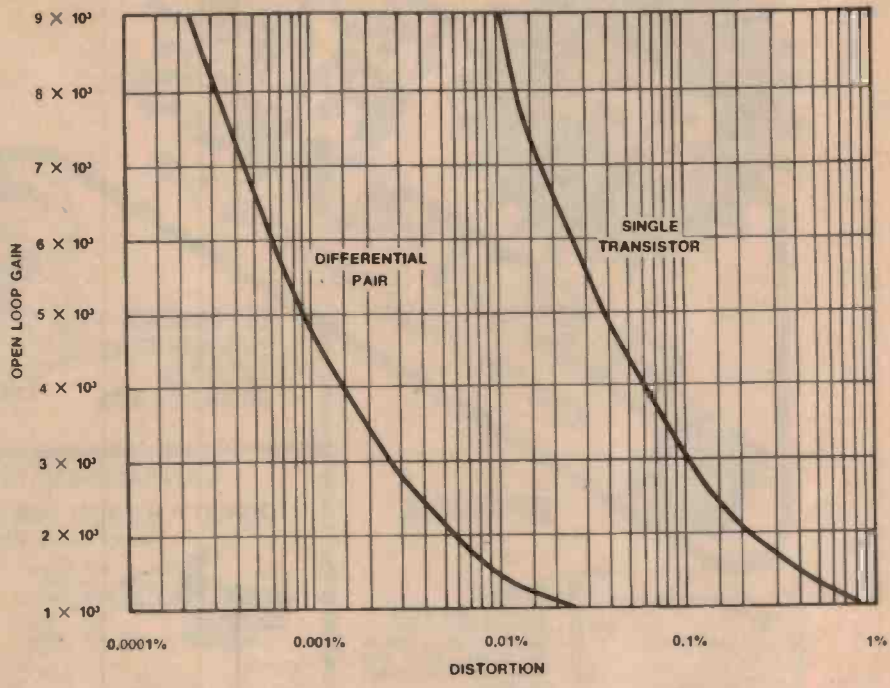


Figure 18

$$e_{o_o} = A\,e_i + D$$

gives $$\frac{A\,e_i + D}{1 + \beta A} = \left(\frac{A}{1 + \beta A}\right) e_i + d$$

$$A\,e_i + D = A\,e_i + d(1 + \beta A)$$

$$\frac{D}{A\,e_i} = \frac{d(1 + \beta A)}{A\,e_i}$$

$$d = \frac{D}{1 + \beta A}$$

where d is the distortion with feedback applied,
D is the distortion, open loop,
β is the feedback factor,
A is the open loop gain.

The distortion generated in the amplifier operated open loop is decreased by a factor of $1/(1 + A\beta)$. So, if with the open loop gain, A, or the feedback factor β are *increased*, the distortion is *decreased*. This does not imply that we should design power amplifiers for maximum open loop gain and rely on negative feedback to reduce distortion since the problem of stability of feedback loops still exists.

If, however, the amplifier is designed with a realistically low open loop distortion, the feedback loop can be used to decrease the remaining distortion to negligible levels while still not using *unnecessary* overall negative feedback.

When designing amplifiers intended, as this project is, for extremely low distortion, it is essential that all stages in the amplifier be designed for as low a distortion as possible. When the negative feedback is applied, truly excellent performance can be expected.

In any practical power amplifier design the bulk of the open loop gain is provided by the main voltage gain stage. The difference amplifier will generally provide some voltage gain, but its main ojbective is to provide a linear difference signal with respect to its two inputs. In some power amps the output stage is operated in a common emitter configuration and therefore provides some voltage gain as well. In the ETI-477 module however, the output stage is a common drain or source follower MOSFET design and consequently has a voltage gain slightly less than unity.

It follows from the discussion of the effect of negative feedback on distortion that this main voltage amplifier must provide a large voltage gain with low distortion and with low phase-shift to minimise stability problems.

An analysis of the distortion characteristics of the differential pair, discussed earlier, reveals that it is significantly better than a single transistor operated in common emitter configuration. If we assume that the distortion in a bipolar transistor is due exclusively to the exponential relationship between collector current and base-emitter voltage, the distortion generated by a differential pair and a single transistor can be calculated by techniques of Fourier analysis. The results of this analysis are plotted in Figure 18 for a differential pair with a 10% mismatch. The superiority of the ▶

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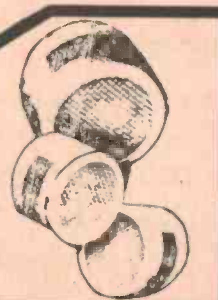

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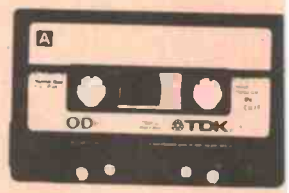

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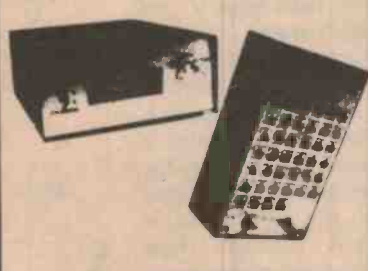

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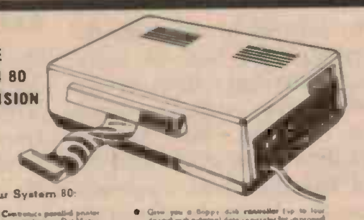

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differential pair is clearly evident and it is for this reason the differential pair was chosen as a basis for the design of the voltage gain stage in the ETI-477 MOSFET power amp module.

As well as having low distortion itself, a differential voltage amplifier will enable both outputs of the input differential pair to be used, thus giving a balanced output. This overcomes the problem of asymmetrical loading of the input pair by the input impedance of a single-ended voltage amplifier, a problem that would otherwise lead to increased distortion in the first stage.

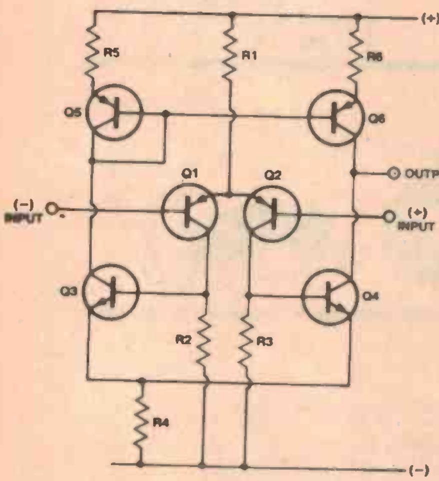


Figure 19

Figure 19 is a circuit diagram of the voltage gain stage developed for this project. The stage is really a double differential pair with a 'current mirror' load. Transistors Q1 and Q2 form the first differential pair with R1 as the common emitter resistor. The output of the Q1, Q2 pair provides a differential drive to Q3 and Q4. The latter pair however, must be converted into a single-ended stage suitable for driving the output stage. This is the job of the current mirror formed by Q5, Q6, R5 and R6. Transistor Q5 has its base-collector junction shorted and therefore acts like a diode, but with the same characteristics as the base-emitter junction of Q6. The bases of Q5 and Q6 are connected together and therefore the voltage on the bases is identical. Since Q5 forms a "mirror image" of the base-emitter junction of Q6, the voltage drop across the two transistors will be almost identical, depending on how well the two transistors are matched. Since the voltage on the bases and the voltage drop across the base-emitter junctions is almost identical, the voltage on the bottoms of R5 and R6 will be almost identical. If these two resistors are made the same value, the current through each resistor, and therefore the current in the collectors of Q3 and Q4, will be identical. This ensures the Q3, Q4 pair will operate symmetrically, even when a single-ended load is attached to the pair.

Furthermore, since the collector of Q3 is connected directly to the base of Q6, the transistors Q6 and Q4 combine to form a push-pull pair with very high gain.

The transistors used in this stage need to be able to handle the full supply voltage and still function with low distortion. They must also be high-speed devices so the overall feedback loop will be fast enough to ensure freedom from transient distortion.

The transistors finally chosen for this stage were the BF469 and BF470. These are a complementary video output pair and as such combine both high V_{ceo} of around 250 V and high speed.

In order to achieve good transient performance when driving the slightly capacitive load of the output stage it is necessary to run a fairly large amount of current through this stage, especially the final differential pair and the associated current mirror. In the 477 there is approximately 16 mA through these transistors, and the average power dissipation is therefore around 0.8 W.

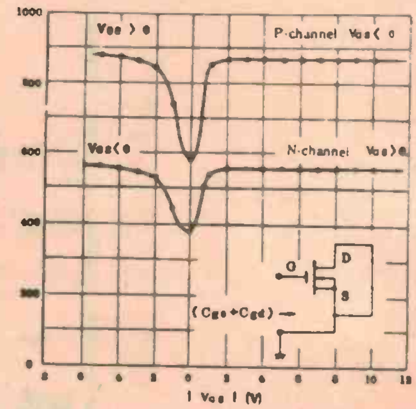
These transistors will run fairly hot, approximately 60°C on the small heatsink shown, but the transistors are well inside their maximum ratings. The result is a voltage amplifier stage of exceptional linearity and very high gain. Coupled with a well-designed input differential amplifier and a good output stage, the phase linearity produced by this voltage stage is excellent, and makes it an easy matter to ensure total stability of the amplifier.

The 477 power module

Since the output of the voltage gain stage has been designed to have sufficiently low output impedance to drive the gates of two MOSFETs in parallel, the output stage consists simply of the MOSFETs themselves. If a preset pot is inserted between the collectors of Q6 and Q4 in the voltage amplifier stage of Figure 19, the voltage across this preset can be used as the bias voltage for the output stage. This is shown in the circuit diagram for the 477 module.

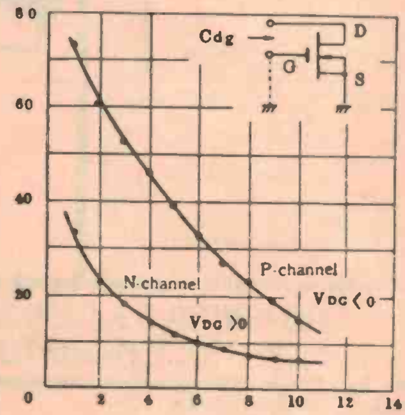
The gates of the output devices are connected to either side of the preset via resistors R21, R22, R23 and R24. As mentioned earlier, these resistors increase the time constant associated with the MOSFET gate capacitance, reducing the frequency response of the output stage slightly but ensuring stability.

A study of the inter-terminal capacitance of these MOSFETs reveals that the characteristics of the N-channel and P-channel devices differ. Figures 20, 21 and 22 show comparison curves between



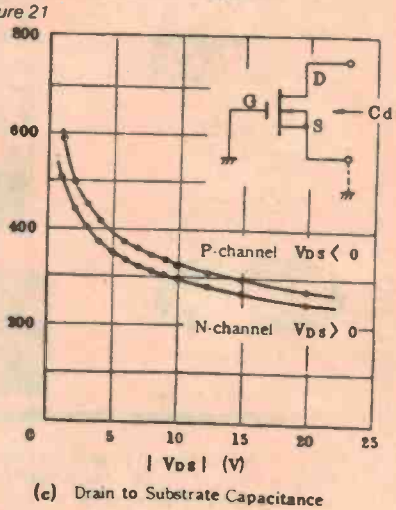
(a) Gate to Source Capacitance + Gate to Drain Capacitance

Figure 20



(b) Drain to Gate Capacitance

Figure 21



(c) Drain to Substrate Capacitance

Figure 22

the N-channel and P-channel MOSFETs used in this project. The important difference is the value of gate-source capacitance for the two devices (Figure 20). If this is not equalised the presence of asymetrical reactance in the output stage makes it almost impossible to ensure stable operation. The only cure is to decrease the open-loop gain of the whole amplifier, so that the negative feedback is reduced, and accept the consequent increase in distortion.

The most common method employed to achieve this is to increase the value of the emitter resistors in the input stage. This reduces the voltage gain of the input stage, at the same time increasing its small-signal bandwidth. Consequently, in a power amplifier employing MOSFETs in the output stage, the relatively small amount of negative feedback available will not be able to linearise the transfer characteristics of the output devices, and the result is an amplifier with only mediocre performance.

The use of resistors in the emitters of transistors generates a local negative feedback effect and will improve nearly every parameter of the transistors. The correct balance between the amount of local and overall negative feedback employed in any particular amplifier design must be established by considering such factors as the distortion generated in the output stage and the speed, gain and linearity of the other stages in the amplifier. Any attempt to put a figure on the 'optimum' ratio of overall to local negative feedback that attempts to be universal for all amplifiers is to me a gross oversimplification.

The problem of the asymetry of the gate-source capacitance is cured by the addition of the capacitors C7 and C8 shown in the 477 circuit diagram. With these capacitors in the circuit and with the 100 R resistors R21, R22, R23 and R24, the only other component required to ensure total stability of the output stage is the power RLC combination formed by R29, C9, R30, L1 and the supply bypass capacitors C10, 11, 12 and 13.

When a square wave, for example, is fed into a purely capacitive load, the output stage will virtually see a short circuit, since the high frequency (>100 kHz) fourier components of the sine wave will see very little impedance in the capacitive load.

The inductor L1 ensures that this does not happen by inserting a reactance that increases at high frequencies. The resistor R30 is placed in parallel with the inductance so the top end frequency response of the amplifier is not unduly affected.

This inductor is made by winding 20 turns of 0.8 mm (20swg) enamel-covered copper wire around a plastic bobbin normally supplied for use with potcores. The bobbin in the prototype modules has a 12 mm outside diameter and is 10 mm long; winding two layers of ten turns gives the desired value of inductance around 5 uH.

The other two components of this network, R29 and C9, ensure that the amplifier always has a load at high frequencies. Without this 4.7 R load the gain of the output stage is slightly greater than unity, due to the presence of positive feedback caused by the effective capacitance around the output devices, and this causes oscillation.

The 220 n capacitor is necessary since the resistor must be removed from the circuit for frequencies inside the audio passband or the high power dissipation in the resistor would destroy it instantly. You should expect this resistor to get hot when testing the amplifier with full power square waves or high frequency sine waves, but this condition will not occur under normal operation.

Resistors R25, R26, R27 and R28 provide slight emitter degeneration to the output devices. This helps to linearise the output transfer characteristic of the amplifier and thereby assists in ensuring stability of the output stage.

In bipolar designs where output transistors are used in parallel these resistors are essential to make the parallel devices share the load current equally. In a MOSFET design, however, this is only of secondary importance, since the negative temperature coefficient will increase the impedance of any output device that conducts more than its share of local current.

The final components needed to ensure stability of the output stage are the supply bypass capacitors C10, C11, C12 and C13. Capacitors C12 and C13 are 100 uF electrolytics that provide general supply bypassing to frequencies inside the audio passband, but have little effect at 1 MHz, where the MOSFET would tend to oscillate.

For this reason capacitors C10 and C11 have been included also. These capacitors must be positioned very near the output devices, since the resistance of only several centimetres of p.c. board track will greatly decrease their effectiveness.

In the 477 these capacitors are mounted on the rear of the circuit board with one lead soldered directly to the drains of the output devices.

The gate resistors R21, R22, R23 and R24 and the gate power capacitors C7 and C8 are also mounted on the rear of the circuit board, again soldered directly to the MOSFETs.

Incidentally, if you are experimenting with MOSFET circuits a few fundamental precautions with layout will save many headaches. The length of wire soldered to the gate of the MOSFET is critical. Hitachi quote 50 mm as the maximum length of wiring that can be safely connected to the gate, and in many applications even this is too long.

This is the reason the 477 pc board was designed so the power transistors solder directly on to the board rather than adopting the approach of mounting the output devices on the heatsink and running flying leads between the board and the MOSFETs. Certainly wherever flying leads are used the gate resistors should be soldered directly to the gate of the MOSFET with as little wire left on the gate side of the resistor as possible. The gate wiring can be soldered between the p.c. board and the other side of the gate resistor. You may never experience this problem with flying leads, but this is a simple and effective precaution that is worth regarding as a fundamental design rule when working with MOSFETs.

The remaining components in the output stage are the zener diodes ZD1 and ZD2 and their associated diodes D3 and D4, and the bias preset RV1. It was mentioned earlier that the maximum gate to source voltage of these MOSFETs is 14 V. If this voltage is exceeded the MOSFET can be destroyed, so the zeners and diodes are placed between the gate and the output of the power amp to prevent the drive voltage ever becoming more than 12.6 V above or below the output voltage.

This condition would mainly occur when the output is driving a short circuit or a capacitance load big enough to look like a short circuit. Under these conditions the output voltage cannot deviate much from 0 V since it is shorted to 0 V, and the negative feedback loop will drive the output of the voltage gain stage into clipping in an attempt to compensate for the error.

The gate to source voltage is now around ±50 V, well above the absolute maximum voltage for the output devices. The diodes D3 and D4 are necessary to prevent the zeners from shorting out the gate drive under normal operating conditions.

The current flowing through the preset RV1 will give rise to a voltage drop across the preset that can be varied ▶

by adjusting RV1; this acts as the bias voltage for the output devices. If the diodes D3 and D4 are not present, the gates of Q10 and Q12 for example can never go more than 0.6 V above the output voltage, due to the 0.6 V forward voltage drop of the ZD2. Since the voltage drop across RV1 is around 1 V, the drive voltage to the gates of Q9 and Q11 can never go higher than the sum of these two voltages, i.e: 1.6 V, above the output voltage, and this limits drive to the MOSFET. The same occurs to negative-going signals due to the 0.6 V forward turn on voltage of ZD1.

The combination of all these techniques yields an output stage that is totally free of instability and with a bandwidth of a round 5 MHz! Furthermore, the transfer characteristics and phase response of the output stage are predictable, making it relatively easy to ensure stability of the overall feedback loop.

The voltage amplifier of the 477 module is of the type shown in Figure 19 and is formed by transistors Q3 through to Q8 and the associated passive components.

The only components not discussed earlier are R31 and C14 (477 circuit diagram) that make up a series RC network. This applies local negative feedback around the voltage amplifier output stage by decreasing the impedance between the collector and the base of Q6.

Remember that the signal on the base, is πrads out of phase with that on the collector of a transistor operated as this one is, in common emitter. The effect of this negative feedback is to decrease the open loop gain for frequencies well above the audio passband.

The input differential pair is formed by Q1 and Q2, with R10 and R13 supplying emitter degeneration.

Q3, R8, R12 and diodes D1 and D2 form the constant current source for the input pair and maintain the current at around 240 uA. This relatively low amount of emitter current was chosen specifically to ensure a good noise figure in the first stage.

The capacitor C4 decreases the impedance between the two inputs of the voltage amplifier stage i.e: the bases of Q3 and Q4) and therefore decreases the gain of the differential pair at high frequencies. This is the main phase compensation in the amplifier and is often referred to as phase lag compensation.

The resistors R19 and R16 form the negative feedback potential divider and therefore determine the closed loop voltage gain of the power module.

The 100 uF electrolytic capacitor C5 has the effect of increasing the impedance between the base of Q2 and ground for frequencies below the audio passband.

Theoretically the resistance through C5 at dc is infinite, which increases the negative feedback, thereby decreasing the closed loop gain to unity. This ensures that any dc voltage occurring on the output of the amplifier is connected directly to the base of Q2, where it can be compared to the dc voltage present on the base of Q1. Since the base of Q1 is connected to ground via the series combination of resistors R2, R4 and R5, the voltage drop across these resistors will be determined by the base-emitter current and this resistance. Since the emitter collector current in Q1 is around 120 uA and given that the h_{FE} of Q1 is around 250, the base emitter current will be roughly

$$\frac{120\text{ uA}}{250} \doteqdot 0.5\text{ uA}.$$

So the voltage on the base of Q1 will be approx.

$$0.5\text{ uA}(47\text{ k} + 4\text{k}7 + 1\text{ k}) =$$
$$0.5\text{ uA} \times 52.7\text{ k} = 25.3\text{ mV}.$$

The voltages and currents shown on the circuit diagram were obtained by measurement of the prototype modules, and as shown the voltage on the base of Q1 was −25 mV, in good agreement with the calculated value. If the differential pair and the negative feedback loop are operating correctly the dc voltage on the output should be almost identical to this voltage.

We saw earlier that the problem of transient intermodulation distortion is eliminated by limiting the maximum signal slope of the input signal to something less than the slew rate of the amplifier. In the 477 module this is accomplished by a 12 dB/octave passive low pass filter formed by R4, C2 and R5, C3. Both sections have similar cut-off frequencies, but the value of the resistor R5 has been increased to reduce the loading effect it would otherwise have on R4. The value of C3 has been reduced accordingly so that within the limits of component tolerance the 3 dB point remains the same as the first stage.

The two-section filter was used, since it is possible to limit the maximum signal slope of the input to a greater extent than with the single-section filter, while still keeping response within the audio passband flat. The attenuation of the filter at 20 kHz is only 0.2 dB. Adding another 0.2 dB at 20 kHz due to the passive output filter L1, R30 gives the final frequency response figure of 0.4 dB down at 20 kHz. Both the frequency response and the slew rate of the amplifier are determined by the passive components eliminating the problem of transient intermodulation distortion.

The low frequency response of the amp should also be controlled by a passive filter on the input. In this case it is a high pass filter formed by C1 and R2. Since the amplifier is entirely dc coupled after the input capacitor C1, it would have a frequency response that extends to dc, provided the 100 μF electrolytic C5 was removed from the circuit. Since it is desirable to include C5 for the reasons mentioned earlier, it is necessary to prevent the voltage across it from becoming too great.

Remember that if the amplifier were fed by a subsonic frequency the impedance of C5 would be high and it would therefore drop nearly the full supply voltage across it. Furthermore, it is not desirable to have these large voltage swings coupled directly to the differential pair. For this reason the practice of allowing this capacitor and its associated resistor (R16 in this case) to define the low end characteristics of the amplifier is a dangerous one.

This problem is easily overcome by including a high pass filter at the input of the power amp with a higher 3 dB point than that of C5R16, and this is the function of C1 and R2. The 3 dB point of the input low end filter (C1, R2) is:

$$f = \frac{1}{2\pi R2\ C1} = \frac{1}{2\pi(0.47\times10^{-6})(47\times10^{3})} \doteqdot 7\text{Hz}$$

while for the negative feedback RC (C5,R16):

$$f = \frac{1}{2\pi R16\ C5} = \frac{1}{2\pi(10^{3})(100\times10^{-6})} \doteqdot 1.6\text{ Hz}$$

It is clear that the input filter will determine the low frequency characteristic of the amplifier.

The resistor R1 is included in the design simply to make certain that C1 does not become charged by dc. If this is allowed to occur the result is a loud crack through the loudspeakers if the input RCA sockets are plugged or unplugged while the power amp is on.

Construction Part 2

In construction last month we gave all the necessary details for assembly of the pc board itself. The heatsink bracket shown was a 152 mm length of 40 mm x 12 mm x 3 mm thick aluminium angle extrusion. This extrusion is entirely satisfactory for hi-fi use ▶

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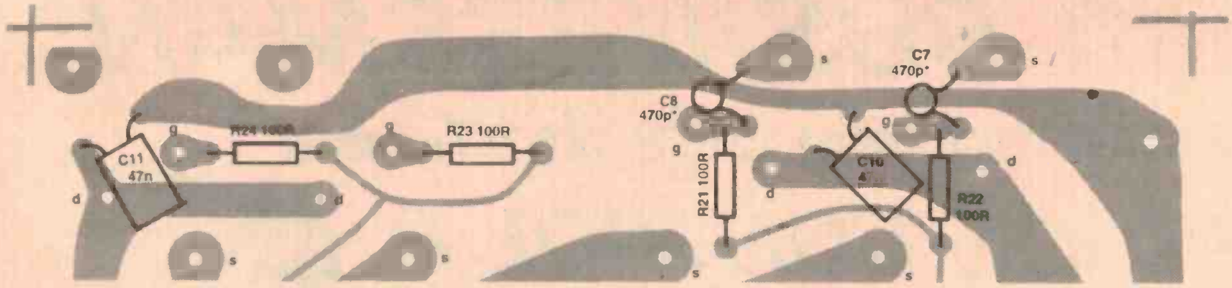
Project 477

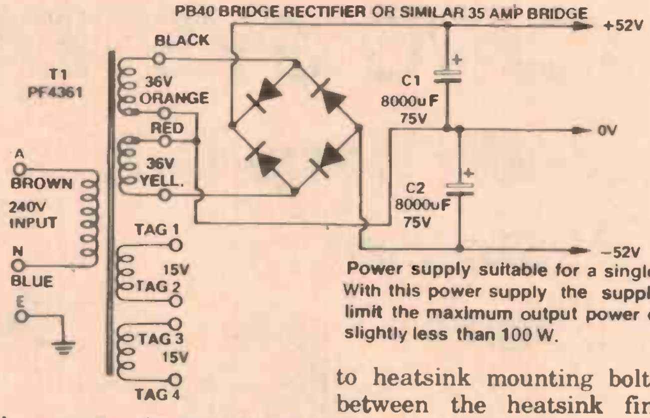


when bolted to an adequate extruded aluminium heatsink. If you intend the module for use in sound reinforcement applications, however, where the average operating levels could be near the clipping point for extended periods of time, two 152 mm lenths should be used back to back to decrease the thermal resistance.

In order for these heatsink brackets to work effectively it is important that there is good contact between the heatsink bracket and the heatsink itself. Use some heatsinking paste between these two surfaces and bolt them together firmly. In the Series 5000 power amplifier (next month) we will be using a cast aluminium front panel heatsink that we have designed and are having manufactured. The front panels will be available from us directly and also from a number of parts suppliers.

In order to ensure good thermal contact with the back of this panel it is necessary to use a 40 mm x 40 mm x 3 mm thick extrusion. Since two modules are required for the stereo amplifier the heatsink bracket can be constructed as a double length (305 mm) bracket, as shown in the photograph with this article. Alternatively two independent modules can be bolted to the rear of the front panel, but the 40 mm x 40 mm extrusion should be used.

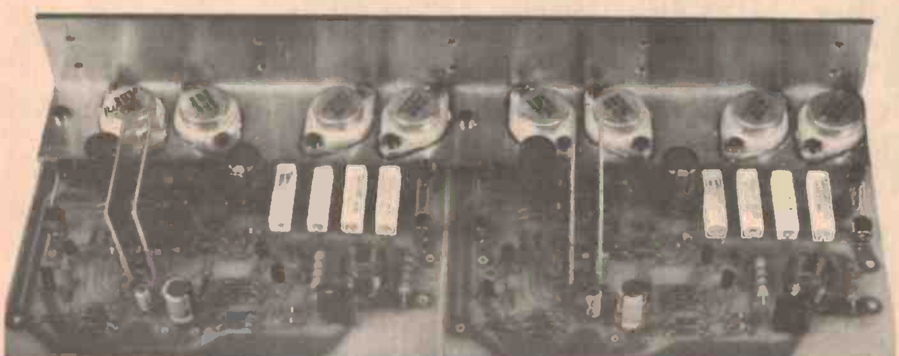
Drilling details for the heatsink brackets are given this month so that the construction of the pc boards for the Series 5000 amp can be finished this month, if desired. The heatsink bracket to heatsink mounting bolts must fit between the heatsink fins, so the dimensions shown are critical. If you elect to use two independent heatsink brackets you will need to work out the drilling details from the front panel heatsink.



Power supply suitable for a single 477 module. With this power supply the supply voltage will limit the maximum output power of the 477 to slightly less than 100 W.

NEXT MONTH: we complete the series of articles, describing construction of the Series 5000 Stereo Amplifier with details on the measured and subjective performance.

To house our Series 5000 stereo amp we have designed and are having manufactured this cast aluminium heatsink/front panel. It will mount in a standard 19-inch rack or be used as a stand-alone unit with the cabinet panels fitted.



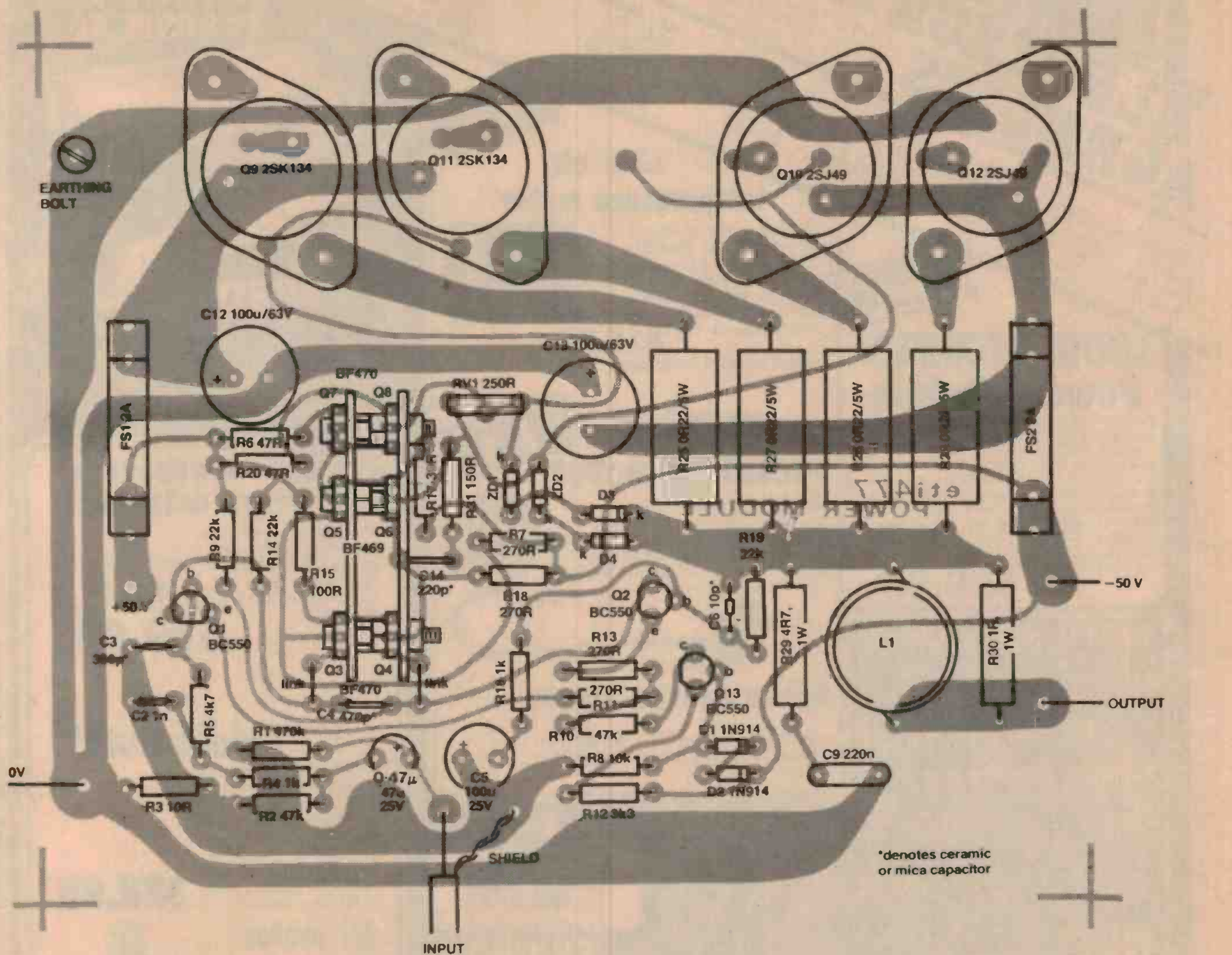
Two modules mounted on the dual bracket, details for which are given right.

ERRATA TO PART 1

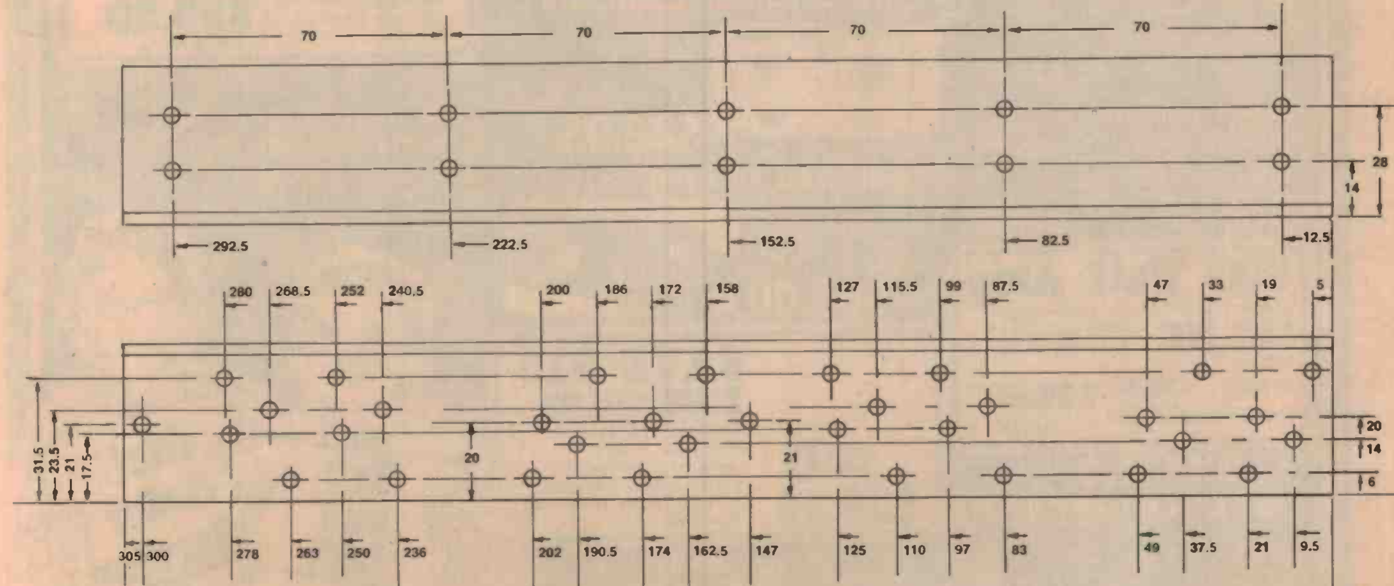
Unfortunately the value of C1 was shown incorrectly last month in the parts list and on the circuit diagram as a 47 uF 25 V electrolytic. The correct value is 0.47 uF 25 V. This capacitor is part of an input RC filter that defines the low end roll-off of the amplifier. The incorrect value of C1 will move the 3 dB point of this filter down to around 0.1 Hz, where it is completely ineffective, but it will not affect any other specification of the amplifier. Since it is important for the reasons discussed elsewhere in this article that the 3 dB point is defined at the input, the correct capacitor should be fitted.

The transistor Q13 on last month's overlay photograph has its base and collector leads shown inverted. The correct orientation for this transistor is as shown in this month's overlay, i.e: with its flat side pointing towards the resistors R13 and R10.

The capacitors C7 and C8 were shown incorrectly last month to be connected between the gates of MOSFETs Q9, Q11 and the output side of the emitter resistors R25, R27. These capacitors actually connect between the gates of MOSFETs Q9, Q11 and their respective sources. The circuit is shown correctly this month.



DRILLING DETAILS FOR SERIES 5000 POWER AMP-HEATSINK BRACKET.



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47 uf	25v	6c
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10 uf	25v	6c
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33 nf	250v	5c
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562	.75	495	1.60	1018	3.18	1678	2.35
564	1.40	496	1.90	1047	.75	1685	.75
628	.65	509	1.30	1061	1.60	1687	.95
634	1.95	536	.50	1096	1.40	1760	3.20
673	.70	538	1.50	1124	2.20	1846	1.40
683	1.15	605	2.35	1162	1.15	1893	
706	4.20	710	.70	1172	14.50	1957	1.35
719	.90	711	.55	1215	.70	1969	6.25
844	.75	732	.65	1226	1.25	1973	1.85
1015	.85	733	.65	1239	9.70	1974	2.75
2SB 187	1.00	735	.80	1247	2.20	2029	5.20
474	2.15	763	.80	1306	3.15	2075	4.95
525	1.45	776	9.40	1307	6.65	2166	3.65
536	3.85	781	6.50	1312	.90	2SD 187	1.35
544	1.10	784	.90	1318 R	.90	200	6.30
555	15.00	785	.85	1327	.70	235	2.25
681	9.80	799	6.25	1345	1.65	261	.95
2SC 103	2.10	815	.90	1359	.90	288	2.00
372	.70	828	.90	1383	1.30	313	1.80
373	.60	829	.75	1384	1.05	325	1.60

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525	2.90
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Phil Wait

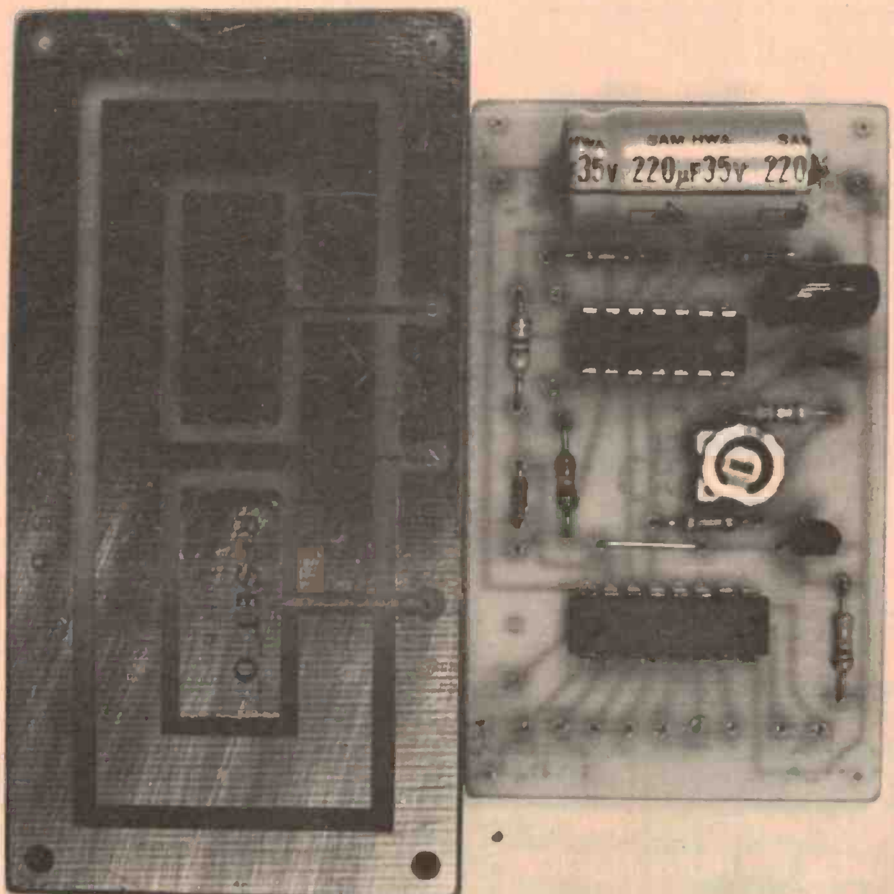
TOUCH SWITCHES have begun to appear everywhere . . . lifts, TV sets, cassette decks, turntables — to name only a few devices. Some are simple on/off types while others are designed to provide multiple functions. With this inexpensive unit, you can arrange to control up to ten pieces of equipment, or whatever. In addition, you can arrange to have the unit automatically 'reset' when any one of the ten outputs is reached. This latter feature enables you to restrict the number of controlled devices attached to the outputs — by adding a suitable multi-position switch you can select where the unit resets as you wish — as well as providing an automatic 'return to start'.

The reset function provides a further advantage. When connected to the second output ('1' on the circuit diagram) the unit will act as a 'toggle'. Touching the 'count' pad once will operate output '1'. Touching it again will turn off output '1'.

The ten sequentially-selected outputs can drive various switching devices and may be interfaced directly with CMOS and TTL circuitry. As the unit is operated from a standard 9 V battery (it draws very little current), it can be completely isolated from the equipment it controls by using a switching transistor on each output to drive a relay, the contacts of which can control mains-operated equipment, interrupt high current supplies, etc. Details on interfacing are discussed later in the article.

Many touch switch designs rely on the presence of an ac voltage on the body of the operator, induced from nearby mains wiring and conducted to the circuit when the pad is touched. Our circuit is designed for dc operation from a battery supply and employs the change in capacitance that occurs when the sensor pad is touched.

As the touch switch can be used in a wide variety of situations, only basic constructional details are given along with suggestions for interfacing the unit. Applications and installation details are entirely up to you, good reader!

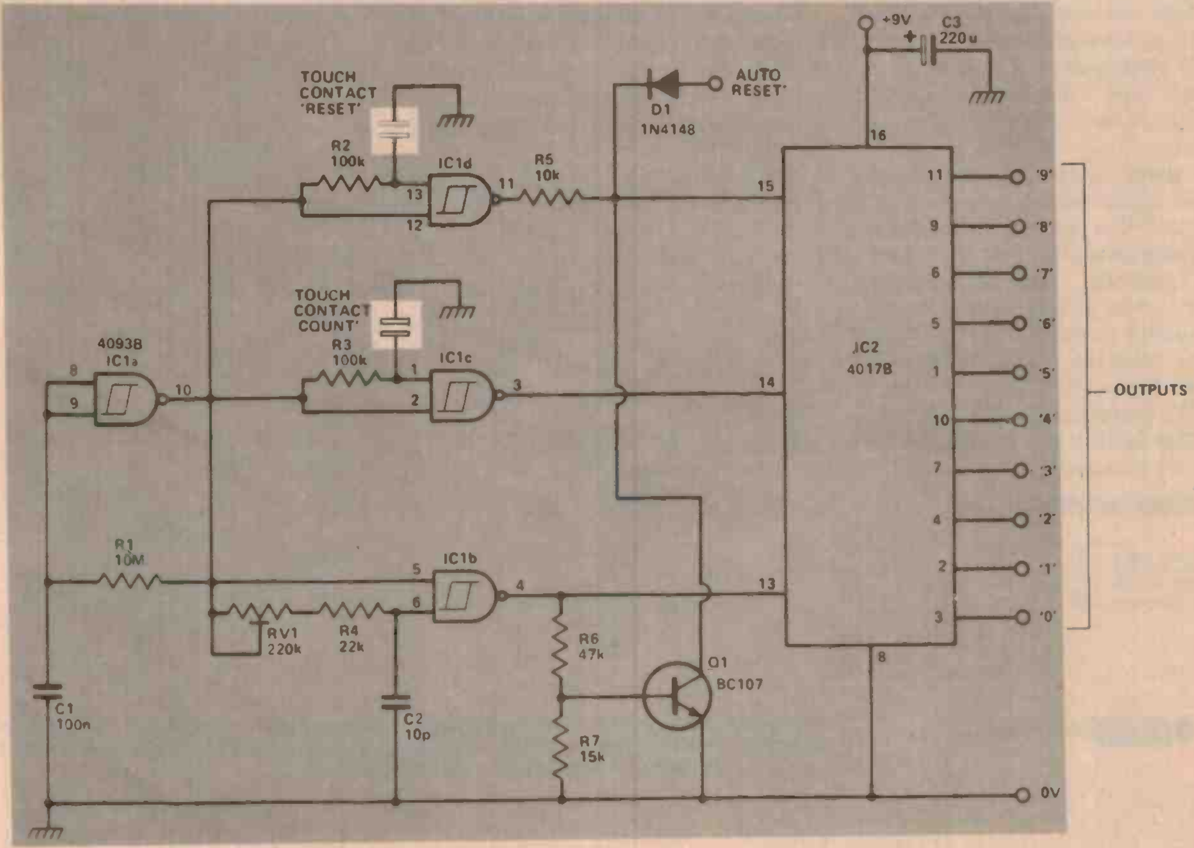


At left is our contact pc board, at right, the electronics for the touch switch. As individual requirements will differ, we have left the packaging to you.

Construction

To avoid introducing stray circuit capacitance which will affect the operation of the circuit, we strongly recommend you use the printed circuit board specified (ETI-598a).

Mount the components in any order, but be careful with the orientation of the ICs, diode and transistor. Observe the usual precautions when handling the CMOS ICs. Almost any general purpose, small-signal NPN transistor will work in this circuit, but be careful with the pin connections so that you install it



HOW IT WORKS - ETI 598

The circuit operates by using the hand as part of a capacitor in a critical timing circuit. When the detector contacts are touched, the extra capacitance introduced has the effect of delaying the transmission of a clock edge.

The circuitry is driven by one single-phase clock, IC1a, whose output consists of a continuous stream of pulses at about one Hertz with a nominal fifty per cent duty cycle. A delayed and inverted clock is generated from this signal by IC1b whose output drives one of the clock inputs of a decade counter decoder IC2.

This chip does all the work of decoding the clock signals and provides a reset input which can be controlled from the touch circuitry or driven directly by one of the outputs of the chip. For example, to reset to zero after the 'fifth' count has been reached, just connect output 'six' (pin 5, IC2) to the 'auto reset' input at the anode of D1. If no connection is made to D1 then the circuit will cycle through all ten outputs.

By connecting output 'two' (pin 4, IC2) to 'auto reset' and taking an output from 'one' or 'zero' (pins 2, 3 IC2), the circuit will operate as a bistable: one touch turning the output on; another touch resetting the output to off. The 'reset' touch contact may be left disconnected in this case.

A certain delay will always be introduced by IC1c, d, owing to stray capacitance from the circuit board and connecting leads. This may be nulled out by adjustment of RV1, which should be set to minimum resistance consistent with reliable operation.

The touch 'reset' circuit operates in a similar manner to the 'count' circuit.

the right way round. There is one link which must be installed on the pc board.

In its simplest form, a touch sensor pad could consist of a piece of unetched pc board split into two copper areas by scoring or cutting down the middle, breaking the copper, but leaving the board intact. Sensitivity depends on the size of the touch pad and the area covered by the fingertip or hand. We have provided a touch pad pc board design, ETI-598b, which can easily be installed in a panel or piece of equipment. Reliable operation was obtained with the touch contacts covered by a thin layer of adhesive plastic film. Using a coloured film like that used to cover books could make an attractive addition. The design of the touch contacts can be left very much to your imagination, so don't be afraid to experiment. Note that it is not necessary to physically 'connect' with the sensor contacts.

When connecting the COUNT and RESET sensors, *don't* twist all the leads together, keep the leads to each pad separate and don't make them too long.

The trimpot, RV1, is adjusted to take into account the capacitance of the leads to the sensor pads and stray capacitance from the mounting arrangements. It should be set at the minimum resistance which gives reliable operation.

Interfacing

The ETI-598 Touch Switch can drive CMOS or TTL circuitry directly as each output from the 4017B is capable of sourcing about 2 mA. If you want to control mains-powered equipment, high voltages, high currents, etc, the outputs will have to drive an interface circuit that isolates the switch — a transistor operating a relay, or an opto-coupler for example. A number of circuit suggestions are given in the diagrams on page 46.

Note that, as most common relays are designed for 12 V operation, the touch switch can be operated from the same supply as the relays, but make sure the ▶

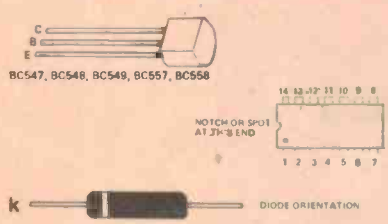
supply does not exceed 15 V. A 220R resistor in series with the supply lead to the touch switch should be used to decouple the unit. The electrolytic, C3, should effectively 'stop' supply rail transients.

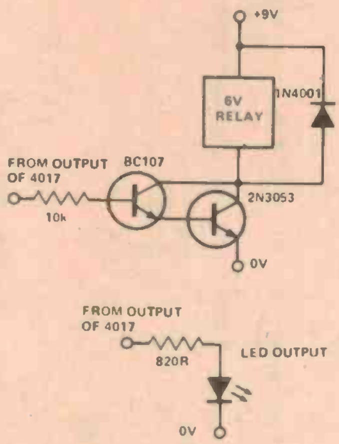
When using a relay to switch the controlled equipment make sure it is rated for 240 Vac operation if switching mains-operated equipment, and has a suitable current carrying capacity. Take care when wiring mains leads to relay contacts to ensure that no shorts occur and that the wires to the relay coil(s) are kept well away from mains wiring. We cannot stress this too much as we'd like to have you reading ETI for many years to come!

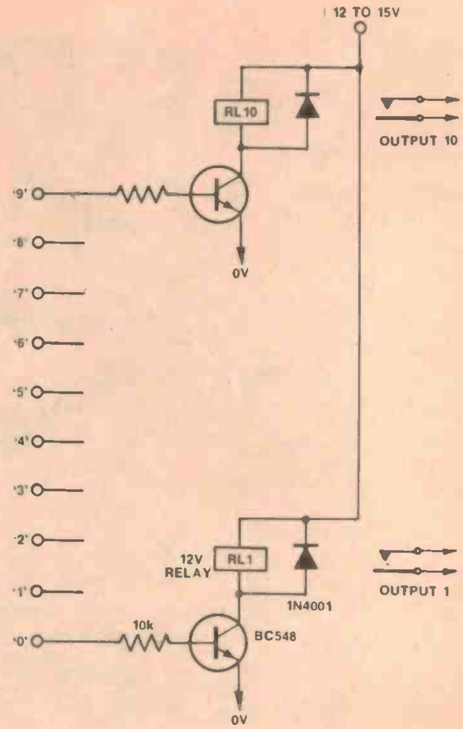
Under no circumstances should you attempt to drive an SCR or triac circuit directly from a touch switch output to control mains current. Opto-couplers are just about *the* safest way if you must do this.

From here on in, it's all up to you. Good luck and have fun! ●

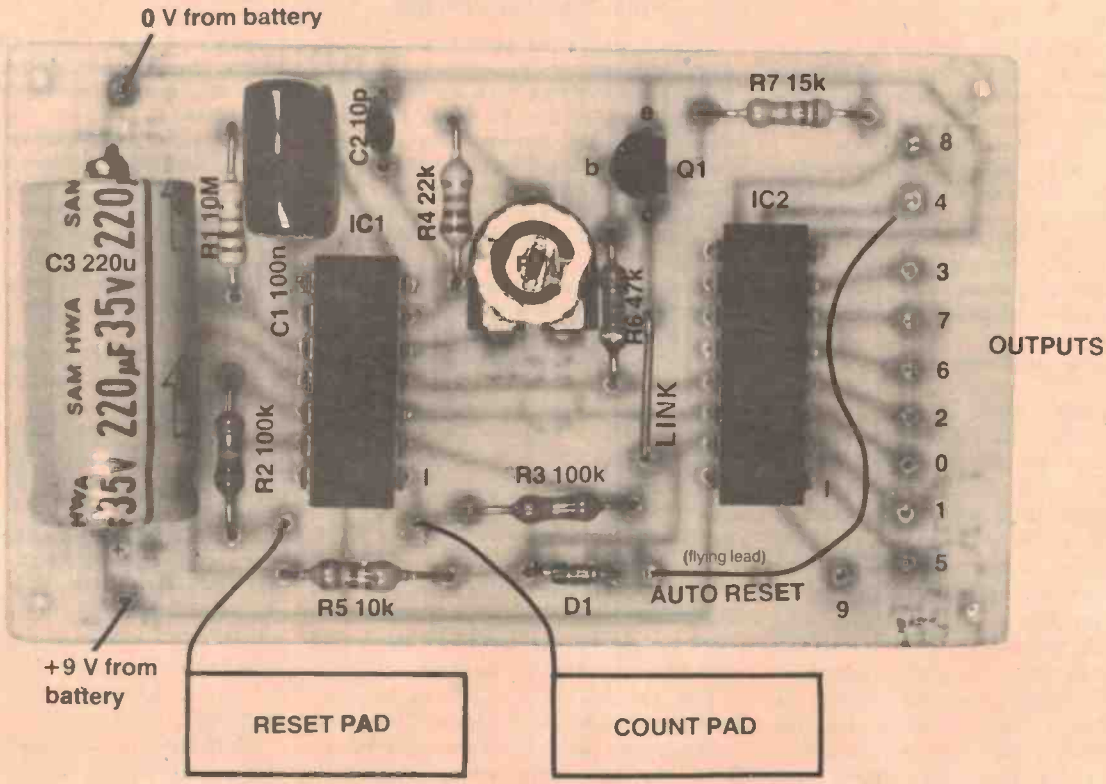
COMPONENT PINOUTS







Suggested interfacing circuits for controlling dc or ac operated equipment, etc. Relay sensitivity will determine whether or not you'll need a Darlington circuit for relay operation, as at left. DO NOT drive a Triac or SCR directly if it controls mains-operated equipment.



CD4017BM/CD4017BC Decade Counter/Divider with 10 Decoded Outputs

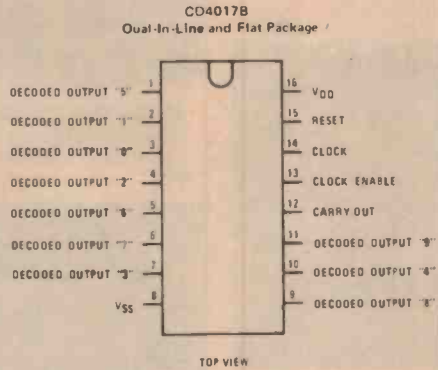
general description

The CD4017BM/CD4017BC is a 5-stage divide-by-10 Johnson counter with 10 decoded outputs and a carry out bit.

These counters are cleared to their zero count by a logical "1" on their reset line. These counters are advanced on the positive edge of the clock signal when the clock enable signal is in the logical "0" state.

The configuration of the CD4017BM/CD4017BC permits medium speed operation and assures a hazard free counting sequence. The 10 decoded outputs are normally in the logical "0" state and go to the logical "1" state only at their respective time slot. Each decoded output remains high for 1 full clock cycle. The carry-out signal completes a full cycle for every 10 clock input cycles and is used as a ripple carry signal to any succeeding stages.

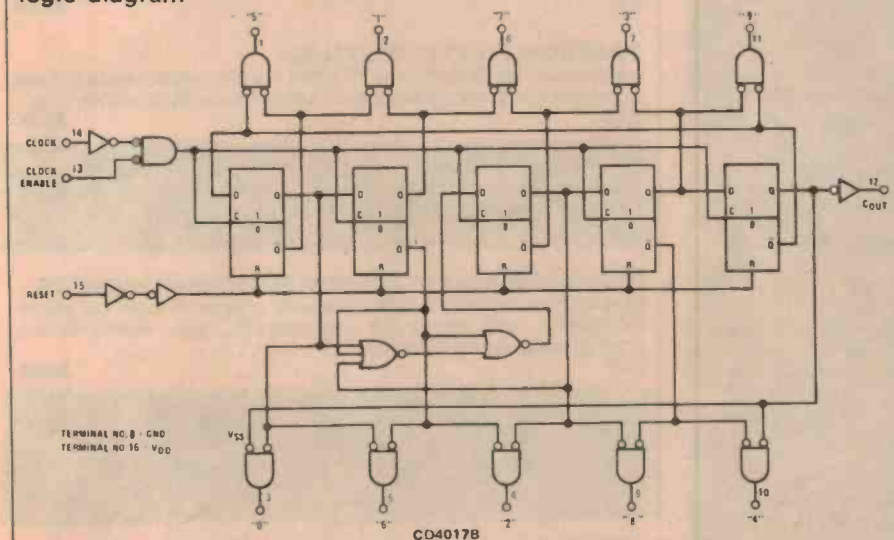
connection diagram



features

- Wide supply voltage range — 3.0V to 15V
- High noise immunity — 0.45 V_{DD} typ
- Low power TTL compatibility — fan out of 2 driving 74L or 1 driving 74LS
- Medium speed operation — 5.0 MHz typ with 10V V_{DD}
- Low power
- Fully static operation

logic diagram



PARTS LIST - ETI 598

Resistors .... all ½W, 5%
- R1 .... 10M
- R2,3 .... 100k
- R4 .... 22k
- R5 .... 10k
- R6 .... 47k
- R7 .... 15k
- RV1 .... 220k miniature flat mounting trimpot

Capacitors
- C1 .... 100n greencap
- C2 .... 10p ceramic
- C3 .... 220u, 16V axial lead electrolytic

Semiconductors
- Q1 .... BC547, BC107 or similar
- D1 .... 1N4148, 1N914 or similar
- IC1 .... 4093B
- IC2 .... 4017B

Miscellaneous

ETI-598A and ETI-598B pc boards; hookup wire; interfacing components (see text).

Price estimate

We estimate that the cost of purchasing all the components for this project will be in the range:

$9 - $11

(excluding interface items)

Note that this is an **estimate** only and not a recommended price. A variety of factors may affect the actual price of a project, whether bought as separate components or made up as a kit.

Babani Books —

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How to make RF, IF, audio and power coils, chokes and transformers. Covers AM and FM radio and TV.
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Enables the reactance of any capacitor or resistor to be read off immediately — from 10 Hz to 100 MHz. Resonant frequencies of LC networks ditto.
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Complete IC equivalent and substitute guide. Full data on over 9500 digital and linear ICs from UK, USA, Japan, Germany, France, Czechoslovakia etc.
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Includes many circuits and designs for constructing test and measuring instruments mostly using modern ICs. Includes AF osc, TTL pulse detector, hi-impedance Vm, square-wave osc/pulse gen, logic probe, lo-range ohmmeter, bridge, signal tracer etc.
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A number of novelty projects using modern ICs and transistors. Includes 'Optomin' — a musical instrument played by reflecting a light beam with your hand, water warbler for pot plants, music tone generator, LEDs and ladders game, touch switch, electronic roulette wheel etc.
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A must for those interested in any way in this inexpensive and versatile IC. European best seller!
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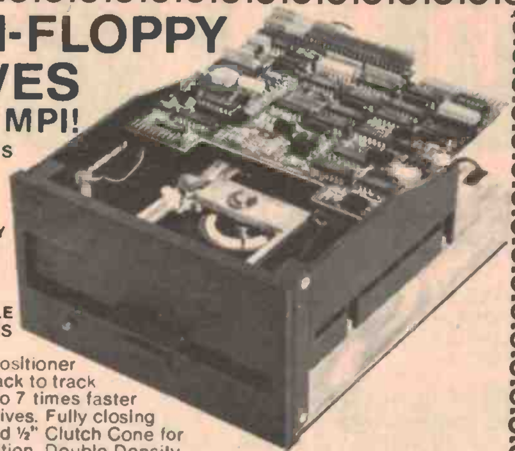
Turn to page 152 for more electronic book bargains and your order form.

MINI-FLOPPY DRIVES FROM MPI!



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FOUR MODELS AVAILABLE
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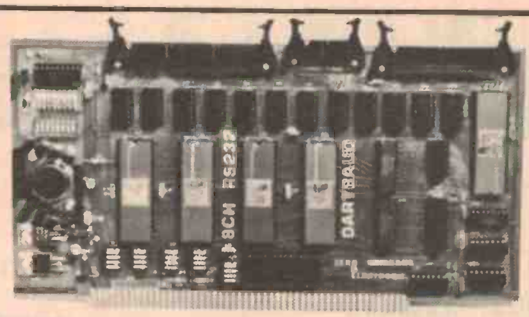
PRICING: 51, $350 ● 52, $450 ● 91, $450 ● 92, $550 ● Cables $30
Tandy owners special 2 MPI Model 51's with power supply & case $725

Write or call for technical description. Power supply/case to suit two drives $75. Since we are the Australian Distributors OEM discounts are available.

DARTBAUD



FEATURES:

Serial Ports: 8 Independent ports using Zilog DARTs (sync) or optionally S10/0 (may be retrofitted for synchronous parts, for any pair (S10 and DART are dual devices).

Baud Rates: 6 Independent, crystal-controlled, software selectable rates for each port selected from the 16 standard rates between 50 and 19,200 baud.

Parallel Ports: 2 Independent ports using Zilog P10, selectable as either input or output.

Interrupts: Full on-board interrupt control provided. On-board devices daisy chained. Rotating priority control provided for running multiple boards (through top connector). Jumper selection of interrupt control (local, rotating, vectored). **PRICE: POA & MANUAL AVAILABLE**

KEYBOARDS

THE CLARE MODEL C70/MGP — by far the best value in keyboards we have seen to date ● 70 key full upper and lower case with non mechanical Capacitive Keyswitch ● fully encoded Microprocessor control with RS232 or 20ma serial options ● parallel output standard single 5V supply ● Serial baud rate jumper from 110 to 9600 baud.
PRICE: $140 ea. Connector $3.00. **MOULDED ABS** plastic case to suit $25.

MOTHERBOARD/CASE/POWERSUPPLY/FAN

Our new 6 slot Motherboard is actively terminated and pre-regulated on the 8v line and comes complete with card guide brackets and fan, which allows this unit to be used without case. ie: it is an entire sub assembly and the only items mounted externally to the board are the transformer and the switches. The Motherboard can be fitted by user with power fail detector circuitry. The case has been configurated so that the back panel plug card of the "Pied Piper" will screw directly into it and the overall dimensions are approx. 8" high x 6" wide x 20" deep.
PRICE: $240 ● without case — $200 ● Assembled and tested — add $60

2650 USERS!

24k static Ram card supplied complete with 2k Ram (2114 type) all sockets switches etc to be fully expandable to 24k, organised as 3 x 8k blocks with one of the 8k blocks selectable in 8 x 1k blocks is fully bus compatable and size compatable with the 2650 Kt 9500 type No 24 Kt 9500. **PRICE: $120**

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With features that far outweigh anything available. We believe most advanced range of cards available in the world. All cards to IEEE S100 BUS specifications plated thru with silk screen component position and solder masked.

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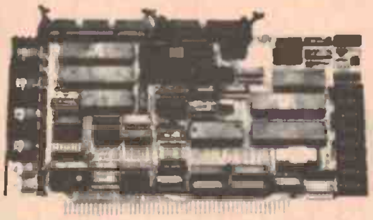


PIED PIPER

A FULLY POPULATED OR PARTLY POPULATED PROCESSOR CARD. SURELY THE MOST ADVANCED YOU HAVE HEARD ABOUT

FEATURING 4 MHz Z80A components as standard although user can run this board at 2MHz with the following main chips supplied and used in the basic kit. **Z80A C.P.U. Z80A P.I.O.** utilized as parallel key-board interface and printer interface **Z80A DART** dual serial port with baud rate selections from 50 to 19200 baud in either RS232c or 20 milliamp serial formats **Z80A C.T.C.** quad counter timer 2 ports of which are used as baud rate generators one utilized as a real time clock using 100Hz mains as reference and fourth for user applications.

4k bytes of onboard monitor program with features such as block move etc., 16k bytes of onboard dynamic ram which can be replaced with the new 64k dynamic ram chips since provision has been made for same. 2100 baud **high speed cassette interface** which is under software control and cassette supplied with unit holds program for 300 baud Kansas City standard. Extended memory addresing feature to address up to 16 megabytes. On board ram can be externally D.M.A. accessed and all **peripheral devices are interupt driven.**

User options can either be of a serial video and keyboard (terminal) or parallel keyboard and memory mapped video (software in monitor program controls E.T.I. 640 type video). User option of either parallel or (parallel centronics) or serial printer.

The big surprise with this card is that the board has allowed for the addition of the components for an optional DMA controlled, CP/M compatible double density disc controller! This controller will control up to a maximum of 4 drives in either 8" or 5¼" single or double headed drives. The bootstrap for CPM is already in the monitor program and in fact a full 64k of memory can be addressed due to the monitor "go away" feature. The on board 16k bytes of ram can be upgraded to 64k onboard or external ram cards such as our DYNARAM II can be added to the bus.

The card also comes as standard with a rear panel plug card which contains some minor logic and all of the connectors for the various IO devices. These connectors are 2 x RS232 sockets, centronics parallel printer socket, parallel keyboard socket, cassette interface socket and sockets for 5¼" & 8" disc drives.

Manual available — refundable with order — $4.

PRICE: with 16k Ram — $495 ● with 64k of Ram (delivery Feb. 1981) $945 ● Disc controller option in both cases, extra $175 ● Assembled and tested add $150 without disc controller ● $200 with disc controller.

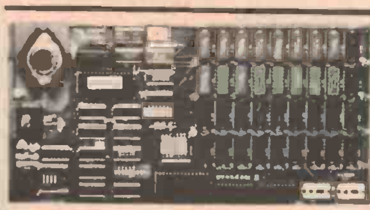
Z6401 VDU

LOOK AT THE SAVINGS HERE!

You all know the ETI640 VDU and its accessory the ETI681 programable character generator. Well we have combined both* on one card! At the same time we have improved the picture and added half brightness characters and four user definable control bits. The P.C.G. can be mapped into memory above or below the VDU (a total of 4k bytes of RAM). The Z6401 is fully software compatible with the ETI640 and ETI681 and is supplied with 250nS (4 MHz) RAMS as standard.
*Does not include the joystick interface.

PRICE: $140 ● PCG option $32 ● Assembled and tested, add $45.

DYNARAM II



This Ram card will hold up to 64k of dynamic Rams of the 4116 type and is supplied with 200 nano-second Rams as standard for 4MHz max speed of operation. It can be used with either 8 bit or 16 bit processors (in 16 bit mode 2 cards required) extended memory addressing feature, phantom feature, switch selectable for Z80, 8080 or standard S100 bus timing. Invisible refresh and self refreshing during long wait state or reset pulses. Uses digital delay line for accurate timing. Bank selectable in 16K blocks and also can be fitted by user with parity error detection bit

PRICE: with 16k — $225 ● with 32k — $295 ● with 48k — $365 ● with 64k — $435
Assembled and tested — $60

CARDS IN DEVELOPMENT (Available in 2nd quarter '81)

Eprom card holds 8 Roms. 2716, 2732, 2516, 2532 with programmer. Double density disc. controller for 5¼" x 8" drives, CP/M compatible, TRS80 to S100 Interface. Graphics terminal complete 80 character x 25 line alpha numeric plus 640 x 400 pixel graphics. Z8002 Card with 16/64k words memory

SOFTWARE LIST ON REQUEST

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Prices exclusive of sales tax. Add 15% where applicable.

ZERO ONE ELECTRONICS

The Dick Smith Daisy Wheel

If you just bought any other printer you'll eat your heart out!

When you want letter-quality printing you are usually talking big money. If you've just bought a word processor printer you'll know what we mean.

In fact, if you've just bought a word processor printer you'd better not read any further. You might get too upset!

The new Dick Smith Word Processor Printer gives you superb print quality (even three carbons down!) at a brisk 25 characters per second. It uses standard Diablo-type daisywheels, giving you low cost replacement and a large variety of fonts. It uses standard business stationery, up to 400mm wide, prints with proportional spacing, in two directions — if you wish. It's hundreds of dollars less than its nearest competitor and thousands of dollars less than many others!

specifications:

Print speed: 25 characters per second; Carriage return speed: 1000ms; Line feed speed: 40ms (4.25mm); Characters per line: 136 (2.5mm pitch) 163 (2.0mm pitch); Resolution pitch: space 0.2mm, line feed 0.5mm; Form width: 398mm maximum; Printing width: 345mm maximum; Number of printing characters: 96; Number of copies: original plus 3 copies; Noise level: below 65db with cover; Print Wheels: Diablo-compatible plastic; Ink ribbon: cloth or multi strike; Interface: Centronics-type parallel; Operating conditions: 5-36 degrees C. 10-90% RH; Power requirements: 240v/50Hz, 70 watts; Dimensions: 625mm (w) x 380mm (d) x 258mm (h); Mass 19.5 kg including cover, power supply.

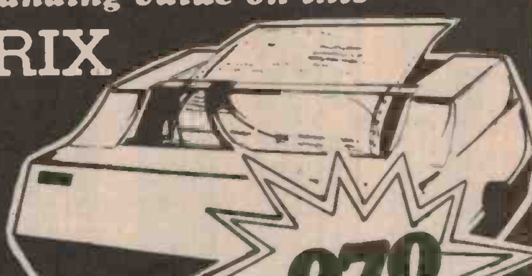
Credit terms available to approved applicants

All this for only **$1995**

Cat. X-3265

We also offer outstanding value on this

DOT MATRIX PRINTER



Fantastic value for less than $1,000!!!

This incredible dot matrix printer uses inexpensive fan fold paper. Upper and lower case with 125 characters per second print speed and a one line buffer memory, plus lots more

$970

Cat X-3255

SYSTEM 80 OWNERS. . .

DON'T NEED S-100 EXPANSION?

Use this parallel printer interface if you don't need full S-100 expansion. Save a bundle! Uses similar connecting cable to S-100 interface

Cat X-4013

$49.50

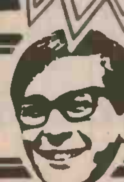
PRINTER CABLE

Fitted with edge connector at one end. 57N-36 plug at other: suits virtually all Centronics-type printers. Use with either S-100 interface or parallel printer interface.

$39.50

Cat X-4014

DICK SMITH
Electronics



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4008	1.00
4009	.80
4010	.50
4011	.40
4012	.50
4013	.80
4014	1.70
4015	.90
4016	.70
4017	1.50
4018	1.50
4019	.60
4020	1.20
4021	1.10
4022	1.05
4023	.70
4024	1.00
4025	.50
4026	2.20
4027	.60
4028	.90
4029	1.20
4030	.60
4031	2.20
4034	3.00
4035	1.30
4039	.70
4040	1.70
4041	1.05
4042	.70
4043	.70
4044	.70
4046	1.20
4047	1.20
4048	.60
4049	.60
4050	.60
4051	1.00
4052	.80
4053	.80
4060	2.00
4066	.80
4068	.60
4069	.70
4070	.50
4071	.60
4072	.50
4073	.60
4075	.60
4076	1.20
4077	.50
4078	.60
4081	.60
4082	.60
4089	1.00
4093	.80
4503	.60
4510	1.50
4511	1.50
4512	1.10
4514	2.50
4516	1.40
4518	1.50
4519	.55
4520	1.60
4522	1.25
4527	1.20
4528	1.25
4529	1.60
4539	1.60
4541	1.60
4543	2.00
4553	5.50
4555	1.00
40097	.95
40098	.95
40175	1.00
74C SERIES	
74C100	.40
74C02	.40

74C04	.40
74C08	.40
74C10	.40
74C14	.90
74C20	.40
74C30	.40
74C32	.40
74C42	1.10
74C48	1.55
74C73	.75
74C74	.70
74C76	.75
74C83	1.40
74C85	1.20
74C86	.80
74C90	.80
74C93	1.40
74C95	.95
74C107	.70
74C150	3.40
74C151	1.00
74C160	.90
74C192	.90
74C164	1.10
74C173	1.00
74C174	.80
74C175	1.00
74C192	1.20
74C195	1.00
74C221	1.90
74C373	1.80
74C374	2.00
74C901	.90
74C902	.90
74C905	11.20
74C906	.90
74C907	.80
74C915	1.50
74C922	3.80
74C923	5.00
74C925	5.50
74C926	5.90
74C927	5.90
74C932	5.50
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80C96	.90
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LM307-H	.90
LM308	.70
LM308-H	1.20
LM310-N	2.20
LM310-H	2.60
311	.60
LM311	.60
LM311-H	1.20
LM318	2.80
LM322	3.90
LM324	1.20
LM325	3.10
LM329-DZ	1.40
LM334-Z	1.30
LM335	12.40
LM336-Z	3.20
LM339	.90
LM348	1.10
LM349	1.80
LF351-N	.70

LF356-AN	1.10
LF357	1.10
LM358	.70
LM373	4.10
LM374	5.40
LM376	.70
LM377	2.90
LM379	5.70
LM308 8PIN	1.30
LM380 14PIN	1.50
LM318A-N	2.40
LM318N	1.80
LM382N	2.00
LM383	2.70
LM384	2.40
LM386	1.00
LM387	1.30
LM391	1.80
LM393	.80
LF398	5.00
8038	6.00
NE530	1.10
OM350	9.90
555	.40
556	1.10
LM565	1.30
LM565CH	2.00
NE566	2.50
LM567	1.50
NE571	6.50
LM709 14PIN	.70
UA710CA	.60
LM710-CH	.90
711	.80
UA711-H	.85
UA716HC	6.25
723	.50
LM723CH	1.10
LM725	3.90
LM733	1.20
UA739	2.00
741	.25
LM741-H	1.20
UA747	1.00
UA747HC	2.20
UA748	.50
UA748HC	1.25
UA753	1.80
UA760HC	4.10
UA777	2.40
UA777HC	2.65
9334	1.70
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UA760HC	4.10
UA796HC	1.70
LM802	1.10
LM1310N	2.40
1408	4.90
LM1458	.60
UA1488	1.50
UA1489	1.50
MC1495	7.30
MC1496L	11.40
LM1558	1.50
LM1596	1.40
LM1380	3.10
LM2902	1.40
LM2917 8PIN	2.80
LM2917	3.10
CA3028	1.80
LM3039	.90
CA3046	1.70
3065	.45
LM3080	1.20
LM3089	3.90
CA3130T	1.40
CA3130E	1.80
CA3140	1.40
3401	.70
3611	1.10
LM3900	.90
LM3909	1.00
LM3914N	3.90
4136	1.40
LM4250	1.75

UA4558TC	1.40
MM5837	2.50
LM7555	1.80
Mc10116L	.95
LF13741	.60
LF1374-1H	.70
DS75452	.60
76477	4.90
75451	.60
75491	1.40
75492	1.40
TTL (s)	
74S00	.80
74S02	.80
74S04	.80
74S10	.75
74S11	.75
74S32	.75
75S51	.75
74S74	1.20
74S86	1.40
74S112	1.20
74S135	2.20
74S138	3.20
74S157	2.95
74S158	2.95
74S182	3.30
7400 SERIES	
7400	.40
7401	.40
7402	.40
7403	.40
7404	.40
7405	.50
7406	.50
7407	.50
7408	.40
7409	.40
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7411	.40
7412	.40
7413	.50
7414	.70
7416	.50
7417	.60
7420	.40
7421	.40
7423	.50
7425	.45
7426	.40
7427	.40
7430	.40
7432	.40
7437	.40
7438	.50
7440	.50
7441	1.00
7442	.50
7443	1.40
7444	1.20
7445	1.10
7446	1.00
7447	1.00
7448	1.00
7450	.50
7451	.50
7453	.40
8T26	2.20
9300	.60
9307	1.80
9308	1.20
7454	.60
7472	.60
7473	.60
7474	.60
7475	.60
7476	.60
7480	.65
7482	1.80
7483	.80
7485	.80
7486	.60
7489	2.60
7490	.70
7491	.55
7492	.60
7493	.60

7494	.90
7495	.45
7496	.80
7497	2.50
74107	.80
74109	.60
74116	2.20
74121	.45
74122	.65
74123	.60
74125	.55
74126	.60
74132	.80
74141	1.10
74145	.85
74147	2.00
74148	1.40
74150	1.20
74151	.60
74152	4.90
74153	.70
74154	1.20
74155	.90
8T28	1.60
9310	.65
9311	1.00
9312	1.35
74156	1.50
74157	.60
74161	1.00
74162	1.00
74163	.85
74164	.60
74165	.60
74174	.50
74175	.90
74176	1.10
74177	1.10
74180	.90
74181	2.30
74182	.90
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74185	1.20
74190	1.00
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74192	1.70
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74197	1.10
74198	1.10
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74221	.90
74290	.90
73293	.90
74365	.80
74366	.80
74367	1.00
74368	1.00
8T96	1.80
9314	1.30
9368	1.75
9370	2.00
74LS SERIES	
74LS00	.40
74LS01	.40
74LS02	.40
74LS03	.40
74LS05	.40
74LS08	.40
74LS09	.40
74LS10	.40
74LS11	.40
74LS13	.50
74LS14	.90
74LS15	.40
74LS20	.40
74LS21	.40
74LS22	.40
74LS26	.40
74LS28	.40
74LS30	.40
74LS32	.40
74LS33	.40
74LS37	.50
74LS38	.50

DIP SWITCHES SPST

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SD4	4	1.70
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SD6	6	2.30
SD7	7	2.40
SD8	8	2.50
SD9	9	2.70
SD10	10	3.00

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16 Pin	1.00	.90
18 Pin	1.20	1.10
20 Pin	1.40	1.30
22 Pin	1.60	1.40
24 Pin	1.90	1.80
28 Pin	2.20	2.10
36 Pin	2.60	2.40
40 Pin	2.90	2.70

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15,000uf	40V	12.00
22,000uf	25V	12.90
22,000uf	40V	23.00
27,000uf	35V	23.50
33,000uf	16V	23.50
68,000uf	16V	21.50
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Price per metre

	1-9	10+
10 Way	.70	.60
12 Way	.75	.65
16 Way	1.00	.90
20 Way	1.35	1.25
40 Way	2.70	2.50

74LS40	.50
74LS42	.75
74LS47	.85
74LS48	1.00
74LS49	1.00
74LS51	.40
74LS54	.50
74LS55	.55
74LS58	.65
74LS73	.55
74LS74	.60
74LS75	.45
74LS76	.50
74LS78	.50
74LS83	1.00
74LS85	1.00
74LS86	.50
74LS90	.70
74LS92	.90
74LS93	.80
74LS95	.65
74LS96	1.55
74LS107	.60
74LS109	.60
74LS112	.60
74LS113	.65
74LS114	.50
74LS122	.50
74LS123	.75
74LS125	.50
74LS126	.70
74LS132	.80
74LS133	.50
74LS136	.50
74LS138	1.20
74LS139	.85
74LS151	.75
74LS153	.60
74LS154	1.50
74LS155	1.00
74LS156	1.00
74LS157	.90
74LS158	.70
74LS160	.85
74LS161	.85
74LS162	1.00
74LS163	.85
74LS164	1.30
74LS165	.50
74LS168	1.90
74LS169	1.90
74LS170	2.80
74LS173	.90
74LS174	.90
74LS175	.90
74LS181	2.50
74LS189	3.80
74LS190	1.30
74LS191	1.10
74LS192	.85
74LS193	.85
74LS194	.70
74LS195	.80
74LS196	1.25
74LS197	1.00
74LS221	1.10
74LS245	2.35
74LS247	.90
74LS249	1.30
74LS251	.80
74LS253	.90
74LS257	.65
74LS258	.50
74LS259	2.45
74LS260	.90
74LS266	.90
74LS273	1.60
74LS279	.65
74LS283	1.15
74LS290	1.10
74LS293	1.15
74LS295	1.60
74LS298	1.00
74LS352	1.30
74LS353	1.30
74LS365	.50
74LS366	.70
74LS367	.90
74LS368	.90
74LS373	1.50
74LS374	1.70
74LS386	.50
74LS670	2.70
81LS95	2.10
95H90	11.50
11C90	19.50
81LS96	2.10

81LS97	2.10
TRANSISTORS	
2N301	2.20
2N657	.60
2N930	.60
2N1613	1.10
2N1711	.50
2N1893	1.00
2N2219A	.60
PN2222	.20
PN2222	.30
2N2463	.35
2N2484	.65
2N2646	.70
2N2647	1.10
2N2894	.80
2N2904	.45
2N2905	.40
2N2906	.45
2N2913	1.20
PN2907	.30
2N3053	.60
2N3054	.90
2N3055	.90
2N3301	.40
2N3440	1.10
2N3502	.70
2N3503	.70
2N3563	.30
2N3564	.30
2N3569	.30
PN3565	.30
PN3566	.30
PN3567	.30
2N3568	.30
2N3638	.30
2N3639	.30
2N3640	.30
2N3641	.30
2N3645	.30
PN3642	.30
PN3643	.30
PN3644	.30
2N3646	.30
2N3692	.50
2N3693	.35
2N3702	.30
PN3694	.30
2N3704	.30
2N3709	.30
2N3713	2.20
2N3819	.80
2N3866	2.00
2N3904	.30
2N3906	.30
2N4030	1.10
2N4032	.55
2N4033	.90
2N4036	1.00
2N4037	.90
PN4121	.30
2N4233	1.60
2N4235	1.90
2N4236	2.20
2N4248	.30
PN4249	.30
2N4250	.30
2N4258	.30
2N4292	.70
2N4354	.30
2N4355	.30
2N4356	.30
2N4398	5.00
2N4401	.50
2N4402	.50
2N4403	.50
2N4416	1.00
2N4906	2.80
PN4868	.30
2N5088	.30
2N5089	.30
2N5179	1.90
2N5303	3.30
2N5320	.80
2N5401	.30
2N5458	.70
2N5459	.70
2N5461	.70
2N5484	.70
2N5485	.70
2N5486	.70
2N5769	.30
2N5770	.25
2N5830	.25
2N5831	.30
2N5856	.30
2N5873	1.10

2N5874	1.40
2N5961	.30
2N5963	1.10
2N6027	.60
3N201	.90
AC127	.70
AC128	.70
AC187	.70
AC188	.70
AD149	2.50
AD161	1.70
AD162	1.70
BC318	.30
BC319	.18
BC327	.15
BC328	.30
BC337	.30
BC338	.30
BC547	.15
BC548	.15
BC549	.15
BC549C	.40
BC557	.16
BC558	.16
BC559	.16
BC637	.25
BC638	.36
BC639	.40
BC640	.40
BCY70	.85
BCY71	.85
BD115	1.50
BD135	.70
BD136	.70
BD137	.70
BD138	.70
BD139	.70
BD140	.70
BD235	.65
BD234	.50
BD237	.50
BD262	1.20
BD301	.75
BD302	.75
BD263	1.25
BD435	.75
BD646	1.70
BD647	1.80
BD675	.80
BDV64B	4.50
BDV65B	4.50
BF115	.50
BF173	.70
BF180	.70
BF195	.30
BF198	.30
BF199	.30
BF336	.80
BF337	.80
BF458	.90
BF494	.40
BFX85	.75
BFY50	.90
BFY90	1.30
BSV17	1.00
BU126	3.00
BU208	3.00
BUX80	7.90
FT2955	1.40
FT3055	.75
MEL12	.90
BU326A	3.40
MJ2955	1.00
MJ4032	7.40
MJ802	3.40
MJ4035	6.90
MJ4502	3.70
MJE340	1.20
MJE350	1.70
MJE295	1.90
MJE8055	1.90
MJE3521	.60
MJ15003	4.00
MJ15004	4.00
QF102	.60
MPF131	1.40
MPSA05	.60
MPSA06	.60
MPSA12	.60
MPSA14	.60
MPSA42	.60
MPSA56	.80
MPSA92	.60
MRF475	4.40
TT31B	.90
TI3PIC	1.00
TIP32B	.90

TIP32C	1.00
TIP33A	1.10
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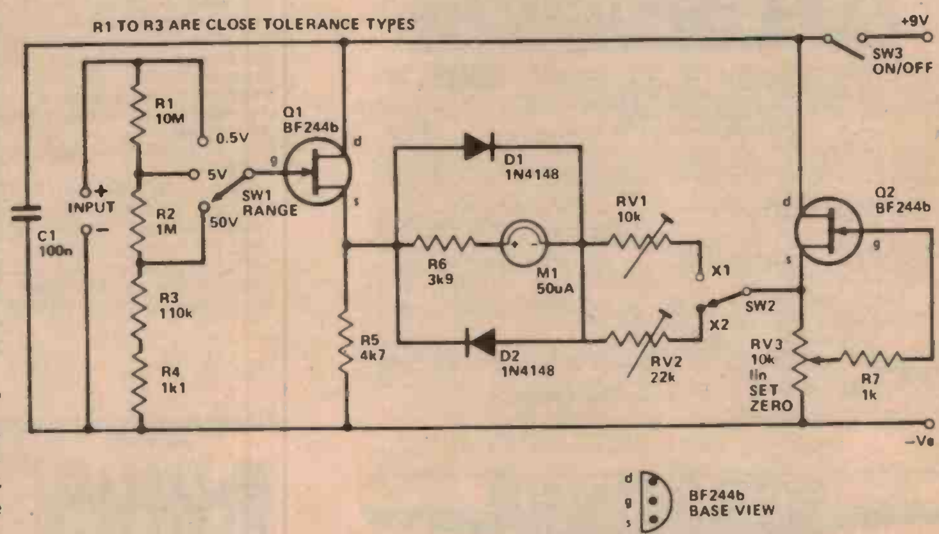
Six-range FET dc voltmeter has 11M input impedance

This circuit can be made as a handy add-on unit for a multimeter or as a stand-alone test instrument.



ALTHOUGH an ordinary multimeter is suitable for most dc voltage measurements, it can occasionally prove to be inadequate — usually just when you need it most! This is the case when making measurements on high impedance circuits which cannot supply the input current required to operate even a very sensitive moving coil meter of the type normally employed in a multimeter. The loading effect of the meter then causes the voltage at the test point to fall substantially, resulting in a misleading reading.

The problem is overcome by this FET voltmeter circuit which has six ranges, from 0.5 V (500 mV) to 100 volts full scale deflection (FSD). The circuit features an input impedance of a little over 11M on all ranges. This provides a sensitivity of more than 22M/volt on the half-volt (lowest) range, falling to a little over 110k/volt on the 100 V range. Most common multimeters have a sensitivity of 20k/volt, good quality types 50k/V and top-line models 100k/V, so this unit should compare quite favourably by the time you want to measure high voltages.

The high input impedance is achieved by using Q1 as a unity voltage gain buffer (source-follower). The FET has an inherently high input impedance. The actual input impedance is really set by the value of the series combination of the input attenuator consisting of resistors R1, R2, R3 and R4.

A simple voltmeter circuit is driven from the source of Q1. Ignoring the two diodes, D1 and D2, for the moment, the meter (M1) is arranged with several 'range' resistors in series: R6, RV1 and RV2. The latter two are switched to provide 'x1' and 'x2' ranges. In the x1 range, M1 has a full scale deflection sensitivity of 0.5 V, while in the x2 range it has an FSD sensitivity of 1 V. The unit is set up by adjusting RV1 and RV2 to give the appropriate full scale readings.

As the input FET develops a small bias voltage across R5, the negative side of the meter circuit has to be 'biased up' to counteract a permanent meter deflection. This is provided by another FET connected as a source-follower, Q2. Its gate is returned to the source bias, a potentiometer, so that the 'zero point' on the meter may be adjusted. This arrangement also provides a measure of stability, and little 'drift' in the meter reading is noticeable.

Diodes D1 and D2 protect the meter against serious overloads. When the voltage drop across R6 and M1 exceeds about 550 - 600 mV, of either polarity, one diode or the other will conduct, shunting the meter with a low impedance, reducing any further increase in current flow through the meter. A high reverse voltage at the input may destroy Q2, but the meter will be protected.

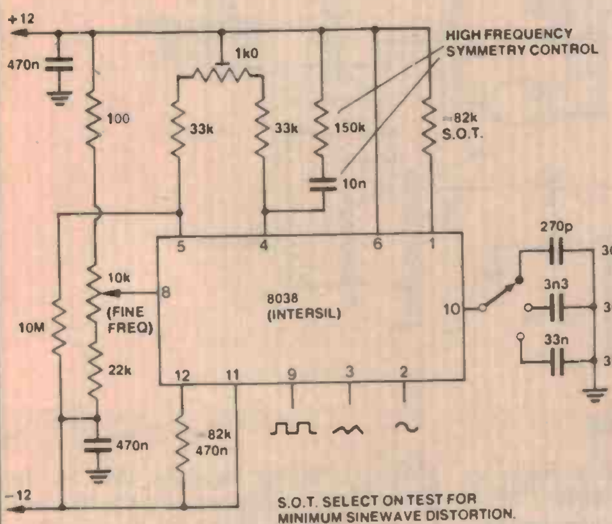
A simple input attenuator is arranged to provide three basic ranges of 0.5 V, 5 V and 50 V full scale, in the x1 range, these double to 1 V, 10 V and 100 V respectively.

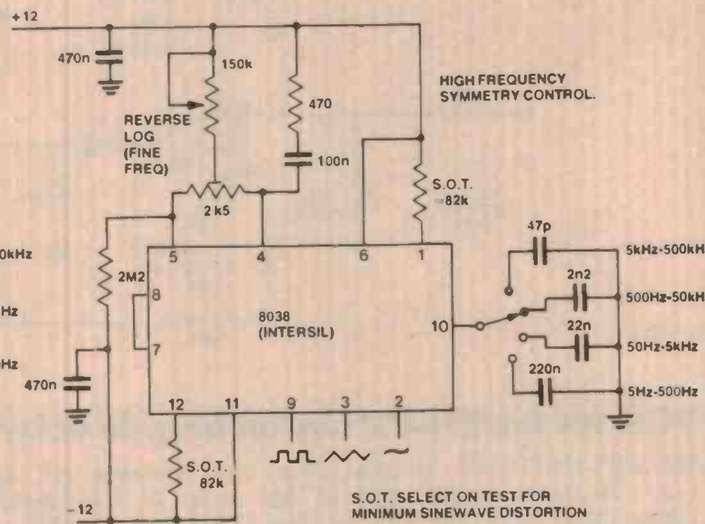
The circuit is not critical as to layout, apart from the usual precautions to avoid possible accidental shorts, but a good quality switch having excellent insulation resistance impervious to humidity variations should be employed for the RANGE switch, SW1. A switch with ordinary bakelite insulation would be unsatisfactory. The circuit need not be built as a stand-alone unit, but makes an excellent add-on for a multimeter that has a 50 uA current range. Alternatively, if your meter has a 0.5 V range and is protected, delete D1, D2 and R6, connecting the meter between R5 and the junction of RV1 and RV2.

If building it as a stand-alone unit, buy a meter with a good-sized face (80 mm wide, for example). If you can get a mirror-scale type, so much the better. ●

Ideas for Experimenters

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.





Improving performance of the 8038 function generator

When using the popular 8038 Function Generator IC in a switched range oscillator, connect a series RC network between pin 4 and the positive supply rail to retain waveform symmetry when operating on the higher frequency ranges. This avoids the need for re-adjusting or switching the symmetry control resistors along with the frequency determining capacitor.

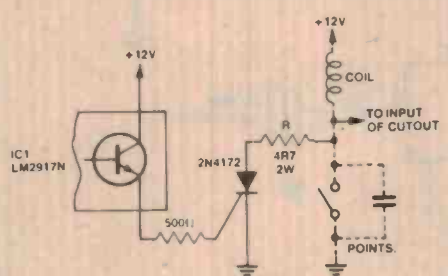
The bypassing RC network on pin 4 is proportioned to counteract the distorting effects of the IC's internal parasitic circuit paths on the high frequency charge-discharge characteristic when the frequency determining capacitor is less than 1nF. Values are given for two typical circuit configurations. The maximum rate of frequency sweep is reduced in this circuit, with all other IC functions being unaffected.

This suggestion comes from **R. Beaumont of Pennant Hills, NSW.**

Over-rev safety cutout

In the ETI-322 Over-rev Alarm project (March 1980, p.45), it was pointed out that for road use, the alarm should never be used to cut the ignition. However, **N. Pollock of Sandringham, Vic.** points out that many high performance engines used in racing cars and boats have a very small speed margin between maximum power and physical destruction! For such engines, used in competition, it may be desired to have an over-rev ignition cutout to prevent the otherwise very expensive consequences of a missed gear change or a broken propellor shaft.

An ignition cutout cannot simply turn off the low tension supply to the ignition system since this would deprive the cutout of its engine speed information. This problem is easily overcome for a capacitor discharge ignition system

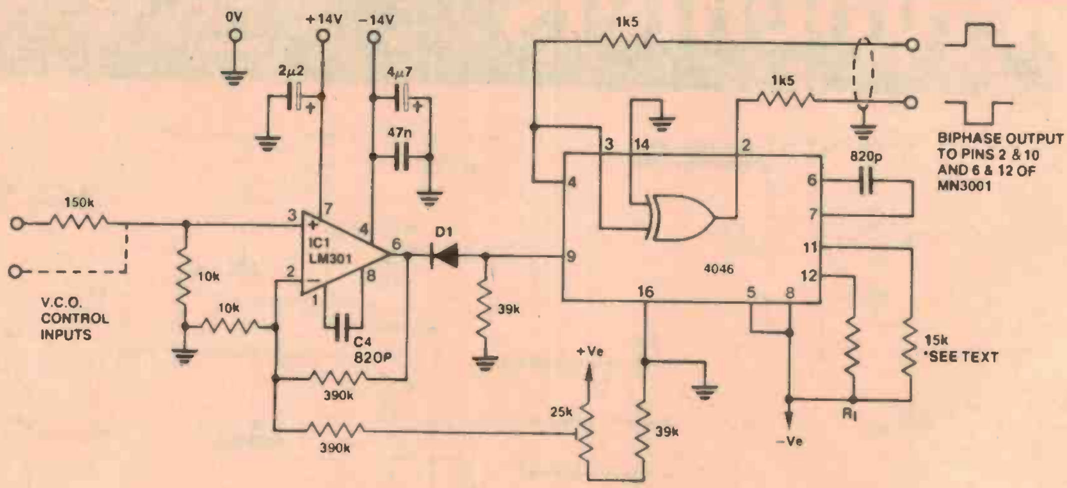


but requires somewhat more work for a conventional system. The following suggestions should assist those wishing to convert the ETI-322 project to a cutout.

For a CDI system (referring to the original article) Q1 can be used to pull the gate of the CDI's SCR to ground, but a germanium transistor (i.e: AC127) should be used so that its c-e voltage hard-on is lower than 0.6 V else the SCR may still trigger. Alternatively, Q1 could drive a relay, the contacts of which short the SCR gate to ground in the CDI. Mount the relay close to the SCR. It is suggested that R7 be reduced to 1k.

For a conventional ignition system, the circuitry shown here should do the trick. The output stage of IC1 in the ETI-322 alarm is taken via a 500 ohm resistor to the gate of a 2N4172 SCR, shunting the points. The resistor R (4R7, 2W) effectively shunts the points when the engine exceeds the rev limits, and its value must be low enough to prevent spark production, but high enough to leave sufficient signal for the input comparator on the LM2917 in the ETI-322 alarm. It should be noted that a cutout of this type will have some small delay in operation when the engine speed is increasing rapidly. To reduce this delay it is suggested that C4 be removed and C3 reduced in value.

Ideas for Experimenters

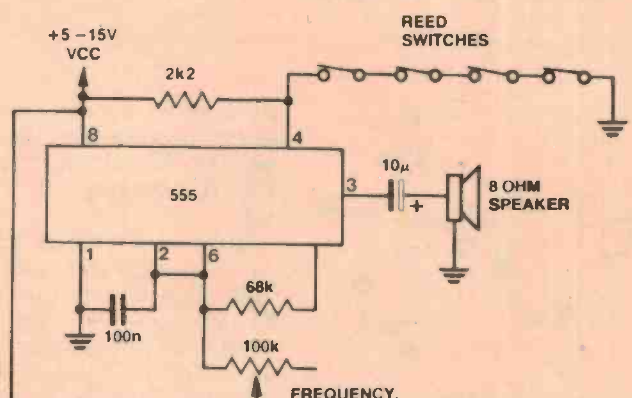


VCO for the ETI-450 bucket brigade delay line

The ETI-450 Bucket Brigade Delay Line (see December 1977 ETI, or Top Projects Vol.5. or 30 Audio Projects) has many uses. In some applications (i.e: phasing or flanging) it requires a variable clock. This circuit, submitted by **Hugo Bramall of Canterbury, Vic.** will interest those enthusiasts considering the use of the Bucket Brigade Delay Line project.

An op-amp, IC1 (LM301), sums control voltages and amplifies them to about 14 V to control a 4046 CMOS VCO chip. The 25k potentiometer sets the minimum range of control voltage and hence the minimum frequency. In this case it's set to about 20 kHz, just beyond the audible range.

The phase comparator in IC2 is an exclusive-OR gate; wired as shown, it becomes an inverter, providing one opposite-phase output to drive the MN3001 bucket brigade chip in the ETI-450. The components C5, R8 and R9 may need adjustment "to taste" as the oscillator tracks over a wide range. Decreasing the capacitor value or increasing either resistor will increase the frequency, whilst Rt also trims the oscillator range (though this component is optional). Several control voltages can be mixed if the inputs are sourced from an impedance around 150k.



Simple burglar alarm

A 555 timer IC is used both as alarm and sensor in this simple circuit from **Simon Moran of Wollongong, NSW.**

A normally closed loop system is employed, using reed switches, trip wires, window tape, photoelectric relays etc. These hold the 555's 'inhibit' pin low during normal operation. When the loop is broken, the 555 will commence to oscillate and the alarm will sound.

The circuit operates from any supply rail from 5 V to 15 V; standby current is less than 3 mA at 6 V, so the alarm is capable of being run from a small battery. Set the 100k potentiometer for the desired alarm tone. A horn loudspeaker is recommended.

Keeping coil slugs in place

Ferrite or powdered iron slugs are widely used to adjust the inductance of RF coils. There are many ways to secure the slug in the coil so that it does not move after initial adjustment (causing some measure of inductance value drift), yet to allow subsequent adjustment. Some manufacturers employ rubber 'string' or 'tape', others specify a sticky rubber solution, or something similar. As usual, Murphy's Law gets into the act and the stuff disappears when you most need it.

A neat idea from **Gary Brooker, of Newcastle NSW,** is to use Teflon thread-sealing tape that plumbers use. Wrap a small piece around the thread of the coil slug and then insert it in the coil former. The tape will hold the slug quite well following initial adjustment.

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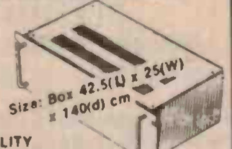

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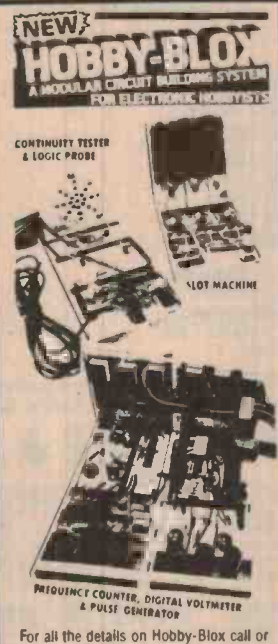

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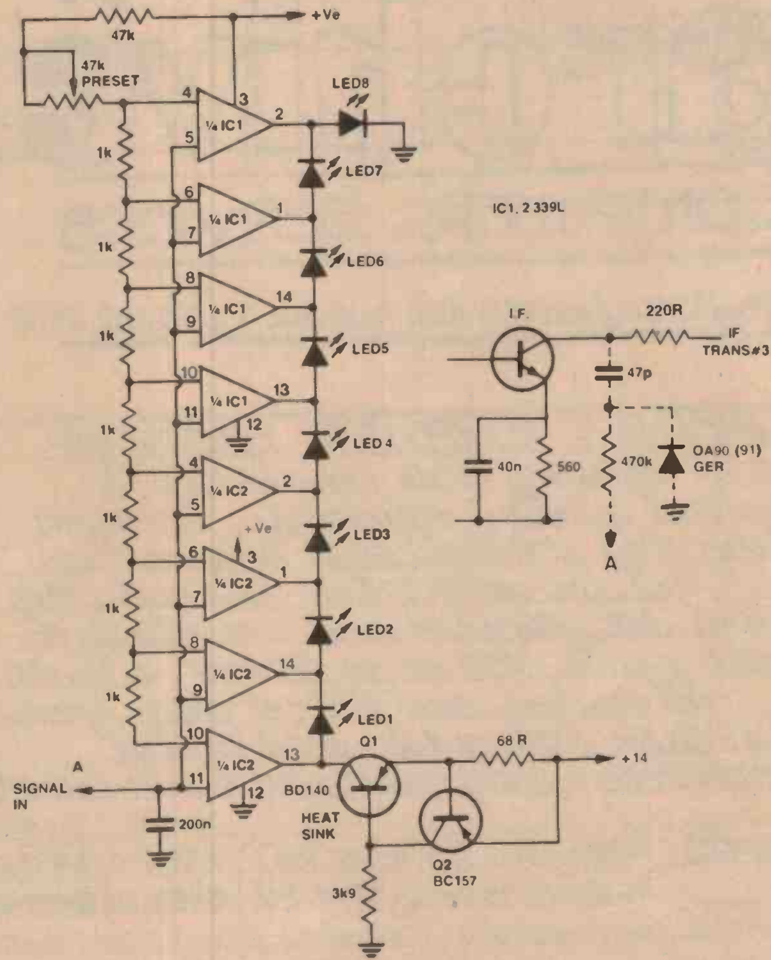
Ideas for Experimenters

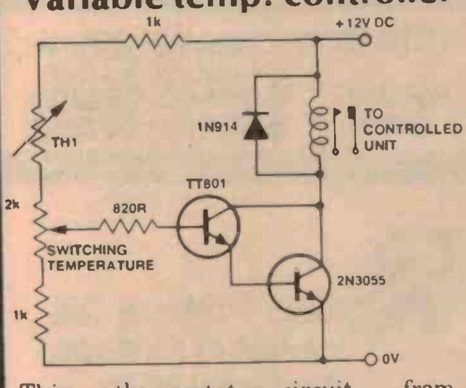
LED S-meter

This circuit, from **Ivan Zaletel of Liverpool, NSW,** employs two quad comparator ICs connected to drive a row of LEDs in a bargraph arrangement with the input coming from the detector dc output or AGC line of a receiver. Thus, signal strength is indicated on the row of LEDs.

Transistors Q1 and Q2 provide a constant current drive for the row of LEDs. All the comparators have one input tied together and driven from the detector output ("signal in"). Each other input of the chain of comparators is connected to taps on a resistive divider 'ladder'. As the input voltage increases, it will exceed the voltage on each successive tap of the ladder and the comparators will each change state in turn. The output of each comparator will initially sink current until it changes state and thus the LEDs will only turn on in sequence, commencing with LED1. The output from my receiver was derived from the point A in the supplementary circuit (I added the 47p capacitor, 47 k resistor and OA90 germanium diode). The voltage at point A varies from 0 V with no signal to just under 1 V for a strong signal. The 47k preset pot in the S-meter is set so that no LEDs are lit when no station is being received.



Variable temp. controller



This thermostat circuit, from **P. Schoenwald of Doonside NSW,** employs the pull-in current of a relay to determine the trip point, the trip temperature being set via a potentiometer. The sensor is a common thermistor.

The thermistor is part of the bias circuit for a super gain Darlington pair using a TT801 and 2N3055. When the voltage on the wiper of the potentiometer exceeds about 1.2 volts, the two transistors will be biased on. When the bias current increases, determined by the decrease in resistance of TH1 and the setting of the potentiometer, the 2N3055 collector current will exceed the relay pull-in current at a particular temperature and the relay will operate. At a temperature lower than this point, the bias current to the Darlington pair will decrease such that the collector current will fall below the relay hold-in current and the relay will return to the non-operated condition.

The switching temperature is determined by the exact range of resistance variation with temperature of TH1 and the setting of the 2k potentiometer.

The 2N3055 may need a small heatsink depending on the relay used. TH1 should be mounted remote to the circuit such that it measures the temperature of the controlled unit.

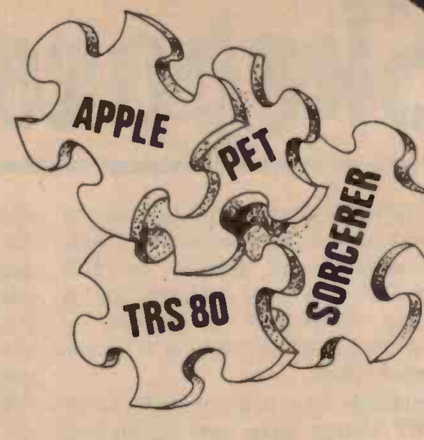
Any ideas ?

Have you had a bright idea lately, or discovered an interesting circuit modification? We are always looking for items for these pages so naturally, we'd like to hear from you.

We pay between $5 and $10 per item — depending on how much work we have to do on it before we publish it.

The sort of items we are seeking, and the ones which other readers would like to see, are novel applications of existing devices, new ways of tackling old problems, hints and tips.

Puzzled? Which computer to buy?



The solution . . .

At Applied Technology we do things a little differently. Our market research has shown that a lot of people buy their first computer mainly to learn the basic concepts involved. Once they have mastered the basic principles only then can they effectively apply the computer to carry out their specific requirements.

We believe that a first computer must start small and be expandable and at the same time be supported with enough documentation and examples so that a user can master both hardware and software concepts at his own pace. Unless you can get "hands on" experience and actually make a computer actually do something like switch on a relay or play a musical tune you will find mastering the microcomputer a difficult, time consuming battle.

With this in mind we have designed a series of computer boards each with a specific function and yet fully compatible with each other. You can have fun and build each from kits (or buy them assembled and tested) and when a board is ready to go, plug it into the S100 BUSS (the hobby standard!) and you are ready to explore the fascinating world of the microcomputer. Some users of our Z80 system have already developed sufficient expertise to set up their own business-writing software and designing industrial control systems. You could easily do the same!

$399 INSTRUCTOR 80

An ideal starting point and a powerful self-contained computer on two S100 cards. The kit includes DGZ80 CPU (with on-board ROM and RAM and adequate I/O for most applications), the DG640 VDU (64 character/line display with upper and lower case and graphics facility), a full feature RCA keyboard, 3 slot motherboard with edge connectors. The kit comes with complete manuals, a step by step programming course and sample programs to run. All you need to do is connect a simple power supply and a monitor/modified TV to complete the unit. Our exclusive warranty service and technical backup are readily available.

ADD ON S100 CARDS AND PERIPHERAL EQUIPMENT

The Instructor 80 can be readily expanded using cards from our wide range of S100 boards. You can, for example add 16K or more of reliable static memory using our AT16K RAM boards or add fine detail graphics/programmed screen characters and connect joy stick controls with the TCT PCG (see ETI July 1980). A full set of hardware is available to house your S100 computer system and if required we have just developed a professional quality 12" monitor with an easy-on-the-eye green phosphor and resolution to cater for up to 132 characters/line! A full range of peripheral equipment including printers and high capacity floppy discs is available as your needs arise.

SOFTWARE SUPPORT

The Z80 is probably the most popular 8 Bit microprocessor in the world and has an abundant software base including business packages, word processing and languages such as CP/M, PASCAL, FORTRAN, FORTH. We have developed cassette based programs including Microworld Basic, Microworld Editor/Assembler, Utility Package and many exciting and challenging games. Courses in microprocessor applications and programming are run regularly. Please enquire for more details.

PRICE LIST

DGZ80 S100 CPU Kit	$199.00
Assembled	$249.00.
DG640 S100 VDU Kit	$149.00.
Assembled	$159.00
DGOS Operating System in 5Volt EPROM	$40.00
AT16K Memory Module Assembled	$199.00
TCT 16K Static RAM Kit	$209.00
Assembled	$229.00
TCT PCG Kit	$140.00
USCI Cassette Interface Assembled	$25.50
JC100 9 Slot Motherboard	$49.50
JC200 Card Cage	$49.50.
JC300 Power Supply	$69.50
JC400 Desk Mount Cabinet	$69.50
Clare C70 Keyboard	$165.00
NT300 Hires Monitor	$230.00
Software now available on cassette tape (DGOS format)	
Microworld Z80 Basic 2.1T Package	$25.00
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Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project — check with our advertisers if it is not mentioned here.

Enthusiasts keen to get their ETI-477 MOSFET Power Amp module up and running should have little difficulty finding components or kits. The Ferguson PF4361 power transformer can be used to power a single module but any type meeting the specifications recommended in this month's article will do the job. We understand toroidal types may be available at a later date.

ETI-1500 metal detector

Firstly, a reproduction problem caused the overlay picture on page 45 of the December issue to come out very dark and many copies were unreadable. If you have this problem, send a large, stamped, self-addressed envelope to "ETI-1500 Metal Detector Overlay", Electronics Today Magazine, 15 Boundary St, Rushcutters Bay 2011 NSW and we will send you a clear dyeline copy of the overlay. We have already supplied a number to kit and component suppliers stocking this project.

Secondly, University Graham Instruments can supply a 50-0-50 uA meter with a special scale to suit this project. The scale is produced in several colours — red to the left of centre (bad) and green to the right (good). But, what's special about the University meter is the pointer. What they've done is to produce a meter with the pointer painted fluorescent orange. This makes it easy to see when you're holding the instrument in its normal operating position. It's worthwhile having! If you want to get one, and your local supplier doesn't stock it, contact University Graham at P.O. Box 204, Enfield 2136 NSW. (02)53-0644.

ETI-598 Touch Switch

If ever a project was designed using all 'bog standard' components, it was this one! The only 'unique' items are the two pc boards — and you don't have to use them either as construction is quite non-critical. Need we say . . . pc boards will be available from the usual suppliers.

ETI-329 Vehicle Ammeter

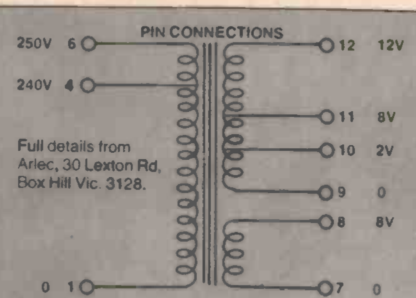
The two ICs used in this project are generally available — the LM394H through National Semiconductor distributors (we bought ours at Radio Despatch Service in Sydney). The 78L05 is a commonly stocked item — cheap, too. Note that it looks like a common, plastic encapsulated transistor.

A number of different meters can be used with this project. The University types TD-48 and TD-66 will be available with scales to suit. If you can't find a source of supply, you could contact University Graham at P.O. Box 204, Enfield NSW 2136, or phone Sydney (02) 53-0664 or Melbourne (03) 387-6170.

The Minipa MU-45 meters are widely available from several suppliers, e.g: Dick Smith stores, Ellistronics, Rod Irving Electronics, Electronic Agencies, Altronics etc. Scotchcal panels to suit these meters should be available also as we have sent suppliers the appropriate artwork prior to publishing this issue.

Printed circuit boards will be available from the usual suppliers.

MULTITAP PC MOUNT TRANSFORMER



Arlec's popular (and much-copied) Model 2155 transformer with the multitapped, 1 A secondary now has a pc mount cousin — the AL10VA/20. Primary is tapped to take 240 V or 250 V ac (50 Hz) and there are two secondary windings. The main winding is 12 V, tapped at 2 V and 8 V and rated at 600 mA. The other secondary winding is 8 V, rated at 600 mA also. Insulation is to AS.C126 standard. The pc mounting pins require a 1.5 mm hole and the transformer weighs just 260 g. There are a variety of secondary configurations possible, including centre-tapped operation for full-wave rectifier circuits using just two diodes.

Join	Output	Rectifier	dc out (full load)	Ripple
8-9	7-12	bridge/2200u	22.4 V @ 350 mA	250 mV RMS
7-9, 8-11	7-12	bridge/2200u	12.3 @ 600 mA	400 mV RMS
7-9, 8-11	7-11	bridge/2200u	7.4 @ 900 mA	580 mV RMS
8-9	7-9-11	full-wave/2200u	7.1 @ 800 mA	460 mV RMS

The Rolls Royce of personal computers or the basis for a fine business system

Yet the Sorcerer will still cost you less!

Looking for a really serious small computer? Feature for feature, dollar for dollar, the Sorcerer is way out in front. When you've finished playing with the others, move up to the Sorcerer.

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Cat. X-3000 8k Memory	Cat. X-3001 16k Memory
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Features:

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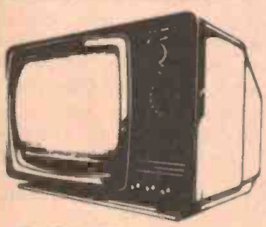
look at our prices for peripherals

Video Monitor



Suits Sorcerer, Tandy TRS-80, Apple etc.

Why waste money on overpriced monitors? This unit has large 30cm diag. screen plus it simply connects to your computer via an RCA socket. 240V AC or 12V DC operation.

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S-100 Expansion Unit

Use other manufacturer's peripherals with your Sorcerer & S-100

For the serious computer owner. Contains powerful computer power supply plus buffer/interface circuit to protect the computer in case of damage to the S-100 Plus many more benefits.

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Floppy disc drives

Need more storage? Floppies are the way to go. Quality Micropolis disk drives added on to your system can give up to 1260K bytes capacity!
Start with the Micropolis 1043 — it comes with the controller board to plug into your S-100 expansion unit. This gives you 315K.

If you want more capacity, use the Micropolis 1023 drive: it uses the 1043 controller board, so it's cheaper — much cheaper ($600 to be precise!) You can add up to three 1023 drives, bringing your total capacity to over one and a quarter megabytes! Compare the cost of our 1.26M system with others — and be pleasantly surprised.

X-3205 **$1350.00** X-3208 **$750.00**

Sorcerer ROMPACS™

Just plug them in — they instantly re-program the Sorcerer for specific uses. No problems!

WORD PROCESSOR PAC™

Want professional quality Word processing at a fraction of the cost of commercial systems? Your Sorcerer, Word Processor Pac™ and our daisy-wheel printer . . . and you're there!
Cat. X-3085 $275.00

DEVELOPMENT PAC™

If you're serious about developing your own software, this is a MUST! It turns the Sorcerer into a powerful, dedicated development system for Z-80 assembly language programming.
Cat. X-3090 $139.50

EPROM PAC™

The Sorcere is ideal for dedicated uses: this PAC allows an EPROM to be used to control the computer. Ideal for all types of control systems, etc.
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CAN YOU AFFORD NOT TO SUBSCRIBE TO MICRO-80?

MICRO-80 is a monthly magazine dedicated to users of SYSTEM 80 and TRS-80 microcomputers. Owned and produced entirely in Australia, each issue of MICRO-80 contains at least six programs, articles, useful hints and answers to readers' problems; all designed to help YOU get the most out of your SYSTEM 80 or TRS-80. Since MICRO-80's first issue in December 1979, we have published over 80 major pieces of software and 10 hardware projects. Most of the programs and articles are written by our readers to whom we pay publication fees thus enabling them to make their hobby pay. MICRO-80 readers can save money by buying Tandy products at 10% discount from an authorised dealer — for details see any issue of MICRO-80. Our sister business, MICRO-80 PRODUCTS, sells Australian designed and produced software and high quality, imported goods at low, sensible prices. We repeat, if you own a SYSTEM 80 or TRS-80,

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If you do not have enough time at the keyboard to type in the program listings which are published in MICRO-80 each month, then you need a cassette subscription. As well as MICRO-80 magazine, you receive a cassette each month containing all the programs listed in the magazine.

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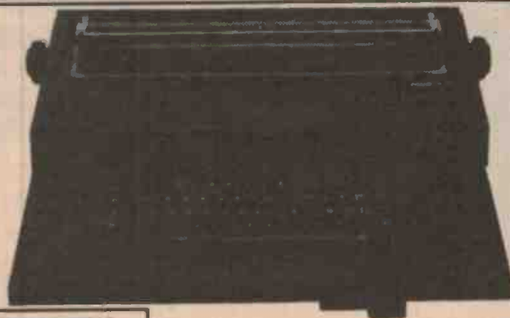
Suspicious of mail order? Then send $2.50 for a single copy of MICRO-80 and see for yourself that this is the magazine for you!

Daisy Wheel Typewriter/Printer

MICRO-80 has converted the new OLIVETTI ET-121 DAISY WHEEL typewriter to work with the TRS-80 and SYSTEM 80 or any other microcomputer with a Centronics parallel port (RS 232 serial interface available shortly). The ET-121 typewriter is renowned for its high quality, fast speed (17 c.p.s.), quietness and reliability. MICRO-80 is renowned for its knowledge of the TRS-80/SYSTEM 80 and its sensible pricing policy. Together, we have produced a dual-purpose machine:- an attractive, modern, correcting typewriter which doubles as a correspondence quality Daisy-wheel printer when used with your micro-computer.

How good is it? - This part of our advertisement was typeset using an ET-121 driven by a TRS-80. Write and ask for full details.



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MPI is the second biggest manufacturer of mini floppy disk drives in the world. They produce a family of high quality 5¼" drives with super-fast track-to-track access times (5ms!)

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40 TRACK DUAL HEAD	$449
80 TRACK SINGLE HEAD	$499
80 TRACK DUAL HEAD	$599

Dual head drives use both sides of the disk and occupy two drive positions — it is like having two drives for little more than the price of one!

Prices quoted are for bare drives. Add $10 per drive for a cabinet and $30 per drive for a power supply.

DISKETTES FOR TRS-80

NASHUA 40 track single side	$4.50 ea
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VERBATIM 77 track single side . .	$5.90 ea

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The disk operating system that gives:

- New basic commands that support variable record lengths up to 4095 bytes long.
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- A security boot-up for basic or machine code programs. User never sees "Dos-ready" or "Ready" and cannot "break" clear screen or issue any direct basic statement including "List"...

. . . and much, much more

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DD-7S $775

Micropolis Floppy Disk, 77 Track, 100% larger capacity than most mini-floppy drives, complete with cable, power supply, chassis, and includes NEWDOS '80.

SYSPAND 80 FOR THE SYSTEM 80
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SYSPAND 80 is a self-contained module which connects to the expansion port on your SYSTEM 80 and gives you a CENTRONICS parallel port to drive a printer PLUS the TRS-80 40 line bus. SYSPAND 80 allows you to connect all Tandy peripheral, including the expansion interface, disk drives, MICROTEK MT-32 memory expansion unit and the fabulous EXATRON STRINGY FLOPPY.

TRS-80 MEMORY EXPANSION UNIT
MT-32 ... $149.00

The MT-32 is manufactured by MICROTEK Inc., USA. It provides a CENTRONICS printer port and sockets for up to 32K of dynamic RAM. It comes complete, ready to plug into the expansion port of your Level II 16K machine. (Will also work with your SYSTEM 80 via SYSPAND 80).

MT-32A without RAM.	$149.00
MT-32B with 16K RAM	$204.00
MT-32C with 32K RAM	$249.00

16K MEMORY EXPANSION KIT
ONLY $55 incl. p&p

These are prime, branded, 200 ns (yes, 200 ns!) chips. You will pay much more elsewhere for slow, 350 ns chps. Ours are guaranteed for 12 months. A pair of DIP shunts is also required to upgrade the CPU memory — these cost an additional $4.00. All kits come complete with full, step-by-step instructions, no soldering is required. You don't have to be an electronic type to instal them.

DISK DRIVE HEAD CLEANING DISKETTES
$29.00 plus $1.20 p &p

Disk drives are expensive and so are diskettes. As with any magnetic recording device, a disk drive works better and lasts longer if the head is cleaned regularly. In the past, the problem has been, how do you clean the head without pulling the mechanism apart and running the risk of damaging delicate parts. 3M's have come to our rescue with SCOTCH BRAND, non-abrasive, head cleaning diskettes which thoroughly clean the head in seconds. The cleaning action is less abrasive than an ordinary diskette and no residue is left behind.

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TRS 80 and SYSTEM 80 OWNERS

Attention all computer users

The exciting new 700 Series acoustic modems have been designed to allow you to transfer computer data via the telephone. These low cost modems are modular in design, easy to operate and can be used in conjunction with most terminals, computers or word processors.

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- Plug compatible with Teletype 43, Digital LA34 and TermiNet 2030.
- Lightweight carry cases available for above terminals.
- Designed and manufactured in Australia.

- Suits all personal computers with Serial RS232 ports.
- Provide remote diagnostic service for your customers.
- Word processors can communicate with the Answer/Original model.
- Telecom now approves the use of acoustic couplers at both ends of the telephone line.

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New single-board micro features low cost, expandability

The RCA COSMAC VIP VP-111 is a new single-board system offering the major elements of a full microcomputer on a single pc board.

Just add power, make connections to your video monitor or RF modulator and home TV and you're ready to go!

The ROM-resident operating system and simple instructions enable you to start programming immediately. You can use CDP1802 machine language or enter the interpreter program shown in the instructions to use the simple CHIP-8 programming language provided.

The latter contains 31 easy to understand instructions which are claimed to be ideally suited for use with video displays.

An on-board interface for all 1802 microprocessor lines, on-board provision for an I/O interface or the many expansion options available enable the hobbyist to add music system prototyping, control functions and other applications.

On board you get 1K of static user RAM, expandable to 4K on-board, 32K off-board. You get a 512 byte operating system in ROM, video interface, cassette interface, and a tone generator (drives a standard 8 ohm speaker). The latter can be used to verify cassette and keypad operation and can be used in programs as well.

Cost of the basic unit is $139 plus $10 for a power pack. An instruction manual is included.

A range of expansion options will be available. A memory expansion kit, allowing you to have 4K RAM on-board, is available now and includes components for the 8-bit I/O port and system expansion. An auxiliary keypad accessory kit, VP-580, with VP-585 interface board allows you to program the unit for two-player interaction games!

You can add another dimension with the VP-595 Simple Sound Board. This provides 256 tone frequencies and is great for supplementing graphics or providing sound effects, music or tone control functions.

You can go much further with the sound options, though. Soon to be available is the VP-550 Super Sound Board that turns the VP-111 into a music synthesiser! This provides two sound channels with independent control of frequency, time and amplitude. This can be expanded to four sound channels by adding the VP-551 board and 4K of RAM (the VP-550 needs 2K of RAM).

Tiny BASIC is available, expansion kit VP-700. Stored in 4K of ROM, it includes the standard Tiny BASIC plus 12 additional commands. However, you'll need an ASCII keyboard. The VP-611 keyboard is a standard ASCII keyboard plus a 16-key numeric keypad — available shortly, also.

Additional options to become available are the VP-565 EPROM Programmer and a 32K memory.

There's plenty of documentation, too. The VP-320 Users Guide includes operating instructions for the VP-111 and step-by-step CHIP-8 programming for the beginner. In addition, the VP-711 manual is a comprehensive book covering instructions, maintenance, circuits, board layouts, ROM contents, diagnostic programs, CHIP-8 language and 20 video games.

For more information on the COSMAC VIP micro system, contact J.R. Components, P.O. Box 128, Eastwood, NSW 2122. (02) 85-3976.

The Mini-Wini — a very small horse?

No, it's not a new breed of Shetland pony; the Mini-Wini is Pertec's new 8" Winchester-style disk drive, marketed in Australia by Digital Electronics.

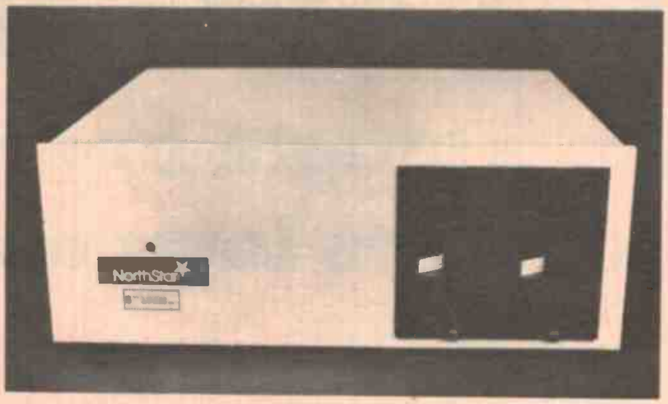
This new model D8000 Mini-Wini is claimed to have 20MB of on-line storage, 80 millisecond maximum seek time, and 17 millisecond read or write time. It is also said to be comparatively inexpensive compared to most current technology storage methods, and since it is also very reliable, should lend itself to small business systems where costs are important.

Although the Mini-Wini has several technical and cost advantages over the floppy disk, Pertec still sees a long life ahead for floppies, particularly at the lower end of the microprocessor market.

The Mini-Wini will be available in Australia in the first quarter of 1981.

The Northstar Horizon shines

After months of hearing the virtues of Northstar extolled, a system arrived from The Logic Shop complete with Televideo and Microline printer for ETI to put through its paces.



This system was completely plug compatible and simple to start — flick the switch and off it goes. Programs automatically load from the diskette within seconds and the system is up and running.

The design of the Northstar is rugged and no-fuss — good for operation in a range of environments such as schools, factories and remote locations. Switching is a simple on/off switch and restart button; the restart button proved to be one off the most effective seen to date.

The operating system features a Zilog Z80A microprocessor board operating at a 4 MHz clock rate; two miniature disk drives; 64K of RAM; two serial and one parallel input/output interfaces; and a motherboard which has slots for up to twelve S-100 circuit boards.

The Disk Operating System (DOS) gives access to data either through commands typed from the terminal or subroutines called by software — both fast and failproof.

With power on, the bootstrap PROM loads the DOS from the diskette into RAM, where it is ready for the commands. The DOS occupies 3.25K of RAM. "GO BASIC" loads BASIC into RAM and begins execution; alternatively the DOS may be set for 'turnkey' start-up with any specified program.

DOS commands include: CR — create a file; DE — delete a file; LI — list a file; TY — set file type; IN — initialise diskette; DT — disk test; WR — write to disk; JP — jump to RAM address. These commands are both clean and fast-executing.

5¼" mini diskettes are used in the Horizon. They are double density and dual-sided, each holding 358K bytes of data. Less expensive single-sided diskettes are available, which would be suitable for the top end of the hobby market. For larger business applications a Winchester-technology hard disk with 18M-byte capacity is offered.

As the Horizon is built around the S-100 buss it provides plug compatibility with a range of equipment from other manufacturers. Real-time clocks, digital to analogue converters, musical synthesisers and other specialised items are available off-the-shelf. With the addition of Digital Research's CP/M operating system, access to a huge library of application software is opened, including that of Lifeboat and Associates.

The most popular and useful of these packages would be 'Wordstar', which is a menu-driven visual word processing system. Having run 'Wordstar' on a Horizon it is easy to see why this is one of the most popular application software packages in Australia — it provides a word processing ability as good as if not better than 'stand-alone' systems selling for $15 000+.

The Televideo CRT display terminal (TV1-912) proved clean and easy on the eyes, with none of the flickering associated with some terminals. The 1 920-character screen capacity, formatted 24 lines by 80 characters of both upper and lower case letters, provides for considerable text-holding capability and easy TAB setting for figures, etc. Standard QWERTY key pattern was both welcome and comfortable to use, even for an amateur typist. Commands were easily executed, with no fiddling around on too many shift locks and no lock-ups.

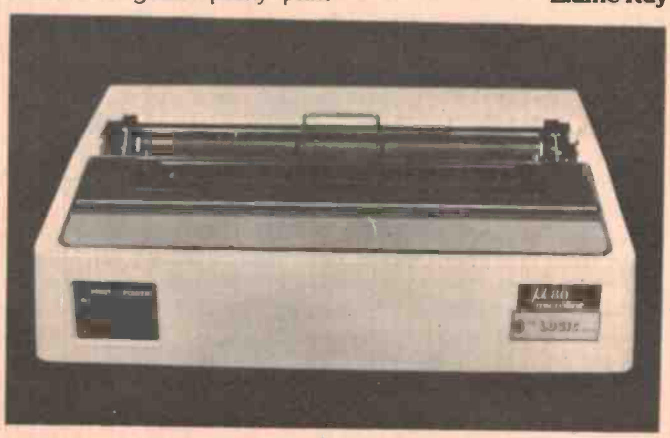
OKI's Microline 80 9 x 7 dot matrix printer churned out a remarkable 80 characters per second of good quality print with no paper alignment problems for the continuous sheets provided and no desire to eat paper, as some of these smaller printers are apt to do.

The Northstar gives amazing flexibility as a system, providing a huge range of applications for the serious hobbyist, small business user and also as an intelligent terminal for either minis or mainframes in a large commercial network. The standard technology lends itself to all sorts of innovations.

Andrew Wong of Amcomp Systems has designed an interface board for a micro thermal/electrostatics receipt printer, together with cashdraw opening through software.

For a complete system, priced at less than $7 000, the Northstar is astounding — giving fast performances that challenge a number of other systems selling at twice the price. The Northstar is both flexible and application-oriented, and it is little wonder that it has taken on so readily in the Australian market.

Elaine Ray



44-column printer/plotter

Gulton Industries have developed their Microplot 44 thermal graphic printer for use with microprocessor based systems.

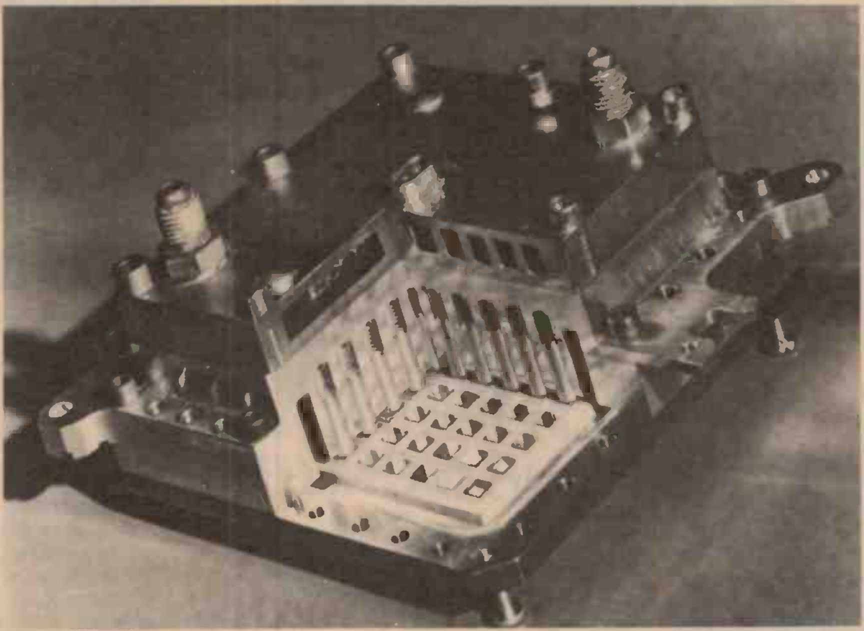
The new printer/plotter incorporates a fixed head design using thick film linear dot array technology. It is available as a desk top text printer or in a panel mounted data logging version.

Both versions will accept analytical and computational data in digital form and plot the data, print the grid and scale, annotate the data with alphanumerics and print alphanumeric text with both X and Y axis orientation.

Microplot 44 will print the full set of 96 ASCII characters, over 44 columns, with 256 dot resolution. Double height and double density characters are also possible.

Microprocessor based electronics provide a fully programmable graphics interface, which allows the mixing of a variety of printing and plotting capabilities.

For more information, contact Technico Electronics at P.O. Box 50, Lane Cove, NSW 2066; (02) 427-3444 or P.O. Box 520, Clayton, Vic 3168; (03) 544-7833.



IT'S A WATER-COOLED INTEGRATED IC !

The new IBM 3081 packs more than three quarters of a million logic circuits into four compact packages, each approximately 600 mm square and 75 mm thick.

Within the 3081, two distinct processors, in a dyadic (paired) design, operate at 26 nanoseconds under the system's control program, which both provides high performance and improves availability with the interchangeability of workloads.

As many as 118 silicon chips are sealed in the new IBM-designed module, with metal pistons pressing lightly against each chip and conveying heat to a metal plate in contact with a circulating chilled water system. The chips are customised by special IBM tools that use beams of electrons to connect the three levels of wiring on the chip's surface. Up to 704 circuits are contained on each chip.

Inside the module, the chips are fixed to a ceramic carrier, each of which has up to 33 layers and about 121 m of internal 'wiring' for signal connection and power distribution.

The modules are mounted on a new type of multilayer circuit board, also developed by IBM. It provides power and signal distribution functions previously contained in a number of separate cards, boards and cables. For rapid servicing, modules can be easily removed from the board and replaced.

Viscount Electronics in N.Z.

Viscount Electronics, a division of Viscount Printing and Publishing Co Ltd, have opened a microcomputer shop in Palmerston North, New Zealand.

The firm has been appointed distributors in New Zealand for Instant Software of the USA, and carries TRS80, CBM, Apple, Heath and Sorcerer software, for which dealer enquiries are invited.

Viscount have also introduced the System 80 16 K microcomputer, which is compatible with TRS80 Level II software, as well as stocking the Commodore range of microcomputers.

There is a large range of software for business and educational use, and the shop also displays most popular micro magazines and books.

Contact Frank Goldingham at 306-308 Church Street, Palmerston North, New Zealand.

Data encryptor/decryptor

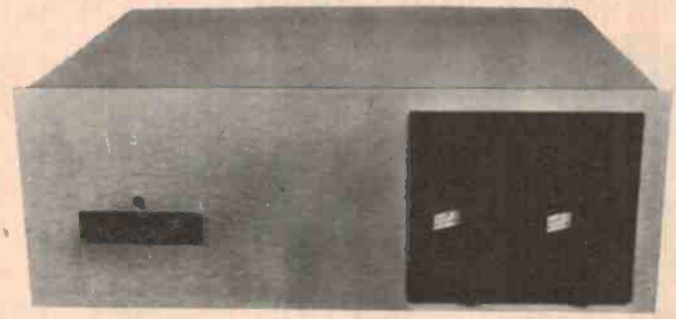
Electronics Research Australia's data encryption/decryption unit is a medium-speed data security device for the encryption or decryption of serial stream data up to 19.2 K bits/sec.

The unit is normally connected between a VDU and the appropriate modem for attachment to telecommunications, lives and the like.

Its applications are in such areas as: electronics fund transfer in the banking and financial industry; transaction oriented systems; communications systems involving sensitive information transfer; word processing and electronic mail systems; access security for mainframe computer systems; security of systems involving personal/individual information.

For further information contact ERA, P.O. Box 500, Fyshwick 2609 ACT. (062)80-6911.

NorthStar Computers



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Above prices include all cables and connectors where applicable but do not include sales tax. (Dealer enquiries invited).

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For Sorcerer Apprentices

We apologise for leaving Sorcerer apprentices to their own devices in the January issue of ETI, but due to speeded-up deadlines over Christmas the column didn't reach us in time for publication. We hope no one got into a Mickey Mouse situation as a result!

This month's column is entirely dedicated to the novice and deals mainly with Exidy Standard Basic. I remember all too well my initial experiences and frustrations, largely due to the poor documentation supplied with the Sorcerer and my own lack of experience. I hope the following will be of assistance in similar situations.

Q. What's the difference between 'CLEAR' and 'CLEAR'?

A. The black key clears the screen and generates an SN (Syntax) error when followed by a CR (Return). This SN error is rather annoying, but clearing the input buffer with an '@' sign before entering the next line will overcome the problem. The second 'CLEAR' (Graphic A) is a BASIC function. This command clears the data area (eg. A$, A, B, etc.) and does not clear the screen. Using the second 'CLEAR' will eliminate all data in your program and is used at the beginning of a program to allow a fresh start of the program. Use 'PRINT CHR$(12)' to clear the screen in programs.

Q. What's the difference between 'LET' A = 2 and A = 2?

A. No difference at all. There is no need to use the 'LET' statement. In fact, most BASIC compilers do not require 'LET' any more. The statement is kept to allow old programs to run on the newer compilers.

Q. What's the difference between a string and a numeric data field?

A. A numeric data field can be manipulated with most mathematical functions and is regarded as a number. A string can be any character(s), number(s) or letter(s). No mathematical functions can be performed on strings, but some powerful string handling commands make programming tasks a lot easier. Note that Exidy Standard Basic differentiates the first two characters of the name you give a string. For example, TEST$ is assumed to be the same as TEST1$ or COUNTER is the same as COLOUR. The best way to avoid confusion in programming is to put a remark after the first definition, eg:

```
10 C1 = 10: REM C1 = COLOUR
20 C2 = 3: REM C2 = COUNTER
30 T0$ = 'ABCDE': REM Test
40 T1$ = 'abcde': REM test1
```

P.S. I managed to secure a machine language program which will allow you to remove all the remarks in a program. It will appear in next month's column. Thus it is not a good practice to have 'GOTO' or 'GOSUB' statements to lines which include remarks only, as the said program deletes these lines, thereby generating an error.

Q. How can I stop word wrap-around on my printer after the 64th character?

A. Include the following lines in your program:

```
10 INPUT 'How wide is your printer'; WD
20 POKE 322, WD
```

This will set the width of both printer and screen to whatever you nominate. Note that if WD = 0 you will have double spacing on your screen, which makes reading of listings, etc., a lot easier.

Q. How can I convert a hexadecimal number to a decimal number?

A. The following program does the job for you. X$ contains the hexadecimal number.

```
200 INPUT 'enter hexadecimal number'; X$
210 X=0
220 FOR I=0 TO LEN(X$)-1
230 A=ASC(MID$(X$,LEN(X$)-I,1))
240 IFA>57 THEN A=(A AND 95)-7
250 A=A-48
260 IFA >150RA < 0THENPRINT 'INVALID HEX NUMBER':END
270 X=X+A*16^I:NEXT I
280 IF X >32767 THEN X=INT(X+.05)-65536
290 PRINT 'hex'X$;' = ';X;'dec.'
300 GOTO 200
```

Q. What's the difference between 'INPUT' and 'INP'?

A. INPUT is used to interrupt a program and allow the user to enter data (see above). INP is used to scan the status of a port. For example, you can test if your printer is connected:

```
10 PR=INP(255)
20 IF PR = 255 THEN PRINT 'Printer not connected or busy'
```

or you can scan the same port until the printer is available:

```
10 PR=INP(255) IF PR=255 THEN 10
20 PRINT 'Printer ready now';
```

This is handy to stop the program from 'locking up' if a printer routine is called without actually having the printer connected.

A.P.F. Fry

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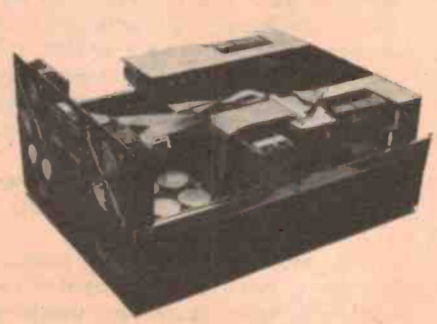

OPTIONAL SOFTWARE

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Application packages. Extensive software development tools are available from leading software vendors, including software for the following applications: payroll, accounts receivable, accounts payable, inventory control, general ledger and word processing.

Mensa computers provide a service network throughout Australia at major service centre locations to minimise response time to service calls. To ensure that equipment will operate at peak performance, engineers and technicians are trained to ensure the highest possible standard of service.

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For 2650 enthusiasts

This information was sent to ETI by the 2650 Enthusiasts Group and written by **Brian L. Young** of **Traralgon Vic.** Called Rytmon, it is information on an amateur-orientated ROM, for RTTY use, and is written for memory location 1400 in page zero, using RAM from 0400 upwards.

There are 13 commands: A, B, C, E, F, H, I, O, Q, R, S, T, Y. Unless otherwise stated, 'XX' is any hex pair between 'OO' and 'FF'.

Use the commands as follows:

G1400 (CR)
This will get you into the command handler and will prompt with '='.

A(XX)
Will pick up the callsign from the buffer and send it twice, then DE, then your callsign twice. It will do this as many times as entered at XX. It will then CR/LF, and send 'TEXT FOLLOWING'.

B
This will print, to the screen only, the callsign contained in the buffer. If you have not entered a call, it will print empty.

C(XX)
Will send 'CQ' six times, then DE, then your call six times. It will do this as many times as entered at XX, then CR/LF followed by 'PLEASE KKK'.

E
This is used at the end of each over. It picks up the call from the buffer, sends it once, then DE, then your call once, then 'PLEASE KKK'.

F
Same as 'E' but instead of 'PLEASE KKK' it sends 'SK SK SK'. Used at the finish of a QSO.

I
This allows you to input a message to memory starting at a predetermined 0500. This can be done while your QSO station is sending to you. End your input with CR/LF, then 'ETX' (Hex 03) or CONTROL 'C'.

O(CR)
This will output the message in memory until it finds the 'ETX'.

H
Will send your QTH details that will be stored in place of the 58's in the program. The text must end with CR/LF and 'ETX'.

Q(XX)
Will send 'THE QUICK BROWN FOX' etc. as many times as in XX, then will send CR/LF.

S
This allows you to store a callsign in the buffer. (Eg. the call of a station you see calling CQ). This is the buffer that is called by each of the programs that call the buffer. Terminate entry with 'ETX'.

T(XX)
This allows you to call a specific station. It picks up the call from the buffer and sends it twice, then DE, then your call three times, then does a CR/LF followed by 'PLEASE KKK'.

Y(XX)
This will send a complete line (64 characters) of RY's, as many times as entered at XX.

R
This can be used as a reply command. It first calls the callsign from the buffer and sends it twice, then DE, then your callsign twice, then goes straight to the output program.

ESC
Will immediately return you to your normal monitor control.

Enter your callsign between 160D and 1613. If your call is only five characters long, put in an extra space (20).

Your address text area is between 148A and 14A6. It must start with CR/LF and end with CR/LF and ETX.

The baudot routines in this ROM are timed for 45.45-baud and are output via bit-7 of port-D. The program allows simultaneous printing to the VDU screen via the normal flag.

Following is a hex listing of this ROM.

```
1400 20 04 80 F0 3F 00 8A 04 3D 3F 02 B4 3B F7 3F 02
1410 86 E4 41 1C 14 FC E4 4F 1C 16 60 E4 53 1C 15 B0
1420 E4 49 1C 16 80 E4 43 1C 15 01 E4 45 1C 15 60 E4
1430 59 1C 15 06 E4 54 1C 14 A7 E4 51 1C 14 F7 E4 46
1440 1C 15 55 E4 42 1C 15 32 E4 1B 1C 00 22 E4 48 1C
1450 14 55 1F 14 67 76 40 07 FF 0F 34 8A E4 03 18 05
1460 3F 17 70 1B 74 13 6B E4 52 18 03 1F 14 04 76 40
1470 3F 17 65 3F 15 A3 04 20 3F 17 70 3B F7 04 20 3B
1480 F8 3F 16 2C 3F 16 30 1F 16 60 0D 0A 58 58 58 58
1490 58 58 58 58 58 58 58 58 58 58 58 58 58 58 58 58
14A0 58 58 58 58 0D 0A 03 76 40 3F 14 F0 0E 04 03 3F
14B0 17 65 3F 15 A3 04 20 3F 17 70 3B F7 04 20 3B F8
14C0 3F 15 70 3F 16 30 3B FC FA 65 3B E4 3F 16 28 1F
14D0 14 04 76 40 3F 17 F8 3F 17 65 0E 04 03 07 FF 0F
14E0 35 BD E4 03 18 05 3F 17 70 1B 74 FA 70 1F 14 04
14F0 3F 02 24 CD 04 03 17 3B 77 1F 14 D2 3B 72 1F 15
1500 7B 3B 6D 1F 15 0B 3B 68 1F 16 C9 76 40 0E 04 03
1510 3F 17 65 3F 16 1B 3F 16 2C 3F 16 30 C0 C0 3B FA
1520 3B F3 3B F6 3B F4 3B E9 FA 69 3F 16 28 3B E2 1F
1530 14 04 06 08 07 FF 0F 24 20 E4 03 18 07 3F 02 B4
1540 FA 74 1B 02 1B 0D 07 FF 0F 36 15 E4 03 18 04 3B
1550 ED 1B 75 1B 14 76 40 3B 13 3F 16 34 3B 8F 1B 09
1560 76 40 3B 03 3F 16 28 3B 84 1F 14 04 3F 17 65 3F
1570 15 A3 04 20 3F 17 70 3F 16 2C 17 76 40 0E 04 03
1580 3F 17 65 3F 15 A3 04 20 3F 17 70 3B F7 04 20 3B
1590 F3 3F 16 2C 3F 16 30 3F 17 65 FA 67 3F 16 38 3B
15A0 F7 1B 46 07 FF 0F 24 20 E4 03 14 3F 17 70 1B 75
15B0 05 04 06 20 3F 16 39 1F 16 96 FF 0D 0A 54 48 45
15C0 20 51 55 49 43 4B 20 42 52 4F 57 4E 20 46 4F 58
15D0 20 4A 55 4D 50 53 20 4F 56 45 52 20 54 48 45 20
15E0 4C 41 5A 59 20 44 4F 47 20 20 31 32 33 34 35 36
15F0 37 38 39 30 0D 0A 03 43 51 20 43 51 20 43 51 20
1600 43 51 20 43 51 20 43 51 20 03 44 45 20 58 58 58
1610 58 58 58 20 03 45 4D 50 54 59 03 07 00 0F 35 F6
1620 E4 03 14 3F 17 70 1B 75 07 5E 1B 71 07 13 1B 6D
1630 07 16 1B 69 07 45 1B 65 07 4F 1B 61 53 4B 20 53
1640 4B 20 53 4B 20 03 54 45 58 54 20 46 4F 4C 4C 4F
1650 57 49 4E 47 03 50 4C 45 41 53 45 20 4B 4B 4B 03
1660 05 05 06 00 3F 16 89 3F 17 F8 3F 17 65 0C 84 0D
1670 E4 03 18 0A 3F 17 70 3F 16 B0 1B 71 C0 C0 C0 C0
1680 C0 1F 14 04 04 04 1F 16 F0 CD 04 0D CE 04 0E 17
1690 05 05 06 00 3B 73 BB A5 3F 02 86 C3 CF 84 0D E4
16A0 03 1C 14 04 E4 08 1C 16 C0 03 BB A0 3B 02 98 68
16B0 0D 04 0D 06 01 8E 04 0E 98 02 85 01 3F 16 89 17
16C0 03 BB A0 06 FF 3B 6E 1B 65 76 40 3F 17 65 0E 04
16D0 03 07 20 04 52 3F 17 70 04 59 3B FA FB 75 3B EC
16E0 FA 6F 3B E8 1F 14 04 01 2C 04 2C D0 CC 04 2C 17
16F0 3F 17 2D 75 10 17 04 02 1B 76 04 03 1B 72 C0 C0
1700 CD 04 12 3F 16 E7 51 51 51 51 45 0F 0D 77 1D 3F
1710 17 70 0D 04 12 45 0F 0D 77 1D 3B F4 17 30 31 32
1720 33 34 35 36 37 38 39 41 42 43 44 45 46 C2 04 80
1730 F0 05 05 3B 18 3B 16 20 F0 3B 12 52 1A 04 20 F0
1740 1B 03 04 80 F0 F9 72 3B 04 04 80 F0 17 20 F8 7E
1750 F8 7E F8 7E F8 7E F8 7E F8 7E F8 7E F8 7E F8 7E
1760 04 8E F8 7E 17 04 0D 3F 17 70 04 0A 3F 17 70 17
1770 C1 BB A0 01 77 10 E4 0A 1C 16 F6 E4 0D 1C 16 FA
1780 E4 20 1C 16 84 E4 41 1E 17 BE C3 0C 04 02 98 0A
1790 04 FF CC 04 02 04 1F 3F 17 2D A7 41 0F 77 A4 3B
17A0 F7 75 10 17 03 19 0E 09 01 0D 1A 14 26 0B 0F 12
17B0 1C 0C 18 16 17 0A 05 10 07 1E 13 1D 15 11 C3 0C
17C0 04 02 13 0A 04 00 CC 04 02 04 1B 3F 17 2D A7 20
17D0 0F 77 D3 3B F7 75 10 17 04 04 05 14 1A 0D 04 05
17E0 0F 12 14 11 0C 03 1C 10 16 17 13 01 0A 10 15 07
17F0 06 18 0E 0E 0F 1E 12 19 04 50 C1 F8 7E F9 7C 17
```

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COMPUTER CLUB AND USER GROUPS DIRECTORY

SECTION 1 — arranged by districts

Adelaide
South Australian Microprocessor Group Inc, P.O. Box 113, Plympton, SA 5038. (08) 278-7288. Meets at 7.30pm on the second Friday of each month at Thebarton High School, Ashley St., Thebarton.

Armidale
New England Computer Hobbyists Club, c/- Union, University of New England, Armidale, 2351.

Brisbane
IREE Microcomputer Interest Group, P.O. Box 81, Albion, Qld 4010. (07) 356-6176.

Brisbane Youth Computer Group, 14 Cupania St., Algester Qld 4115.

Queensland Sorcerer Users (QSU), sec. Ian Branch, 41 Chuter St., Stafford Heights, Qld 4053. (07) 350-2889.

Canberra
Microprocessor Special Interest Group (MICSIG), P.O. Box 446, Canberra City ACT 2601, (062) 72-2237.

Essendon
Victorian O.S.I. Users Group, c/- Ian Eyles, 10 Forbes St., Essendon, Vic. 3040. (03) 375-3478 a.h.

Geelong
Geelong Computer Club, c/- Ian Stacey, (052) 22-1455 (business hours). Meets 2nd Thursday of each month at Tybar Engineering, Hampton St., Newtown, Geelong Vic 3220.

Gosford
Minicomputer Interest Group, P.O. Box 525, Gosford NSW.

Hobart
Tasmanian Electronic and Microcomputer Oriented Society (TEMOS), (formerly Darth Amateur Computer (and Electronics) Society), 4 Melinga Place, Taroona, Tas. 7006.

Small Computer Users Group, P.O. Box 474, Sandy Bay, Tas. 7005. Phone Steve on 23-2211. Meets on first Tuesday of each month at Computer Centre, Elizabeth Matriculation College, North Hobart.

Melbourne
Microcomputer Club of Melbourne (MICOM), P.O. Box 60, Canterbury Vic 3126. Meets on third Sunday of every month at AMRA Hall, Willis St., Glen Iris, opposite Glen Iris Railway Station, at 2 pm.

Monash Personal Computing Club, c/- Union Building, Monash University, Clayton Vic 3168.

Newcastle
Newcastle Microcomputer Club, c/- Dr. Peter Moyland, Dept. of Electrical Engineering, University of Newcastle, Newcastle NSW 2308. (049) 68-5256 (office), (049) 52-3267 (home).

Orange
Bruce Carroll, (063) 62-8703 or Neville Wilde (063) 31-5809 or write c/- P.O. Box 1117, Orange 2800.

Perth
Western Australian Computer Enthusiasts Group, c/- R. Langlois, Memorex Pty Ltd, 49 Haty St., Subiaco WA 6008. Meets last Monday of each month at 7.30pm at Taimac Video Corporation, 1st floor, Cnr Newcastle and William Streets, Perth.

University Computer Club, Room 217, Guild Building, Guild of Undergraduates of WA, Crawley, WA 6008. (09) 380-2297.

Sydney
Microcomputer Enthusiasts' Group, P.O. Box 3, St. Leonards NSW 2065. Meets at WIA Hall, 14 Atchison St, St. Leonards, on the first and third Mondays of the month at 8pm.

IREE Microprocessor Group, c/- Dr. Barry Madden, School of Chemical Technology, University of NSW, P.O. Box 1, Kensington NSW 2033. (02) 662-2423.

Marrickville Microcomputer Society, c/- 26 Malakoff St., Marrickville NSW 2204. (02) 569-5689.

Manly Micro Interest Group, c/- Lionel Hirning, (02) 98-7338 or Ron Bloom (02) 938-1476. Meets 2nd Monday of each month at Manly Youth Centre, Kangaroo St, Manly NSW.

Wagga Wagga
c/- David Aleksic, P.O. Box 186, Wagga Wagga NSW 2650.

Wollongong
Wollongong Computer Club, c/- Gary Nelson, 220 Farmborough Road, Farmborough Heights, NSW 2526. (042) 71-4054.

NEW ZEALAND

Auckland
The NZ Microcomputer Club, P.O. Box 6210, Auckland 1, NZ.

Christchurch
c/- Paul Campbell, 50 Francis Ave, Christchurch, NZ.

Wellington
Wellington Microcomputer Club, P.O. Box 1581, Wellington, NZ.

SECTION 2 — arranged by processor or computer

Apple II
Apple II Users Club, c/- Computerland Australia Pty Ltd, 55 Clarence St, Sydney 2000.

Compucolour II
Compucolour II Users Group, c/- The Logic Shop, 91 Regent St, Chippendale, NSW 2008. (02) 699-4919.

Compucolour II Users Group, c/- The Logic Shop, 212 High St, Prahran, Vic 3181. (03) 51-1950.

Commodore
Commodore Computer Users Association, P.O. Box 4721, Sydney NSW 2001.

Commodore Computer Users Association, P.O. Box 60, Clarence Gardens, SA 5039. Phone Earle Rowan on (08) 297-7253. Group meets at 7.30 pm on the first Tuesday of each month, usually at the Adelaide University Union Building.

Exidy Sorcerer
Exidy Sorcerer Users Group, c/- Frank Schuffelen, 66 Porter St, Templestone Vic 3106.

Sorcerer Users' Group, P.O. Box 43, Peakhurst NSW 2211. Meets at WIA Hall, 14 Atchison St, St Leonards, 4th Monday of every month. Workshops on 1st Friday of odd months, 2nd Friday of even months.

North Star
North Star Users Group, P.O. Box 156, Carnegie, Vic 3163.

Sord
SMUG — Sord Microcomputer Users Group, c/- Emmanuel Cargakis, 4/8 Clarkson Avenue, Brighton, Vic. 3186.

T159
T159 User Exchange Service, c/- Serge Petelin, 95 Gerler St, Bardon Qld 4065. (07) 450-2026.

TMS9900
Australian 9900 Users Group, P.O. Box 835, Melbourne Vic 3001. Barry Day, (03) 661-2523 (business hours).

TRS-80
TRS-80 Users Group, c/- G.F. Stevenson, 34-36 Sturt St, Adelaide, SA 5000. (08) 51-5241. Meetings 1st Thursday of every month at address available from the above.

TRS-80 Users Group, c/- Les Kinch VK2BBD 128A Booralie Duffys Forest NSW 2084. (02) 450-2026.

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Australian 2650 Users Group, c/- Applied Technology, 1A Paterson Ave, Waitara, NSW 2077.

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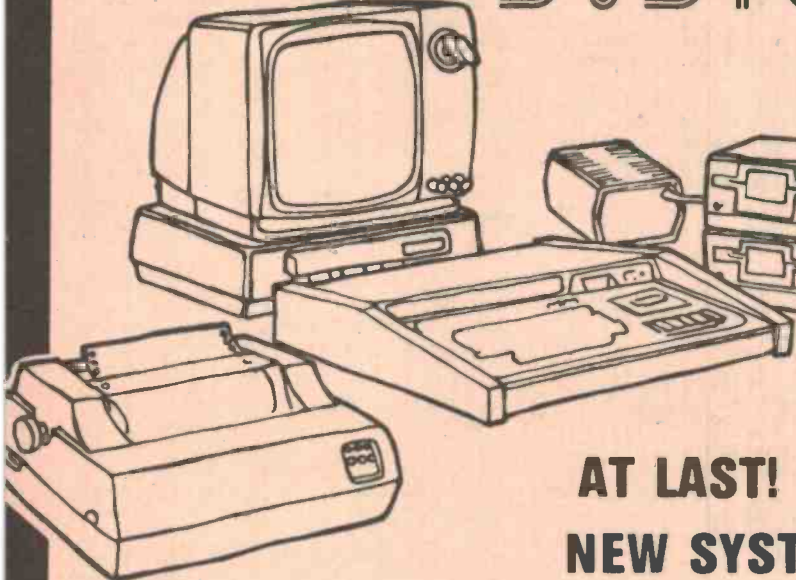

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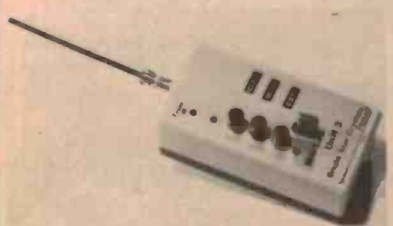

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The big Apple

For those looking for a little more than just a hobby computer, the Apple (with a few add-ons) may be the answer. Phil Cohen takes a bite . . . (byte ?)

by Phil Cohen

IN REVIEWING a 'hobby' computer, there's usually not much to say. Mention some of the features this machine has which others don't, point out some of the things which would have been nice to have seen included, figure out what the manufacturer had to leave out in order to get everything into the price . . .

This is not the case with the machine I'm reviewing this month — it's an Apple, but not *just* an Apple. Its full title is 'Apple II Plus', fitted with a 'language card' and a disc drive. It also arrives with some very impressive software packages.

The case for the defence

Most screenless machines these days use a moulded plastic case — so does the Apple. The difference here is that it's built with a removable 'hatch' in the top. Just grab hold of the back edge of it and pull and . . . hey presto! Laid out in front of you is the main pcb, complete with lettering identifying all the parts.

Starting from the top, the eight edge connectors are the Apple's 'mother board', into which a variety of goodies can be plugged. The Apple in the photo is fitted with (at the left) a 'language' card (more on that later) and (at the right) a disk controller. The ribbon cable leading through the slot at the back of the case goes to the disk drive itself.

The rather large chip just below the edge connectors is the 6502 microprocessor. Next come six ROM sockets, followed (in the white box) by the RAM area.

The full addressing capability of the 6502 is 64K, and the machine pictured has a full 64K of RAM: 3 x 16K rows of RAM on the main board, and a further 16K on the language board — which can be called in to replace the system ROM when a lot of memory is required (i.e: when running compilers — thus the name 'language board').

At the bottom left is the Apple's speaker. Not just a 'beeper' — a speaker, which can be used to play tunes, give sound effects, or what-have-you.

Above the speaker is the power supply; as the manual takes pains to point out (it gives the patent number) this is not just any old power suply — it's a switching power supply. (This was why I wondered if the box was empty the first time I picked it up — no bulky 50 Hz transformer.)

The editor couldn't resist . . .

Next comes the keyboard — nice feel to it, but a little 'light'. The keys have something of a hair trigger — they 'go off' at the top of their travel. No problem for two-fingered typists, though.

The upper right-hand corner of the board holds the miscellaneous I/O — video output, cassette input and output, three software-testable TTL inputs, four software-settable TTL outputs . . . oh, and four analogue inputs!

Each analogue input circuit is designed to take an external variable resistance connected to +5 V. Under software control, a capacitor is charged through this external resistance, and the time taken for it to charge gives the value of the resistance. It's not accurate to umpteen bits, but for games applications it's more than accurate enough. (Other applications, too).

Powering up

My first problem was that I didn't have a video monitor — that's something worth remembering if you're going to buy an Apple. Although it has room inside the case for a modulator, it doesn't come fitted with one (unless you ask for it specifically, of course).

After organising a monitor, I turned the computer on — and the disk drive started whirring. Subsequent reference to the manual showed that this was due to an 'Autostart' version of the ROM, which allows turnkey systems to be created — an operator can simply turn the machine on, and it will immediately boot a disk.

Pressing the RESET button stopped the whirring, and presented me with a prompt into the BASIC interpreter. Being an 'Apple II Plus', this machine was equipped with Applesoft II BASIC — a standard up-market BASIC with all of the requisite functions . . . plus a few more. Here's a quick run-down on the extras:

Variables: Real, integer or string. Variable names may be of more than two characters, but only the first two are recognised. Arrays may be of any variable type and of any size, to the limit of memory. A(0) is permissible.
Operators: Full set of algebraic operators, as well as logical ones — NOT, AND and OR included.
Functions: Usual set of mathematical and string handling functions. USR(x) allows easy conversation between BASIC and machine code. DEF FN allows definition of functions (with user-defined names), but of one line each only.
System Commands: TRACE will cause all program execution to print its line numbers as it runs, which facilitates debugging. WAIT allows the monitoring of external switches (i.e: software-mapped inputs). HIMEM and LOMEM allow the user to define the limits of the BASIC available memory (useful for BASIC/machine code combinations).
Looping, etc: IF . . . THEN (no ELSE — surprising). ON . . . GOTO, ON . . . GOSUB. ONERR GOTO allows the use of user-defined error handling routines. POP removes one address from the GOSUB stack (Could be tricky!).
I/O Commands: TAB allowed both horizontally and vertically. HOME returns cursor to upper left, clears screen. STORE and RECALL allow numeric arrays to be stored on tape. FLASH and INVERSE allow modification of the next character(s) to be put on to the screen.

The above list only gives the roughest of introductions to Applesoft BASIC — I've left the graphics commands out, too, because they require special attention.

Graphics

The Apple's graphics are certainly superior to any domestic machine I've seen (including the Sorcerer — see ETI April 1979). There are two types of graphics: high resolution and low resolution. Either can be used over the whole screen, or with a text 'window' at the bottom. Both types of graphics allow access to two 'pages' of memory — the processor can be filling one while the other is being displayed. Both types of graphics (and the text) allow different colours to be used with each character on the screen.

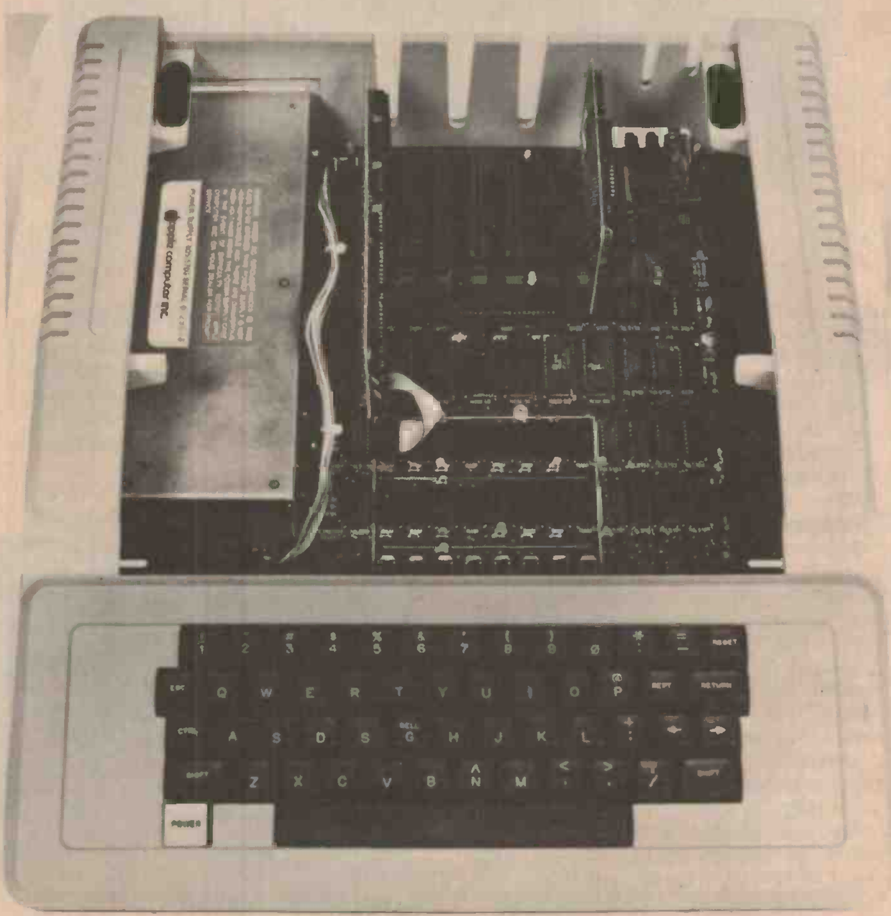
The screen resolution in text mode is 24 lines by 40 characters. In low-resolution graphics mode, it's 48 by 40 (effectively). In high-resolution graphics, it's a staggering 192 by 280.

Even in high-resolution mode, each dot (all 53 760 of 'em!) can have its colour defined (with some restrictions) to be one of 16 possibilities.

Routines in Applesoft BASIC allow single commands to draw lines, and even user-definable shapes on the screen. Shapes are defined by means of a 'shape table', which may be stored on tape. The shape may be rotated and sized by single commands.

Graphics commands include:

Low-resolution graphics
GR: Sets machine into low-resolution graphics mode, with a 4-line text window at the bottom of the screen.
COLOR=X: Sets the colour of the subsequent plotting to X (X = 0 to 15).
PLOT X,Y: Places a coloured dot at X (horizontal) and Y (vertical) on the screen.
HLIN X1, X2 AT Y and VLIN Y1, Y2 AT X: Produces horizontal and vertical lines (as appropriate) at any point on the screen.
SCRN(X,Y): Returns the colour of the point on the screen with coordinates X,Y.
High-resolution Graphics
HGR: Sets high-resolution graphics mode (showing page 1 of graphics memory). Clears screen except for 4-line text window at bottom.
HGR 2: Sets high-resolution graphics mode (showing page 2 of graphics memory). No text window.
HCOLOR=X: Sets colour (0 to 7) for subsequent plotting.
HPLOT X,Y: Places a coloured dot at X,Y on the screen.
HPLOT X1,Y1 TO X2,Y2: Plots a line from X1,Y1 to X2,Y2.
HPLOT TO X1,Y1: Plots a line from the last point plotted to X1,Y1.
SHLOAD: Loads a 'shape table' from tape.
DRAW Z AT X,Y: Draws shape number Z (from previously loaded shape table), starting at X,Y and using the last colour set by HCOLOR.
XDRAW Z AT X,Y: Draws shape number Z starting at X,Y and using the complement of the colour it finds on the screen. Executing XDRAW with the same parameters as a previously executed DRAW will remove the original shape from the screen, leaving the background undisturbed.
ROT=X: Sets the rotation of the shape to be drawn by subsequent DRAWs or XDRAWs. Maximum resolution is 360/64 degrees.
SCALE=X: Sets size for subsequent DRAW or XDRAW executions. Resolution is 1 to 255. ▶



Inside the Apple II Plus. Hatch off, showing language card at left, disk controller card at right.

Finally on the Apple

The last thing most people seem to consider when buying hardware is the documentation that comes with it.

It's only when (at 3 o'clock in the morning, mind you) they want to find out which of the output pins of a connector is +5 V and which is just TTL high that the documentation comes under scrutiny.

The Apple documentation is beyond reproach. Not only are there a number of manuals describing the BASIC, the disk operating system, etc, but there is even a manual which describes the *hardware* in detail. (I stress this point because it is so rare — most computer manufacturers do their best to keep the user *out* of the hardware.

The Apple II Reference Manual gives a complete run-down of the machine's makeup — memory organisation, monitor program, I/O routines, etc. It goes on to give complete circuit diagrams, connector pinouts and descriptions of hardware operation. It even gives a rundown on the 6502 instruction set and gives the locations of 32 monitor program subroutines, with information on how to use them. At the back of the book is a complete (and readable) ROM listing, with symbol table (which is even listed alphabetically *and* numerically!).

In short, rather than try to keep the inside of the machine mysterious, the intention seems to have been to open everything up and let the user see exactly what he is getting. And it's a lot. ▶

APPLE DISK II FLOPPY WITH DOS 3.2 DISK OPERATING SYSTEM

Up to six floppies can be powered directly from the Apple — and each holds up to 116 Kbytes. The disk operating system (also with very extensive manual) uses named files, with individual write protect on each file. Time to load an 8K binary image file is claimed to be 6.5 seconds.

The files can be of several types: integer BASIC program, Applesoft BASIC program, binary image, sequential text file or random-access text file.

BASIC programs stored as files may be chained — this means that a program can be RUN by a statement in an earlier program, without destroying the values of the variables created by the first program. This means that large programs (even compilers?) can be written in BASIC and loaded and run as required.

Applesoft BASIC system commands may be stored on disk, then 'EXECuted' at a later stage — even from within a program. This allows complete turnkey systems to be stored on disk, and booted using the 'Autostart' ROM fitted in the Apple II Plus.

Again, an excellent manual is provided.

LANGUAGE CARD AND SOFTWARE

Although the full complement of the Apple main board is only 48K (only!), the addition of a 'language card', which plugs into one of the system expansion slots, can extend the available RAM to the full 64K capability of the 6502.

The language card RAM replaces (by means of a software switch) the existing ROM installed in the Apple, and a language can be loaded into the system from disk automatically on power-up by means of an 'Autostart ROM', which is standard with the Apple II Plus.

Pascal comes as standard with the 'language system', on a disk which also holds both Applesoft BASIC and Integer BASIC.

Other languages available for the Apple include FORTRAN, PILOT, a 6502 assembler, FORTH and a BASIC compiler.

Z-80 SOFTCARD

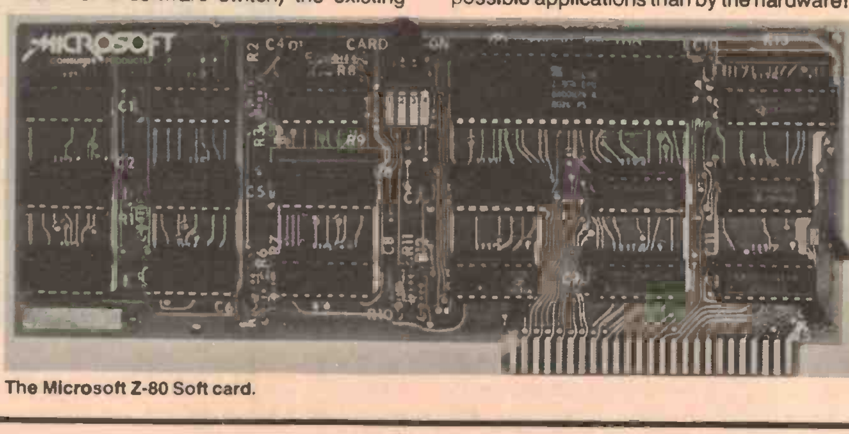
What is Z-80 hardware doing in an article on the Apple, I hear you ask.

Microsoft have developed a card which fits into one of the Apple expansion slots and carries a Z-80 processor plus all of the hardware needed to interface it to the rest of the Apple.

All of a sudden, you've got a reconfigurable computer that will run 6502 code, Z-80 code or 8080 code. With the addition of a CP/M disk, you have the capability to run any Z-80 CP/M software — and that's a *lot* of software. Like FORTRAN-80, COBOL-80, Microsoft BASIC Compiler, MACRO-80 (macro assembler), LINK-80 (linking loader) ...

That doesn't mean the Apple becomes a Z-80 machine; it becomes *software*-switchable between Z-80 code and 6502 code. So software packages written for both processors can be used within the one system.

It's pretty pointless trying to describe all the possible combinations of software and hardware that the Apple can support with a Softcard in it — it is limited more by the possible applications than by the hardware! ▶



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WP 2000 Specifications

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DP 2000 Stand-alone Computer (shown).
WP 2000 Word Processing Terminal (not shown).

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Apple Leaves and Branches

Although I could describe the Apple itself for the next ten pages (if the editor would let me!), I think it would still present a limited picture of the machine.

The Apple is not just one piece of hardware — very few home computers are. One of the things which I think a potential buyer should look for (especially for business applications) is the *expandability* of the system.

This doesn't just mean the number of slots there are on the computer to plug things into — it means the variety and quality of the things which are available to plug into those slots. Things available not just from the original manufacturer, but from other people, too.

In this regard, the Apple shapes up as a potentially very powerful system indeed — especially for multi-terminal applications.

I have listed in the boxes some of the hardware add-ons available for the Apple. This is by no means a complete list — to do that would require devoting practically the whole of this issue to it! ●

Review equipment and software kindly supplied by Direct Computer Retail, 32 Lloyd Ave, Cremorne 2090 NSW. (02)908-2235.

CORVUS DISK, MULTIPLEXER AND VIDEOTAPE BACKUP SYSTEM

The maximum system consists of up to 64 Apples connected to a multiplexer. This allows all 64 of them to access the same 40 Mbyte hard disk system. Before you start to say, "Oh, but this is no longer a home system . . .", remember that an expanded Apple need not *be* a home system — it could just as easily be part of a stock-keeping system in a large warehouse, or even a word processing system in a publishing house.

The multiplexer allows four types of disk access to each user — access to a 'personal' area for that machine only, access to a 'read-only' area of system software, access to 'common' areas (in which each file can be accessed by one user at a time only) and lastly access to 'spooling' areas, in which messages (of any length) can be sent from one Apple to another. This last facility allows, for example, one machine to be designated as a 'print despooler' — it would receive files to be printed from all the other machines, and send them one at a time to a printer to which it is connected.

The videotape backup is a means of storing last week's disk on tape — this means that if the disk should be destroyed accidentally (these things happen), then only one week's programming effort is lost.

As it takes about 10 minutes to save 10 Mbytes on the backup recorder (any video recorder can be used), the backup procedure can be done daily, or even hourly.

If a VCR with remote control facilities is available, the system will allow random access of the tape — up to 100 Mbytes!

Corvus have named the multiplexer 'Constellation', and the backup system 'Mirror'.

MISCELLANEOUS SOFTWARE PACKAGES FOR THE APPLE II PLUS

Rather than try to list all the possible software you can get for the Apple — and in view of the availability of the Microsoft Z-80 Softcard (see elsewhere in this article), that would be a major task — I will give a quick run-down on some representative samples.

Visicalc

There is a large class of programs produced by amateur and professional programmers alike which can be defined very simply: data is fed into one end by the user, interactively; the data is 'plugged' into one or more equations; the results are provided to the user in a more or less readable form.

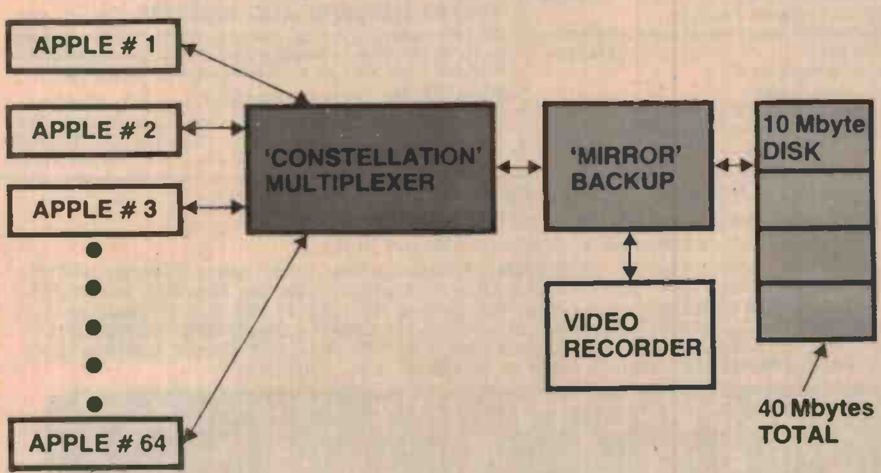
Many computer-aided design tasks fall into this category — sizing heat exchangers for chemical engineering applications, designing power cable runs, etc. Programs written to cope with this sort of problem usually spend most of their time either prompting the user to input data, or outputting the results in a decent format.

Visicalc is a software package, on disk, which allows the user to make entries on an 'electronic page' of up to 254 rows of 11 entries per row. The screen shows part of the 'page', and can be scrolled in any direction.

Each of the entries can either be a label — which will simply show up on the screen in its appropriate position; or a number — which will also show simply as a number; or an equation. The equation will use as its variables *references* to other screen entries.

The user can put in a number of entries with references to each other. The program will then (starting from the first entry) calculate the value of each *equation* entry and display it as a number.

This means, for example, that a set of entries can be put in (and, by the way, subsequently stored on disk) which completely defines the calculation steps in a design problem. Not only that, but the user can then play with any or all of the values fed in, and see immediately the way in which those changes affect the whole calculation sequence.



Easiwriter

Developed by a company with the rather unusual name of "Cap'n Software", this is a disk-based word processing system.

Editing commands include cursor moves around the screen, scrolling, insert mode, block move and search.

Embedded commands (ie. commands which the user inserts into the text, and which are acted on when the file is output) include automatic page numbering, automatic indentation, justification (making all the lines the same length) and character substitution. The last feature allows the user to specify, for example, that anywhere a "@" appears in the text, an ASCII 153 (control Y) should be output to the printer. Control Y may cause the printer to change to a red ribbon, or some other control function.

Although the Easiwriter software is powerful, the application of this program is a little limited by the fact that the Apple cannot display lower case characters (non-capital letters). The program gets round this by showing capitals as reverse characters (black on white). Perhaps an add-on program will allow the user to select screen representation in capitals and lower case by the use of the high-resolution graphics facilities of the Apple?

Flight Simulator

This one is a doozey. Not only does it simulate the flight of an aircraft in terms of its speed, altitude, attitude, etc, it also displays the view out of the cockpit.

This is a showpiece of what can be done using Apple high-resolution graphics. The 'terrain' is a grid of squares with a mountain range and a few other features thrown in for good measure, and the display shows these with full regard for perspective, pitch and roll, etc.

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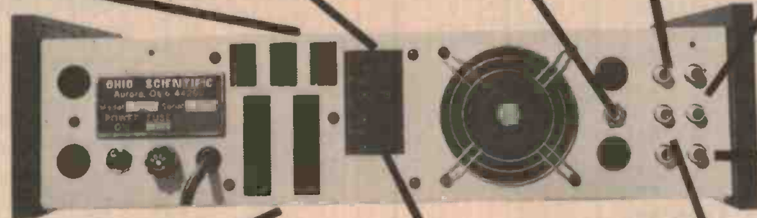

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Back Door Into BASIC

Phil Cohen

In this part of the series, Phil Cohen expands the arithmetic functions he covered last month to include arrays, and introduces strings and string manipulation functions — which form the basis of word processing.

AN ARRAY is a method of storing a large number of values in different places in memory in such a way that they are easy to handle.

For example, say you own twenty chooks (that's 'chickens', for the English-speaking audience) and want to keep track of how many eggs they lay. I realise this is hardly the sort of task you would buy a computer for — but it's only an example (eggsample? — Ed.)

Every time one of your chooks lays an egg, you go to your computer and add 1 to a number stored in it somewhere. Simple.

For chook number 1, you would input at the start of the week: 'C1 = 0'. This would cause the computer to set aside an area in memory for variable C1, and to put the value 0 into it. Then you would input 'C2 = 0', which would do the same for chook number 2. And so on up to C9.

Then you come to a problem. You can't put in C10 — BASIC only allows one digit after the letter. The next variable name you use has to be something like H1 (for 'hen' number 1). You then have H1 to H9 — but you're still stuck. So you use R1 and R2 — roosters 1 and 2. I know they're not roosters, but it's as close as you can get.

Now you're set. Every time one of the chooks lays an egg, you input something like 'C5 = C5 + 1', which, if you think about it for a minute, will add 1 to the present value of C5. At the end of the week you can 'PRINT C5' to find out how many it's laid.

This is all a bit messy. After all, you have to remember that chook 11 is called H2 in the computer, and then there are chooks 19 and 20 which are getting neurotic because you keep calling them roosters 1 and 2 . . .

This is where arrays come in. If you input 'DIM C(20)', the computer will set aside space for 20 variables and call them C(1), C(2), . . . C(20). DIM is a BASIC word which is short for 'dimension'.

Now when chook number 15 lays an egg, you input 'C(15) = C(15) + 1'. At the end of the week, you can 'PRINT C(15)' to get the total.

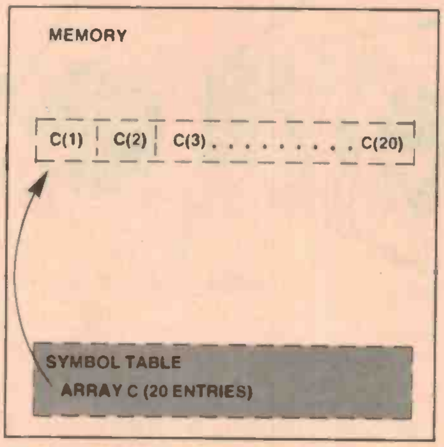

Figure 1. An array could be stored in the computer in this way. The symbol table holds information on how big the array is, what its name is and where it begins.

Figure 1 shows what this looks like in memory. All the computer needs to remember is the name of the array and the position in memory of the first item. When asked to find C(15), the computer will figure out the distance in memory of C(15) from C(1), then add this to the position of C(1). This will give it the position of C(15). The computer will, of course, know how much space each of the items takes up.

By the way, an item of an array takes up less space than a normal variable — this is because of reduced symbol table usage, amongst other things.

In fact, you can save even more space by using C% as an array — an array of integer variables. The dimension statement would then be 'DIM C%(20)'.

Any valid BASIC variable name can be used (in most versions of BASIC) as a variable name. D3(120) is quite acceptable. Even T8%(9) is OK.

Multi-dimension arrays

What if we complicate the problem? Say we want to find out how many eggs each chook has laid — and that we want to know how many of them were brown, how many white and how many green (well, like I said, it's only an example . . .).

We could dimension three arrays, one B(20), one W(20) and one (G(20). The way to do this would either be to input 'DIM B(20)', then 'DIM W(20)', then 'DIM G(20)', or, more simply, to input 'DIM B(20), W(20), G(20)' (which means the same in BASIC).

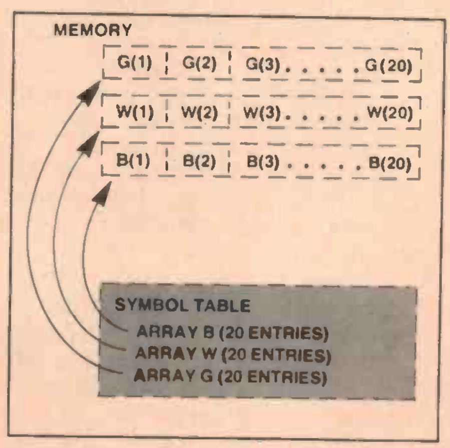

Figure 2. Three arrays — but there's an easier way . . .

Either way will set aside three lots of 20 variables (see Figure 2). This works in exactly the same way as with C(20) in Figure 1.

Every time chook number 15, say, laid a brown egg, you would input 'B(15) = B(15) + 1', and every time chook 3 laid a green egg you would input 'G(3) = G(3) + 1'.

At the end of the week, you could find out how many green eggs chook 11 had laid by inputting 'PRINT G(11)'.

This is all very well, but say that instead of grading the eggs by colour, you decided to grade them by size, and that you had a machine that told you which of ten sizes the egg was. You could dimension ten arrays called A(20), B(20) . . . J(20), but again this is getting messy. What you need is a two-dimensional array.

This means that you are actually creating an array which instead of taking up a row of memory, takes up a rectangular area. The dimension statement you would use would be something like 'DIM E(20,10)'. This would set aside 200 spaces in memory (ten for each chook). Figure 3 shows what it would look like.

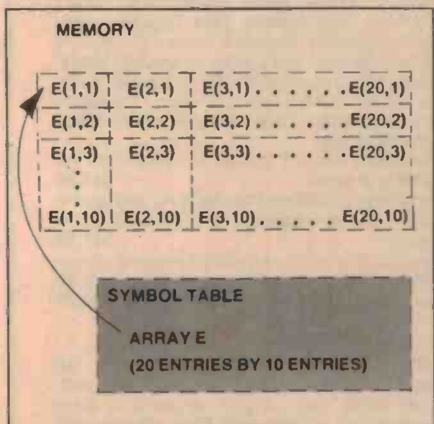

Figure 3. **An easier way to arrange data of the type shown in Figure 2.**

The items of the array are laid out in rows and columns. E(5,7), for example, is in row 5, column 7 — or if you like, it's the number of size 7 eggs laid by chook 5.

Whenever chook 15 laid a size 3 egg, you would input 'E(15,3) = E(15,3) + 1'. At the end of the week, to find out how many size ten eggs chook 2 had laid, you would 'PRINT E(2,10)'.

You have to be careful, though, not to confuse the egg size and the chook number — it's up to you to remember that E(3,5) is the number of size 5 eggs by chook 3, and *not* the number of size 3 eggs by chook 5!

Arrays are very useful in programming, because they allow the user to do the same thing to a large number of items automatically. Say, for example, that you wanted to print out the number of size ten eggs laid by all of your chooks. You could input 'PRINT E(1,10)', then 'PRINT E(2,10)', then . . . This would be rather tedious.

Instead, you would be better to write a program (we'll look at this more closely next month) which sets aside a variable, say K, and makes it equal to 1: 'K = 1'. Then you make the program do 'PRINT E(K,10)', then 'K = K + 1', then 'PRINT E(K,10)', then 'K = K + 1', then . . .

This is what's called a 'loop', and it's something we'll cover in some detail later.

Strings

As I mentioned earlier in the series, one of the advantages which a computer has over a programmable calculator (apart from increased memory capacity) is its ability to handle text — letters as well as numbers.

Say for example you want a program to print a simple message, like HELLO. In BASIC, all you have to do is 'PRINT "HELLO" '. Notice that the message to be printed out must be in double quotes "". Inside the double quotes, anything goes. Even 'reserved' words like RUN and PRINT will be handled simply as messages to be printed.

So, if you type in 'PRINT "THIS IS A PRINTED OUTPUT" ', the computer would respond with 'THIS IS A PRINTED OUTPUT'.

PRINT statements can be made to output several things on one line, simply by separating them by commas in the print statement.

For example, say in a program you wanted to print out the value of K. Let's set 'K = 6'. Now if we input 'PRINT "K IS", K, "AT THIS POINT IN TIME" ', the computer will respond with 'K IS 6 AT THIS POINT IN TIME'.

What we've done is to print on one line three things: a message (a 'string'), a value, then another message.

This facility makes the output of programs readable. In the chook example, where we wanted to print out the number of size 10 eggs each chook had laid, we could have used: 'PRINT "CHOOK NUMBER", K, "LAID", E(K,10), "SIZE 10 EGGS" ' and the computer would respond with something like 'CHOOK NUMBER 15 LAID 197 SIZE 10 EGGS'.

This is one of the many special facilities available using the PRINT function — we'll look at some more of these later.

As far as the computer is concerned, 'PRINT "HELLO" ' is in the same category as 'PRINT 5'. We're presenting the computer with an absolute value to output. It's also possible to have 'string variables' which hold 'values' in the same way as normal variables do. These 'values', however, are messages.

String variables have a special nomenclature in BASIC. In the same way as integer variables end with a %, string variables end in $. So valid string variable names are: A1$, B$ and K9$.

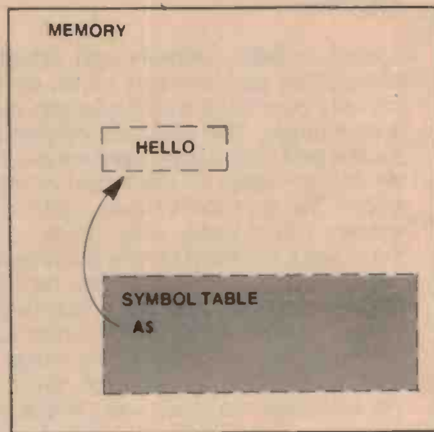

Figure 4. **A string variable in memory.**

A statement like 'A$ = "HELLO" ' will produce the situation in memory shown in Figure 4. Notice that the amount of space needed to store a string variable is not always the same — the longer the message, the more space is needed.

'PRINT A$' will cause the computer to output 'HELLO'.

It's even possible to have arrays of string variables. Say for example that each of your 20 chooks had a name, and you wanted to print that name along with the total number of size 10 eggs she had laid. First, you would create space to store the names in: 'DIM N$(20)'. Then you would have to fill it up: 'N$(1)="TAMMY" ', then 'N$(2)="FLO" ', then the rest through to 'N$(20)="MAGGIE" '.

The print statement would look something like this: 'PRINT "THE CHOOK CALLED", N$(K), "LAID", E(K,10), "SIZE 10 EGGS" '. This would give an output like: 'THE CHOOK CALLED MAGGIE LAID 2 SIZE 10 EGGS'. Notice that we're not even bothering to output the value of K; in cases like this, K is called a 'dummy' variable.

Figure 5 shows what N$ would look like in memory. Notice that, because all of the entries in N$ are of different sizes, the symbol table has to keep track of where *each* of them is.

String functions

What else can you do with string variables, other than just printing them? There are many string functions available in BASIC — in general, the larger the machine and the more ▶

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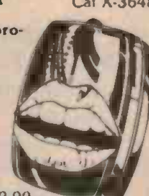

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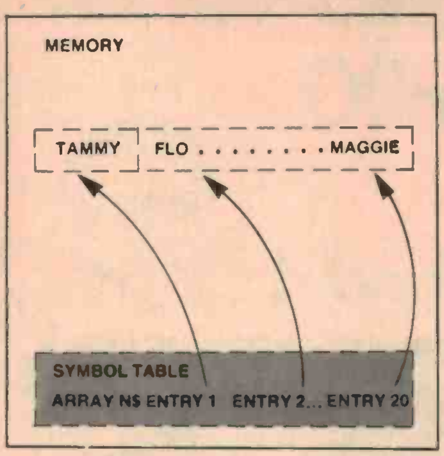


Figure 5. A string array. Notice that, because the entries in the array are different sizes, the symbol table has to hold the position of each of them (there are other ways of doing it, but we won't go into them at this stage).

comprehensive the version of BASIC, the more string functions will be available. I've listed the more common ones below.

Concatenation: This allows two (or more) strings to be joined together to form one long string. Example: 'A$ —"HELLO"', 'B$ = "GOODBYE"', 'C$ = A$ + B$'. C$ will now be equal to "HELLOGOODBYE". Typical uses for this function include adding spaces to the end of a string: 'A$ = A$ + " " ' will make A$ equal "HELLO ".

String Length: LEN: This function gives the length of a string. If, for example, you wished to know how many characters were in A$, inputting 'D = LEN(A$)' would set D to the number of characters. For example, if A$ was "HELLO", D would be 5.

Value: VAL: If a string is in the form of a number, then the VAL function will allow the value of the number to be used in the program. For example, if A$ is equal to "2.3" (and there is absolutely no reason why a string should not include digits), then inputting 'D = A$' would give an error message — the computer does not know that A$ is a representation of a number; it thinks of it only as a string of characters. Inputting 'D = VAL(A$)' would, however, set D to 2.3.

String Splitting: LEFT$, RIGHT$ AND MID$: These allow the user to split a string into several other strings (the opposite of concatenation). 'B$ = LEFT$(A$,3)' will make B$ equal to the three left-hand characters of A$. (A$ will be unchanged, by the way.) Similarly, RIGHT$(A$,3) will give the three right-hand characters of A$ and MID$(A$,3,2) will give two characters in A$, starting from the character third from the left. MID$(A$,3) will give the third character from the left in A$.

Some examples:

input	output
A$ = "HELLO"	
PRINT LEFT$(A$,2)	HE
PRINT RIGHT$(A$,2)	LO
PRINT MID$(A$,3)	L
PRINT MID$(A$,3,2)	LL

PRINT special functions

PRINT is not such a simple function as it first appears. All of the clever output formatting in BASIC computer programming is achieved using the PRINT function.

You already know that 'PRINT A,B' will output the value of A, followed by the value of B. The comma between A and B actually means 'tabulate'. That is, move to the right across the screen until you reach one of the predefined 'columns' built into the computer function.

On a typewriter, you can set the 'tabulations' (or 'tabs', as they are usually called) to any position you like on the typewriter. When you press the TAB button, the carriage will move to the left until it hits one of the tabs you have set. This means that you can type in columns of figures by pressing the TAB key each time to move you to the next column.

A similar system is at work in the computer — but this time the tabs are predefined when you turn the machine on (there is another sort of tab in the PRINT function, but I'll come to that later).

So when you put a comma between the two variable names A and B, the computer will output the value of A, then move to the right until it finds one of the tabs (there are usually four or five, equally spaced across the width of the screen — you can't see them, of course).

This is all very well, but what if you want to 'PRINT "THE VALUE OF A IS", A'. This will mean that the computer will output 'THE VALUE OF A IS', then tabulate to the next tab before outputting A. This could leave a sizable space — very unsightly.

The alternative is to use a semi-colon, ';'. Using one of these between successive variables (or between variables and strings, or whatever) in the PRINT statement will cause the computer to leave no room at all between them on the screen.

This means that if you input 'PRINT "THE VALUE OF A IS";A', and A is 4, then the output will be 'THE VALUE OF A IS4'.

Wait a minute, though, this isn't much use either — we want *some* gap in there.

The answer is to plan your PRINT statements carefully. What if we use 'PRINT "THE VALUE OF A IS ";A' (notice the extra space at the end of the string). The output will now be 'THE VALUE OF A IS 4'. Bingo.

Another nice point to remember is that every PRINT statement will cause the computer to go to the start of the next line when it is finished — unless it ends with a semi-colon. I can't really give an example at this stage because you're still using the machine in the 'calculator' mode, and the machine will take a new line at the end of every output anyway — but remember it later on.

Tabs

I said earlier that there was another way to tab in BASIC. This is by means of a function called TAB (surprise, surprise).

Inputting 'PRINT TAB(20);"*" ' will cause the machine to move 20 spaces to the right, then output a '*'. Inputting 'PRINT TAB(20);"*";TAB(30);"@" ' will make the machine move 20 spaces to the right, output a '*', then move another 9 spaces to the right (bringing it 30 spaces *from the left-hand edge of the screen)*, then output a '@'.

Most machines will ignore a TAB which asks for a move to the left. In other words, if the machine is outputting at a position 30 spaces from the left (call that 'position 30'), and then encounters a TAB(20), it will do nothing.

TAB can be used with a variable — TAB(A) is quite acceptable. This is very useful in plotting applications — wait and see the example program in part five of the series.

Some machines (including the Apple — see this month's ETI) allow *vertical* tabs as well. This means that inputting 'VTAB(10)' will bring the next computer output to the 10th line from the *top* of the screen.

Graphics

'Graphics' is a word which is used to describe the ability of a computer to put diagrams on the screen.

For example, say I got the computer to 'PRINT "-------" '. This would leave a line of '-'s across the screen.

Now, it doesn't take much imagination to realise that by judicious use of characters like '!' and '-', you could cause the computer to draw horizontal and vertical rulings on the screen, to clarify a table, for example — and in fact this is done quite commonly. ▶

But '-' and '!' are a bit limiting. It would be nice to have characters that were a bit wider, such as '—', so that putting a row of them on the screen would give a '————————', with no gaps in it.

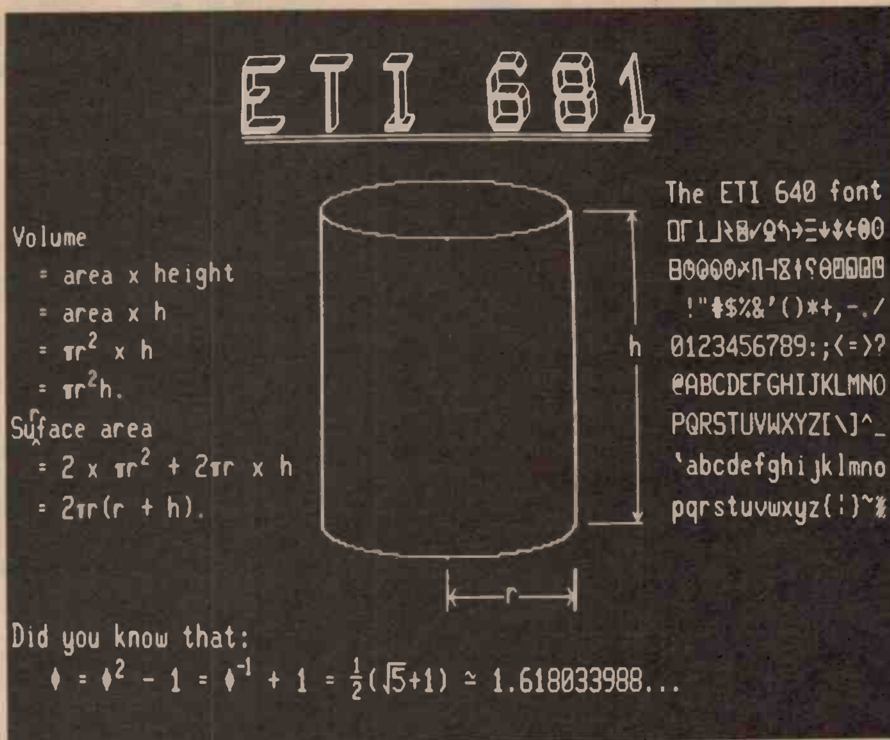
Some machines (notably the PET, from Commodore), have a comprehensive set of graphics symbols which allows not only vertical and horizontal lines, but also areas of tone, 45° lines and a whole host of other shapes.

Some machines, such as the Exidy Sorcerer, allow the user to define some of his *own* characters — which may be anything from the letters of the Greek alphabet to the shape of a duck — for 'duck shoot' games!

The Apple, and other machines, allow the user to switch the machine into various graphics 'modes', in which the screen becomes like a plotting surface, on which lines and curves can be 'drawn' under program control.

In most applications, though, especially where the computer is being used mainly for computation (and that is what the word means, after all), the graphics produced is usually limited to ruling tables and simple graph plotting. ●

Next month, Phil Cohen explains how to write some simple programs, explores the mysteries of 'debugging' and introduces PEEK and POKE.



This is a photograph taken from a VDU screen which is being 'driven' by our ETI 681/640 VDU with programmable character generator.

The block of characters on the right are the full set which can be produced by the ETI 640 VDU on its own. Notice that there are a small number of characters which can be used to provide various simple 'graphics' outputs — the shaded box at the lower right, for example, and the minus '–' and underline'__' symbols.

The rest of the screen uses the ETI 640 symbols plus a feature which is added by the ETI 681 programmable character generator — user-defined characters.

Although it is not immediately obvious from the photograph, the graphics on the rest of the screen are made up of characters the same size as the ETI 640 characters, but with shapes which make them join up to produce the various patterns shown.

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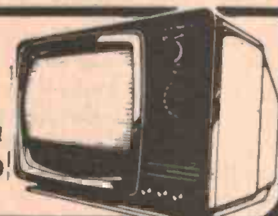

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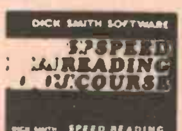

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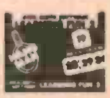

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7426	.40
7427	.40
7430	.30
7432	.30
7437	.40
7438	.40
7439	.50
7440	.30
7441	2.50
7442	.80
7447	1.10
7448	1.10
7450	.30
7451	.30
7453	.30
7454	.30
7460	.30
7470	.50
7472	.55
7473	.55
7474	.35
7475	.45
7476	.40
7480	1.00
7483	1.40
7485	1.40
7486	.55
7489	2.90
7490	.40
7491	1.00
7492	.80
7493	.50
7494	1.15
7495	1.00
7496	1.10
74100	2.00
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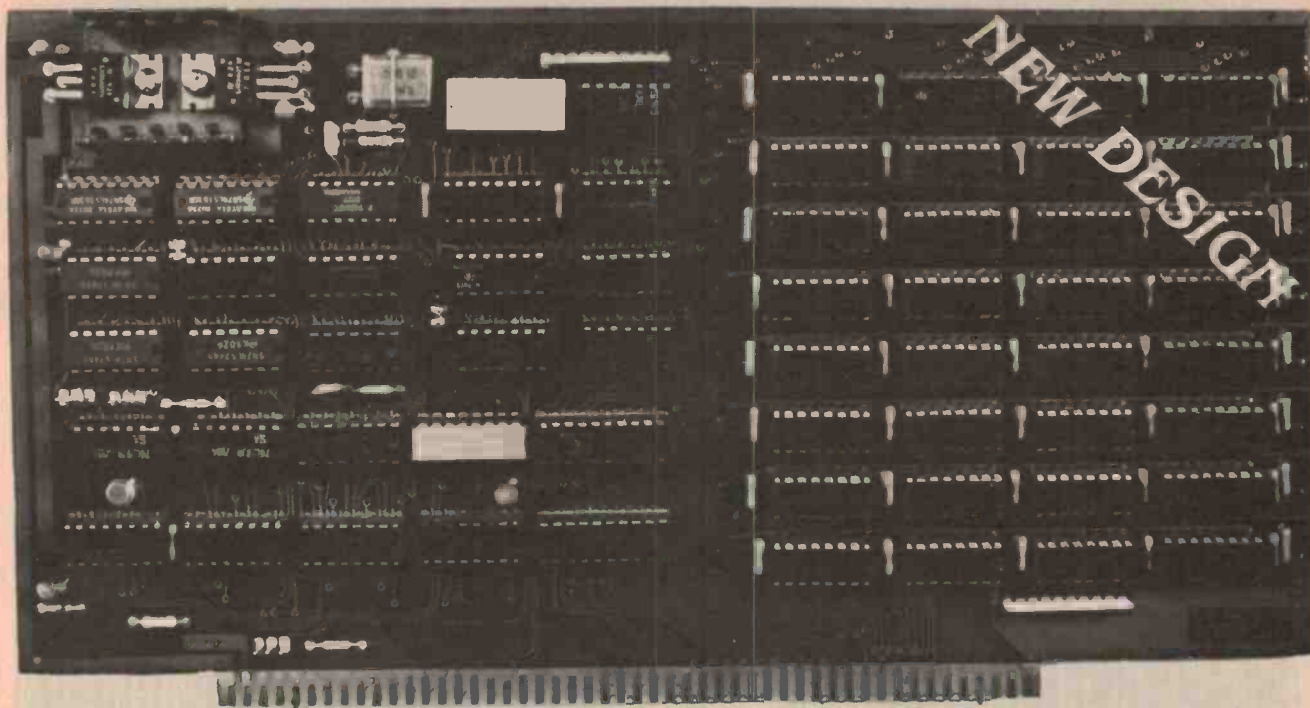

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The FT-707 — big rig in a small space

Yaesu's latest offering for the mobile/home station market, the FT-707, is a transceiver loaded with features that were 'optional extras' a few scant years ago.

Naturally, it's an all solid-state rig, designed to operate from a nominal 13.8 Vdc supply. A matching ac power unit, the FP-707, can be coupled to the rig for home station use. The FP-707 includes a speaker which improves the audio when the transceiver is bench or table mounted.

The FT-707 is extraordinarily compact — measuring only 93 mm high by 240 mm wide by 295 mm deep overall. It weighs just 6.5 kg.

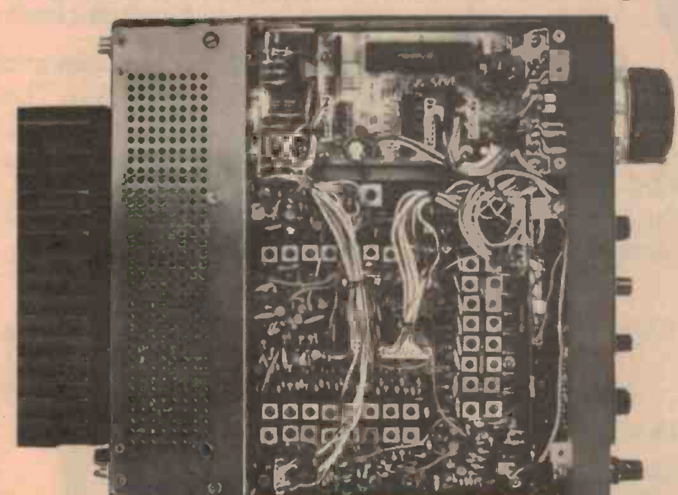
After you get over the tiny package, you next notice the number of bands on the bandswitch — 11 in total. Apart from the usual four 500 kHz segments for 10m, there's '30m', '17m' and '12m', the new so-called "WARC" bands. Next to the bandswitch is a dual-concentric 'CLAR-WIDTH' control. The latter permits 'variable IF bandwidth' control employing a cunning mixing technique.

The usual SSB, CW and AM modes are provided; two optional 'narrow' CW filters are available (350 Hz and 600 Hz). The IF filter is Yaesu's standard 8-pole crystal type with a quoted -6 dB bandwidth of 2.4 kHz. AM bandwidth is given as 3.6 kHz at -6 dB. AM modulation is not pseudo-AM but produced by modulating a low power driver stage.

The displays include digital readout to 100 Hz and a string of coloured LEDs for an S-meter/ALC/Po display.

A fairly conventional mixing scheme commencing with a 5.5 – 5.0 MHz reverse-tuning VFO provides 500 kHz tuning segments on each band. The front panel is dominated by the tuning knob, which has an adjustable skirt, familiar to all Yaesu owners/operators. Immediately below the frequency knob are two small controls for the VOX — gain on the left, delay on the right. You can't turn the VOX off, except by turning the gain down.

Also incorporated is two-speed AGC, a noise blanker, MOX (holds TX on) switch, marker, fixed channel operation and receiver offset tuning. Of special note is a mic option with slide-switch operation for electronic tuning across the bands.



On the bench, PEP SSB power output was measured at 110 W across all bands. AM output was a little under 40 W, and CW a little under 60 W. On receive, SSB/CW sensitivity was measured at 0.1 uV for 10 dB SINAD, a shade under 1 uV on AM for 10 dB SINAD. Frequency stability was measured at just under 200 Hz drift in the 30 min. period after switch-on, better than 50 Hz in any 30 min. thereafter. All pretty good. No tune-up is necessary — just pick your band, dial your frequency and talk!

We couldn't measure receiver crossmod or overload but sensitivity and overload performance seemed adequate and Yaesu say the front end employs a Schottky diode ring mixer and carefully designed gain distribution.

Subjectively, the receiver audio on SSB was not the best. The general consensus was that "... it sounds like a Dalek in a powdered milk tin with the lid on". And that's for the FP-707 speaker! 'Communications quality', but barely. Room for improvement. The transceiver's internal speaker is worse. AM's even poorer.

The S-meter is unusual but handy — especially for mobile operation. S1 has a high threshold, 1 uV — higher on 15m and 10m, strangely enough. It's easy to read 'at a glance'. S9 is −94 dBm, 5 uV. Not much range there! On 'slow AGC' the S-meter appears to function in a 'peak-hold' mode.

Transmit audio is best described as 'normal'.

The IF filter has noticeable 'bumps' and true "single signal" CW/SSB reception is not possible either. Bandwidth and shape factor seem OK for the job but overall impression is "... run of the mill". The 'width' control is useful on SSB & CW, but shifts the frequency on AM. You can get rid of 'monkey chatter' and heterodynes — at the expense of audio quality, naturally — but we didn't use it very much. Probably more use in contests.

VOX works as it should (anti-VOX setting inside case), but not recommended for mobile use as it's too easy to trip when uttering expletives in peak-hour traffic!

The PA has a fan which cuts in when the heatsink exceeds a preset temperature. It's possible to fool the system by driving the rig hard on CW (or RTTY, SSTV etc) until the heatsink gets hot enough to bring in the fan. Quickly turning the power off and then on will cause the fan to stay off — but no damage was caused by continued operation as before.

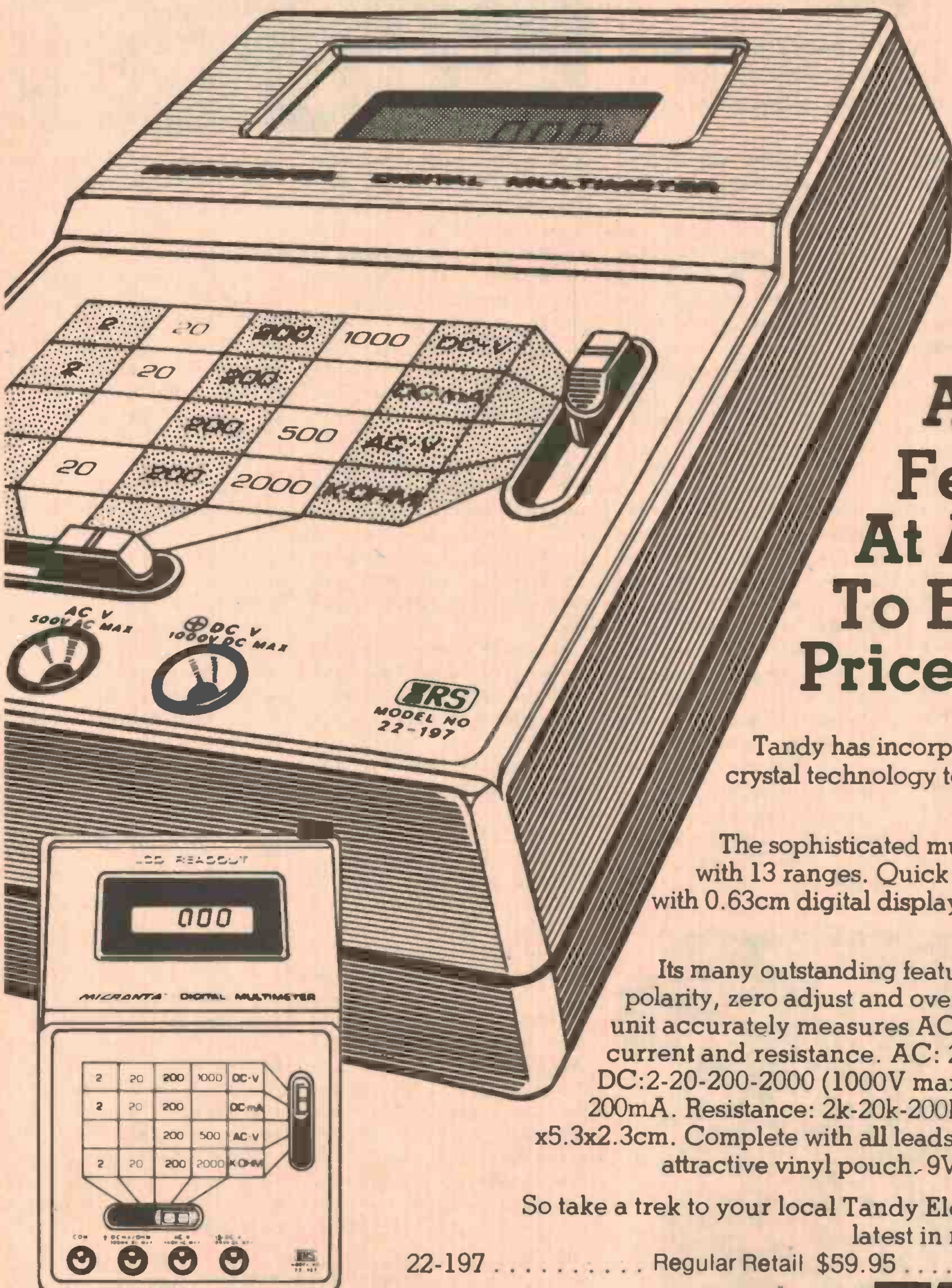
Overall, the FT-707 offers quite a lot — the size and general features are great and it generally offers good value for money at $765. We'd recommend a well-designed external speaker, though. The handbook is presented to Yaesu's usual high standard.

Our review unit came from Dick Smith Electronics. Enquiries should be addressed to your nearest store or dealer. Apart from the FP-707 mains supply, an external VFO (FV-707DM) and antenna coupler accessories are produced by Yaesu. As a matter of interest, a 220 mV (50 ohm) RF output socket is provided for use with VHF/UHF transverters.

Roger Harrison
Simon Campbell
Phil Wait

LCD MULTITESTER

2001 TECHNOLOGY, 1001 USES



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Tandy has incorporated the latest liquid crystal technology to design a truly accurate tester for the 80's.

The sophisticated multitester has 3½ digits with 13 ranges. Quick recognition's a breeze with 0.63cm digital display and smart blue/white function chart.

Its many outstanding features include automatic polarity, zero adjust and over-range indicator. The unit accurately measures AC and DC voltage, DC current and resistance. AC: 200-2000 (500V max). DC:2-20-200-2000 (1000V max). DC Current: 2-20-200mA. Resistance: 2k-20k-200k-2M. Dimensions: 8.4 x5.3x2.3cm. Complete with all leads and instructions in an attractive vinyl pouch. 9V battery not included.

So take a trek to your local Tandy Electronics store for the latest in multitesters and save!

22-197 . . . . Regular Retail $59.95 . . . . $39.95 *

*Sale Ends 28th February, 1981 **

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TANDY ELECTRONICS

Nigeria testing new transmitters

The Voice of Nigeria, with studios in Lagos, has recently been carrying out test broadcasts using new 500 kilowatt transmitters on shortwave.

Lagos has recently installed new transmitters for the Overseas Service at the Ikorodu transmitter site to the north of Lagos.

Powerful signals have been noted on the new outlet of 17 800, with the English service directed to North Africa and overseas audiences between 0600 and 0800 daily. With this service still listed for broadcast on 15 120 and 15 185, it seems that Voice of Nigeria's new transmitter must be one of the high-power ones scheduled for use in this service.

Nigeria has long been planning for the installation of a total of seven new 500 kilowatt shortwave transmitters for use by the Overseas Service, and the transmitter in use on 17 800 in our late afternoons appears to be one of these, due to come into full operation over the next few years.

Voice of Nigeria publishes a quarterly frequency and programme booklet, available upon request from: Voice of Nigeria, Broadcasting House, Ikoyi, Lagos, Nigeria.

DX on the air!

DXers in Australia may soon be able to pick up the latest DX tips and news on the mediumwave band.

Radio 4VL in Charleville in south-western Queensland, which operates on 918 kHz, has offered air time to the Australian Radio DX Club for a regular DX programme of 5 to 15 minutes' duration.

The programme will feature latest DX tips, loggings, new station schedules and frequency moves, plus recordings of unusual DX catches. Presenter will be Robert Chester of Adelaide, an honorary life member of the Australian Radio DX Club.

Radio 4VL is widely heard during night-time hours throughout Queensland and NSW. It is hoped that the ARDXC can offer special verification cards for correct reception reports of the new DX programme. More news of the programme will be given in this column when a regular schedule for the broadcast becomes known.

Sydney to host DXers in 1981

The 1981 National Convention of the Australian Radio DX Club will take place over Easter in Sydney.

The 1980 Convention in Melbourne last Easter saw almost 60 DXers from all over Australia attending the three days of events. The 1981 Sydney Convention promises to be equally well attended, and should include displays of latest shortwave receivers and other DX gear, as well as talks and displays to interest shortwave enthusiasts.

The 1981 Sydney Convention of the ARDXC provides an opportunity for those who have an interest in the SWL/DX hobby to come along and see how the latest developments can increase their enjoyment of their hobby. Come along and meet fellow DXers, and see what membership of the Australian Radio DX Club can do for you.

Further information about the ARDXC National Convention '81 can be obtained from the address in this column.

NOTE! All times are given in Greenwich mean time (GMT). To convert to Australian Eastern Standard Time, add 10 hours (11 hours during Daylight Saving Time, November to February). To convert to Central Standard Time, add 9.5 hours and Western Time add 8 hours.

All frequencies are given in kHz.

These notes are compiled by Peter Bunn on behalf of the Australian Radio DX Club (ARDXC). Further information on DXing or the activities of the ARDXC may be obtained from P.O. Box 79, Narrabeen, NSW 2101, for a 22¢ stamp.

South-east Asia signals

During our summer months, reception of stations in the South-east Asian area is enhanced. Here is a roundup of current frequencies and operating times for some of the regional broadcasting stations in both Vietnam and Laos.

Vietnam: Cao Bang broadcasting station 6 590, 1200-1400 sign-off.

Bac Thai broadcasting station uses either 6 880 or 7 070, operating between 1200 and 1400 sign-off.

Ha Tuyen broadcasting station operates on 4 820, and is generally audible in eastern Australia between 1100 and 1400 sign-off.

Hoang Lien Son station operates on 5 628, sometimes giving good signals between 1200 and 1330 sign-off.

Lai Chau station operates on 5 870 currently, and is heard from sign-on at 1140 through to sign-off at 1330.

Son La is currently heard on 6 330 from 1100 fade-in until 1330 sign-off.

Laos: Pakse provincial station operates on 6 615 between 1100 and 1400.

Luang Prabang station operates on 7 000 between 1100 and 1400.

Savannakhet station uses 7 383, and can be heard from sign-on at 1100 until sign-off at 1430.

Xieng Khouang station uses 5 602 and 7 183 from 1000 to 1400.

Houa Phan station uses 6 168 and 4 657 between 1000 and 1205 and again between 1300 and 1430 nightly.

Probably the stronger signals are provided by Ha Tuyen on 4 820, Bac Thai on either 6 880 or 7 070, Xieng Khouang on 5 602, and Savannakhet on 7 383.

All the stations above present programming in their local language, ie: in Vietnamese for the Vietnamese stations and Lao for the stations in Laos. Some stations also present programmes in some minority languages.

The Vietnamese are not currently verifying reception reports. The only way to gain a QSL from Vietnam is to report the widely heard overseas service from Hanoi.

However, the Lao stations can be QSL'd by writing to the capital, Vientiane. For best results, you should report reception during the time of the nightly relay of the main Vientiane news bulletin, which is relayed by all regional and provincial stations from 1200 to 1230. If you report the regionals at this time, the Vientiane staff can more easily check your report against their programme log. A useful check as to whether you are tuned to a Lao station is to check the main Vientiane frequency of 6 130 at 1200, and check if the station you are tuned to is in parallel with that outlet. Vientiane on 6 130 is usually very well heard in eastern Australia during our evenings between 1200 and 1400.

New Portugal outlets

Keep up to date with the changing political and social scene in Portugal by tuning in to Radio Portugal's English broadcasts during our local mornings.

Lisbon can be heard well at 2030 to 2100 in English every day, with current frequencies being 9 740, 7 185, and 6 025. This programme is actually beamed for reception in Europe, but the darkness path between Europe and Australia at that early time across Asia and the Indian Ocean assures us of regular reception here in Australia also.

Bangladesh evening changes

Radio Bangladesh in Dacca recently moved to 21 670, replacing 21 770, for the daily English broadcast beamed to South-east Asia 1230-1300.

The new outlet gives adequate reception most days, with the parallel frequency being 15 285. All programmes include a news bulletin, a news commentary and features on Bangladesh life and events.

PREDICTIONS

MARCH 1981

These GRAFEX style computer generated predictions are provided courtesy of the Australian Ionospheric Prediction Service, Dept. of Science and Technology.

Covering 3 MHz to 40 or 60 MHz, these predictions show the times radio contact is possible between the areas designated beneath each graph, as well as the possible 'mode' and reliability. Vertical columns indicate time — commencing at 0000 UT on the left, to 2300 UT at right. For reliable predictions follow the times and frequencies indicated by the F character.

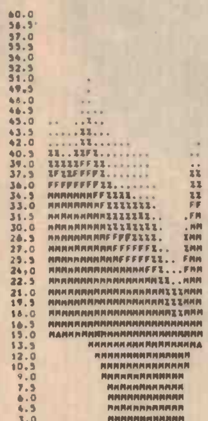
Complete information on using these predictions can be obtained by sending a stamped, self-addressed envelope to:-

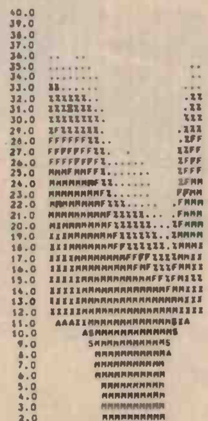
ETI — Predictions
3rd floor 15 Boundary St
RUSHCUTTERS BAY NSW 2011.

KEY TO SYMBOLS

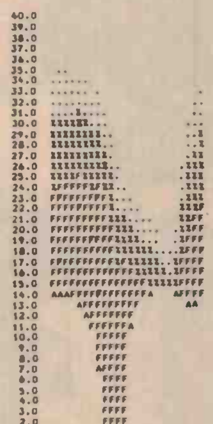
A blank area means no normal propagation is possible.

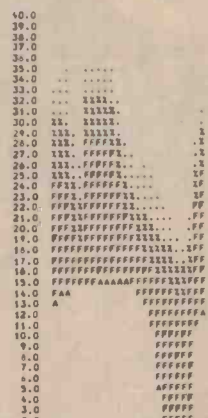
- **●** . . . path open less than 50% of days in month.
- **%** . . . path open 50-90% of days in month.
- **F** . . . path open at least 90% of days in month.
- **X** . . . complex mixture of modes. Expect abnormal propagation.
- **M** . . . propagation possible by both 1st and 2nd F-layer modes. Expect strong fading.
- **S** . . . propagation possible by 2nd mode (also 3rd and mixed E and F modes). Expect strong fading, weak signals.
- **A** . . . High absorption indicated. Expect weak signals.

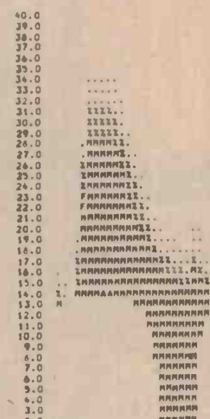

East Coast to Japan (Also serves N.E. and S.C.)

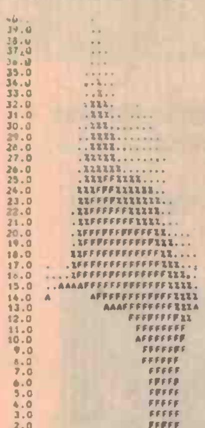

East Coast to South Pacific

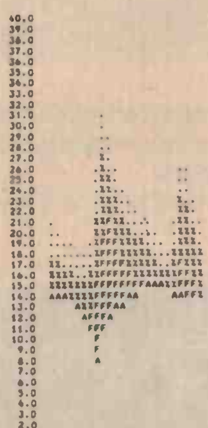

East Coast to North America (Also serves N.E. and S.C.)

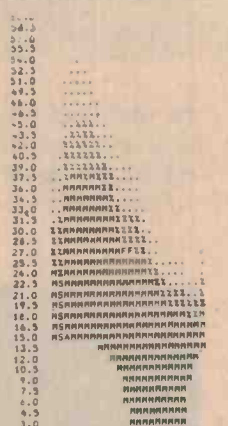

East Coast to South America (Also serves S.C.)

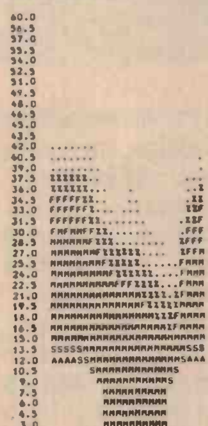

East Coast to North Africa (Also serves S.C.)

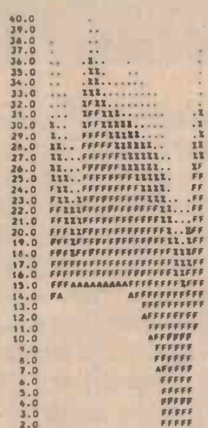

East Coast to South Africa (Also serves S.C.)

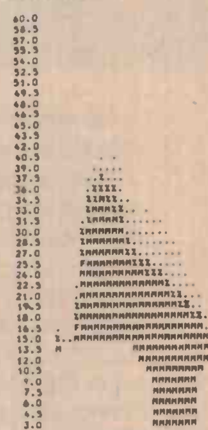

East Coast to Europe (Short Path)

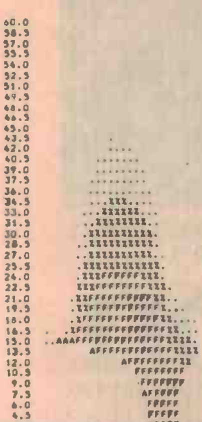

E.C. and S.C. to Europe (Long Path)

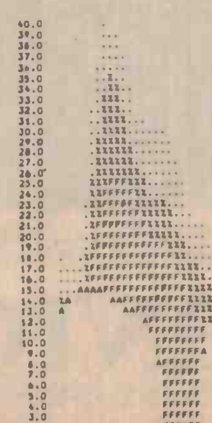

East Coast and S.C. to Persia

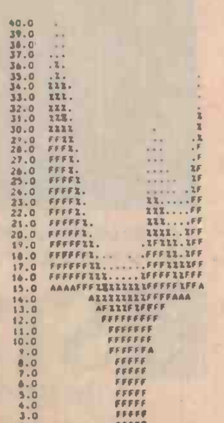

North East to South Pacific (Also serves S.E.)

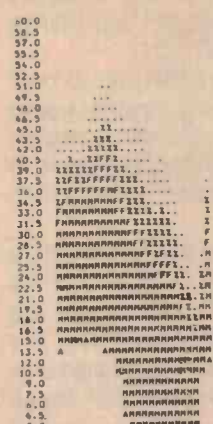

North East to North Africa

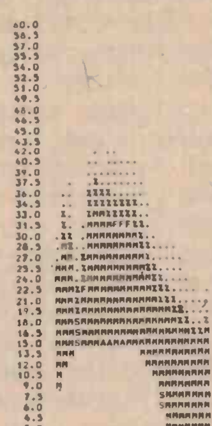

North East to South Africa

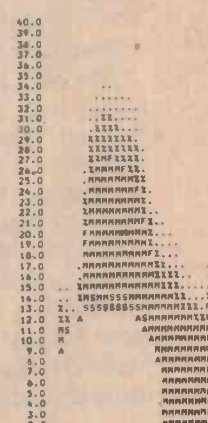

North East to Europe (Short Path)


S. Central & W.C. to Europe (Short Path)


West Coast to North America


West Coast to Japan


West Coast to North Africa


West Coast to South Africa

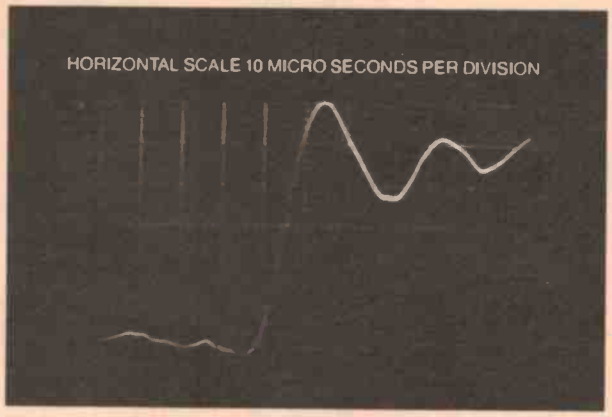
The moving coil replacement from Stanton Magnetics... the revolutionary 980LZS!

Now from the company to whom the professionals look for setting standards in audio equipment comes a spectacular new cartridge concept. A low impedance pickup that offers all the advantages of a moving magnet cartridge without the disadvantages of the moving coil pickup. At the same time it offers exceedingly fast rise time—less than 10 micro seconds—resulting in dramatic new crispness in sound reproduction—a new "openness" surpassing that of even the best of moving coil designs. The 980LZS incorporates very low dynamic tip mass (0.2 mg.) with extremely high compliance for superb tracking. It tracks the most demanding of the new so called "test" digitally mastered and direct cut recordings with ease and smoothness at 1 gram $^{+1/2}_{-1/4}$.

The 980LZS features the famous Stereohedron™ stylus and a lightweight samarium cobalt super magnet. The output can be connected either into the moving coil input of a modern receiver's preamps or can be used with a prepreamp, whose output is fed into the conventional phono input.

For "moving coil" audiophiles the 980LZS offers a *new standard* of consistency and reliability while maintaining all the sound characteristics even the most critical moving coil advocates demand. For moving magnet advocates the 980LZS provides one more level of sound experience while maintaining all the great sound characteristics of cleanliness and frequency response long associated with fine moving magnet assemblies.

From Stanton... The Choice of The Professionals.



Actual unretouched oscilloscope photograph showing rise time of 980LZS using CBS STR112 record.

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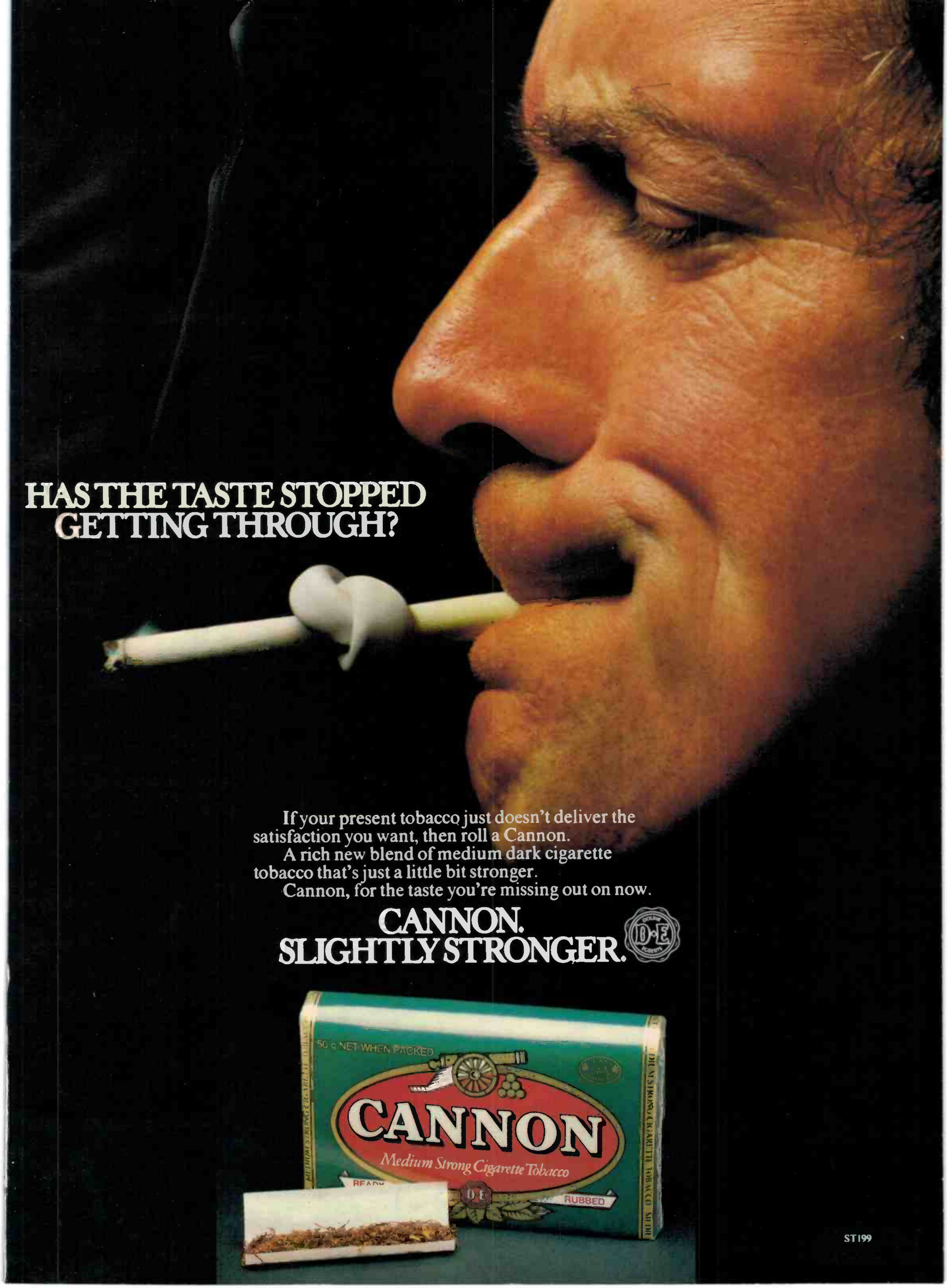
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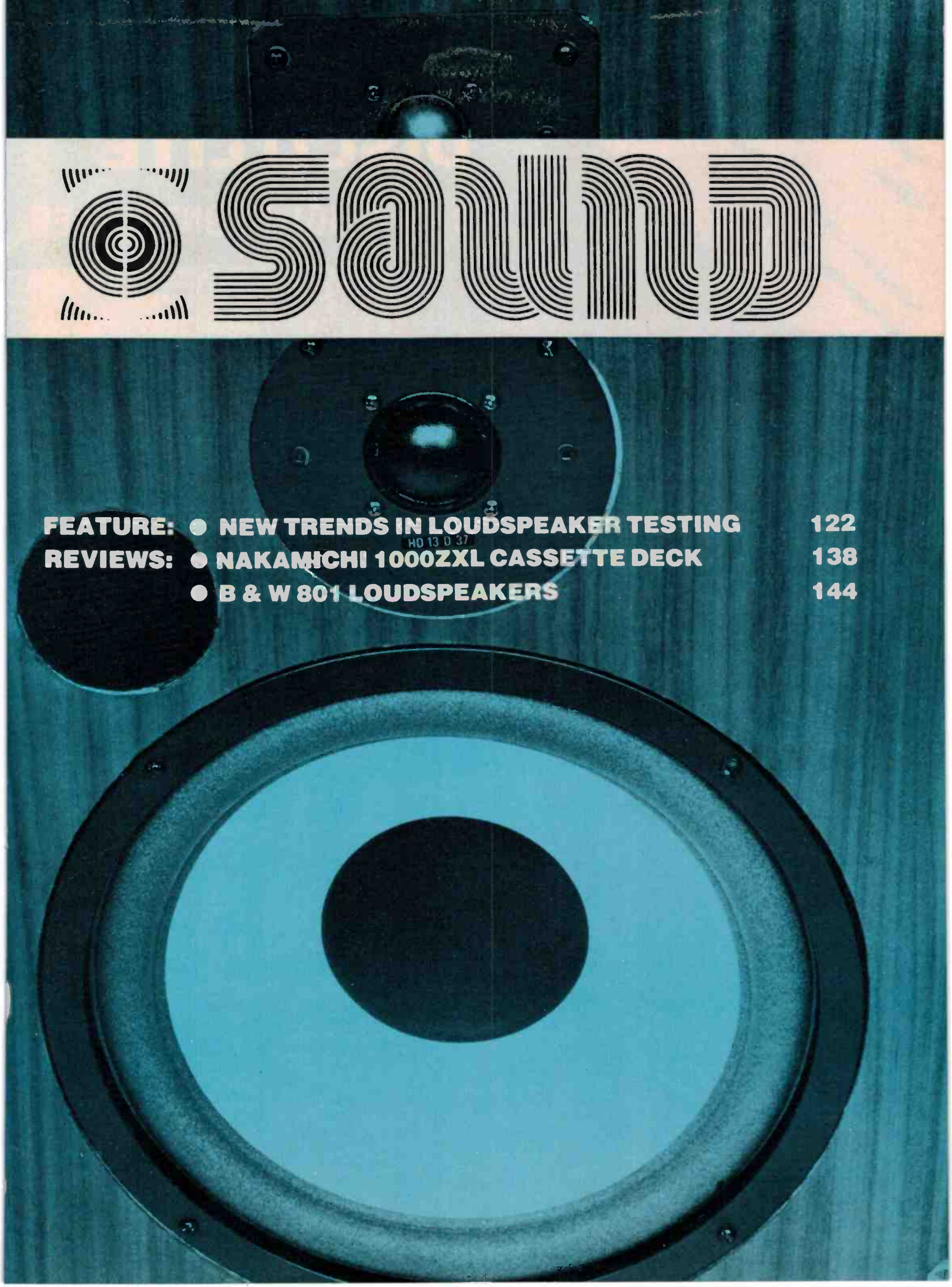

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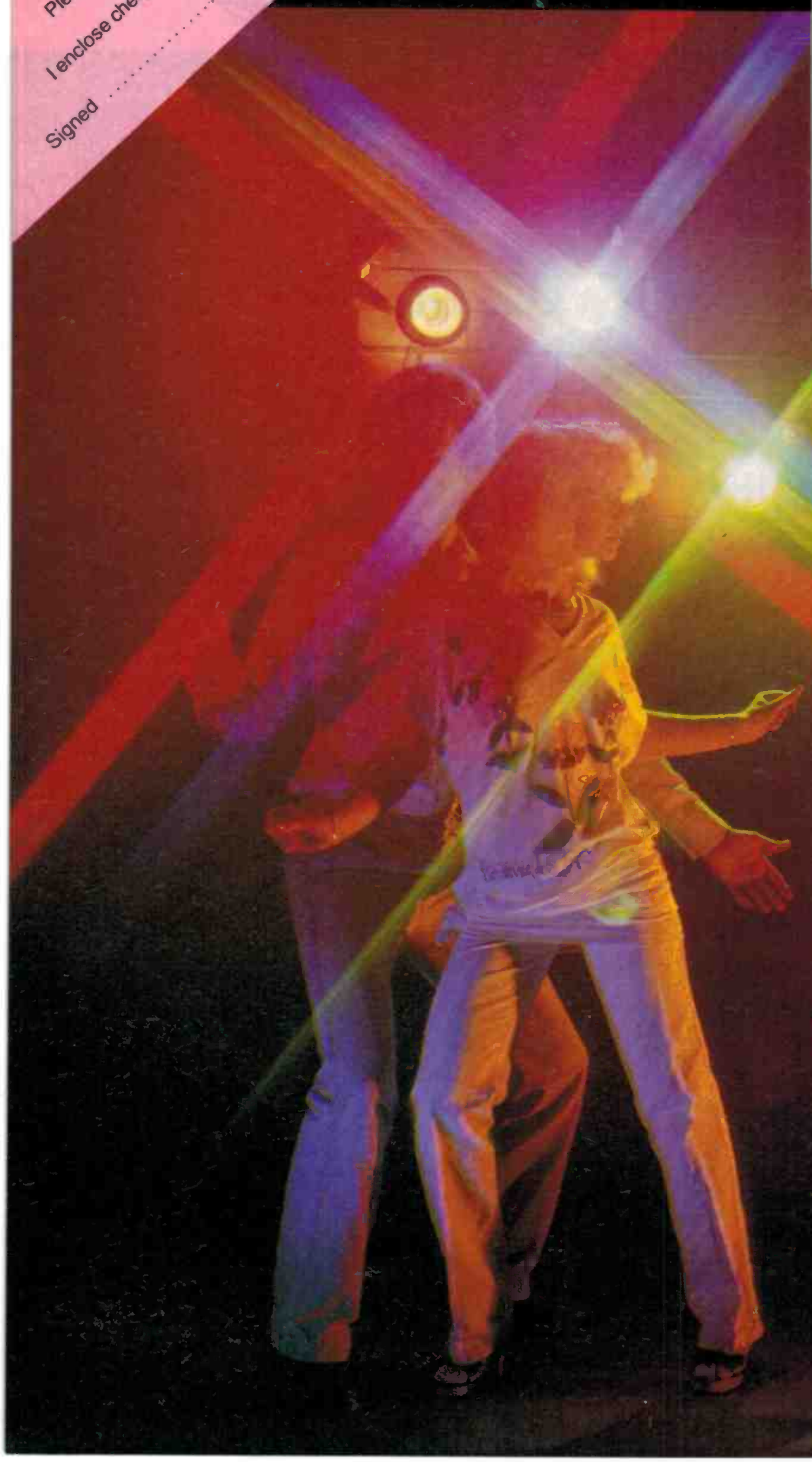

PC410

- Great for parties, advertising displays, Christmas tree lights etc.
- Light dimmer for mood and effects lighting
- Variable speed strobe
- Flashes lights to beat of music

FEATURES

• Plugs directly into 240 V power socket, no wiring needed • Three position switch selects (1) "music colour" (using coloured lights) that flashes lights to beat of music — built in microphone, variable sensitivity control; (2) "strobe" effects for flashing lights at variable speed; (3) light dimmer with variable intensity • Continuously variable control provides complete flexibility in all modes of operation • Can be used with 240 V filament lamps to the total of 500 watts • Double insulated • S.E.C. approved and fully guaranteed.

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The PC410 Disco Lite is a product of A & R Electronics, manufactured under the Arlec label.

While these units are sold through some retail outlets, they are not generally available and ETI has arranged to offer them to readers via mail order.

Amazing double act !

At first glance the Toshiba KT-S2 looks like a tiny cassette player with headphones — which it is — but that's not all. Just eject the cassette, insert the cassette-like tuner pack and — behold! — you have a full-range FM stereo tuner.

No longer is the luxury of FM reception restricted to your living room, your car or even the larger portable tuners.

The KT-S2 provides a choice of FM or cassette-recorded programmes — with private listening facility — wherever you happen to be. What's more, the KT-S2 is so compact and lightweight, it can be held in the palm of the hand.

The KT-S2 packs a number of sophisticated features into its tiny package. The cassette section accepts normal, chrome and metal tapes, provides cue and review functions and has an automatic shut-off mechanism. The unit has a two-position tone control and independent left/right channel volume controls.

A special feature is the talk-line button which, when pressed, enables the user to hear external sound through the headphones — useful for conversation and sing-alongs!

The Toshiba KT-S2 comes complete with lightweight headphones, protective case and carrying strap. More information from Toshiba (Aust.) Pty Ltd, P.O. Box 452, Lane Cove 2066 NSW.

Phase Linear Series Two tuner

Phase Linear's Model 5100 Series Two FM/AM tuner employs a digital frequency synthesiser for 'precision' tuning, a unique LED signal meter and a distortion quoted under 0.1%.

In addition to these features, the 5100 sports a digital memory which can store up to five stations for push-button recall and digital frequency readout of the selected station's frequency.

There are no knobs — everything is push-button controlled — including the tuning! Pressing the UP or DOWN buttons will step the tuner up or down in frequency accordingly. You can scan the band manually or set the 5100 to scan automatically. The synthesiser steps in 100 kHz increments on FM and 10 kHz increments on AM. The latter could provide some difficulties with Australia's 9 kHz channel spacing, though.

A very handy inclusion is a recording level oscillator. When planning to record an FM broadcast you can turn on an internal 333 Hz oscillator (50% FM modulation) and set your tape deck's level meter to −6 dB. Phase Linear say this helps you get "... perfect recordings off the air every time".

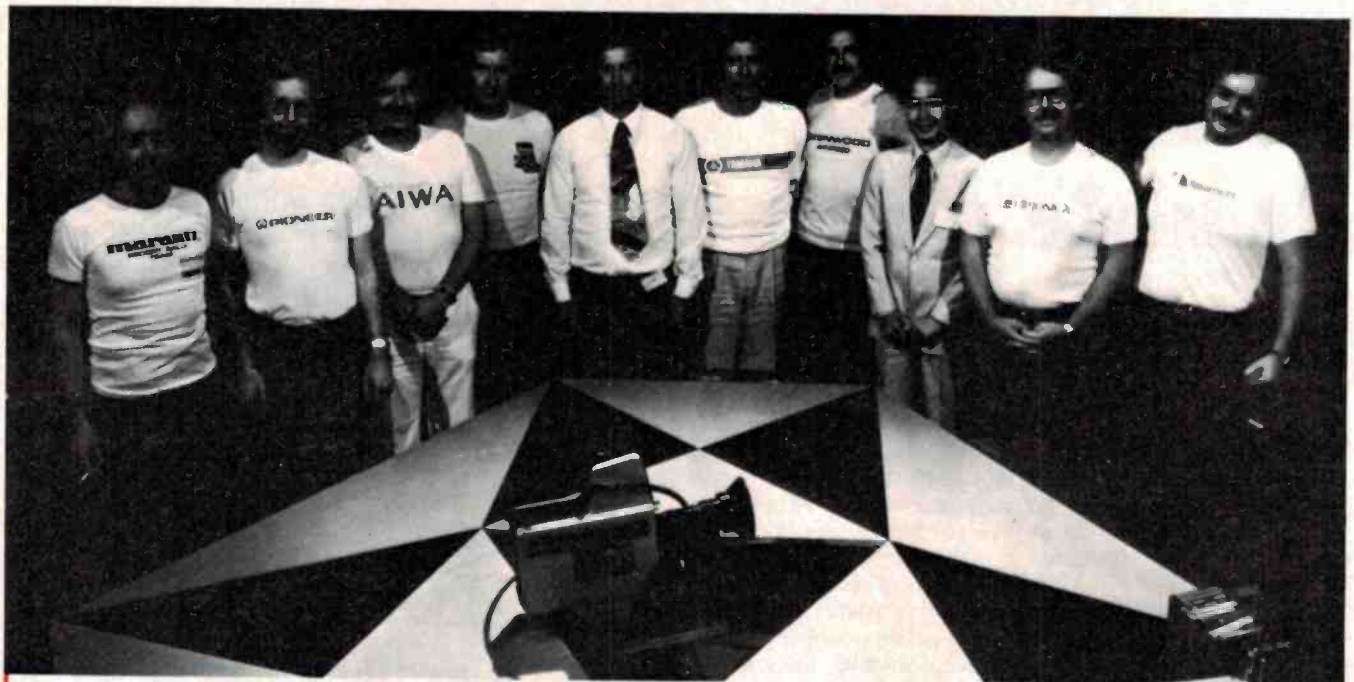
The Model 5100 measures 483 mm wide by 88 mm high by 305 mm deep and weighs 4.7 kg. Power consumption is a mere 10 watts. For all the specifications and any other details, contact the Acoustic Monitor Co. Pty Ltd, 12-18 Gould St, Enfield 2136 NSW. (02)642-7888.

Permostat! — where do you get it ?

Yes, we were remiss in not including an address for the local distributor of Permostat in last month's review of this remarkable product.

In an effort to reduce the deluge of phone calls, and to reduce the temperature of the exchange's ring and busy generators, here is the address you've all been clamouring for:

Permostat is sold in Australia by Concept Audio Pty Ltd, 22 Wattle Road, Brookvale NSW 2101. (02)938-3700. Don't call us, call them!



THE TDK "PUSH"

Many readers are familiar with TDK as a 'low profile', high quality tape and cassette firm. Scratch that. TDK have marked down 1981 as their 'year of the big push'. Above — meet 'the push'. That's a line-up of 'heavies' from the Australian audio industry (read 'audio marketing industry') featured in advertisements and TV promotions currently circulating in the media. For the first time, TDK say, world leaders in hi-fi equipment — Aiwa, Kenwood, Marantz, Nakamichi, Pioneer, Sansui, Sharp and Yamaha — have joined together in their endorsement of TDK audio cassettes. Each sings the praises of TDK tape as recommended for use with their equipment. Dramatic stuff!

Pictured, from left to right, are: Joe Maccioni (Marantz), Graham Ham (Pioneer), Don Smith (Aiwa), Geoff Brown (Sansui-Vanfi), Paul Wilcock (TDK), John Fahey (Yamaha), Reg Hall (Kenwood-Trio-Kenwood), Alex Akakura (TDK), Geoff Muir (Optonica-Sharp) and Geoff Mathews (Nakamichi-Convoy).

Low cost Sennheiser microphones

Sennheiser's low-priced model MD611 and MD72 microphones were first marketed in 1967 and have enjoyed a popularity amongst amateur tape and movie enthusiasts that is legend.

After 14 years and sales in excess of 100 000 for these two mics, Sennheiser recently released two replacement models — the MD200 and MD400. The MD200 has an omnidirectional pattern, the MD400 super cardiod.

The two new models have been updated with modern styling and the latest electroacoustic advancements. Both feature a dull grey-black finish, matching the latest equipment styling trends, and a frequency response extending from 60 Hz to 13 kHz.

The MD200 employs a pressure type transducer, while the MD400 uses a pressure gradient type transducer. Sensitivity for each is quoted as 2.5 mV/Pa, ±3 dB and the output impedance is given as 600 ohms.

Each mic is provided with a three-pole DIN connector (41 524), but two other types are available to suit commonly obtainable equipment. Each model is 160 mm long and has a shaft 24 mm in diameter and a sound head 49 mm in diameter. Both weigh 105 g. A desk stand is included with each.

For more details, contact R.H. Cunningham Pty Ltd, 146 Roden St, West Melbourne 3003 Vic, or 4-8 Waters Rd, Neutral Bay 2089 NSW.

Sanyo car stereo cassette deck

Sanyo has just released a new, super-mini car tape player, model FT 210.

The FT 210 has been designed for in-dash mounting in any compact car. Power output is quoted as six watts per channel, and the unit has positive, push-button controls for fast-forward and eject functions, and slide controls for volume, tone and balance.

The unit also has automatic stop at the end of the tape play mode and a simple to operate 'slot-in-on' tape load mechanism. Finish is in attractive brushed silver look with black detailing. The FT 210 is available now at a recommended retail price of $83.40. Sanyo also offers a wide choice of matching speaker systems.

For further information, contact Sanyo Australia Pty Ltd, 225 Miller Street, North Sydney 2060 NSW. (02)436-1122.

Psst. Want a hot tip?

Think for a moment about the single most important element between your record and your ears. The cartridge.

Too often it's the forgotten component even in expensive component stereo systems. That's sad.

A low-fi cartridge not only robs you of your stereo investment, it steals part of every record you buy, usually the "presence" and "definition" of the original recording.

Sony would like to recommend a sure thing. The Sony XL-55 Pro moving coil cartridge.

It's a highly original cartridge proved by exacting studio tests and critical home listening trials.

The moving coil cartridge, as compared with the moving magnet type of cartridge, uses a direct voltage generating system that obtains superior sound with extremely low distortion. Output voltage is very low and either a head amplifier or step-up transformer must be used. Sony's HA-50 Head Amplifier offers extremely low-noise amplification for virtually all kinds of MC (Moving Coil) cartridges.

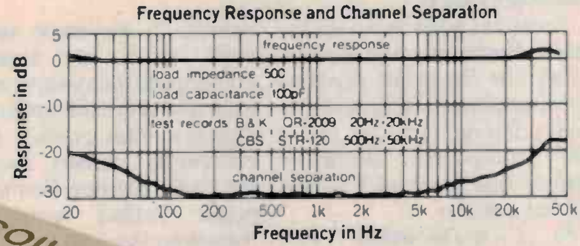
Sony's unique method of generating voltage in our XL-55 Pro is based on a simple figure-8 coil. Output is double that of conventional round coils.

To harness resonance, we adopted an extremely intricate three-layer cantilever mechanism. Tracking is sure and precise.

Sony's top-of-the-line XL-55 Pro MC cartridge and the more economical XL-44 and XL-33 cartridges will surely change your listening life.

As only Sony can.

Frequency Response and Channel Separation



XL-55 Pro

Specifications

Type:	Moving-coil
Output voltage:	0.2mV NAB (1kHz, 5cm sec, 45°)
Frequency response:	10-50,000Hz
Channel separation:	More than 30dB (1kHz)
Channel balance:	Less than 1dB (1kHz)
DC resistance:	40Ω
Impedance:	40Ω (1kHz)
Load impedance:	More than 40Ω
Compliance:	15x10⁶cm dyne
Tracking force:	1.5-2.5g (recommended value 2.0g)
Type of stylus:	Elliptical (0.3x0.8 mil) Nude diamond
Weight:	22g (including the shell)
Installation dimensions:	EIA

Design and specifications subject to change without notice.

SONY®

AP 3558

Rumours, rumours . . .

The audio game is full of rumours, but the following we know for a fact!

There has been much speculation about a takeover of Audio Reflex, the Brookvale (Sydney) hi-fi equipment importer/distributor. Strong rumours had it that component distributor Ralmar had grabbed it. Close, but not quite so . . .

As of 1st December, 1980, Serex Investments has taken over the business of Audio Reflex (Aust.) Pty Ltd and has formed a new, wholly-owned company — Inkel Pty Ltd, to operate in the audio systems field. It is an associated company to Ralmar and as such will assist in the strengthening of Ralmar's total position in the electronics Industry, they say. Mr David Aboody (formerly of Audio Reflex) remains as Marketing Manager.

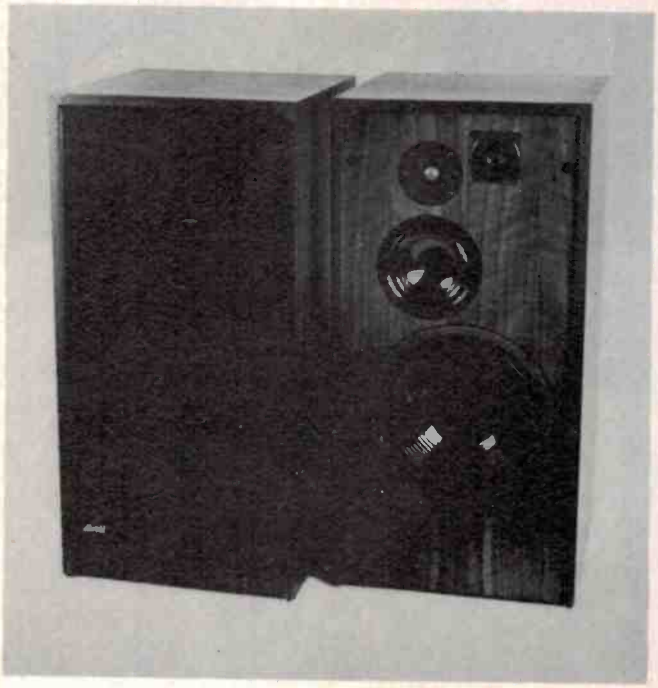
That's from the horse's mouth — the Ralmar Newsletter, December 1980 — January 1981.

Knock the shock !

For those awkward situations that arise where you need to isolate a microphone from 'shock' noises, there's only one device that will help (short of a skyhook) — a shock mount.

This Maruni shock mount can attach to a standard mic stand assembly and is designed to take the Maruni microphone range, but will doubtless get you out of trouble with quite a few other types, too.

Complete information, pricing etc. available from Archer Sound Systems, 109 Bungaree Rd, Wentworthville 2145 NSW. (02)631-4538.



Speakers to suit direct cut discs ?

The Executive Monitor loudspeakers from Chadwick Audio Furnishings have been designed to handle the "whole contents" of modern direct cut discs, according to their recent press release.

It goes on to say that the components that have been chosen to feature in the Executive Monitor have been selected on the basis of performance and quality, not brand name.

The Executive Monitor could be yours for just $990 a pair, or you may choose to start lower in the Executive range with the Executive 10 model at $449 a pair or the Executive 12 at $499 a pair. Performance you'll have to judge for yourself. To find out where you can audition or buy a pair, contact Chadwick on (02)647-1103.

Sound reinforcement amp sports many features

Featuring a 'lusty' 80 watts RMS output, five-input source mixing, volume 'memory' and portability, the new Realistic MPA-80 amp has been aimed at the PA and sound reinforcement market.

On top of all the facilities provided, Tandy reckon the MPA-80 will be a surefire winner priced at $269.95.

Frequency response is quoted as 30 Hz to 20 kHz, and Tandy say the unit can be used on both voice and music. Mike jacks have XLR connectors as well as quarter-inch plugs and the unit accepts both high and low impedance microphones.

Tandy say you can hook it up to a set of four mics, cassette deck/tuner, two phono magnetic turntables and a frequency equaliser — all at the same time! (Although we can't see how.) The MPA-80 even includes a 'mix bus' jack so that you can connect other amps for added power.

Apart from a carry handle, Tandy have thoughtfully included cord storage posts and a 12-page owner's manual packed with helpful hints and applications. The volume 'memory' is a skirt surrounding the large volume knob that can be set to indicate your 'standard' volume position. You also get an overload/auto-reset button, clipping indicator and a power output meter, along with a headphone monitor jack and source switch. Individual fader controls are provided for each of the five inputs.

See your nearest Tandy store for details and/or a demo.

New trends in loudspeaker testing

Over the past decade a technique has been developed that can truly quantify and plot the performance of a loudspeaker, and which matches the abilities of our ears. The 'cumulative decay response' technique is now available to ETI — we are **the first magazine worldwide** to employ it. Here's how it works.

Louis A. Challis

OVER THE LAST ten years of evaluating the performance of loudspeakers for magazine review articles and for manufacturers wishing to improve their products, I have found significant differences between objective and subjective evaluations. These differences have given rise to many problems, not the least of which is the need to find a set of objective tests which are able to provide a reasonable correlation between these two vastly different approaches of loudspeaker evaluation.

The art of speaker testing is currently a subject of more than just passing interest, for some of the foremost engineers, acousticians, and manufacturers in the world have been applying their knowledge, ingenuity, and financial resources to overcome the criticism heaped upon them by the public and the trade alike. These problems, of course, are being solved, and even we are involved in our own small way in providing new solutions to circumvent the problem.

Loudspeaker testing involves a number of "standard" procedures and "standard" environments. These generally include the use of swept oscillators, synchronised chart recorders — which are capable of measuring the level of the resulting sound — precision laboratory microphones, and suitable amplifiers to power the speaker. A typical setup of the type we use ourselves is shown in Figure 1. Whilst such a system can provide accurate and elaborate information, an additional element is normally required in the form of a suitable test environment. The preferred environment is an anechoic room, which to the uninitiated is an echo free room where all the reflections above a frequency known as the "cutoff frequency" are attenuated. This results in the output of the speaker, rather than the combination of the speaker plus reflections, being recorded and thereby provides an accurate (even if unnatural) evaluation of the speaker's performance.

Another type of environment sometimes used is the hemichoic (or hemi-anechoic) room, which is an anechoic room with a solid, normal floor. This type of environment is often used with speakers requiring a reflection element, such as a floor, for them to function properly. Another type of environment is the reverberation chamber, which is a large diffuse room featuring long reverberation times which make it possible to measure the total acoustical output of the loudspeaker, its electro-acoustic efficiency, and effective sound power generated, with greater ease than in the anechoic room. Whilst we use our reverberation chamber for special speakers, particularly those designed to interact with walls and floor, this type of testing environment is seldom used for conventional loudspeakers of the type most frequently manufactured or purchased by the public.

There are a number of other parameters which are conventionally evaluated and used to test loudspeakers. These include the total harmonic distortion at various power levels, off-axis sensitivity, phase

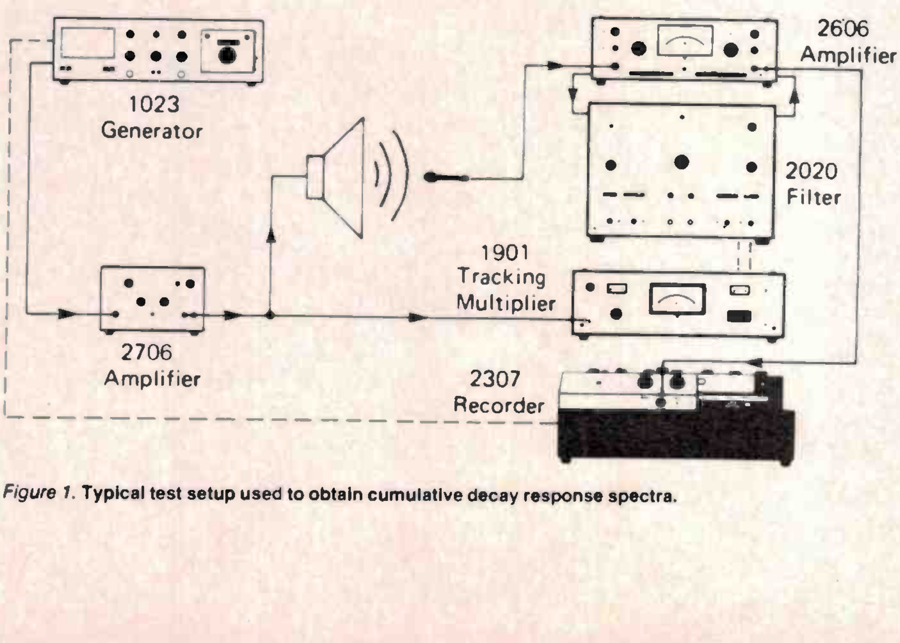


Figure 1. **Typical test setup used to obtain cumulative decay response spectra.**

response, speaker impedance, and electro-acoustic efficiency. All of these parameters are normally evaluated, either as a continuous function and presented as a graph, or sometimes at discrete frequencies, as called for.

The evaluation of these parameters has been the backbone of laboratory testing for more than forty years, and whilst such tests do tell you a great deal about the loudspeaker, they do not really tell you enough. Put another way, if the results are all bad the speaker most probably sounds terrible, but if they are all *good*, there is still absolutely no guarantee that the speaker will *sound* good. Obviously, if you think about it, all these parameters fall into the realm of "steady-state" parameters, whilst the loudspeaker in reality is fed with signals which are seldom steady-state. What this amounts to is a situation in which we tend to be comparing apples with pineapples; they may both be fruit but that is where the similarity begins and ends.

About two decades ago some bright engineers decided to try and evaluate the transient performance of their loudspeaker with bursts of sine wave using a device which is now commonly known as a tone-burst generator. The results of this evaluation when viewed on a cathode ray oscilloscope synchronised to the mark-space ratio of the signal, exhibited a number of exciting and different visual features.

The first of these features was that when the evaluation was performed in an anechoic room, particularly at high frequencies, it was possible to produce different results for different speakers. The results depended on the exact frequency chosen, the type of crossover network, and other factors which could not be readily explained at that time. Thereafter, most researchers and many reviewers, ourselves included, made extensive and sometimes outrageous use of tone-burst evaluations.

The problem with tone-burst evaluations was that they introduced new information content, created as a result of the step process initiated at the start and finish of each cycle. This information was in many respects more dangerous and often more confusing than it should have been, as it produced unwanted effects which often masked the phenomena which were actually being searched for. It did not take long for a number of researchers to produce a clear exposition of the problem, resulting in tone-burst testing being labelled as unfair, inaccurate and often biased unless certain precautions were taken which would be likely to nullify the objectivity of the test anyway.

Around about the beginning of the 1970s one clever scientist, Laurie Fincham, who is well known at the International Electro-Technical Commission TC29 meetings, presented a series of papers on a new method of evaluating loudspeaker performance. His procedure was only made possible through the release of a range of new powerful computers and associated fast Fourier analysers. These made it possible to generate, sample, store and analyse copious quantities of analogue data, which was converted into a digital format prior to the complex procedures which followed.

The basis of Fincham's system was to feed the loudspeaker with a series of specially shaped transient signals, which were then recorded by a laboratory microphone with a flat frequency response and known phase response extending from 20 Hz to beyond 25 kHz. The results were sampled and averaged before being converted by the computer into a signal on which a complex frequency analysis was performed. The analysis was far more complex than a conventional Fourier analysis, for it set out to produce a series of sequential Fourier analyses which presented the frequency response of the loudspeaker at a number of increments in time from time zero (the actual creation of the pulse) to some subsequent time after the signal had died away.

Obviously, with the power of a computer and the flexibility of a digital plotter it was possible to summate all this information and present it as a three-dimensional plot — which is frankly the *only* way in which it could be readily assessed.

Fincham's interest in this approach was far from academic. As the Technical Director of K.E.F. Loudspeakers in the United Kingdom he was searching for the solution to the enigma which had troubled him and all other speaker manufacturers, that objective testing and subjective testing were still so far apart that they could not reliably base manufacturing or marketing on the results of their laboratory testing. What he had developed, of course, was the first objective test which presented a graphical presentation of the transient sound produced by the speaker, taking into account both frequency and time (see Figure 2).

A typical analysis produced by Fincham revealed a strange and almost unbelievable picture of what the typical loudspeaker does to its emitted sound after being excited by a transient. The picture takes the form on the time zero line of a smooth frequency response (with a linear frequency scale) of what the speaker produces under steady-state conditions.

With increasing increments in time after switch-off this sound dies away, producing various decay times which are obviously a function of frequency, but more importantly, a function of the natural resonance characteristics of the loudspeaker itself. Here for the first time it was possible to *see* what could previously be *heard*, but which did not show up in conventional steady-state objective testing. The typical mountain peaks or spurs radiating out at discrete frequencies constituted resonances of ▶

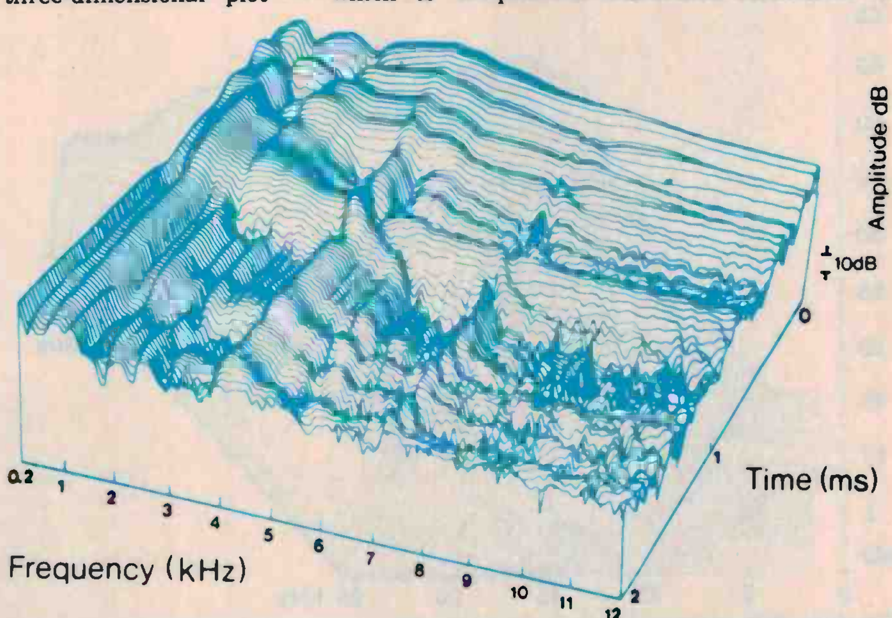
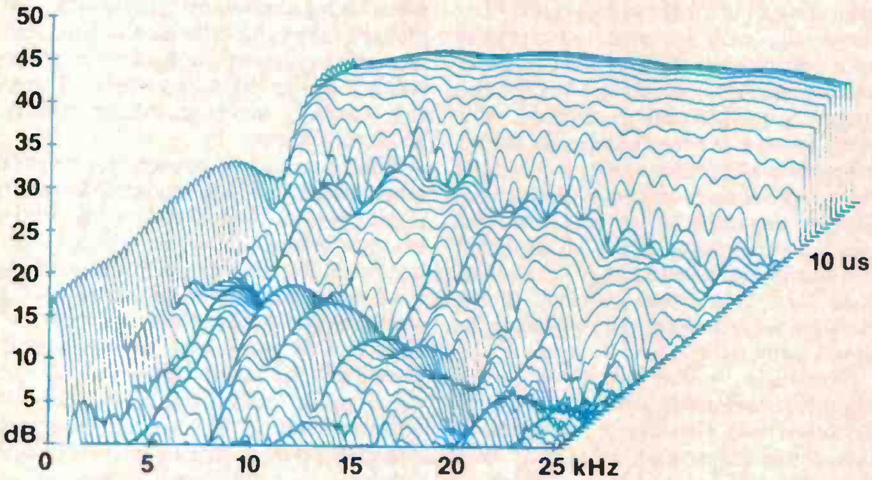
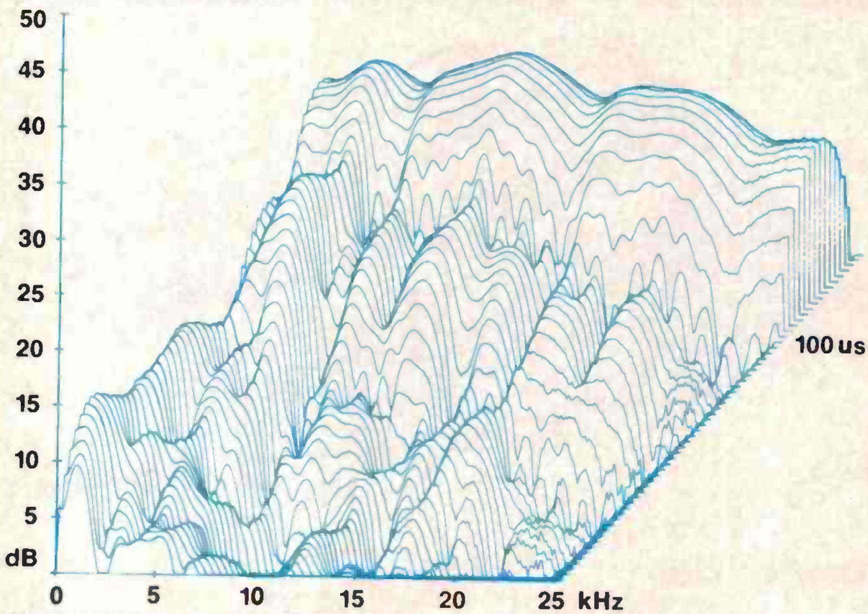


Figure 2. 'Three-dimensional' plot of the 'decaying' response of a loudspeaker excited by a specially-shaped pulse, as produced by Laurie Fincham.

A view of Louis Challis' laboratory. All ETI's objective equipment measurements are carried out here, loudspeakers of course in the anechoic chamber, which is a few metres away.





Cumulative decay response spectra graphs for two different loudspeakers, produced in the Challis laboratory. Note these are somewhat different to Fincham's isometric plot, but the details are clearly shown nevertheless.

the speaker system, either from the speaker diaphragm, the speaker basket or the enclosure itself. These resonances decay more slowly than the other responses do at other frequencies and thereby create the tonality, colouration, and consequently the abnormal sounds that separate one speaker from another and more importantly, the best speakers from the rest.

When Laurie Fincham presented his first papers at the A.E.S. in America, the technical world was agog. Whilst Fincham himself is modest and unpretentious, he realised the value of what he had produced as did the firm for whom he works.

Here for the first time was not only an objective test method by which speakers could be evaluated, but more importantly, an objective test method through which they could be improved and by which those improvements could be objectively as well as subjectively assessed.

Before you could say "Fourier transform" or even "Jack Robinson", half a dozen other manufacturers, most notably in Japan, were working on their own versions of the Fincham technique, for here quite obviously was the greatest thing that had yet happened in the world of objective loudspeaker testing. It is now no secret that the latest generation of superlative K.E.F. loudspeakers are the direct result of the Fincham technique, and that quite a few of the best Japanese speakers are able to ascribe their quality to the use of an 'eastern' version of the same technique.

For more than six years the editors of ETI and I have realised that it was only a matter of time before we too would have to join the ranks of the "me too's" and emulate Fincham. It had to await my purchase of a new digital narrow band Fast Fourier analyser, which could be interfaced directly with my existing computer and real time analyser, before I could start to contemplate reproducing the Fincham technique. We already had our anechoic room, which is one of only a handful in Australia, and this simplified the task, for Fincham had already found and recorded that the lack of an anechoic room had initially made his task very much more difficult.

The research and development of our system had to await the completion of more urgent work which seemed to keep the equipment busy week after week. In the end, when it was clear that this situation was not going to change, a decision was made to transfer the research and development work to weekends and thereby make it possible ▶

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. . . see pages 48-49

Kodachrome slide film... full color, sharp color.

What some Australian photographers say about Kodachrome slide film:

"For nature and close-up photography... incredible sharpness and color rendition." – Otto Rogge (Beetle)

"When I want good accurate color, very fine grain and extreme sharpness." – Peter Hunter (Cricket Match, Puffing Billy)

"A certain snap or visual impact is apparent in photos taken with Kodachrome film." – Doug Spowart (Bird).

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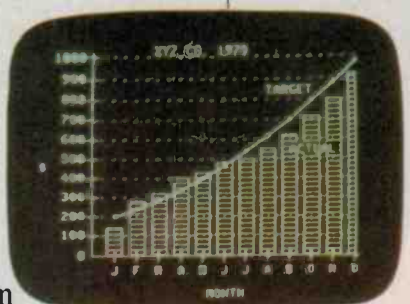
Apple personal computer systems help you collect, store and analyze data as fast as you can load a disk and execute a program. Because more than 100 companies offer software for Apple, you have the largest program library for manipulating your data in the personal computing world. Need special programs? Use any of Apple's development languages — BASIC, FORTRAN, Pascal.

2 In engineering

Apple personal computer systems let you define models, make trade-offs and refine prototypes. Want to study cause and effect of several variables? Apple computes new results instantly and displays them in colorful, easy-to-read graphs, charts or plots on a video monitor.



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Apple personal computer systems make it easy to gather data, analyze productivity, measure yields and facilitate all phases of production control. Want to speed up repetitive tasks? Rely on Apple's word processing capabilities to write, edit and print your reports.

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Maximum Memory Size	64K bytes	128 bytes
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Keyboard	Fixed	Programmable
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Disk Drives	Add-on one to six drives	One drive built-in, plus interface to support three more drives
Languages	BASIC Fortran 77 Pascal Assembly Pilot	Enhanced BASIC Fortran 77 Pascal Assembly
Typical Configuration Pricing	CPU, 48K RAM, single disk drive, B&W Monitor (9"), Silentype™ printer, and BASIC.	CPU, 96K RAM, integrated disk drive, B&W Monitor (12"), Silentype™ printer, SOS, Enhanced BASIC.

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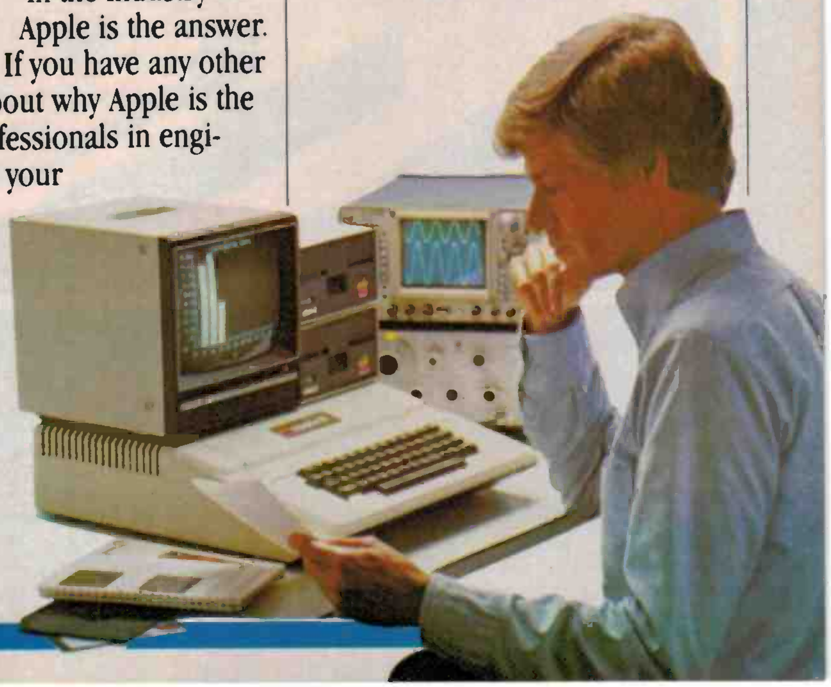

I've finally found a personal computer I respect. Compucolor II.

It's not surprising that professionals get excited about the Compucolor II. It's a totally-integrated 8080A system with full color graphics display, 51K mini-disk drive, and the best cost performance ratio available in a personal computer.

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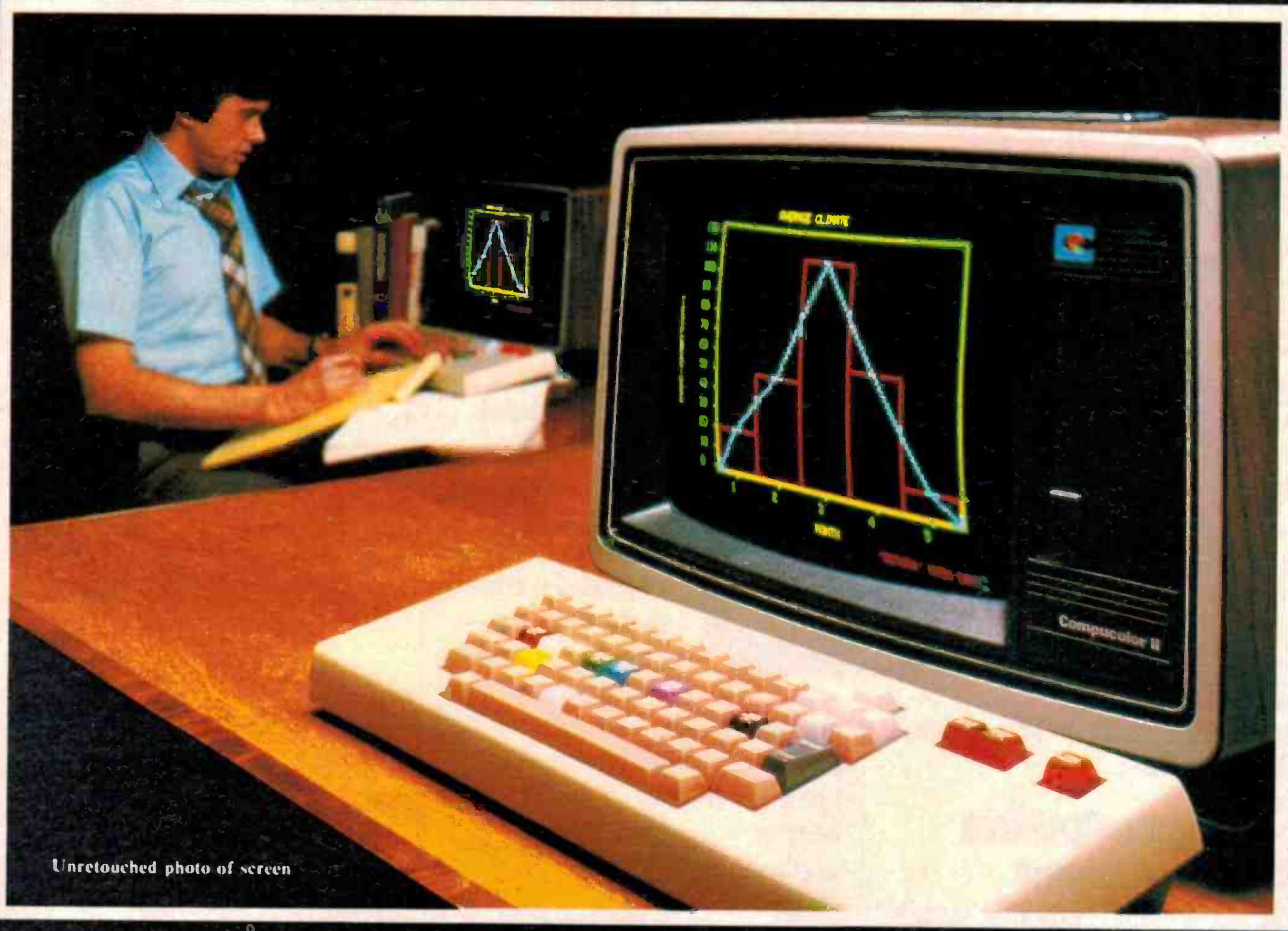
Compucolor II offers a number of other options and accessories, like a second disk drive and expanded keyboard, as well as expandability to 32K of user RAM. Of course we also have a whole library of low-cost Sof-Disk™ programs, including an assembler and text editor.

Visit your nearest computer store for details. And while you're there, do some comparison testing. With all due respect to the others, once you see it, you'll be sold on the Compucolor II.



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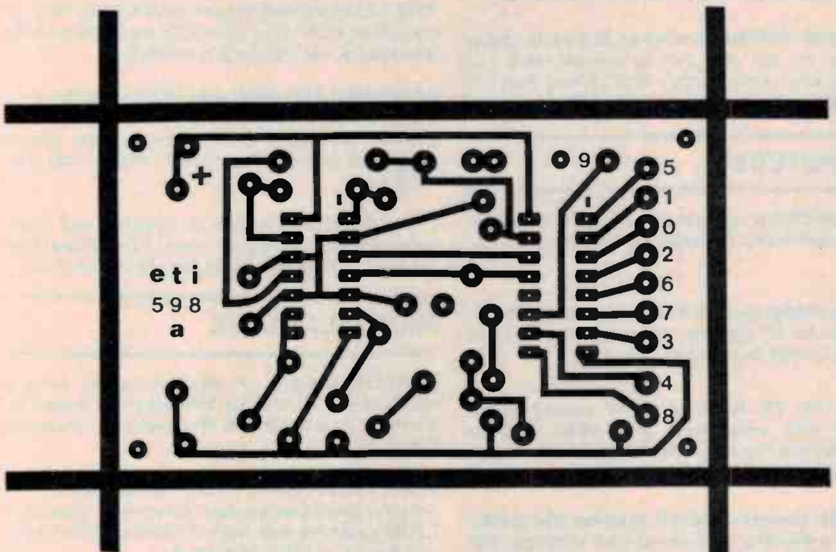

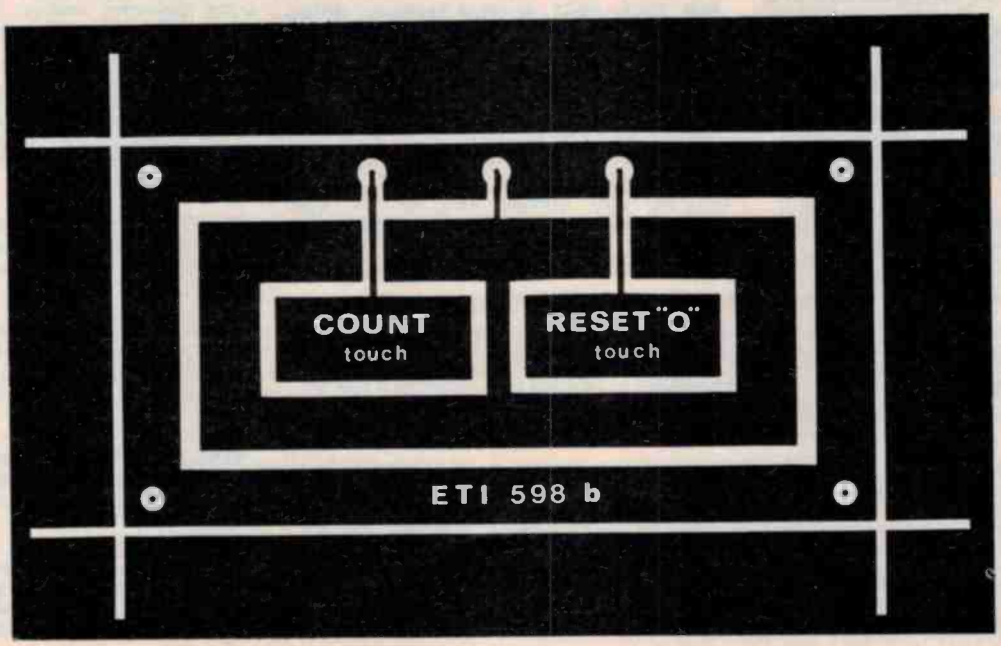

Using ETI PCB Artwork

This method can be used to make negatives of ETI artwork from October 1977 on, provided the reverse of the page is printed in blue. The film used is Scotchcal 8007 which is UV sensitive and can be used under normal subdued light.

Cut a piece of film a little larger than the pc board and expose it to UV light through the magazine page. The non-emulsion side should be in contact with the page. This surface can be detected by picking the film up by one corner — it will curl towards the emulsion side. Exposures of about 20 minutes are normally necessary.

The film can now be developed by placing it emulsion side up on a table, pouring some Scotchcal 8500 developer on the surface and rubbing it with a clean tissue.

Further information on Scotchcal and pcb manufacture can be found in the September and December 1977 issues of ETI.

Please note that occasionally lack of space may prohibit the printing of blue type behind all pcb's. In this case the reader must resort to more conventional photographic techniques for pcb manufacture.

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Where readers can advertise — For Sale/Wanted/Swap/Join.

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Send your advert to:
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MAKE FULL USE of your cassette recorder. Full details: The Tape Club of Australia, P.O. Box 118, Wellington NSW 2820.

SPEAKERS: Playmaster 3-way, 12", 80 W system in 75 litre enclosures. Beautiful sound, perfect cabinets. $250 pair. Will gladly demonstrate. Brian, (02) 579-6867 after 5 pm.

BOOMERANG TAPE RECORDING CLUB: Established 1972, we promote tape recording through many varied activities and services. Only $9/year. Enquiries: P.O. Box 155, Carlingford NSW 2118.

COMMUNICATIONS

FOR SALE: FRG-7 communications receiver — $200. Kenwood TR-72006 2 m FM transceiver — $100. Contact C. Nash, 24 Haughton St, Red Hill, Qld. Phone 36-5575.

WANTED: RF spectrum analyser, 3.5 to 500 MHz. G. Campbell, phone ah. (02) 81-2143.

FOR SALE: Collins KWM2 with p/s. Very clean, excellent rig. Can be heard on air. $650 o.n.o. Phone (066) 86-2718. J.W. Larsson, VK2 BVC.

KENWOOD TS120S transceiver, 200 watts, digital readout, inc mic and service manual, plus 13.8 volts 25 amp power supply $750. Phone Bert (03) 758-4086 (a.h.).

COMPUTERS

SINCLAIR ZX80 programs. Send SAE for details to Sinclair Software, 35 Herbert St, Mornington Vic. 3931.

ITHACA AUDIO IA-1130 S100 floppy disk controller pcb. All IC sockets, regulators, no ICs, no circuits — $40. Phone (03) 848-1257.

MICRO, F8, 8 K RAM, +/−12 V supply, all in cabinet with card cage, plus VDU, cassette interface, and more — $350. Burwood, Vic. Phone 299-1712.

WANTED: Second-hand SD systems Z80 starter board, preferably assembled and working. Will pay to $250. Write Greg Bond, Potts Road, Cranbourne Vic. 3977, or phone (059) 78-2613 ah.

FOR SALE: ASCII encoded keyboard, 63-key, assembled and tested. New, unused. $80 ono. Write Greg Bond, Potts Road, Cranbourne Vic. 3977, or phone (059) 78-2613 ah.

16K DYNAMIC RAM on-board refresh, 4 MHz, S100 memory boards — only $300, assembled, tested and burned in. Phone (085) 84-1347 ah.

ETI 640 VDU, working, $120; HP 19C, good condition, with 1 K RAM, $250. Phone Clifford, (02) 604-3819.

FOR SALE: 2 × 8" Shugart disk drives, $500 each. 1 × Intertech Intertube II 80 × 24 VDU, $1000. 1 × Tarbell single density disk controller, $240. 1 × DG Z80 CPU, $100. Or the lot for $2000. Phone (02) 633-5999.

NATIONAL SINCLAIR ZX80 USERS CLUB: Tips, discussions, sample programs, news and marketplace. Write for free introductory newsletter to 24 Peel St, Collingwood Vic. 3066.

OTHELLO: Challenge your LII System 80/TRS80 to this intriguing game of strategy. For tape and listing send $5 to G. Lawrence, P.O. Box 191, Heidelberg Vic. 3084.

SCM I/O electric typewriter, suit word processor and computer applications, non-ASCII, parallel input — $225. Long, 46 Gloucester St, Sydney 2000. (02) 27-2982 ah.

FOR SALE: S100 16 K static RAM A & T — $250 ono. Also two games to suit zero-one CPU ($8 on cassette). M. Russell, 21/1 Corby Avenue, Concord NSW 2137. Phone (02) 747-4227.

SYM-1 6502 microcomputer incl 2K RAM, VDU. Ex condition $250 o.n.o. David Leslie, 9 Gordon St, Beaumaris, Vic. Phone (03) 93-6922.

SORCERER 16K RAM with BASIC and development packs, word processor, VDU, IBM Selectric golfball typewriter with interface, plus games programs and manuals $3000. Phone (02) 633-4915 a.h.

C1P OWNERS: 10 original, graphic and other programs $20. Saving for floppy, please help! Paul Janson, 14 Hayward St, Kanahooka, NSW 2530.

MISCELLANEOUS

WANTED: Antique or old-style record cutting machine — 33⅓, 45 or 78. Will repair. Mr. Harwick-Sinclair, 70 Copperfield St, Geebung, Brisbane Qld. 4034.

ELECTRONIC ORGAN, ¾-built, in cabinet. 2 × 44 note keyboards and pedals. Also two professional Leslie speakers with built-in 50 W amplifier. NAZ (02) 631-5111; (047) 39-1348 ah.

WILL SELL to best offer 500 kHz oscilloscope, signal generator, meters: level, RLC, others. Phone (02) 724-4411. 9/17 Hughes St, Cabramatta NSW.

AKAI video power adaptor current model VA-7100EG. (checked by Akai), provision extra battery charge (new $229) $95 o.n.o. G.E. Julien, 68 Ada Av, Wahroonga, NSW 2076. Phone (02) 48-3689.

WANTED: HP 19C calculator in full working order. Urgently needed. Martin Smith, St Pauls College, Newtown, NSW 2042. Phone (02) 514-1693 after 7.30 p.m.

ANALOGUE devices 16 bit D/A converters (3 off), 14 bit (.003% linearity) type DAC-14QM. $500 each (new price $800 ea). G. Cohen, 72 Spofforth St, Holt, ACT 2615. Phone (062) 49-2688 b.h., 54-7608 a.h.

TRANSFORMERS: 240V fused primary, 5.5V - 6V - 6.5V secondary, 6V tapping at 30 amp. Bob Ingram, 37 Faraday Rd, Sth Croydon, Vic. Phone (03) 723-2050.

TEXAS Instruments TI59 portable programmable computer as new with box, all instructions, card reader. Only $200. G. Buckley, 69 Bancroft Av, Roseville NSW 2069. Phone (02) 406-5218.

from page 124

to complete this development work.

The results were better than expected and the program was soon churning out (albeit slowly) beautiful cumulative decay response spectra for all the loudspeakers in the office and laboratory, listening rooms and from my home.

These results looked different to what we were used to seeing, as the frequency response was linear as opposed to logarithmic, but fortunately our Bruel & Kjaer oscillator can also produce linear sweeps from dc to 20 kHz as well as the preferred log sweeps. Each time we produced a cumulative decay response spectrum we produced a linear swept frequency response for the same speaker set up in the anechoic room. The results were remarkably faithful reproductions of the cumulative decay response spectra at zero delay time. Here at least was the first positive confirmation that the program was working correctly (even if only at the start of the decay).

We then resorted to conventional tone-burst testing at those frequencies where the nasty resonances showed up on the digital analysis and, lo and behold, achieved a remarkable correlation between the two techniques even though we had been fully prepared to discount the accuracy or validity of the conventional tone-burst method.

The most important confirmation, however, came from our ability to hear on normal program content what we could "see" on the cumulative decay response spectrum. All the speakers which sounded coloured exhibited this colouration on the cumulative decay response spectra, whilst those speakers which sounded clean or true to life and provided a degree of realism greater than their poor brothers were found to have cleaner cumulative decay responses, flatter frequency responses, smoother phase responses, and if one resorted to them, even better conventional tone-burst responses.

Fincham's technique is now available not only to K.E.F. in the U.K., Matsushita and Sony in Japan, but more importantly, to ETI in Australia. In future, it is our intention to evaluate all loudspeakers and headphones using this technique and present the results with suitable commentary so that our readers will be in a position to assess a loudspeaker without necessarily being able to hear it. We have already assessed most of the loudspeakers that we have reviewed over the last few months and all those awaiting publication at this moment. The results are exciting and we believe that you will find this analysis technique to be just as exciting and informative as we have. ●

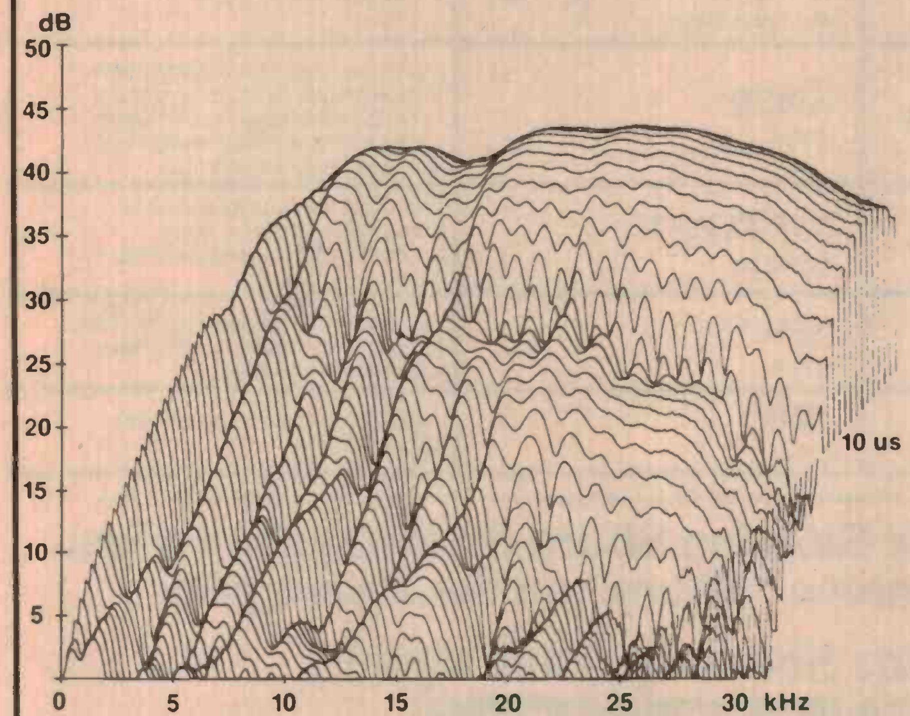
INTERPRETATION OF CUMULATIVE DECAY RESPONSE SPECTRA

The cumulative decay response spectrum is presented as a three-dimensional plot of the smoothed response of the computer's interpretation of how a broad band signal dies away at discrete increments of time following its excitation. The two mutually perpendicular axes plotted have 5 dB increments on the Y axis and typically 5 kHz frequency increments on the X axis. It should be noted that the analysis uses a linear bandwidth in lieu of the more typical logarithmic analysis used in our conventional level recordings. The Z axis is not drawn but the interpretation and presentation uses a typical increment of 10 microseconds for the 25 kHz bandwidth analysis. The topmost line is the smoothed frequency response interpretation derived from the impulse response, whilst the individual lines plotted thereafter are the smoothed interpretation of how that frequency response dies away with increasing time (in increments of 10 us).

If a speaker introduces colouration or effective frequency modification because of self-resonances, reflections or general non-linearities in performance, then these show up as transverse ridges radiating from the top of the graph down towards the bottom. The steepness of the ridge is a measure of how rapidly the resonance dies away; if the ridge extends from the very top to the very bottom of the graph then the colouration is pronounced and most probably clearly audible. The more ridges there are, the greater the extent of the colouration, and if they are apparent in the steady-state signal then it is clear they are affecting and modifying the normal level recording response as well as the transient response.

The ridges on the extreme left hand side of the cumulative decay response spectrum should not be interpreted as a rising low frequency response; they are created primarily by the real-time analyser, whose output gives rise to this anomalous response. On the very best and cleanest loudspeakers, at the very lowest levels and typically after 300 us it is possible to discern low-level reflections from the structure supporting the wedges in the ceiling of our anechoic room. This problem will be obviated in future analyses.

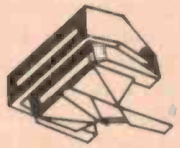
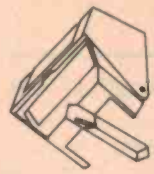
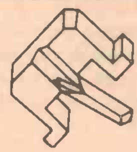
It is observable that a good speaker produces a cumulative response spectrum which 'looks good' and a poor speaker or one that in simple terms does not sound good produces a plot which looks like the 'mountains of the Moon'.



This response graph, obtained on the Peerless PAS-30 loudspeakers reviewed in the December 1980 issue, shows a very low level of initial colouration. Whilst there is colouration evident at 3 kHz, 5 kHz, 7 kHz and 11 kHz, this is not *very* pronounced. The tweeter colouration, being very low, is particularly good.

fact:
a Genuine Shure upgrade stylus is unquestionably the biggest bargain in hi-fi

We strongly urge you to check your stylus for wear at least once a year to protect your records and maintain the highest standards of listening pleasure. Regardless of when (or where) you purchased your Shure cartridge, there is a Genuine Shure replacement stylus available which will bring your cartridge right back to its original specifications. Even better, *you may actually be able to improve its performance significantly over the original* with a Genuine Shure upgrade stylus . . . at surprisingly low cost! For example:

IF YOU OWN:	UPGRADE WITH:	THIS IS THE RESULT:
 **V15 Type III SERIES**  **M95 SERIES**	**VN35HE** Hyperelliptical stylus  **N95HE*** Hyperelliptical stylus 	A dramatic reduction of harmonic and intermodulation distortion (formerly available only to owners of the incomparable V15 Type IV) is now possible with the V15 Type III and the M95 Series of cartridges simply by replacing the stylus. The Hyperelliptical stylus configuration contacts the record groove in a "footprint" that is longer and narrower than the popular Biradial tip design, making it pre-eminent for reproduction of the stereo-cut groove.
 **M70 SERIES**	**N72EJ** Biradial (Elliptical) stylus **N72B** Spherical stylus 	Improved trackability, especially at high frequencies, due to a new, redesigned low-mass N72 stylus assembly.
ANY M91, M92, M93	**N91ED*** stylus	Much improved trackability due to the lower effective tip mass of the nude Biradial (Elliptical) stylus tip. Less tracing distortion compared with a Spherical stylus tip.
ANY M71, M73, M75	**N75 TYPE 2*** Series styli	Improved trackability at higher frequencies due to a stylus assembly with a lower effective tip mass.
ANY M44 Series	**N55E*** stylus	Lower tracking force with a Biradial (Elliptical) stylus, lower distortion, lower effective tip mass.
M3D, M7D	**N21D*** stylus	Improved performance at lower tracking forces.

*** Before purchasing any replacement stylus be certain your turntable is compatible with the tracking force of the stylus you select.**

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Discs Referenced Above
1. Three Blind Mice TBM5005 "No Tears"
2. East Wind EW1001 "The Three"
3. Telarc DG10039 "The Firebird"
4. Telarc DG10040 "Malcolm Frager Plays Chopin"
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SCOOP REVIEW!

Nakamichi's flagship — the 1000ZXL cassette deck

All the bells and whistles and faultless performance. But what's Mr Nakamichi going to do for an encore?

Louis A Challis

HAVING REVIEWED the Nakamichi 482 Cassette Deck in August 1980 and stated prophetically "we still don't doubt that Nakamichi themselves are working right now on refinements to improve this performance", we were not particularly surprised to receive an invitation in September to see the new top-of-the-line Nakamichi 1000ZXL Cassette Deck.

It was Mr. Nakamichi himself who demonstrated the unit to us and sang its praise. He described its virtues and briefly held us enthralled by the concept of a machine which automatically computes its own bias setting and azimuth alignment in order to optimise the record to replay characteristics of a tape.

The Nakamichi 1000 Series II (and previously the Series I) cassette recorder, which this machine replaces, has been the flag bearer of the company for almost nine years. Whilst that machine was state of the art when it was released, it has now been replaced by most other manufacturers' top-of-the-line recorders and most certainly by most of the current range medium-priced Nakamichi machines.

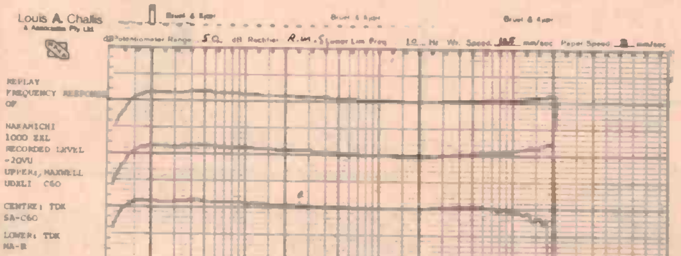
Obviously what Nakamichi had to produce was a machine which incorporated all of the new mechanical capstan drive features, electrical auto azimuth alignment and gimmicky random access music memory features of the 680ZX whilst discarding the half-speed option incorporated in that recorder. The 680ZX machine was intended to follow the 1000ZXL but some of the technical problems had not yet been solved. As a consequence the 680ZX was released first and stole some of the limelight that was originally intended for the 1000ZXL.

The 1000ZXL really has a number of features which place it in a pre-eminent position. Firstly, it is the most expensive cassette recorder in the marketplace. The second feature is its ability to extract more performance from any cassette tape than any other machine that we have yet tested. Thirdly, this is the first machine since the release of the first Nakamichi 1000 series machines at the beginning of the seventies to be worthy of the accolade of being described as a 'state of the art' improvement.

Features

There is a strong physical resemblance between the 1000ZXL and the now ubiquitous 1000 series that it replaces. As with all Nakamichi products "black is beautiful" and this unit comes in a simulated rosewood veneered box, although it is actually designed for standard rack mounting with a 468 mm pitch spacing dimension (19" rack) to meet the requirements of professionals as well as the new domestic trend of rack mounting equipment.

The front panel is laid out in four discrete rows. The top row provides visual indications of the state of the auto calibration function, which is the most important feature of this deck. This is controlled by a microprocessor which automatically calibrates the deck for any given type of tape including



gamma-ferric oxide, chromium dioxide and metal tapes.

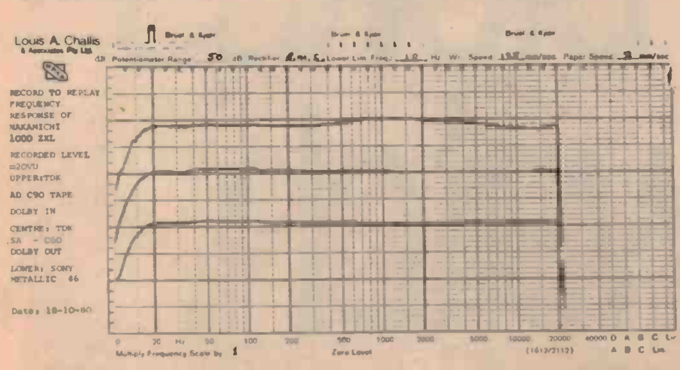
By pressing an auto calibration button whilst simultaneously activating the play button, the automatic calibration procedure is initiated. The machine proceeds to automatically align the azimuth of the heads, which is indicated by the flashing of the auto azimuth alignment button. When this is completed the microprocessor then proceeds to adjust the bias level sensitivity and, independently, the equalisation for both the left and right channels. The microprocessor then rewinds the tape to the start position (0000) and indicates by lighting the standby set button that the machine is calibrated and ready for use with that tape.

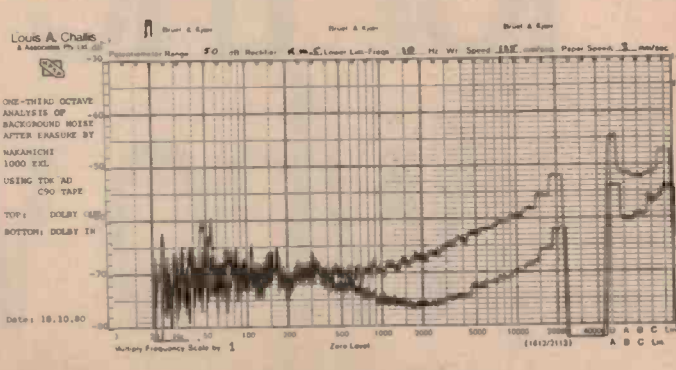
If desired you could proceed immediately with taping, but the machine contains one other function which is both innovative and practical. This is a tape memory facility which allows you to record the characteristics and parameters for four different types of tapes by a single key stroke after a calibration process. On some later occasion the data relating to the equalisation, proper bias level and recording equalisation for this tape are then instantly available by pressing the appropriate key.

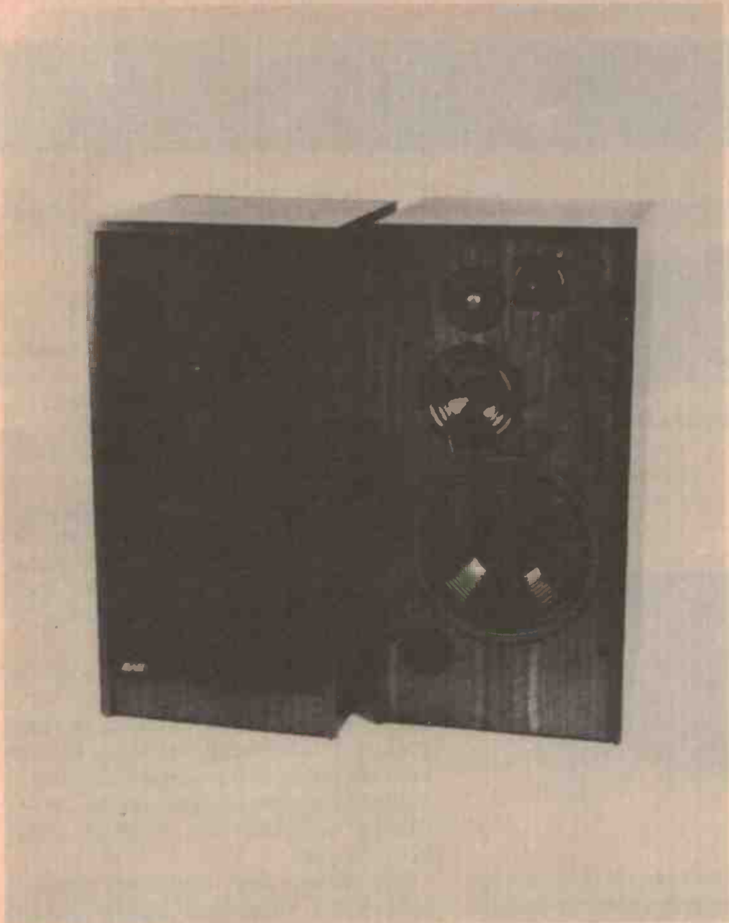
The states of these features are indicated by the equalisation lights and noise reduction selection lights in the top panel to tell you that you have selected the right tape characteristics.

The tape counter utilises a four-digit light emitting diode-type display, and peak and VU type level settings are displayed on a fluoroscan display covering the range −42 dB to +10 dB. This incorporates two separate modes of indications, which are selectable with either peak and a peak hold function being indicated simultaneously or a VU and a peak level being indicated, as selected.

The other indication provided by the display section is the RAMM function ▶







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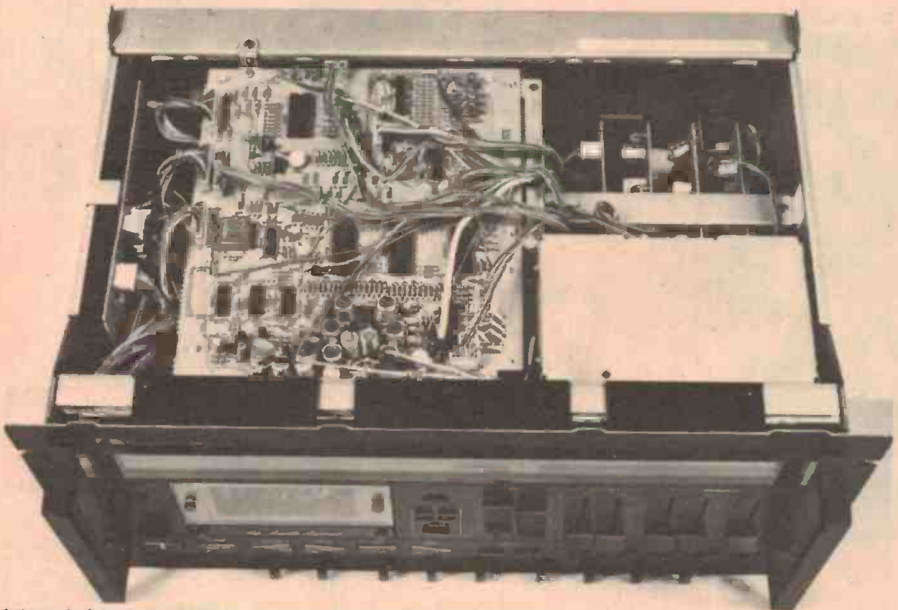


Internal view from the top, showing the modular construction.

(Random Access Music Memory). This system is designed to provide easy location and playing of any desired music selection on a tape. The system works on the basis of recording an inaudible 5 Hz coding signal on the blank space between selections of tape. These signals are then used to automatically program the order selection of the program content required and even to choose repeated playings should this be required. Thus, for example, it is possible to order the machine to play a selection with a sequence with random orders like track 1 ▶ track 4 ▶ track 2 ▶ track 5 ▶ track 3 ▶ track 1 ▶ track 4 ▶ with up to 15 tracks being available.

The Optonica RT7100 system (reviewed in ETI, July 1980) also provided for 15 segments and most probably utilised the same microprocessor. I consider this feature to be something of an unnecessary gimmick which Nakamichi and other manufacturers have incorporated because of the ready availability of microprocessors, but it does no harm to the performance of the cassette deck and is perhaps best regarded as an extra lolly in the bottom of the bag!

The centre of the deck contains the two rows of controls which should be considered as the normal control functions of the machine. The top section has a pitch control to the left of the cassette well which provides up to ±6% speed adjustment on replay only, whilst immediately below it is an eject button which opens the cassette well for loading or unloading the cassette. The cassette cover well is pneumatically damped and features a clear plexiglass front panel. The drive incorporates a double capstan 'silent' mechanism which was not quite as silent as the description would indicate.

Immediately below the opening cassette well cover is a removable cover, behind which are located the screws for adjustment of head height, manual azimuth setting and other controls which the normal user is not intended to touch.

The tape drive incorporates a three-head system based on Nakamichi's unique discrete head configuration and offers performance features that are markedly superior to the 680ZX and the 482/582 class of machines that we have previously reviewed.

To the right of the deck is a counter reset, five buttons for selecting, setting, resetting and programming the RAMM function, and slider controls, with a preferred vertical side by side configuration for the output, line input, left and right microphone and blend controls.

The third level of controls incorporates an extremely well-designed set of large illuminated touch controls for the drive with pause, record, rewind, fast forward, stop and play all featuring clear and sufficiently different discrete indications that confusion is avoided and familiarisation more rapidly achieved.

To the right of these controls are the buttons for selecting auto azimuth calibration, which is used to automatically align the record head azimuth for the tape in use, and the auto calibration button, used to automatically adjust the bias sensitivity setting and the record equalisation characteristics to suit the tape currently in use. The "data set" standby button, illuminated from the rear, then facilitates their setting and storing on one of the adjacent tape memory channels, using buttons A, B, C or D.

The last button in this line up is the manual setting for equalisation and noise reduction, which should be used when it is intended to set these factors independently of the memory function, or if one wishes to change the information contained in a given tape memory store.

The bottom row of controls are the least often used and utilise rotary selector switches. The first switch is the power on/off push button, adjacent to which is a tip, ring and sleeve headphone socket.

The next control is for external timer, which permits unattended recording or playback with an external timer that would have to be purchased separately.

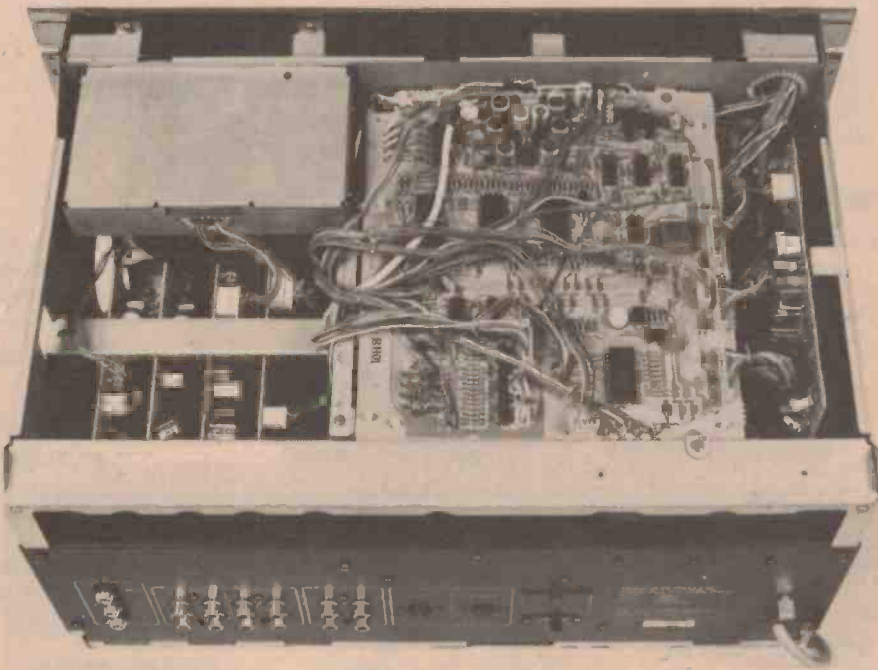
Next to this is a memory switch which stops the tapes at the 0000 position during fast forward or rewind and allows the recorder to automatically drop into the play mode. After this comes a switch for the test tone which provides a 400 Hz 0 dB reference 200 nanowebers/metre signal for level calibration when the recorder is used with other external components.

Next is a bias switch to provide normal bias relative to a 'flat' response in the −20 dB range, while allowing the bias sensitivity and the maximum undistorted output (or overload margin) to be adjusted up or down in both the high and low frequency range. If the recorded signal contains an unusually high proportion of high frequency energy and little low frequency energy then the under position can be selected, whilst for the converse the over position should be used. Nakamichi intend this function to be used only with, as they describe them, 'inferior tapes'.

The equalisation switch provides for 70 and 120 microsecond equalisation for playback and this function is overridden by the automatic controls stored in the tape memory. The filter switch selects either separate or simultaneous cut of the 19 kHz multiplex carrier signal and also allows in a separate position the additional removal of frequency components below 10 Hz, produced by turntable rumble, warped records or tone-arm resonance effects.

The noise reduction switch provides for Dolby noise reduction or the use of an external system such as High-Com II which Nakamichi have been developing in conjunction with other manufacturers. The High-Com facility is not provided and necessitates the connection of the separate encoding/decoding unit, but it can provide a dramatic improvement in signal to noise ratio.

The last but one switch is for the selection of peak hold or VU and peak settings on the plasma display, whilst the last switch is for monitoring tape or source.



Internal view from beneath.

Considering how many facilities are provided on the front, the rear of the unit is relatively sparse. There are three microphone sockets, eight input/output sockets for connecting an external High-Com II noise reduction system, four input/output coaxial sockets, two remote control sockets for the RAMM and for the functional mechanism control, and a battery socket for the two AA cells to provide the power for the volatile memory associated with the tape characteristics preset buttons when the power is switched off.

The inside of the unit appears to contain more circuitry with a greater component density than even the original model 1000. There is little data available on the electronic side of the unit, because it is so new, but the construction appears to be to professional standards in terms of layout, although the components themselves seem only of consumer standard.

Some of the printed circuit boards on the rear right hand side of the unit are vertically stacked for improved cooling and adequate isolation between the individual boards.

We were surprised to find two boards at the top of the unit stacked with a distance of only 10 mm between them, each of the boards being fully crammed with large-scale integrated circuit modules for the RAMM function and the associated microprocessor.

Unlike the other cassette recorders we have seen with fluoroscan displays, this unit has the display fully encapsulated behind a metal cover, as is its associated electronic circuitry, and the unit makes very great use of conventional wiring harnesses with miniature plugs and sockets providing interconnection on each board.

The power supply fuses are hard wired into the protective circuit board, and the power supply and other components normally accessible in other units are particularly inaccessible in this unit, without resorting to removing panels, covers and framing.

Nakamichi have gone to extreme lengths to label components, boards, positions of boards and to provide effective electrostatic screening within the unit.

On test

The replay frequency response of this unit is unquestionably the best we have seen to date. On low noise gammaferric oxide tape the replay frequency response is ±1.5 dB from 13 Hz to beyond 20 kHz. On chrome or tapes requiring a 70 microsecond equalisation this response extends from 13 Hz to 18 kHz with a rise to 2 dB. On the metal tape position the frequency response extends from 13 Hz to 20 kHz ±2 dB. These characteristics are obviously to be expected in a machine which supposedly 'has it all', and this 'top-of-the-line' machine is no disappointment.

If the replay characteristics were excellent, the record to replay characteristics are even better. On TDK AD the frequency response is ±2 dB from 17 Hz to beyond 20 kHz. On TDK SA it is ±1 dB from 17 Hz to beyond 20 kHz and on Sony metal is ±0.5 dB from 17 Hz to beyond 20 kHz. This sort of performance is not just outstanding, but *puts most professional reel to reel recorders completely to shame.*

The distortion characteristics of the machine are equally impressive and on TDK AD, which is more than good enough to extract superlative performance, the distortion levels at 0 VU are 1.8 and 1.9% respectively at 1 kHz and 6.3 kHz, whilst at −6 VU are only 0.31% and 0.82%. With better tapes (TDK SA and metal tapes) these distortion levels are even lower. The dynamic range with Dolby out is 56 dB(A), with Dolby in is 65 dB(A). The erasure ratio on TDK AD is greater than 80 dB and on Sony metal tape is even greater.

The wow averages at 0.03% peak to peak, whilst the unweighted flutter is 0.1% RMS and the weighted flutter 0.065% RMS. These are particularly impressive figures and are better than guaranteed by the manufacturer.

If the objective testing was im- ▶

Louis A Challis and Associates Pty Ltd

MEASURED PERFORMANCE OF NAKAMICHI 1000ZXL COMPUTING CASSETTE DECK SERIAL NUMBER 01013

RECORD TO REPLAY FREQUENCY RESPONSE AT −20VU:

Tape	Dolby	Lower −3 dB Point	Max. Point and Frequency	Upper −3 dB Point
TDK AD C90	Out	14 Hz	0.5 db @ 70 Hz	> 20 kHz
TDK AD C90	In	15 Hz	-	> 20 kHz
TDK SA C60	Out	14 Hz	1.0 dB @ 70 Hz	> 20 kHz
Sony Metallic 46	Out	14 Hz	0.5 dB @ 70 Hz	> 20 kHz

SPEED ACCURACY: 0.05%

WOW AND FLUTTER:

WOW:	Average	0.03% p-p
FLUTTER:	Unweighted	0.10% RMS
	Weighted	0.065% RMS

HARMONIC DISTORTION:
Tape: TDK AD C90

		100 Hz	1 kHz	6.3 kHz	
0 VU:	2nd	−57.6	−43.5	−46.1	dB
	3rd	−50.4	−35.7	−34.6	dB
	4th	−68.7	-	-	dB
	5th	−57.2	−48.9	-	dB
	THD	0.36	1.8	1.9	%
−6 VU:	2nd	−61.4	−53.8	−51.0	dB
	3rd	−60.0	−52.5	−42.3	dB
	4th	−63.6	-	-	dB
	5th	-	-	-	dB
	THD	0.15	0.31	0.82	%

MAXIMUM INPUT LEVEL:
(for 3% third harmonic distortion at 1 kHz)
Tape: TDK AD C90 +4.5VU

DYNAMIC RANGE:
Tape: TDK AD C90

Dolby Out	52 dB (Lin)	56 dB (A)
Dolby In	58.5 dB (Lin)	65 dB (A)

ERASURE RATIO:
(for 1 kHz signal recorded at +4.5 VU)

Tape:	TDK AD C90	80 dB
Tape:	Sony Metallic 46	80 dB

pressive, then the subjective evaluation was even more impressive. This machine provides the ultimate in ease when it comes to alignment of a tape to achieve the best possible performance. Whilst there are other excellent machines on the market (including one we use in our own office) which provide some of these functions manually, this is the first machine to do the whole thing automatically.

Thus if you happen to like TDK SA, Sony metal tape and Maxwell UDXL tapes, all one has to do is to store their characteristics in the memory and just press the appropriate keystroke when playing the tapes.

After a week of using the machine at home, most of the members of my family became attached to it, got used to utilising its features, and found it just as easy to use as any of the conventional machines already in use at home. By contrast, the older Nakamichi 1000 was somewhat harder to use than a conventional machine if the best possible tape performance was required.

The Nakamichi 1000ZXL is currently the ultimate cassette recorder on the market. Whilst some people might rest on their laurels, I doubt that Mr Nakamichi will, and so the question has to be asked: what can he possibly do for an encore? ●

Nakamichi 1000ZXL Cassette Deck
Dimensions: *527 mm wide x 258 mm high x 322 mm deep.*
Weight: *19 kg.*
Manufactured by: *Nakamichi Corporation, Tokyo, Japan.*
Price: *$3 000*
Distributed in Australia by Convoy International, 4 Dowling St, Woolloomooloo NSW 2011. (02) 358-2088.

TOUCH SENSITIVE 88 NOTE PIANO

Model TS-88

COMPLETE KITS from only $550 + freight.
Construction Manual $2.50
Demonstration Cassette $3.00
Send 30c stamp for more information.

The piano has long been the leading instrument for musical expression where all the subtle emotions of the player are instantly transmitted through the fingers. The 'CLEF' TS-88 is a fully touch sensitive electronic piano that allows the same degree of expression as a conventional piano without the problems of weight, size, tuning, and price that have always been associated with the instrument.

Electronic techniques make this possible in a stylish compact form providing variations in sound from a mellow grand to a tinkling barrelhouse piano and even a harpsichord.

The TS-88 is easily moved and is not adversely affected by the movement or the room conditions, damp or dry, and the tuning remains constant.

Practice need not affect the rest of the family as an amplifier with headpiece facilities can be used. The TS-88 will drive any amplifier from a home hi-fi to the largest on-stage amplifier. A small amplifier can be built into the piano if desired.

FEATURES

- Full 7¼ Octave Keyboard
- Touch Sensitive on all Voices
- Sustain and Soft Pedals
- Tuning Electronically fixed on single internal control
- Five Voices - Mellow, Normal, Bright, Harpsichord and Honky Tonk, plus combinations
- Tremelo and Phasing effects
- Output will drive any amplifier
- Compact Size
- Low Weight 20kg

SPECIFICATIONS

MUSICAL COMPASS
7¼ Octaves A to C

FREQUENCY COMPASS
Fundamental Frequency Range
27.5Hz to 4186Hz
Master Oscillator 1.588 MHz

TOUCH CHARACTERISTICS
Dynamic Range $>$ 30dB
Key Action 50g

SOUND ENVELOPE
Touch Range 2 to 40mS
Attack Period $<$ 1mS
Early Delay 500mS nominal
Sustain 2 to 6 sec.

CONTROLS
On/Off Switch.
Normal Voice Select
Mellow Voice Select.
Bright Voice Select
Harpsichord Voice Select.
Honky Tonk Voice Select,
Tremolo Effect Select.
Phase Effect Select
Sustain Foot Pedal
Soft Foot Pedal

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Pedal Output
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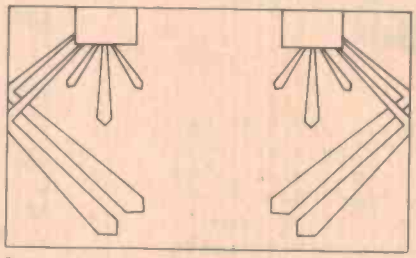
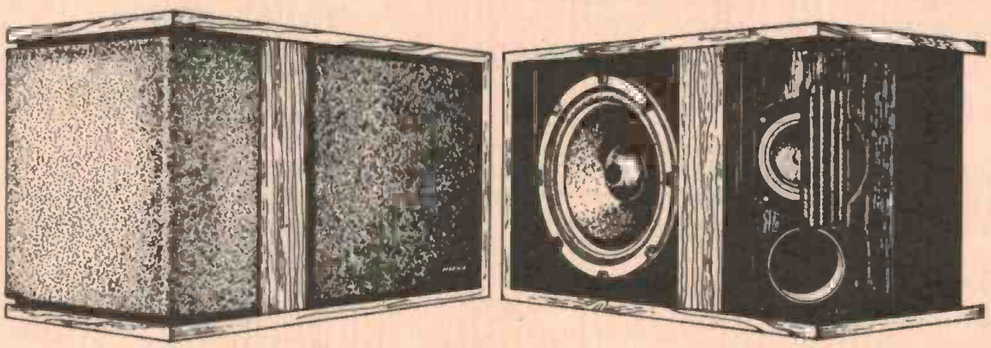
The New Bose® Model 301. Small Size. Small Price. Big Performance.

The Bose Model 301 Direct/Reflecting® speaker system utilizes a carefully produced balance of reflected and direct sound to give you the spatial realism of a live performance. The sound is open, spacious, rich and powerful. Yet unlike some so-called bookshelf speakers, the Model 301 is compact enough to fit on an ordinary-size bookshelf. And you don't have to be rich to own a pair. It's actually the least expensive Direct/Reflecting® speaker system you can buy. Compare the Model 301 against any bookshelf speaker, regardless of price. If you aren't surprised, we'd be surprised. Come in for a personal demonstration.



Balance of reflected and direct sound gives the Model 301 the spatial realism of live-performance sound.



Patents Issued and pending.

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TELEPHONE (02) 684-1022, 684-1255.

The B & W 801 loudspeakers

This is our first review employing the cumulative decay response technique. Louis Challis says these speakers "... should be given the accolade of a 'reference speaker system' ..."

Louis A Challis

BOWERS & WILKINS have always had a reputation for designing unusual speakers; I particularly remember their model DM70, which I reviewed in November 1973. They utilised conventional dynamic low frequency drivers and wide range electrostatic tweeters. Since those early days of the company B & W have revolutionised their approach to the design and assessment of loudspeakers, which has in turn resulted in some revolutionary changes in the products they market and in their manufacturing techniques. As a consequence of the success of their endeavours, the B & W model 801 exhibits a complete change of design philosophy.

I heard about the 801 speaker system well in advance of actually seeing it. In 1980, in discussions with some of my confreres from America and Europe, I was intrigued to find that they already rated the 801 as being the most important new speaker to be recently released. More significantly, at least two of them are already using the 801s as reference speakers for their comparison evaluation of other speaker systems.

The B & W 801 really is an unusual speaker system. Its most immediately striking feature is of course its extraordinary appearance. The enclosures are an expression of the company's design philosophy, which was based on an early determination of the need for a separate enclosure for the mid-frequency driver from that already provided for the low-frequency driver. By utilising a staggered in-line driver configuration they were able to achieve good horizontal dispersion and optimum coherence for the phase relationship between the individual drivers' wave fronts. At the same time they vibrationally isolated the mid-frequency unit from the low-frequency enclosure to achieve resonance-free characteristics.

The base of each speaker consists of a large, unusually shaped, oak-veneered woofer enclosure with chamfered corners, which have been contoured to reduce diffraction effects. The speaker grill, located on the face of the enclosure, is formed over a wire frame covered by an open-weave nylon cloth. This is used to cover the 270 mm diameter low-frequency driver — which is also unusual, as it features a curved thermo-plastic diaphragm coated with a special PVA damping compound to minimise speaker break-up and resonance.

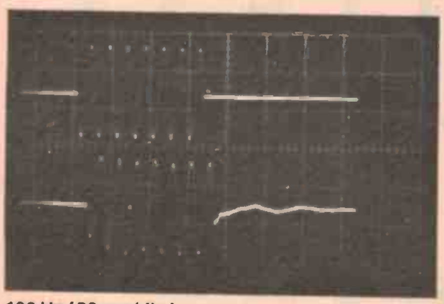
The top of the low-frequency driver enclosure is even more unusual. Firstly, it is surmounted by a geometrically shaped cloth-covered wire frame underneath which the designers have placed a reticulated urethane foam absorptive layer. This reduces spurious reflections from the top of the cabinet and is a significant factor in their achievement of a superlative phase response.

In order to protect the speakers from inadvertent abuse they have included a battery-operated protection circuit which protects the speakers from excessive voltage and current. The circuitry incorporates a small light-emitting diode on a printed circuit card together with a test and reset button to control the active electronics. The switches for this are supplemented by additional bezel plates on the cloth cover, which is fixed over the wire frame on the front edge of the enclosure. This of course avoids the need to take off the cover to reset the protection circuit.

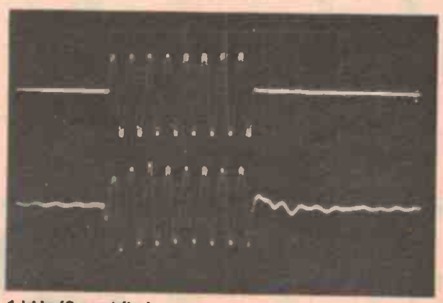
Immediately above this top cover is a geometrically shaped mid-frequency driver enclosure. This features a 125 mm diameter driver whose diaphragm is fabricated from epoxy glass laminate. It utilises a polyamide fibre matrix cone which is impregnated with PVA following a laser interferometry computer-linked pattern.

The magnet assembly utilises a ceramic magnet and the voice coil uses an aluminium-phenolic bonded structure.

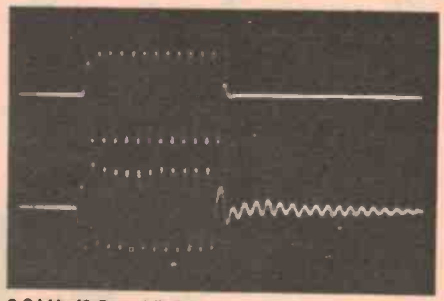
The face of this assembly is covered by an elliptically shaped cloth-covered wire frame, maintaining uniformity of appearance between the circular and truncated hexagonal shapes which the designers have chosen for the basic design configuration. This mid-frequency enclosure is surmounted by a miniature enclosure in which a 26 mm diameter polyester woven diaphragm with mechanical damping and with a total moving mass of only 0.3 gm has been installed. The magnet assembly



100 Hz (20 ms/div.)

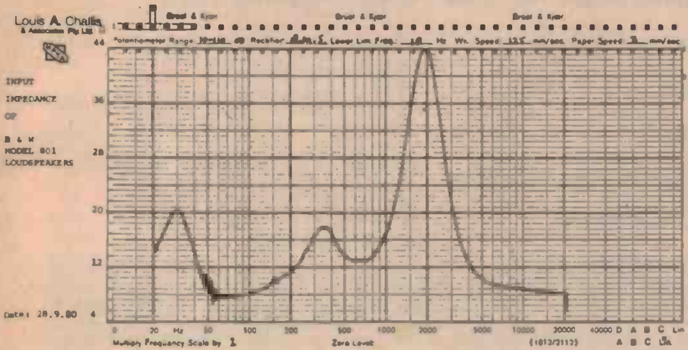


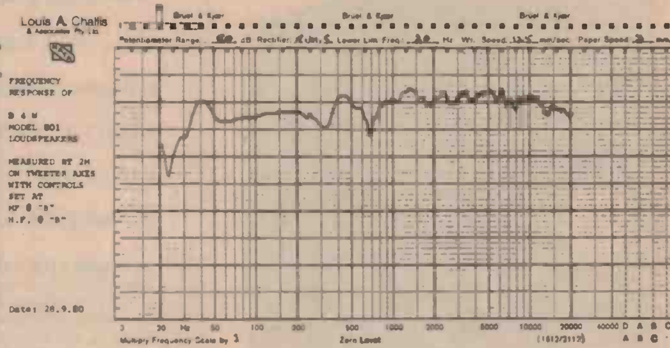
1 kHz (2 ms/div.)



6.3 kHz (0.5 ms/div.)

Tone-burst response of B & W Model 801 loudspeakers, serial number 000018 (for 90 dB steady-state SPL at 2 m on axis). Upper trace is input. Lower trace is loudspeaker output.





for this is a high-energy nickel cobalt centre pole system which achieves remarkable performance in a truly miniscule envelope.

It is very apparent from the set-back of the mid-frequency driver with respect to the woofer and the tweeter, that the designers have gone to a great deal of trouble to achieve a truly linear phase relationship for the three-way system.

The back of the mid-frequency driver enclosure features two attenuators to provide a small degree of contouring for the mid-frequency and high-frequency driver (which B & W describe as the environmental controls), each of which provides A, B and C settings.

The assembly of the mid-frequency driver and tweeter is inserted into a vibrationally isolated recess on the top of the bass driver enclosure. The whole assembly is retained by means of a special plastic-topped sunk-headed screw to provide positive retention and alignment. An optional cloth cover with a more conventional appearance is available to cover the mid-frequency and high-frequency drivers. This cover has obviously been designed to satisfy those owners who object to the space age appearance of the basic design.

The enclosure comes with four castors on the base to handle the not inconsiderable weight, and incorporates a recessed socket on the rear of the unit for the line fuse, together with two polarised terminals to accept banana plugs (which then become essential on the end of the speaker leads).

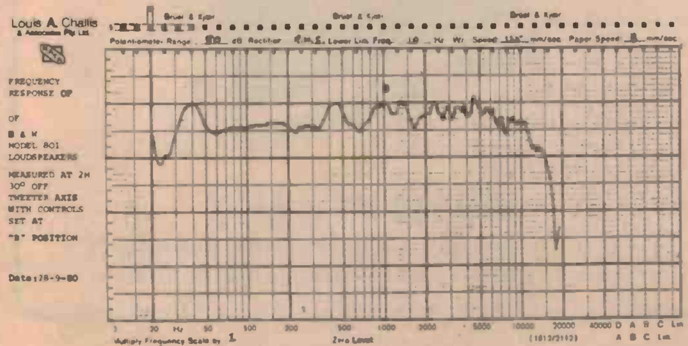
We started the objective testing in an anechoic room with the conventional swept sine wave evaluation of the on axis and off axis speaker response. I was not particularly surprised to find that the frequency response was remarkably flat, nor to find how far it extended both upwards and downwards, compared with other high-quality systems we have previously evaluated. As the graphs show, the response provides excellent performances from 33 to 20 kHz. Even at 30 degrees off the main axis the frequency response extends to beyond 12 kHz, with a usable response to at least 15 kHz.

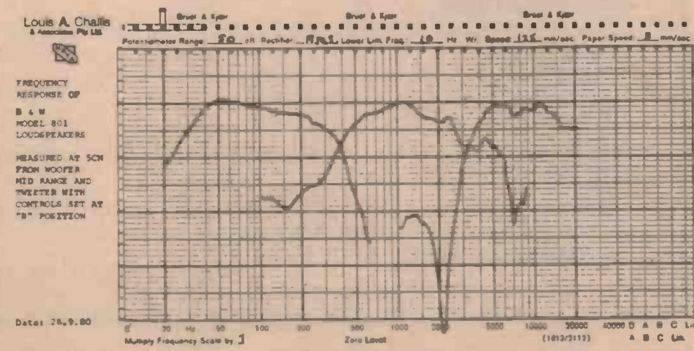
A more impressive feature is the bottom end response which, even allowing for the 30 Hz resonance, is still well controlled.

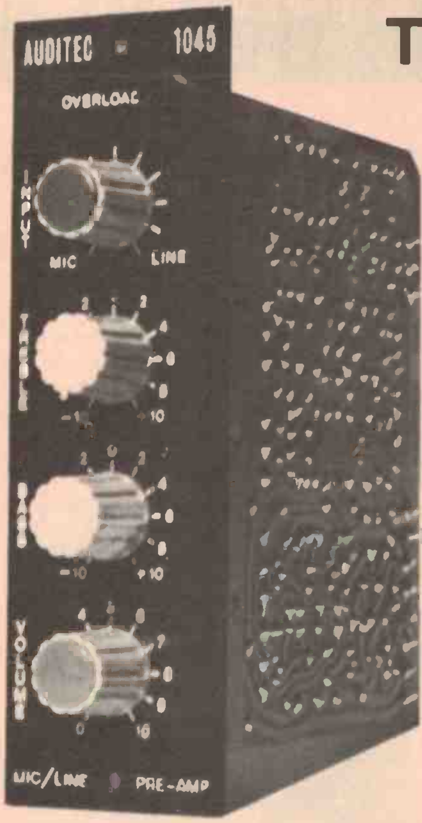
The contouring controls, unlike in most other loudspeaker systems, provide a sensible range of adjustment which features ±2 dB at the upper end of the spectrum and comparable level adjustment of 1 to 2 decibels in the mid-frequency region.

As I half expected, the phase response of the speakers is extremely smooth, being within ±90 degrees range from 2 kHz through to 20 kHz. The impedance curve exhibits a fairly high value at 2 kHz, with an absolute peak value of 44 ohms and a minimum value of just under 8 ohms at 75 Hz and at 20 kHz.

The harmonic distortion characteristics of the unit are a little higher ▶







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Attention all colour TV technicians

At last we are proud to announce a new pocket size PAL TV COLOUR PATTERN GENERATOR.

GENERAL INFORMATION

The TV COLOUR PATTERN GENERATOR, PAL MC-11 B, was intended to be used for control services, installations and repairing of TV sets C.C.I.R. in PAL colour and in the black and white, B and G systems (or I system).
In order to control and adjust the various parameters of the colour TV sets, the MC-11 B has eight adjustment patterns for screen observations.
The technician always has access to the services of this instrument in both the laboratory and in the clients home.
The MC-11 B is a small size pocket generator which one can always have on hand, and thanks to it's autonomic feeding by the nickel cadmium battery, it is always ready for use. An adaptor/recharger is supplied with the generator plus a connecting cable and a Ni-Cad battery.

SPECIFICATIONS

- Output impedance: 75 ohms.
- Signal Pattern:

1. Colour bars. Grey scale in B/W position.
2. Red raster. Grey in B/W position.
3. Crosshatch.
4. Dots.
5. Central single cross.
6. Central dot.
7. White raster.
8. Vertical lines at 2,217 Mhz without sound (half subcarrier frequency).

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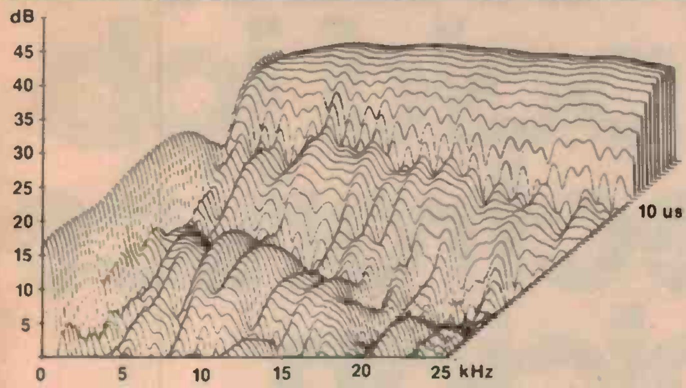
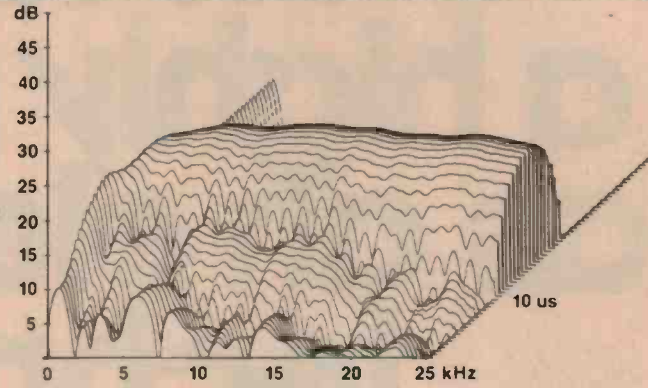
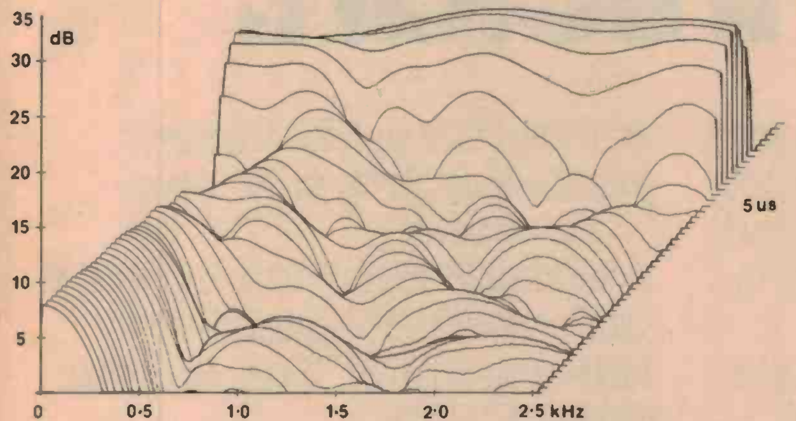






Cumulative decay response graphs for the B&W 801. The above two were taken under identical conditions, but at one metre (left) and two metres (right). Time steps (Z axis) are in 10 microsecond intervals. The analysis shows that the 801 exhibits remarkably little resonance, except for slight spurious outputs at 3, 6 and 10 kHz.

The graph at left shows the critical bass and midrange performance of the 801, taken at 2 m. The result is remarkably free of spurious outputs, indicating very low colouration, confirmed by listening tests.

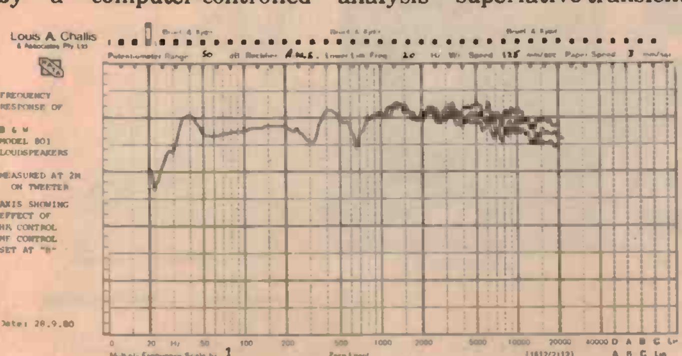
than I would have expected at 100 Hz, but are extremely low in the mid-frequency region and quite acceptable at high frequencies. The conventional tone-burst tests are extremely smooth and only exhibit anomalous decays or any sign of ringing at 6.3 kHz.

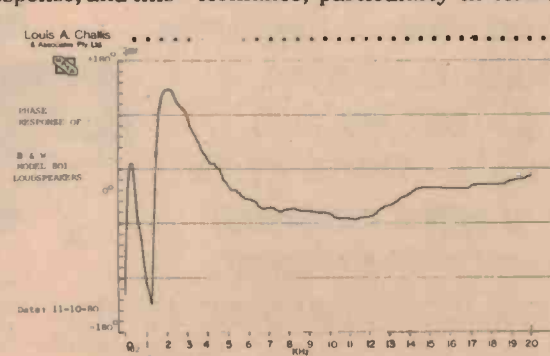
I then carried out a detailed and searching "cumulative decay response spectrum evaluation" on one of the speakers, which produced a remarkable and exciting graphical picture of the transient performance of the 801 speakers. This procedure, which is described in more detail elsewhere in this issue, produces a graphical three-dimensional picture of the decaying transient performance of the loudspeaker. This performance is evaluated by a computer-controlled analysis system using a series of specially shaped pulses which are amplified and fed to the speaker in our anechoic room.

As the three-dimensional plots show, the transient output of the loudspeaker is not only remarkably flat over the frequency domain extending to beyond 25 kHz, but is also particularly smooth in terms of the initial decay response.

The analysis shows that the 801 exhibits remarkably little resonance except for a slight trace of spurious output in the vicinity of 3, 6 and 10 kHz. These spurious outputs are however particularly low and would undoubtedly be the envy of most other speaker manufacturers. The cumulative decay response spectrum indicates graphically that the B & W 801s should have a superlative transient response, and this of course was subsequently confirmed by our subjective evaluation.

The subjective testing and evaluation of the 801 speakers was without doubt the most pleasant task I have had for quite some time. The first and most evident feature of these speakers is the extent to which they are able to faithfully reproduce low-frequency programme content lying in the 20 to 50 Hz region. On organ music and even when reproducing electric guitars, the cleanliness of their response is truly exciting and stimulating. I performed a comparison evaluation of their low frequency response against our normal reference system and found that the 801s offer a fully comparable performance. Some aspects of their performance, particularly in terms of the ▶





overall linearity and balance of the spectrum, are markedly superior.

I played a number of new digital records, including the Telarc Moussorgsky's *Pictures at an Exhibition* and *Night on Bald Mountain*, which was absolutely spine-tingling, and with eyes closed I felt I was in the concert hall with the orchestra during the recording session. When playing a Sony Direct Disc sound recording of the Hido Ichikawa trio in *Direct Piano*, I was able to hear an exciting and brilliant sound which, whilst not creating the illusion of being in the same room, nonetheless was more realistic than I have heard in any other speaker system to this point in time.

My overall impression of the B & W 801 is that here is a loudspeaker system which should be given the accolade or title of 'reference speaker system', as it comes closer to the ultimate aim of faithful dynamic and transient reproduction of sound than any other speaker system I have yet heard. Whilst the 801s are not perfect, they will most certainly give other speaker systems a difficult task in achieving a comparable level and quality of reproduction. ●

MEASURED PERFORMANCE OF B & W MODEL 801 LOUDSPEAKERS SERIAL NUMBER: 000018

FREQUENCY RESPONSE:		33 Hz – 20 kHz		
CROSSOVER FREQUENCIES:		280 Hz, 3.3 kHz		
SENSITIVITY: (for 90 dB average at 2 m)		105 VRMS = 14 Watts (nominal into 8 Ω)		
HARMONIC DISTORTION (for 90 dB at 2 m)		100 Hz	1 kHz	6.3 kHz
	2nd	−31.7	−62.0	−39.4 dB
	3rd	−34.3	−59.8	−53.2 dB
	4th	−56.7	−68.3	−72.2 dB
	5th	−46.4	−64.5	– dB
	THD	3.3%	0.15%	1.1%
INPUT IMPEDANCE:	100 Hz	8 Ω		
	1 kHz	17 Ω		
	6.3 Khz	9.4 Ω		
Minimum at	75 Hz	7.6 Ω		

B & W Model 801 Loudspeakers

Dimensions: *948 mm high x 432 mm wide x 560 mm deep.*
Weight: *44 kg.*
Manufactured by: *B & W Electronics, Worthing, West Sussex, U.K.*
Price: *$3 300 pair*
Distributed in Australia by Convoy International, 4 Dowling St, Woolloomooloo NSW 2011. (02) 358-2088.

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How complete systems work with constructional details of solid state transmitters and receivers. Also included — antennas, field strength meter, crystal controlled superhet, electro-mechanical controls. Ideal for beginners. Section dealing with licencing etc not applicable to Australia.
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This series provides an inexpensive intro to modern electronics. Although written for readers with no more than basic arithmetic skills, maths is not avoided — all the maths is taught as the reader progresses.
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By Mail: There is no charge for replies but a foolscap-size stamped addressed envelope **must** be enclosed. Queries relating to projects can **only** be answered if related to the item as published. We cannot advise on modifications to projects, other than errata or addenda, nor if a project has been modified or if components are otherwise than specified. We try to answer letters as soon as possible. Difficult questions may take time to answer.

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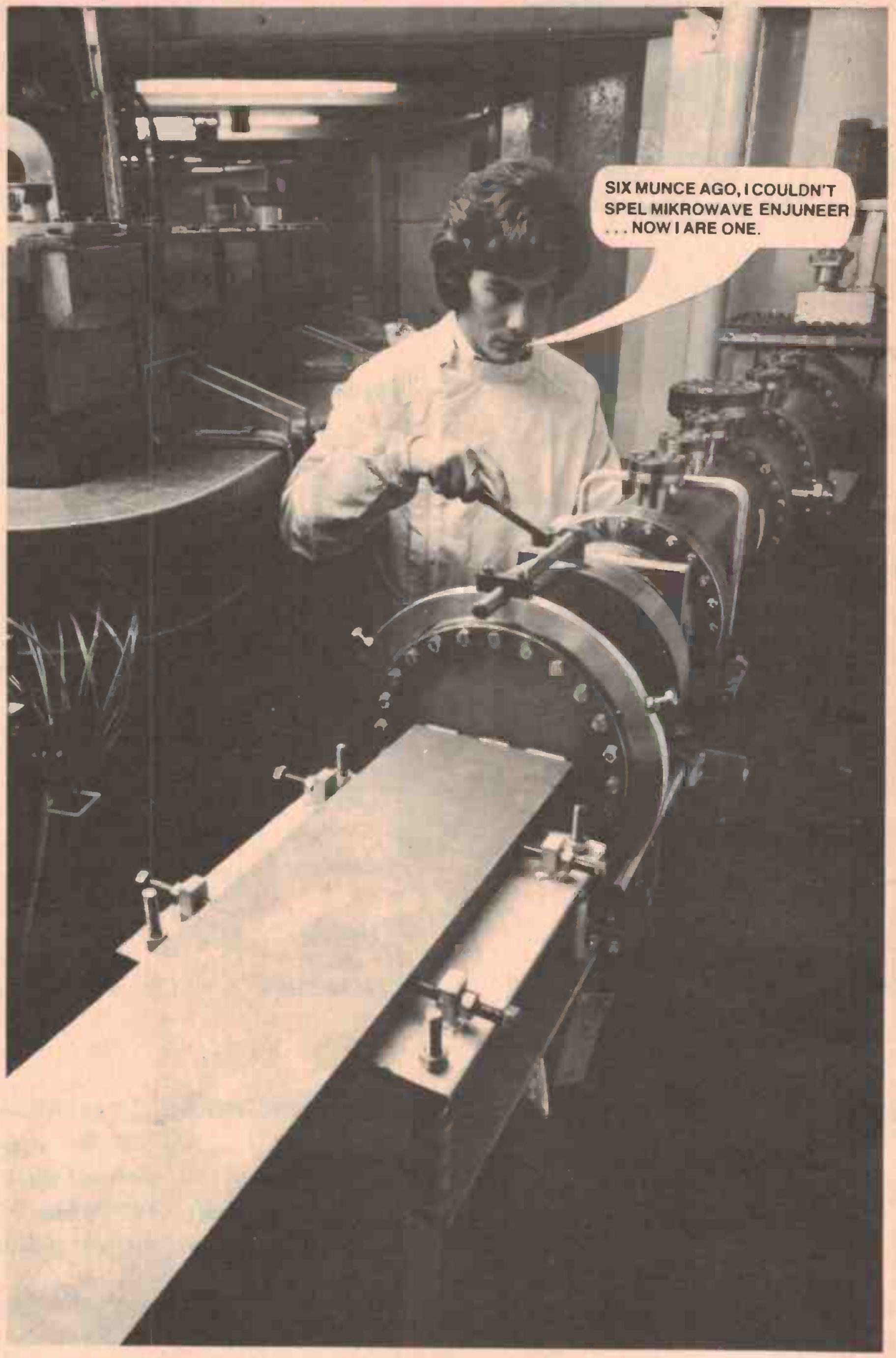

HAVE YOU SEEN single-sided, double-density computer paper? Well folks, everyone can have it! It's cheap, and therefore economical (oh, yes . . .), reduces paper wastage and saves trees etc, etc. What's more, you can make it yourself! Here's how: feed the 'business' end of your computer paper into your printer, take the end, twist it once and join to the other end. The mathematicians amongst you will instantly recognise a moebius loop. Voila! Instant single-sided, double-density computer paper. Neat, eh? Thanks to Helmut Rever of CISA Pty Ltd for that one.

(Note: the Editor takes no responsibility for fouled printers, overprinted programs or listings, enraged operators and servicemen or other adverse effects — maybe including the traditional 'Acts of God' — that may result from any person silly enough to take this seriously).

What's in a name?

In days gone by it was the custom to give a person a name according to his occupation, profession, trade or some other distinguishing proclivity. The origin of names such as Carpenter, Smith etc. exhibit a fairly clear cause-and-effect relationship, but that was in days gone by.

These days, one wonders whether things have turned turtle as we often see examples of a relationship between a person's name and their activities. Do names influence a person's choice of career or other activities these days?

A case in point occurred with an entry to the ETI Computerland Software Contest. The entry was a program that concerned farm management. It was submitted by a Messrs Green and Heap!

Two amusing examples were related by a reader who attended a high school where the French master was a certain Mr English (!) and the Economics master was a Mr Price!

Do readers have any more examples? — write to the editor.

★★★

DID YOU HEAR about the bloke who put some resistors on the stove to cook? Last heard, he was singing — "Ohm, ohm on the range" . . .

That's this month's Awful Puns Contest winner and it comes from the remains of Trevor Bartlett's (VK5ATB) fertile imagination. Your copy of Test Gear 2 is on its way to you in Nurioopta, S.A., Trevor.

Keep those puns coming, dear readers. Last month's crop weren't up to (or down to, depending on your perspective) the usual standard (low/high — cross out whichever doesn't apply). However, Tony Samos of MacGregor, ACT, brought out the bathroom baritones with a cunningly complex bowdlerisation of 'The Kookaburra Sits In The Old Gum Tree' — too long to repeat here. He also sent along half a dozen additional puns, but I'm afraid Trevor Bartlett's beat them.

Michael Park of Browns Plains made a sterling effort and sent in eight! Best of his bunch was: "How would a large mother computer put a baby microcomputer to sleep? — sing 'ROM a byte BASIC, in the tree top' . . ." OK, OK — please, please! nobody send puns set to 'Greensleeves'.

If you'd like to try your hand at winning a copy of 30 Audio Projects/Test Gear 2/Computers & Computing, think up an original pun or two and send to: The Great Dregs Awful Puns Competition, ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011. Indicate which book you'd prefer as a prize . . . assuming you win!

UNTIL WE DEVELOPED THE STEREO GROOVE, HI-FI WAS PRETTY HO-HUM!

The world of hi-fi owes a lot to the original and continuing innovation of JVC. Few companies, if any, have done as much to help turn records and record-players into the virtual musical instruments they are today . . . or to lead the way in developing so many *firsts* in the more recent concepts of sound amplifiers, cassette decks and computer-designed speaker systems. Hi-fi, as we know it today, had its beginnings in 1956, with JVC's development of the 45°/45° groove for stereo records. The fact that this system still remains as the world standard is, in itself, outstanding testimony to the technology of JVC. The development revolutionised not only the record-*making* industry, in which we've been involved since 1930; it also paved the way for enormous advancement in the design and engineering of record-playing equipment. Now, hi-fi has expanded to

R-S77. Super-A FM/AM Stereo receiver

embrace a wealth of highly-sophisticated electronic equipment; and it's not surprising that JVC has continued to play a leading role in so much of its development.

HR-3660 EA. VHS Colour Video Cassette recorder

THAT WASN'T OUR ONLY FIRST, EITHER.

We also pioneered Japan's television industry, introducing their first TV receiver just over 40 years ago. A more recent innovation is VHS, the home video recording system now gaining world-wide acceptance as *the* system for such equipment. In the course of staying ahead, we've introduced a number of world *firsts* of radical importance: the Quartz Lock turntable is one of them.

THE QUARTZ LOCK TURNTABLE. MANY TIMES MORE ACCURATE.

It stands to reason that if your equipment is at the top end of the range, then your turntable must be capable of comparable performance. Only Quartz Lock ensures this, tying the speed of the turntable to the unvarying pulse of the atom, and providing a level of accuracy far in excess of conventional turntables.

MORE MILESTONES IN HI-FI.

To match the superb quality of Quartz Lock, we produced the S.E.A. graphic equalizer system. Then we refined it to such a degree it even compensates for the effect your furniture has on sound when it leaves the speakers! To expand the capabilities of tape, we designed ANRS and

SEA-80. Stereo Graphic Equalizer

Super ANRS — automatic noise reduction systems which not only reduce distortion and 'hiss' but actually extend the dynamic range of the tape. Similarly, with speakers: at JVC we employ computers in their design to help provide the ultimate in sound reproduction.

AND NOW, SUPER-A.

In its own way, as significant a hi-fi development as the stereo groove. Imagine an amplifier which combines the *best* features of the two recognised amplifier classes (A and B) . . . an amp which combines the *efficiency* of one with the *low distortion* of the other. Some engineers said it couldn't be done; but not those at JVC. Enter the Super-A amplifier . . . the *latest* JVC *first!*

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JVC
the right choice

THE FUTURE.

It's already with us. For instance, we were so far ahead in the new metal tape technology that our cassette decks were metal-compatible before the tapes were generally available. And now there's the JVC Electro-Dynamic Servo Tonearm, damping tonearm resonance by means of a purely electronic system and two 'thinking' linear motors. Who was it who dubbed JVC, 'the innovators'?

1861

Receiver with brains.

Sony's new receiver creates higher-fi with a computerized tuner, a DC power amp and Pulse Power Supply.

The new Sony STR-V55 receiver offers the incredible accuracy of frequency synthesized tuning, a versatile microcomputer, and silent uninterrupted power.

A quartz crystal oscillator locks in AM and FM signals for brilliantly faithful reproduction, and the microcomputer provides a choice of 3 tuning systems – Memory, Auto and Manual.

STR-V55

Sony's exclusive Memory scan automatically spans the bands and tunes in 8 pre-set stations for 3.5 seconds each – just stop when you like what you hear!

Microcomputer

Auto tuning tunes in precisely to the next station up or down the frequency band. And pre-set tuning instantly recalls any of the 8 stations stored in our new MNOS (metal nitride oxide semiconductor) memory that can't be accidentally erased.

MNOS memory

The STR-V55 has 55 watts per channel and a high-gain low-noise phono amp in the preamp section enables you to even use an MC cartridge with your turntable.

Pulse Power Supply provides stable DC power even at peak levels, and highly responsive Hi-fT power transistors reproduce complex waveforms even at high frequencies and full power. And the LED's show you station, frequency, and signal strength. It's the kind of engineering you'd expect only from Sony!

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