16K S-100 RAM Card offer $299

electronics today INTERNATIONAL

FEBRUARY 1979

$1·40*
NZ $1.50

LIFE — OUT THERE?

Communicating with other worlds

MAST HEAD STROBE

16K S-100 RAM Card

Reaction Tester

Noise Reduction Systems

Computer show report

News, Communications, Computers

Check DICK SMITH 8-page Catalogue inside!

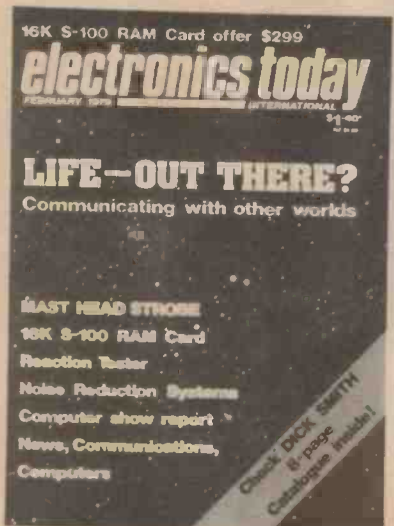
AUSTRALIAN OWNED AND PRODUCED

February 1979, Vol. 9, No. 2

electronics today INTERNATIONAL

Editorial: Les Bell

Managing Editor: Collyn Rivers



Cover: Dead motionless space — or is it? See page 11. . .

PROJECTS

FEATURES

NEWS & INFORMATION

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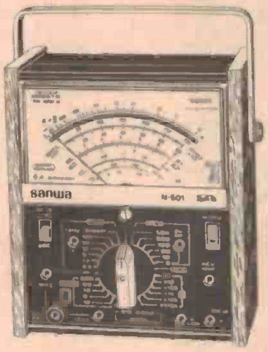
quality you can rely on

REAL POWER LINE UP

sanwa

AX-303TR

44μA meter movement — Si diode protection against pulse input.
Measures hFE (0-1000) by using the extra connector.



N-501

2μA suspension movement — 0.05mA/1mV resolution.
Double protection — fuse & Si diode.
Constant 1MΩ input impedance (ACV) — RF-diode rectified current direct to movement.

BX-505

Fast-response, 24μA movement — fuse & diode protected with high resolution factor. (0.4μA/scale division)
Revised scale marking — intermediate readings readily determined.

U-60D

44μA movement — quality performance, diode protected.
Temperature measurement of −30°C to +150°C with extra scale.

CAM-250D

Clamp meter
Economical and multi-function. Single motion core arm.
Compact yet provides 4 ranges on ACA and 2 ranges on ACV.

PDM-500/C

Performs as low resistance ohmmeter besides insulation tester.
Measurement, scale calibration and battery check are all operated by pushbutton switches.
Has constant voltage impressed irrespective of the value of resistance checked.

N-501

● ±DCV 0-60m 0-0.3-1.2-3-12-30 0-120-300-1.2k-30k (w/HV probe) ● ±DCA 0-2μ 0-0.3-0.3-1.2-3-12-30m 0-0.12-0.3-1.2-12A ● ACV 0-3-12-30-120-300-1.2k ±2.5% Freq. 20Hz to 50kHz ● ACA 0-1.2-12 ● Ω x 1-x10- x 100-x 1k-x 10k-x 100k (max. 200M) Batt. 1.5V x 1 & 9V x 1 ● dB —20 to +63

AX-303TR

● ±DCV 0-0.3-3-12-30-120-300-1200 ● ACV 0-6-30-120-300-1200 ● ±DCV 0.60μ -3m-30m-0.3-12 ● Ω x 1- x 10- x 1k- x 10k (max. 20M)

U-60D

● DCV 0-0.1-0.5-2.5-10-50-250 -1k-25k (w/HV probe) ● DCA 0-50μ -2.5-50-500m ● ACV 0-2.5-10-50-250-1k ● Ω x 1-x 10-x 100- x 1k (max. 5M)

BX-505

● ±DCV 0-0.12-3-12-30-120-300-1200-30k (w/HV probe) ● ±DCA 0-30μ -3m-30m-0.3-12 ● ACV 0-6-30-120-300-1200 ● ACA 0-12 ● Ω x 1-x 10-x 1k-x 10k (max. 20M)

CAM-250D

● ACA 6-30-60-300 ● ACV 300-600 ● kΩ 0-50k ● Batt. 1.5V x 1

PDM-500/C

● V/Ω rated 500V/100M ● Scale range 0-0.1-100-200m (1st effective scale range underlined) ● Ω 0-100Ω ● Power source AM or UM-2 x 3

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● AUCKLAND N.Z. 79-7781 ● WELLINGTON N.Z. 698-272

News Digest

A Message From The NSW Minister For Energy

Few people would question the right of the public to expect that all electrical goods offered for sale in the market place are electrically safe and will remain so through their normal working life.

The New South Wales Government therefore looks to all sections of industry engaged directly and indirectly in the supply of electrical articles they handle comply with recognised electrical safety standards.

Many appliances and some items of equipment have been specifically "prescribed" under the Electricity Development Act in New South Wales and are required to be examined and approved by the Electricity Authority of New South Wales or an approvals body in another State, and to carry an approval marking, prior to sale.

As the responsible Minister I also look to the Electricity Authority to monitor the general safety standard of electrical goods of different types offered to the public and to recommend application of legislative control where necessary.

I have been concerned to learn through reports of recent Electricity Authority inspections of electrical and electronic equipment of the type featured in the columns of some publications that many of the items examined do not comply with safety standards published by the Standards Association of Australia. Several cases have also been reported by the Authority of products which come within the scope of prescribing definitions being offered for sale without approval.

In particular it appears not to be realised that the prescribing definition for "Extra Low Voltage Transformer" includes a number of regularly advertised items such as power supplies of different types, antenna boosters and antenna rotators.

Most sections of the electrical industry supplying consumer goods have developed a safety awareness through knowledge of S.A.A. safety standards and regular contact with regulatory authorities on approvals matters.

However it is clear that the popular electronics (hobby/enthusiast) section of the industry is giving insufficient attention to safety requirements.

It seems clear to me that the first need is for people operating in this section of the industry to be better informed of their responsibilities and obligations in the electrical safety area. In New South Wales closer contact with the Electricity Authority would certainly assist in this regard and I have asked the Authority to give priority to fostering that contact in its safety enforcement work.

Through these columns I also make a general appeal to manufacturers, importers and retailers in New South Wales to co-operate with the Authority and assist in ensuring that all popular electronics goods offered to the public fully comply with Australian safety standards.

Minister for Energy

New Silicon IC Technique

At a recent meeting in the US, IBM announced that they are developing a new IC technology which will allow an order of magnitude increase in circuit density over existing technques.

The new circuits described by the researchers use one tenth of the power of existing devices and operate three to four times as fast.

The technology is believed to be capable of producing 256 000 memory locations – or 10 000 logic gates – on one 4 mm chip.

The research was done on MOSFET devices with polycrystalline gates but is said to be applicable to bipolar devices as well, the main advances having been made in the area of computer-controlled electron beam lithography, producing 0.1 μm accuracy.

Audio Cassette Records a Picture

A possible replacement for the ubiquitous overhead projector – through which a lecturer's scribblings can be thrown (optically !) onto a screen for the edification of hundreds of eventually eyestrained students – has been developed by Matsushita Electric Industrial Co.

The system allows a program of sound and line drawings to be produced using a light pen or keyboard controlling a TV display. This program is stored on cassette for later display.

The package, including the hardware required for the system plus a TV set and stereo cassette deck goes under the name of the Home Amusement Television System – wrong market, Matsushita?

CCD Camera Chip

Nippon Electric Co. and its affiliated company, New Nippon Electric Co. have produced a 1 cm^2 chip containing over 250 000 picture elements for use in domestic colour TV cameras.

New Nippon Electric hope to market a miniature colour camera using the device some time this year.

New Thyristor

Hutson Industries (US) have developed a thyristor with an integral Shottky diode. This is claimed to have improved spurious triggering performance over the more usual technique. The diode provides a non-ohmic path to triggering currents which have resulted from junction temperature change or step changes in input voltage.

Personal Computer Study

The University of Southern California has been given a grant of $220 000 to study the future effects of personal computers on living standards and education.

Microwave Fusion

Nuclear fusion may be brought a step closer by a plan by MIT to boost the temperature of the plasma in their 'Tokamak' chamber by beaming microwaves in through what were previously diagnostic ports.


Hurry! limited stock accessories
CLEARANCE
TANDY
TV Picture Tube Brightener
Clearance Price 99¢
Our normal retail price 2.89
•Give your picture tube a new lease of life
Black and white set/duodecal base. Parallel or series. Standard 12-pin tube renews brilliance, contrast, sharpness and detail. Just plug in! 15-637
Battery Clips
Clearance Price 69¢
Our normal retail price 1.29
Heavy duty, tight fitting, with screw terminals. 4.76cm long. Jaws open to 1.27cm. Pkt. of 8. 270-379
Subminiature Offset Lamp Assemblies
Clearance Price 10¢
Our Normal retail price 1.19
Set of 3 includes 2 red, 1 green jewel-type. Requires T-1¾ threaded bulbs. Mount in 5/16" holes. 272-344
Miniature Electrolytic Capacitors
Clearance Price 10¢
Our Normal retail price 79¢
Manufactured with welds at all critical terminations. 500 uF 16 WVDC axial type. Pack of 2. 272-1007
Miniature Dual Jack Coupler
Clearance price 10¢
Allows two cables terminating with miniature phone plugs to be connected together. Shielded type. 274-298
Flexible "Y" Adaptor
Clearance Price 99¢
Our Normal retail price 1.59
Two phone jacks connected in parallel to a standard ¼" plug. 5¾" long. 274-306
Dual Stereo Headphone "Y" Adaptor
Clearance Price 1.99
Our Normal retail price 3.99
One end has two ¼" phone jacks, connected in parallel to ¼" phone plug. 10" long. 274-319
Adaptor Set
Clearance Price 50¢
For ¼" phone plug to phono jack, 3/32" subminiature phone jack and 1/8" miniature phone jack. 274-356
Stereo-to-Mono headphone Adaptor
Clearance Price 50¢
Stereo jack to 3/32" ultra-mini phone plug. 274-362
Phone Jack
Clearance Price 10¢
Accepts standard ¼" phone plugs. Versatile, panel or printed circuit mounting. 3-conductor. Closed circuit type. 274-376
Component/Console Knob
Clearance Price 90¢
Our Normal retail price 1.49
Gold-colour aluminium-alloy with black base, concave top, faceted grip. 2.69cm dia. 1.9cm deep. Double set screw. 274-422
4-Pole DT Miniature Slide Switch
Clearance Price 10¢
Our Normal retail price 99¢
Contacts 0.3 amps at 12VAC. Size 3.17x .95x1.42cm. 275-405
Mini Audio Amplifier Chassis
Our Normal retail price 4.95
Clearance Price 2.95 350mW output, 5 transistors
Dual inputs: 5,000/10,000 ohms. For 8-12 ohm load. 10.16x5.08x1.9cm. 15,000 Hz. 277-1557
Mini Test Clips
Clearance price 99¢ Each
Our Normal retail price 1.99 each
Miniature test clip on both ends for rapid interconnection of test points.
Black. 5.08cm long 278-1158
Red. 5.08cm long 278-1159
TANDY ELECTRONICS
MINIMUM MAIL ORDER ACCEPTED 2.50 — AVAILABLE FROM ANY TANDY STORE OR PARTICIPATING DEALER

Skylab To Fall

NASA has terminated a contract with the Martin Marietta company for the development of the Teleoperator Retrieval System which it planned to use to keep Skylab in orbit.

The reason for this is that the space laboratory's orbit will decay sufficiently for it to re-enter the Earth's atmosphere sometime this year, long before it can be reached with a 'space robot' carried by the Shuttle and boosted back into a higher orbit.

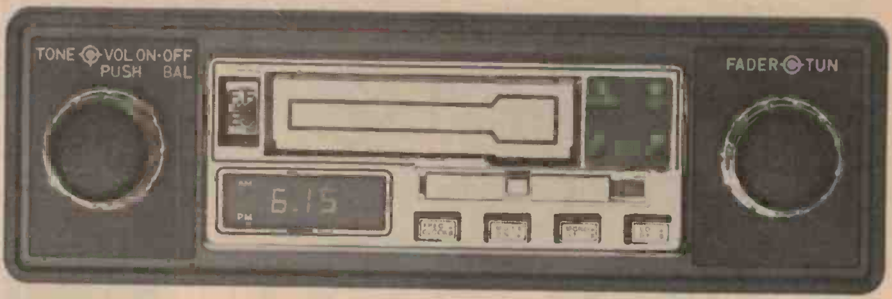
The cost of the project was to be about $US35 million, of which an estimated $US22 million has already been spent. Martin Marietta are beginning a study to see what parts of the hardware already developed can be used for future Shuttle remote control modules.

Solar Power Station

The European Economic Community is doing its bit in the search for alternative energy sources and has funded the development of one of Europe's largest solar power stations. Ferranti Electronics Ltd. developed the station, using their newly-developed MST300 36 cell solar panels (which generate 14.4 V at 1.1 A each) and can deliver 2 kW dc. The dc current is stored in a battery and inverted to 240 Vac at 50 Hz.

Single Beam Colour Tube

A single-beam colour TV set from Matsushita uses a novel method to synchronise colour information. Periodic stripes of phosphor emit UV instead of visible light, allowing the TV to sense the beam's position on the tube face. This allows a more efficient use of energy – the set runs on 7 W.



Atari Personal Computers

Latest TV game manufacturer to break into the home computer market is Atari, Inc. a major supplier of programmable games. Two models are being released – the $450 model 400 and the $900 model 800 – during the third quarter of 1979. Both the machines use an external domestic TV and are based on 6502-type microprocessors, which, incidentally, are also used in their video games.

Sygernist Sigerstin Sin Er Synergistic Beer Drinking

On the second Wednesday in every month, a strange age-old Australian custom takes place in the Bayswater Hotel. Huge numbers (we hope) of technically-minded people meet to discuss the state of the beer. Amongst other things, of course. If you have any suggestions for clean, sensible, worthwhile projects, forget ... er, bring them along and we'll see what we can do you for, or rather do for you.

We're also available for answering questions ("How long have you been an alcoholic ...?) anddiscussing ETI matters in general ("Mine's a middie ..."). The Bayswater Hotel is situated in Bayswater Road, Rushcutter's Bay, Sydney (just through the King's Cross tunnel, on the left by the Rushcutter Bowl). The next Synergistic Beer Drinking session will be on Wednesday, 14 February at about 6.00 p.m.

Bit-slice Nova

The advent of bit-slice microprocessors has caused somewhat of a revolution amongst minicomputer manufacturers, who can now make low cost minis with very powerful instruction sets – some are even compatible with the IBM 370. The latest manufacturer to use bit slices is Data General, whose new Nova 4 line operates up to 50% faster than the previous Nova 3 series, yet sell for about half the price. The Nova 4 also features an expanded instruction set, and is priced from US$2500 up, depending on the model.

Digital Radio Display

An in-car cassette player/radio with a digital clock has been released in which the clock display doubles as a frequency readout. The unit, claimed to be the first of its kind in Australia, operates on AM and FM bands and will sell for around $280.

On touching the tuning knob the clock display changes to one of tuned frequency and will remain so for five seconds after the knob has been released, after which time it will revert to a time display. The radio, called the Ferris SN-2910, was launched by *Intag Marketing Corporation Pty. Ltd., 42 Grantham Street, West Brunswick, Victoria 3055. Tel. 387 3844.*

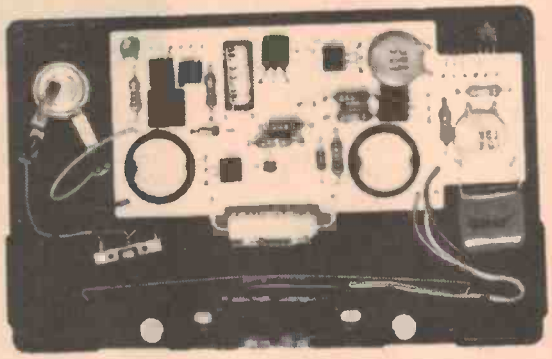
US Scientist For Keynote Address

A distinguished American electronics and telecommunications scientist, Mr. Donald Spencer Bond, of Princeton, New Jersey, will be the Keynote Speaker at IREECON '79, the 17th International Electronics Convention, to be held in Sydney from August 27 to 31, 1979. This was announced by Dr. John Hiller, Chairman of the IREECON '79 Management Committee of The Institution of Radio and Electronics Engineers Australia (IREE).

Mr. Bond has a particular link with Australia; he was the author of the 1977 report, "The opportunity for television programme distribution in Australia using earth satellites", which resulted, after its presentation to the Australian Goverment, in the setting up of the Government's Task Force, National Communications Satellite System.

Mr. Bond, 69, listed in the American Men of Science, and author of numerous published papers, was formerly with the Radio Corporation of America (RCA), and the David Sarnoff Centre in Princeton. He was involved in the USA corporate-wide planning studies of satellite and telecommunications systems for business and military applications, and from 1958 to 1961 was a member of the staff of the

TDK's Revolutionary New Product — The HD-01 Head Demagnetizer Built into a Cassette Shell.

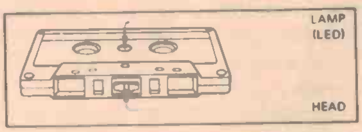


Simply load the HD-01 into any cassette recorder as you would a standard audio cassette and depress the 'play' button.

The HD-01 Head Demagnetizer was designed by TDK for easy, convenient head demagnetization of any cassette deck, insuring crystal-clear, perfect recordings every time.

The TDK HD-01 Head Demagnetizer features:

- A unique cassette format, designed to insure complete compatibility with any cassette deck.
- Powerful de-gaussing circuit instantly demagnetizes recorder heads the moment the play button is depressed. The above diagram depicts the oscillating waveform applied to the recorder heads, removing every trace of residual magnetism in only one second!
- A red LED (Light Emitting Diode) built into the HD-01 cassette shell will light up the moment your recorder heads have been completely demagnetized.



The TDK HD-01 Head Demagnetizer ends forever the fuss and mystique surrounding the demagnetization process and is much easier to use than conventional wand-type tools. Anyone can use the HD-01 and get perfect results every time.
The TDK HD-01 Head Demagnetizer is completely self-contained, battery operated and portable. It can be taken anywhere and stored with your present audio cassettes. The TDK HD-01 is ideal for all types of cassette decks especially those with heads located in hard to get at places such as:

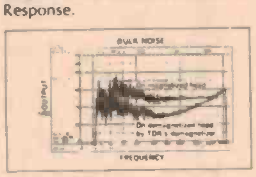
- recorders with heads positioned in the front of the unit but which point to the rear.
- those with 'pop up' loading mechanisms which can not be detached, thus making the heads almost inaccessible.
- cassette decks with heads positioned laterally with respect to cassette loading (car decks are good example of this type).
- automatic loading machines.

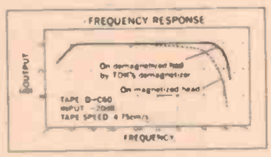
WHY IS DEMAGNETIZING SO IMPORTANT?

TDK, in conjunction with many cassette deck manufacturers, recommend that cassette decks be maintained on a regular basis. Cleaning the heads, capstan and pinch rollers is one important aspect of that maintenance program. – Periodic demagnetizing, about every thirty hours of use, is the other. Failure to do so will cause a build-up residual magnetism on the heads, which can seriously affect tape and machine performance in the following critical areas:

1. The noise level in the low and midrange frequencies is increased by 5 to 7dB, thereby reducing the overall signal-to-noise ratio.
2. Pre-recorded tapes can also be affected with midrange and high frequency distortion, as well as attenuation by as much as 2 to 6 dB, virtually eliminating any hopes for clear sound reproduction.

The interaction of these factors will not only prevent both the tape deck and tape from displaying their true performance capabilities, but will severely limit the Dynamic Range properties of both, rendering pure sound reproduction an impossibility.
The following comparison data clearly demonstrates the effect of residual magnetism on recorder heads in the areas of both Noise Level and Frequency Response.





TECHNICAL DATA

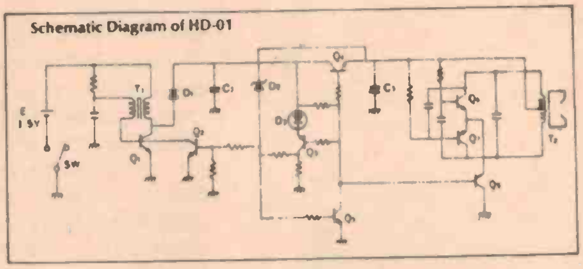
Major Components:
Transistors (8)
Diodes (2)
LED (Light Emitting Diode)

Power Supply – Control Section – Oscillation Section – Head Section

Specifications:

Maximum Magnetic Flux Density	200 Gauss
Oscillation Frequency	630 Hz
Shape	(External Dimensions) Conform to IEC Standards
Battery for Power Supply	G-13 1.5 volt, Silver Oxide Battery (option)

Schematic Diagram of HD-01



For additional information, direct all inquiries to:

CONVOY INTERNATIONAL PTY. LTD.
4 Dowling Street, Woolloomooloo, N.S.W. 2011
Telephone: (02) 358-2088. Telex: AA23111

TDK®

weapons systems evaluation group in the office of the US Secretary of Defence. He is now retired.

IREECON '79 is being organised by The Institution of Radio and Electronics Engineers Australia (IREE), founded originally in 1924 and granted a Royal Charter in 1967. IREE is the only chartered Institution in Australia concerned with the interests of both professional electronics engineers and the skilled and certified engineering technologists and technical officers in the electronics field.

The Convention, to be held at the University of NSW, will be attended by scientific, engineering and technical delegates from many countries.

In addition to the presentation and discussion of approximately 160 papers, there will be an Exhibition with extensive displays of technical electronics equipment by leading Australian and overseas manufacturers and distributors.

Low-loss Bearings

Zero friction bearings are claimed to be possible by the use of a system developed by SKF Industries Inc. The Active Magnetic Bearing System uses a magnetic field under electronic control to keep the shaft at a constant distance from the bearing under varying load conditions.

Analogue Processor

A new multi-purpose device from National, the LH0094, performs mixed multiplication and exponentiation on voltage inputs. The device is fast (10 kHz bandwidth) and accurate (rated accuracy 0.05%).

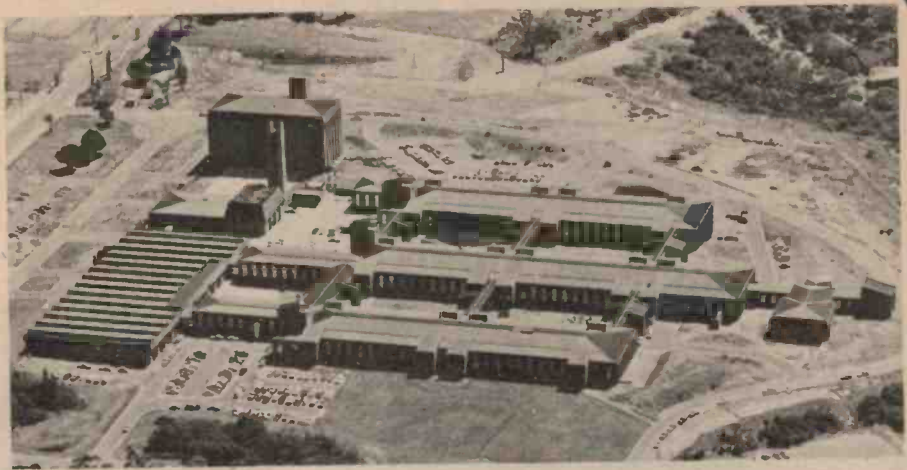
The output voltage will be equal to:

$$E_0 = E_1 \times (E_2/E_3)^m$$

where E_1, E_2 and E_3 are input voltages in the range 0.1 to 10 volts. A precision thin film resistor network in the unit allows squaring and square root extraction by strapping particular pins together.

The device comes in a hermetic 16 pin DIP package and should find applications in a wide variety of industrial applications. It can be used for linearisation of thermometric devices and flow meters, or even for audio companding. The device operates from ± 5 V to ± 22 V.

The cost in 100-up quantities is $23 for the CD (industrial) temperature range. Delivery is ex stock to six weeks from *N S Electronics, PO Box 89, Bayswater, Victoria. 3153.* Further information is available from Ed Schoell (03) 729-6333 or Chris Mason (02) 93-0481.



NEW CSIRO LABORATORY

Special open days have been arranged on Monday and Tuesday 26 and 27 February 1979 at the newly completed CSIRO National Measurement Laboratory, following the Official Opening by the Governor-General.

The Laboratory, the largest in CSIRO, took four years to build. It employs 370 professional and technical staff.

Over 50 selected laboratories will be open for inspection, including a display of holograms, lens-making facilities, computer-aided design facilities, numerically-controlled machinery, an optical research tunnel and a host of other technical exhibits.

The National Measurement Laboratory is in Bradfield Road, Lindfield. There is plenty of parking space on the very large site.

The Laboratory will be open from 2.00 to 5.00 pm and 6.00 to 9.00 pm on both days. Enquiries to 467 6330, 467 6329.

Laser Xerox

Xerox have produced a photocopier which, when linked to a computer, can produce full-colour output with a resolution of 0.01 in on plain paper or transparent film.

The 6500 colour copier uses a scanned laser and can produce 6.4 in by 13.75 in colour copies in under 20 seconds or monochrome copies in under 7 seconds.

Electric Vehicle Battery

NASA has developed a high energy density battery for use in electric vehicles which could run 100 miles on a 20 minute charge. The nickel/zinc battery should cost about $50 per kWh and has the additional advantage that the metals used in it are recoverable, reducing the effective cost of a new battery.

New Display Material

The display medium of the future may well be a piezoelectric ceramic material called PLZT, which will switch about a thousand times faster than LCD, has an inherent memory which will store an image for several days and has a 5:1 better contrast ratio than LCD. When used with light filters, it can even give displays of contrasting colours.

ETI/Unitrex Calculator Contest

December's contest was so easy we were surprised at how few entries we received! The answer was of course one page – the first page of volume 22 lies beside the last page of the next volume with the covers in between (try it!). The winner was Mr Murphy of Victoria.

This month's problem concerns a rather limited processor, whose accumulator works in decimal and holds four decimal digits. There are five possible instructions:

Instruction	mnemonic	before	after
rotate right	RR	6789	9678
rotate left	RL	6789	7896
complement	CM	6789	3210
increment	IN	6789	6790
decrement	DE	6789	6788

Starting with the number 1297, the processor executes five instructions – one of each type but not in the order shown above. At the end of this the accumulator holds 8693. After the first two instructions had been completed, the most significant digit of the accumulator held a 2.

In what order were the instructions executed? Write the mnemonics in order of execution on the back of an envelope, along with your name and address, seal it and send it to us: ETI Magazine (Unitrex Contest February), 15 Boundary Street, Rushcutters Bay, NSW 2011. The closing date is 2nd March.

Dick Smith says:
Just look at this INCREDIBLE HOME ENTERTAINMENT COMPUTER!

BE ONE OF THE FIRST TO ENJOY THIS AMAZING COLOUR COMPUTER – CONNECTS TO ANY TV SET.

Cat X-1200

* EDUCATIONAL!
Your children can actually learn or improve mathematics: addition, subtraction, multiplication and division right there on the TV screen. It even tells you when you're wrong or right!

* EXCITING!
You can play incredibly complex games like BLACKJACK! Imagine: it actually draws your cards, raises the bet, 'pays' you for a win . . . you won't believe it!

* NEW!
Over twenty thousand sold in the USA since its release a short time ago – now available in limited quantity here in Australia. Don't miss out!

$259.00
* Easy terms available!

Imagine! For only $259 you get a real computer – the heart of this unit is an incredibly powerful Fairchild microcomputer containing thousands of transistors. No, this is not just another TV game – this incredible machine has a mind of its own, giving versatility and performance not even thought possible just a few months ago!

Basic price includes the computer console with two inbuilt games (tennis and football), the two 8-way hand control units, an AC power supply plus a BONUS 'noughts & crosses' game cartridge.

Call in today for a demonstration

SPECIAL 7 DAY TRIAL OFFER
Purchase this Fairchild Video Home Entertainment Computer with two or more cartridges and try it in your own home for 7 days. If you're not completely satisfied, return it to us in the condition you received it and we'll refund your money in full!

TERMS?
A pleasure. To approved personal shoppers, terms are available from $29.00 deposit and $2.90 p.w.

MAIL ORDERS:
Yes. We'll send this unit anywhere in Australia for $5.00 extra – game cartridges post FREE with unit. (If purchased separately p&p $2.00)

ADD MORE EXCITEMENT! ALL OF THESE FULL COLOUR CARTRIDGES ARE NOW AVAILABLE!

ONLY $24.50 EACH.

BLACKJACK Cat X-1201
You can play the TV (the bank) by yourself or with a partner. Try to break the bank at your home without losing a cent!

DESERT FOX Cat X-1203
Try and destroy the desert fox without being blown up yourself (tank game) – or try the shooting gallery game on this cartridge.

MAZE Cat X-1204
Four great games: Maze, Jailbreak, Blind-man's-bluff and Trail-blazer. Games that will test your skill and give you feal fun.

BASEBALL Cat X-1205
All the skills and thrills of the real game – played in the comfort of your own home. For two players.

SPITFIRE Cat X-1206
Two games: Solo the red baron is hot on your tail, or for two players you try to shoot each other out of the sky.

SPACE WAR Cat X-1207
Can you escape the piercing laser beams? The aliens from outer spaec are out to get you. Just how good are you?

MATH QUIZ 1 Cat X-1208
Teach the kids addition and subtraction – or brush up on your own basic arithmetic skills.

MATH QUIZ 2 Cat X-1209
Multiplication and division on this cartridge. It poses the problems – it's up to you to come up with the answers

PINBALL CHALLENGE Cat X-1217
Remove different coloured walls of bricks to become the pinball wizard.

BACKGAMMON Cat X-1213
All the rules of this exciting game are programmed on the cartridge. No cheating! Also has Acey Ducey (a variation of Backgammon)

TORPEDO ALLEY Cat X-1211
Sink as many ships as possible. Or play Robot War – try and escape the robots by destroying them in a force field.

SONAR SEARCH Cat X-1214
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Communicating with other worlds

Can we detect signals from intelligent beings in other solar systems? By Brian Dance.

ABOUT 20 YEARS AGO scientists realised that their equipment might be able to detect suitably powerful radio emissions from intelligent beings on planets in other solar systems which may be many light years away from us. Attempts to detect Extra-Terrestrial Intelligence (appropriately abbreviated ETI!) have already been made in the USA, Canada and the USSR without success, but much more work with larger aerials is required to provide workers in this field with a reasonable chance of success.

Apart from the Search for Extra-Terrestrial Intelligence (SETI), drawings and radio signals have been sent into space outside the solar system in the hope that they will eventually be detected and understood by intelligent beings many light years distant. Unfortunately the chances of two way communications with such beings are very remote, since the nearest star is a few light years away and most planetary systems are at much greater distances. Thus anyone sending a message from the earth to anywhere but one of the very nearest of the stars would be dead by the time any reply could be returned to the earth.

Attempts have also been made to detect signs of life within the solar system. In particular, the Viking spacecraft which landed on Mars conducted prolonged tests to try to detect life or the chemicals associated with life. Although no organic molecules that could be the past or present constituents of living things were found and the results were generally rather discouraging, they were certainly not conclusively negative as regards the possibility of life on Mars.

Communication Techniques

It seems likely that there are three possible ways in which we may be able to communicate with intelligent beings from outside the solar system. The first way involves a direct meeting of space vehicles or a landing by them on the earth. Unless the other beings have a longevity which far exceeds that of man, the journey time would make this method quite impossible. Many people do not fully appreciate how much vaster are the distances involved in interstellar space than those within the solar system. Light takes about 8 minutes to reach us from the sun, but about 180 000 years to cross our galaxy and some thousands of millions of years to reach us from the farthest know objects.

As we require something which will convey information quickly, the obvious thing to use is electromagnetic signals which travel at the speed of light. We can only send signals by this technique and not material objects, but generally it is far more sensible to send information on how to construct an object rather than to send the object itself over such vast distances. Should one use light, infra-red, radio waves or some other form of electromagnetic radiation? Radio-waves are to be preferred, since the energy required per transmitted photon is relatively low.

The third possible communicating technique involves the acceleration of sub-atomic particles to velocities very near to the speed of light, but as far as is known this technique has not yet been tried. If particles which can travel faster than light (known as 'tachyons') are ever discovered, one can only wonder whether they could be used in an extra-terrestrial communications system if they can be produced relatively easily; however, at the moment such a suggestion is nothing more than pure speculation.

It has been suggested that we should avoid transmitting any signals into space which would inform possibly hostile intelligent beings of our location. It is generally felt, however, that we can take comfort from the fact that any intelligent beings would be more interested in sharing information with us and co-operating with us as far as possible rather than in attacking us as in science fiction stories. In any event, it seems likely that it would take them so long to arrive here that our civilization would be in a very different state by the time they could reach us.

Basic Problems

Let us first consider the basic problems associated with receiving radio signals from outside the solar system, since any of our attempts to send messages are not likely to bring any result for an enormously long time. Any radio signals reaching the earth from outside the solar system are likely to be extremely weak owing to huge distances involved and it therefore follows that SETI projects require the use of the largest radio telescopes in the world.

One is left with decisions to make on the direction in which one should point the telescope, the frequency or frequencies which one should attempt to receive, the bandwidth one should use and perhaps even the time at which one should attempt to receive any transmissions. In the work on SETI which has been performed up to the present time, the telescopes have usually been pointed towards some star in our galaxy which is not excessively distant and which astronomers feel may possibly have a satellite system on which life could have evolved in some form or other.

In general astronomers have concentrated their searches in the regions of stars of the same or similar spectral classes as the sun. It has been felt that if a star has a luminosity much greater than that of the sun, then the lifetime of any planetary system associated with that star is probably too short to have enabled life to have developed to the point where intelligent civilizations have evolved. Stars of luminosity much smaller than that of the sun seem to have rather violent coronal activity which would probably result in any associated planetary system being rather inhospitable to most imaginable forms of life. Other stars have departed from the main sequence as a result of a super-nova or nova explosion and SETI workers have tended to disregard these because it seems doubtful whether any living species could survive the catastrophic event of such an explosion in the star.

Frequency

As the signals from the regions of other stars would be very weak, it is obviously important to choose a frequency where the background noise from natural sources is relatively small, so that the weakest possible signal can be detected. Some of the most important factors which determine the choice of frequency are shown in the graphs of fig. 1. Noise levels can be expressed in terms of temperature, since a high temperature corresponds to a relatively large amount of molecular agitation and hence to a high level of electro-magnetic noise.

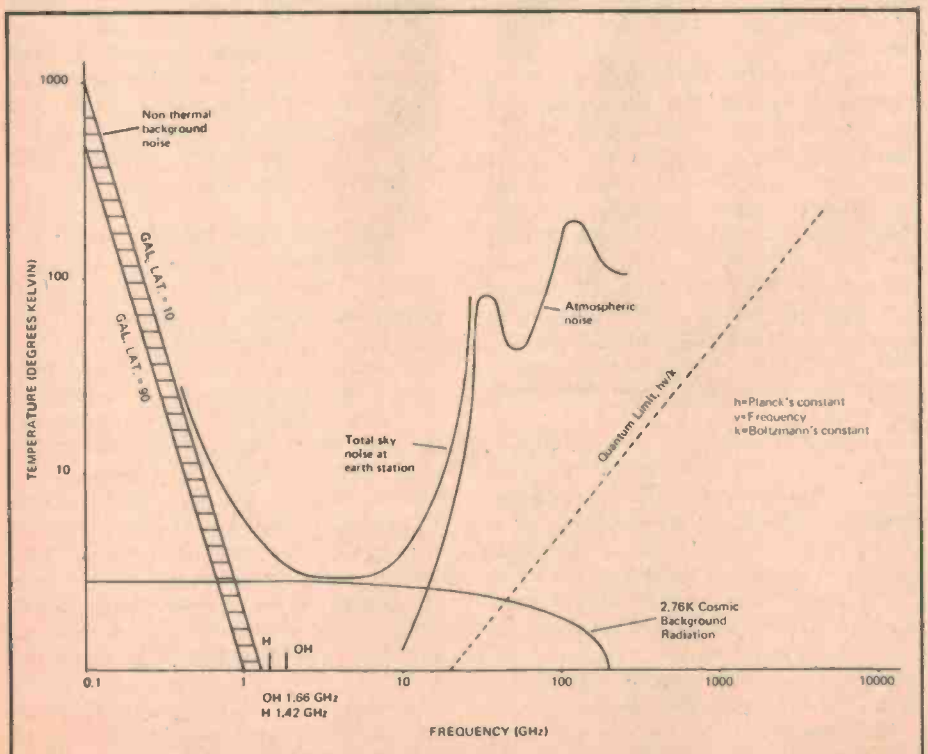
Fig. 1 clearly shows a relatively low total noise level in the region of 0.5 GHz to 10 GHz and most SETI work has been done in this frequency region. However, let us look at the various noise contributions which are themselves rather interesting. One should remember that both scales in fig. 1 are logarithmic and can therefore accomodate a very wide range of noise levels and frequencies.

The 2.76 K cosmic background radiation has a fairly constant level up to about 50 GHz, but then falls off in intensity. This strange form of radiation is believed to be the remnants of the radiant energy formed in the most fantastic explosion ever when the whole of the matter of the universe was formed in a small space somewhat more than ten thousand million years ago. Indeed, the very existence of this radiation is the strongest piece of evidence we have to indicate that the universe was formed in an unimaginable intense explosion. Perhaps it is rather remarkable that this noise from the creation of the universe can affect our choice of frequency for communication with other intelligent beings.

The non-thermal background noise level is mainly due to the synchrotron radiation emitted by particles spiralling around the galactic magnetic fields. The level of this noise varies somewhat with the galactic latitude, the extreme lines shown in fig. 1 being for galactic latitudes of 10° and 90°. The atmosphere of the earth acts as a further source of noise, since molecules of water and oxygen absorb and re-radiate energy with broad peaks, at frequencies of about 22 GHz and 60 GHz respectively. The total sky noise at an earth station is shown by the curve with the pronounced minimum.

If a suitable telescope were set up on the moon or in another place far outside the atmosphere of the earth, there would be no contribution from the atmospheric noise. The noise levels would therefore be much lower at frequencies above about 10 GHz, but at frequencies above about 60 GHz the energy per photon of the radiation becomes so large that the quantum noise level exceeds the cosmic background noise level. The quantum noise level is associated with the fact that noise is generated by the arrival of each photon or quantum of radiation which comes in "packets" of energy rather than as a steady continuous wave.

Fig. 1. The water hole in the radio spectrum from the sky can be clearly seen in the 1 GHz to 10 GHz region with a minimum near to the H and OH characteristic lines.



The Water Hole

The region of minimum extraneous noise has been named the "Water Hole", since it contains frequencies strongly associated with water — one of the most vital chemicals in our form of life. One of the most important frequencies is that of 1.42 GHz (21 cm) which is emitted when the spinning electron in an atom of hydrogen (the most abundant element in the universe) spontaneously flips over so that its direction of spin is opposite to that of the proton in the nucleus of the same atom.

The emission from the free radical hydroxyl (formula —OH) consists of a number of closely spaced frequencies at about 1.665 GHz. Water consists of hydrogen chemically joined to hydroxyl — hence the name 'water hole'.

Most SETI workers agree that frequencies in the water hole are a good place to commence a search for interstellar radio signals. Apart from the low noise in this frequency region which permits communications over the greatest possible distances at specified transmitter power levels, it may well be that the intelligent beings with which we wish to communicate also have a life system based on water and that they have therefore selected frequencies in this region for their attempts at interstellar communications.

It has been suggested as long ago as 1963 that the 1.42 GHz hydrogen frequency could be a logical one to use for work of this type. Professor Robert S. Dixon of the Ohio State University Radio Observatory has shown that this might be reasonable at the present time, but that the emission of noise from hydrogen at this frequency could seriously degrade the noise levels in receivers of improved performance which we hope will be available in the not too distant future. The fact that the hydroxyl frequency is not a single one renders it a non-unique frequency for SETI purposes.

At present there is little man-made noise in the water hole band of frequencies, although there is some

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minor use by weather and maritime satellites. Many SETI workers consider that the water hole frequencies should be kept clear from 1.4 to about 1.7 GHz, but a proposal for a system of Global Positioning Satellites involves the use of this frequency band. SETI workers have said this would be "polluting the water hole". The term water hole is usually reserved for the frequencies lying between the natural frequencies of hydrogen and the hydroxyl radical.

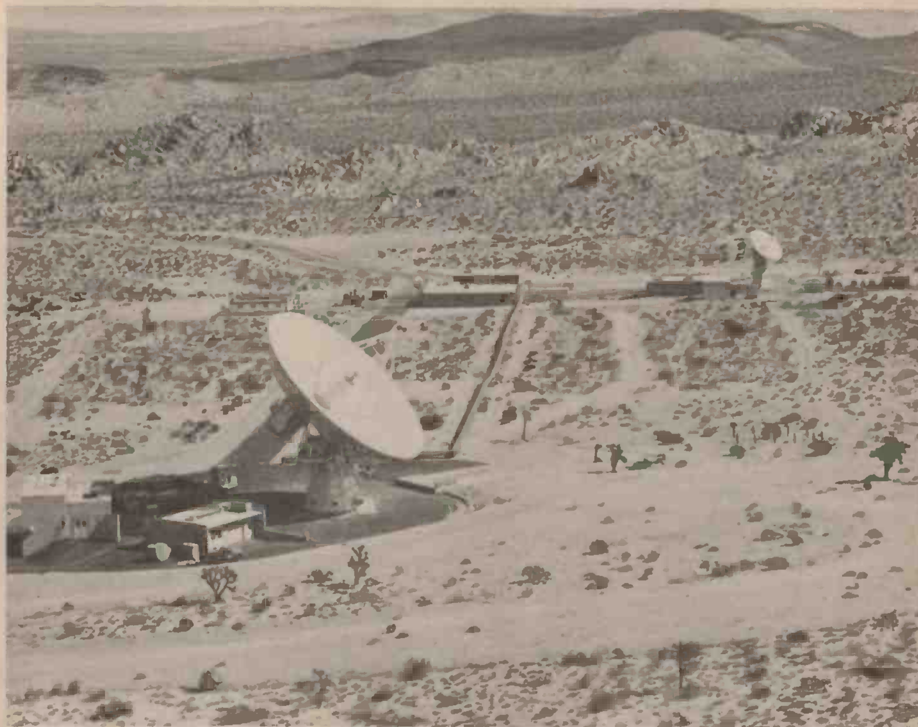
Signal Types

What types of signal should we expect to receive from other planetary systems and how could we recognise such signals as originating from intelligent life? The SETI workers are basically searching for coherent signals, possibly modulated. For example, our own radio transmissions have a coherent carrier wave, although the modulation present inevitably involves a finite bandwidth. The presence of this type of signal would almost certainly indicate it is not of natural origin and hence would imply the existence of intelligent life elsewhere in the universe.

There are three basic types of signal from other planetary systems which we may be able to detect. The first type of signal is leakage of a signal into space in just the same way that our own radio and television signals leak away to a greater or lesser extent through our ionosphere. Indeed, a spherical wave of radio signals of a fairly wide range of frequencies has been travelling away from the earth over a period of rather over 50 years. In the case of more highly developed societies, it seems probable that they have been transmitting such signals for a far longer period (although one hopes they have not been stupid enough to destroy themselves by nuclear war).

A second type of signal we may possibly be able to receive is some form of inter-stellar or even inter-galactic communications between highly developed communities. Such reception would be by chance and it must be assumed that highly developed communities would employ very high gain antennae which are unlikely to be pointing towards our solar system. Thus the chances of intercepting such messages cannot be regarded as being very high.

The third type of signal we may hope to receive is an intentional one directed at our solar system by a society in a distant stellar system in order to notify us of their presence. It is also possible that such a society may send signals out isotropically (that is, all directions at equal intensities), but unless they have transmitters of extremely high power, such signals would be so weak at the earth that it is doubtful if we could detect them.



The Goldstone 26m Deep Space Network Antenna may be used in an all-sky search. (Courtesy Jet Propulsion Laboratory).

It is difficult to make an estimate of the optimum bandwidth one should select for SETI work. Narrow bandwidth receivers (possibly with a bandwidth of a few Hz) enable very weak signals to be detected, since the narrower the bandwidth of the channel used, the less the external noise which can penetrate into that channel. (Someone once said: "The wider you open the window, the more the amount of dirt that flies in." and this certainly applies to radio bandwidths). Unfortunately if one has a very narrow bandwidth channel, it takes a very long time to examine an appreciable range of frequencies. Modern plans are to use both narrow and wide band search techniques together with spectrum analysers containing a million or more channels for the simultaneous examination of numerous frequencies by computer techniques.

The Drake Equation

Before spending millions of dollars on SETI programmes, one would like to have some approximate estimate of the number of civilizations which are likely to possess the technology to be able to communicate with us. Such an estimate can be obtained by the use of the Drake equation. Professor Frank Drake is one of the leading SETI workers and is now Director of the National Astronomy and Ionosphere Centre of Cornell University. His equation reads:

$$N = R_* f_p n_e f_l f_i f_c L$$

where N is the number of existing civilizations possessing the interest and capability for inter-stellar communications

R_* is the mean rate of star formation averaged over the lifetime of a galaxy

f_p is the fraction of stars with planetary systems

n_e is the mean number of planets in each system with an environment favourable for the origin of life

f_l is the fraction of suitable planets on which life does develop

f_i is the fraction of life bearing planets on which intelligence together with

A complex Cyclops array on the far side of the moon containing 216 large (200 m) reflecting radio telescopes with a control building in the middle of the array. The lunar base is in the middle distance towards the left hand side and is quite small. (Courtesy NASA Ames Research Centre).

manipulative abilities appears

f_c is the fraction of the planets evolving advanced technical civilization

L is the lifetime of the technical civilization (perhaps very difficult to estimate!).

The estimate obtained from the use of this equation will obviously vary widely according to the estimated values employed. However, most estimates now place the value of N around one million, these being distributed amongst approximately 500 million stars in our galaxy.

SETI History

Perhaps the first important paper on SETI work appears in *Nature* in 1959 under the title "Searching for Interstellar Communications" by Philip Morrison and Guiseppe Cocconi. It is interesting to note that they suggested the use of the 1.420 MHz hydrogen frequency, since it is a unique standard frequency which must be known to every observer in the universe.

Eight separate major efforts have been made by US, Canadian and Russian radio astronomers since 1960 to detect extra-terrestrial signals from intelligent beings. Although each search has concentrated on one or more specific frequencies in the range from 600 MHz to 22.2 GHz, the receivers used were those designed mainly for normal radio astronomical work which involves the detection of incoherent naturally produced radiation rather than the coherent radiation the SETI workers were seeking.

Although no confirmed sources of signals from intelligent beings outside the solar system have yet been detected, it has been estimated that the number of stars which have been examined is about 0.1% of the number which would have to be investigated if there is to be a reasonable statistical chance of detecting extra-terrestrial intelligent signals.

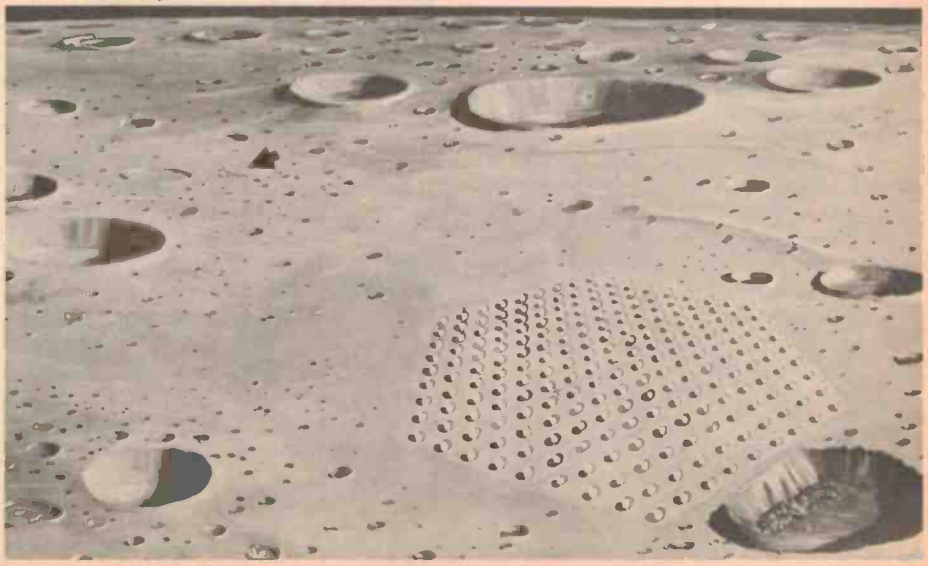
Project Ozma

The first SETI work was led by Frank Drake using the 1 420 MHz hydrogen frequency. It was named "Project Ozma" after the ruler of Oz – a far away place populated by exotic beings. Drake employed a bandwidth of 100 Hz and aimed his receiver at the two stars Tau Ceti and Epsilon Eridani which are both some 11 light years away from the earth. The observing time was some 150 hours using a 26 m (85 feet) diameter steerable antenna in 1960.

Project Ozma II is a much more extensive one which has also been carried out at the National Radio Astronomy Observatory, Green Bank, West Virginia. In this work some of the largest and most sophisticated radio telescopes in the world have been used; they include the 92 m (300 feet) diameter partially steerable antenna completed in 1962 at a cost of about 1 million dollars and the 43 m (140 feet) diameter equatorially mounted, fully steerable antenna which was completed in 1965 at a cost of some 14 million dollars.

Project Ozma II was commenced in late 1972 under the leadership of Benjamin M. Zuckerman of the University of Maryland and Patrick Palmer of the University of Chicago, the intention being to run the project for about two years. However, the Observatory made more time available and the project continued until December 1976 with an examination of about 700 stars at distances of up to some 65 light years. The prime targets were main sequence stars of the F5 to K5 class. The observations were carried out at 1 420 MHz, each of 384 separate receivers being tuned to a slightly different frequency near to the

An array of three antennas constructed in natural craters on the far side of the moon; each contains a receiving platform similar to that used in the Arecibo antenna. (Courtesy NASA Ames Research Centre).



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1 420 MHz hydrogen line. A total bandwidth of 4 kHz was used.

At the end of the Project Ozma II work, about 12 stars showed some unexplained phenomena which were probably due to terrestrial radio interference, but which could have been due to faint signals from intelligent beings. These stars will doubtless be examined very carefully at some later date.

Russian Work

Russian workers have been very interested in SETI since V.S. Troitsky of Gorky University examined 12 nearby sun-like stars in 1968, but the Soviet Academy of Sciences has announced proposals for SETI work extending up to 1990. The 1968 work used the Gorky University 14 m (45 feet) diameter antenna at 1420 MHz and 1 GHz. Sensitivity with their 13 Hz bandwidth was about $2 \times 10^{-21} W m^{-2}$.

In 1972 Troitsky commenced work with a "Eurasian" network of omnidirectional antennas and the Gorky antenna to look for pulsed signals from the whole sky at frequencies of about 1.87 GHz, 1 GHz and 600 MHz. Ambitious Russian plans include a search of the whole radio astronomy window from 1 GHz to 100 GHz. The stars involved are to include likely ones in our vicinity, the nearby galaxies in our local group and an all-sky survey without any particular pre-selected objects. Both ground based and orbiting SETI telescopes are planned, whilst a search may be attempted for the infra-red radiation from extraterrestrial heat generating projects such as one would expect from a region inhabited by intelligent beings.

Canadian Work

Dr. Bridle and Dr. Feldman commenced work at Canada's nationally owned Algonquin Radio Observatory in Algonquin Park, Ontario in 1974. They are using a 46 m (150 feet) diameter telescope to examine many of the nearest sun-like stars, but the frequency employed is 22.2 GHz — the emission frequency of the water molecule — which is much higher than that used by other workers.

Arecibo

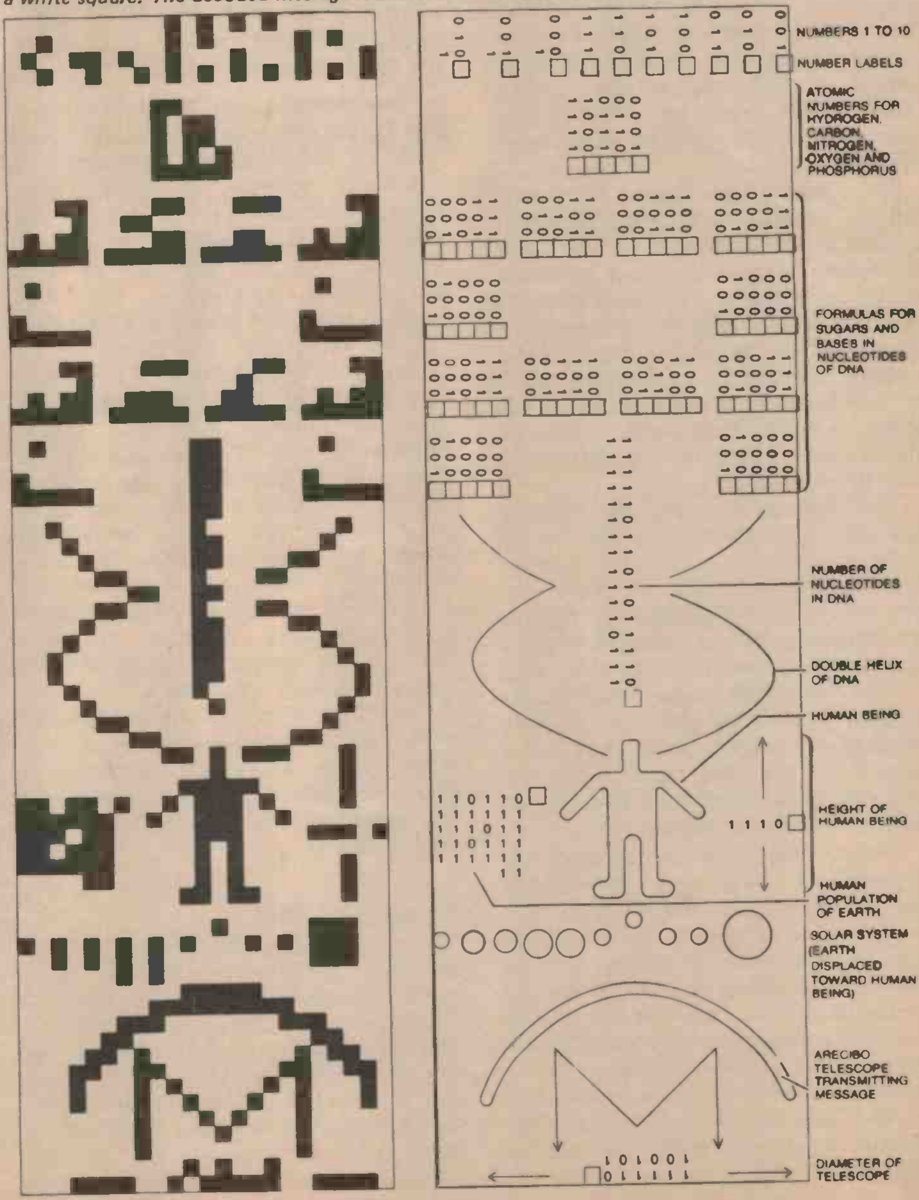
Some SETI work has been carried out using the largest telescope in the world at the Arecibo Observatory in Puerto Rico which has a diameter of 305 m (500 feet) in the air. The reflector panels consist of 38,778 individual panels each a little over 1 m by 2 m in size; each panel must be positioned with an accuracy of better than 1 mm.

In 1967 a British post-graduate student noticed a mysterious regular pulsing signal from space and there was much speculation as to whether this was a signal from intelligent life beaming a message to earth. The Arecibo antenna was used to show that this signal was coming from the first pulsar to be discovered and that it was in the Crab Nebula.

Two of the best known SETI workers, Prof. Frank Drake and Prof. Carl Sagan, have used the Arecibo antenna to examine the radiation from whole galaxies for signs of signals from intelligent life. Although the use of this technique has enabled them to examine many millions of suitable types of stars simultaneously, it would require a signal of very great intensity to enable frequencies of 1 420 MHz, 1 653 MHz and 2 380 MHz, but the time allocated to this work is relatively small. The distances involved are of the order of ten million light years, so two way communications would be very difficult!

It is interesting to note that if the

Fig. 2. The Arecibo message consisted of 1679 binary digits which can be arranged to form an image of the type shown on the left hand side if each '1' is a small dark square and each '0' is a white square. The decoded message is shown on the right hand side.



Arecibo telescope were to transmit at a rate of one bit per second with a 1 Hz bandwidth, a similarly sensitive radio telescope could receive the signal if it were placed anywhere in our galaxy.

There are four transmitters available for use with the Arecibo dish: (i) 5-12 MHz for ionospheric investigations; (ii) 50 MHz for ionospheric and lunar work; (iii) 430 MHz for ionospheric, lunar and planetary radar studies and (iv) 2380 MHz for planetary radar observations. The last of these is a 450 kW transmitter operating in the S band and, when its power is concentrated into a narrow beam by the reflecting dish, the effective radiated power in the direction of the beam is approximately one hundred times the total power production of all of the electrical generating plants in the world. This corresponds to an effective radiated power approaching one hundred million megawatts. In a distant planetary system the intensity of this Arecibo beam would be about ten thousand million times that of the sun at the same frequency.

On November 16th, 1974 the Arecibo telescope was used to transmit a message at 2380 MHz with a 10 Hz bandwidth in the direction of a globular cluster of stars, the Great Cluster in Hercules, Messier 13; this is a group of some 300 000 stars whose apparent size roughly matches that of the beam width. However, as the distance of this Cluster is some 25 000 light years, we should not hold our breath whilst waiting for a reply!

The message describes some points about life on earth which it was felt are likely to interest another civilization. The message consisted of 1679 bits, each bit being transmitted by moving the frequency of the radio transmitter slightly to represent a binary 'O' or a '1'. The frequencies were continuously adjusted to correct for the Doppler effect of the orbital motion and of the rotation of the earth so that the two frequencies remained constant to an observer outside the solar system.

The message can be decoded by breaking it into 73 consecutive groups of 23 characters each and arranging these groups in sequence under one another as in fig. 2. The choice of the prime numbers 73 and 23 greatly facilitates the decoding. The message commences with a lesson which describes the numbering system to be employed, namely by commencing with the first ten digits in binary form. The message continues with the atomic numbers of five common elements found in living things. Information about sugars and DNA follows together with a sketch of a human being and the solar system. Finally some information on the Arecibo telescope is given.

This account of the Arecibo message has been considerably abbreviated, as can be seen from fig. 2. For example the line extending from the head to the foot of the image of the human being is accompanied by the binary number 14; this signifies that the human is 14 units of length in size, the only possible unit of length being the wavelength of the transmission, 126 mm making the height of the person just under six feet or somewhat less than 2 metres. On the left hand side of the human is a number denoting the human population of the earth (over 4000 million), whilst the number 2430 at the base of the message denotes the number of wavelengths across the reflector of the telescope. All of these numbers are in binary form and can tell much about the state of our technology.

The message was transmitted at a rate of ten characters per second over a time of 169 seconds. Although it is extremely unlikely to produce any reply, the transmission of this message was intended rather as a definite demonstration that our level of radio astronomical technology has now reached the point where it is adequate for inter-stellar communication.

It is interesting to note that the first two messages sent into space were engraved plaques that ride aboard Pioneer 10 and 11. Each plaque contains information about the location of our solar system with respect to 14 local pulsars, the precise periods of which are shown in binary code. An image of a man and of a woman is included in each plaque. These plaques will presumably continue to travel through our galaxy at some 16 km/s for an extremely long time.

It can be seen that the encoding of information in various types of message poses some interesting problems in order that decoding can be carried out as easily as possible by intelligent remote beings.

Proposed US Work

The Arecibo telescope reflector is an enormous structure, its diameter being about ten times that of the 30 m reflectors used for international communications using the Intelsat satellites. An increase of the diameter by a factor of ten is equivalent to an increase in the signal collecting area by a factor of the order of one hundred. Nevertheless, SETI researchers want far larger systems in their attempts to achieve their first success.

Workers at the Jet Propulsion Laboratory planned to survey the whole sky in a SETI project scheduled to commence in 1980, but it now seems certain that the few million dollars required for such a preliminary survey will not be made available in the near future. It was intended to use the existing 26 m diameter antennas of the US Deep Space Network (see "Deep Space Communications", ETI, July 1978) with two megachannel spectrum analysers per antenna. Apart from the SETI work, sophisticated computer techniques were to be used to gather radio astronomical data. The vast amount of incoming data required the equipment to be designed so that the amount of stored data would be kept to a minimum and the information would be handled on a real time basis. Unattended operation of the SETI equipment was planned. The search was to be made simultaneously at 4 million discrete frequencies in 300 MHz channels at frequencies between 1 GHz and 25 GHz. All of the sky visible from the Goldstone site (80% of the complete heavens) would have been covered.

The flux levels detectable by this proposed Jet Propulsion Laboratory work are about 10^{-20} to 10^{-23} W/m^2, but a simultaneous search targeted at selected nearby stars was proposed for NASA's Ames Research Centre. The higher sensitivity Ames work should be able to detect signals at levels down to 10^{-27} W/m^2 over frequencies in the 1.4 to 1.75 GHz band, but the total bandwidth would not be more than 10 MHz and the bandwidth of individual channels no more than 4 Hz. The Ames workers would use the Arecibo Observatory and possibly other antennae.

Project Cyclops

One of the most ambitious SETI projects yet proposed is known as Project Cyclops. This is intended to be suitable for not merely detecting high power signals (such as those from our own Arecibo antenna), but also to allow eavesdropping on much lower intensity signals which other civilizations use for their own communications (like our radio and television transmitters). In order to be able to receive such signals from stellar systems at distances of a few hundred light years from the earth, enormous antenna systems are required.

It seems unlikely that it would be a practical possibility to construct a single reflecting dish of adequate size and therefore it has been suggested that the Cyclops project could employ an enormous array of radio telescopes, each of which may be about 100 m in diameter. For example, as many as 1 500 such 100 m dishes could be spread out in lines over an area of perhaps 65 km^2 and connected together electrically to provide the same performance as a single dish of enormous dimensions.

Project Cyclops was initiated as a study by the NASA Ames Research Centre and Stanford University in 1971 under the leadership of Dr. John Billingham and Dr. Bernard Oliver. There have been vast improvements since then in solid state memories, microprocessors, wideband maser low-noise amplifiers, etc. Nevertheless the full project would cost something of the order of 10^{10} dollars, although we have all the required technology already developed. The major cost would be the antennas which would employ reflectors of an area over twenty times that of the Arecibo dish.

Non-terrestrial Antennas

Many SETI workers favour the use of antennas in space or on the far side of the moon. One of the attractions of using antennas on the far side of the moon is the absence of radio interference from the earth. One could probably construct Arecibo-type antennas in some of the natural craters of the moon so as to avoid much of the work involved in moving the surface material of the moon. As in the case of the Arecibo dish, this use of natural craters can greatly reduce the construction costs.

Other proposals include the construction of antennas in orbit around the earth. Such antennas would have the advantage that they would not be affected by interference from the atmosphere of the earth, but they would be susceptible to interference by earth stations (unless screened from it).

It must be made clear that neither NASA nor the US congress is seriously considering the financing of such enormous Cyclops projects at the present time. The availability of such an antenna system of enormous sensitivity would contribute not only to SETI work, but also to many other radio astronomical projects. For example, it would provide unrivalled data for the compilation of detailed star catalogues, it could be used for greatly improving the Deep Space Network used for communicating with spacecraft on interplanetary flights and for radar studies of bodies within the solar system. The Arecibo antenna has been used for radar mapping of the surface of Venus, since

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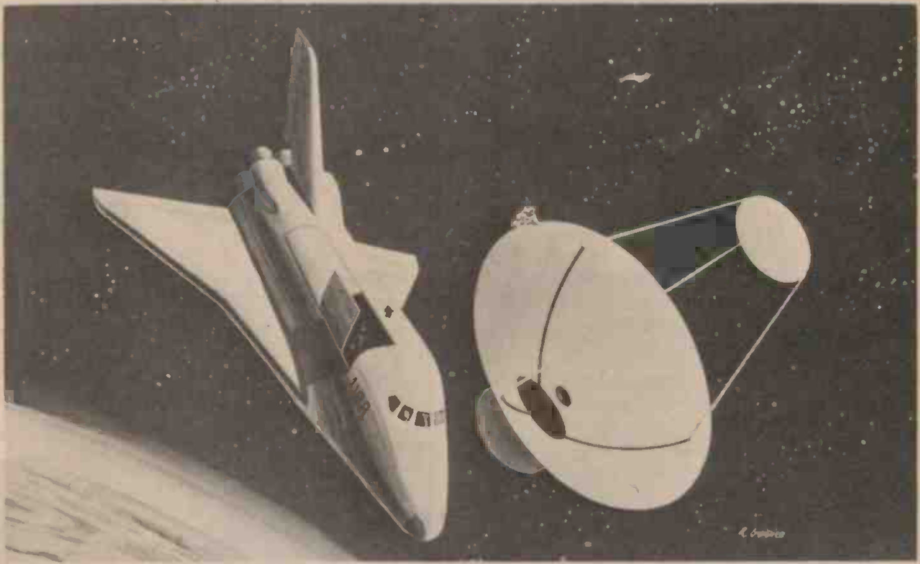

An artist's concept of a relatively small (30 m diameter) space SETI parabolic antenna which could be conveyed into low earth orbit and erected by means of a single Shuttle flight. (Courtesy NASA Ames Research Centre).

the radio waves can penetrate through the thick clouds of the planet and the reflections received provide information about the surface of the planet. A more powerful Cyclops system could be used for radar mapping the surface of the more distant planets. Other work for a Cyclops array would include radio frequency interference studies.

Conclusion

The Search for Extra-Terrestrial Intelligence has not yet been successful, but this is not particularly surprising in view of the small number of star systems which have been examined with high sensitivity equipment. Some people (including many of those who control scientific finance) may feel that the SETI project is rather frivolous and perhaps even a silly one. However, there are many scientists very strongly committed to work in this field – a point which can be demonstrated by the fact that a new journal, *Cosmic Search* devoted entirely to SETI work will be published from January 1979 under the editorship of Dr. Robert S. Dixon who is well-known for his SETI work at the Ohio State University Radio Observatory.

Dr. Frank Drake at times feels somewhat cynical about the cuts in the SETI budgets. Indeed, he has commented that the search for extra-terrestrial intelligence begins with the search for intelligence here on earth! He feels that at the present time there is a very well qualified group of people who are keen to carry out an extensive SETI project and, if no funds are forthcoming for a year or more, it is likely that many of these people will move to other work. If you were paying taxes in a country considering becoming involved in an extensive SETI project, how would you feel about paying an extra amount (far less in total than that to place a man on the moon) in order that the project could proceed? SETI work will doubtless continue, but more funds are required if it is to proceed at a rate which is likely to bring success within the lifetime of most people who are living today.

SETI is still in its infancy. Who knows whether more advanced civilizations have found methods of communicating by means other than electro-magnetic radiation? For example, neutrino beams are interesting because they can pass through matter very easily, whilst there has been much speculation on the existence of gravity waves and the possibility of tachyons has already been mentioned. At present electro-magnetic frequencies near the water hole seem to offer the best possibilities. One wonders whether special cosmic languages already exist and whether the long transmission times will make us cosmic archeologists.

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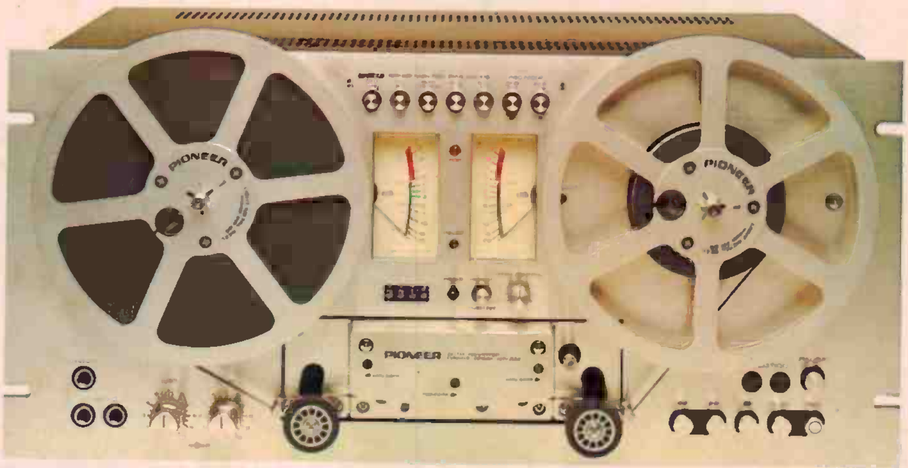
All Pioneer open-reel decks are covered by warranty for one year. Excellent service facilities are available throughout Australia via a network of Pioneer approved outlets.



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SOUND

Noise Reduction Systems

There is a lot which appears on records and tapes that shouldn't be there. How do you go about getting rid of it, or at least reducing it? William King investigates.

OVER THE PAST FEW decades, the standard of reproduction of audio equipment has increased at an astounding rate; so much so that the public is beginning to demand program material of very high technical quality.

One of the major problems in fulfilling this need is being able to recreate the full dynamic range of a live performance, of say, an orchestral concert. The heart of the problem is noise, and this is likely to be worst in the audio link between the studio or concert and the listener at home, whether it be a disc, tape or FM radio link.

For most people a quality tape system with a good signal to noise ratio is far too expensive, and of those people who have FM tuners claiming a signal to noise ratio of 70dB, how many live close enough to a transmitter to have the required 1mV or so available at the front end?

Royal Noise

In the early days of sound broadcasting and recording, when the noise problem was much worse than today, attempts were made to reduce its effect by turning up the gain manually for quite passages of music, thus in effect compressing the dynamic range so that even quiet passages would be above the noise floor. The BBC today still use this technique, in orchestral concerts relayed from the Royal Albert Hall.

The level of quiet passages can be raised by as much as 16dB, thus allowing listeners in poor reception areas who are listening to AM transmissions to be able to receive the entire program without quiet passages being drowned in noise.

The average usable dynamic range of the domestic listening environment allows a usable dynamic range of a mere 65dB. This is about the same as the noise figure introduced between the studio and the listener at home. What use then are noise reduction systems?

Once a master tape has been finished copies will be made, and maybe later even copies made of the copies — but with each successive copying the tape noise will have increased by 6dB (roughly doubled). At home, the now popular 'compact cassette' system, due to its slow tape speed and narrow track width, has a noise figure of –50dB which is noticeable in any listening environment.

Noise reduction systems, then, are a real necessity in the studio and can be justified in the home, and there are at present a number of systems in use, varying in complexity and effectiveness.

The broadest categories into which noise reduction systems fall, are complementary (two pass) units and non-complementary (single pass) types.

Complementary systems, such as the Dolby and dbx systems, consists of two units, a processor and a deprocessor. Before being recorded, or transmitted, the audio signal is passed through the processor and on reproduction through the deprocessor.

Above The Floor

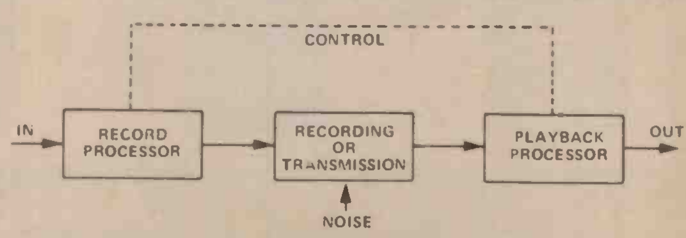
The simplest type of system is the compressor/expander type. In the dbx 122, the processor consists of an audio compressor, which will produce a change in output level of 1dB for a change in input level of 2dB. Thus, an orchestral concert with a dynamic range of 80dB when processed will have a dynamic range of only 40dB, giving the unit a compression ratio of 2:1.

The compressed signal is then recorded on a tape recorder as normal, and now, even the quietest passages (at –40db) will still be well above the noise floor of the tape.

On replay, the recorded signal is played back through the deprocessor, an expander, which restores the original dynamic range of 80dB.

When using a system like this with a tape recorder, the tape recorder must be accurately set up beforehand. If the machine has a frequency response accurate to within ±3dB, when the processed signal is replayed and expanded the frequency response will drop to within only ±6dB. Any defects in the tape will also be more noticeable — a drop out will sound twice as bad when expanded.

Noise reduction with this sort of system can be as much as 40dB, and because it works over the entire audio frequency range, will provide 'wide-band' noise reduction. Unlike the dolby system, because the compression ratio is independent of



A block diagram of a complementary noise reduction system, showing the need for the overall control between input and output.

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relative levels, the dbx system requires no complicated setting up or calibration tapes.

Dolby et al

Perhaps the widest known of all noise reduction systems is the Dolby system. There are two versions of this system available, dolby 'A' for use in recording studios, and Dolby 'B'-a simpler version designed for consumer use.

The Dolby A system also works on the principle of compression and expansion, but does not have a fixed compression ratio. The incoming audio signal is filtered into four bands, below 80Hz, 80 to 3kHz, above 3kHz, and above 5kHz.

As can be seen from the diagram, identical filter and compressor networks are used in the processor and deprocessor; — the only difference being the use of an adder in the processor and a subtractor in the deprocessor.

The Dolby A system processor works only on high and medium level signals. If individual frequency components are less than —40dB down the operating level, they will pass through their particular band side chain without undergoing any form of compression. As signals increase in level, so does the amount by which they are compressed, varying from 0 for low level signals to up to 15dB compression for high level signals.

Banding Together

Being a multi-frequency band system, the system minimises some of the problems associated with wideband systems such as the dbx, one particular advantage being that each band can have operating characteristics (such as attack and decay times) optimised, reducing modulation products caused by too slow, or too rapid gain changes.

The fact that the compression and expansion ratios vary with the audio signal level means that in order to function properly, a tape machine using the Dolby system will have to be accurately calibrated with level tapes before use. Due to the different tapes it also is necessary to recalibrate the system when a different type of tape is used. From Dolby A, the typical noise reduction figure which can be expected is 10dB up to 5kHz, rising to 15dB at 15kHz.

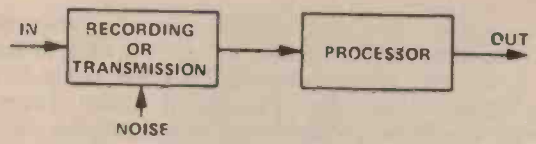
The simpler version, Dolby B, is intended for consumer applications, and fitted as standard to many makes of cassette deck divides the audio signal into two audio bands. The system is based on the assumption that high frequency hiss will be far more noticeable than low frequency noise, and so does not process the low frequency content of an audio signal.

The compressor in the processor boosts low level high frequency signals by amounts of up to 10dB depending on the input level, giving on replay and deprocessing a reduction in noise of up to 10dB in the high frequency range. This increases the dynamic range of a cassette system from around 50dB to a max of over 60dB.

To B Or A?

Dolby B uses a non linear dynamic compression ratio and so must be carefully adjusted for the tape recorder and tape with which it is used; very few external user serviceable controls are found on most cassette decks fitted with the dolby B system, for fear that people might incorrectly calibrate the device and produce worse results than if it were not used at all.

One of the drawbacks of complementary systems is that they will only reduce noise introduced between the compressor and the expander. Complementary systems also offer no help with noisy tapes and discs recorded without being first processed, and of course, the various systems available are all incompatible so the engineer with a nice dolby system and a dbx tape is still at square 1!



Basic functioning of a non-complementary noise reduction system.

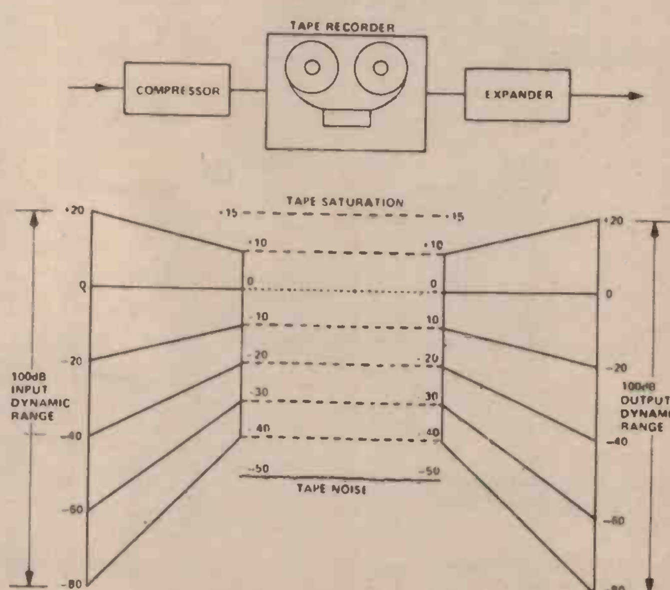
A Fillip To NRS

Single pass non-complementary systems offer some hope for non-encoded material. Philips DNL (dynamic noise limiter) has been around for a few years now, and was specifically designed to reduce noise in unprocessed cassette recordings (but is now also fitted in addition to the dolby system on some Philips reel-to-reel decks).

The DNL consists of a dynamic low-pass filter; noise is most noticeable in quiet passages of music (such as piano music), when most of the higher frequency signal is noise, and it is at this time that the DNL operates.

When the signal's high frequency component is strong, and sufficient to mask the high frequency noise the cut off frequency of the filter increases and allows all the high frequency signal to pass unattenuated. When the level of the high frequency component is low, it is assumed that the noise will be dominant, and the cut off frequency of the filter is reduced, attenuating the noise, and, unfortunately some of the wanted signal.

Burwen's DNF (dynamic noise filter) works on a similar principle but is much more flexible. They system senses the high frequency content of the signal. If there is a lot of high frequency energy present, the filter cut off frequency rises to 30kHz, and all the signal is passed, the high signal level masking the noise. When the signal reduces in level, so does the cut off frequency which falls to 500Hz when no signal at all is present, giving a very substantial noise reduction on blank gaps between pieces of music on tape.

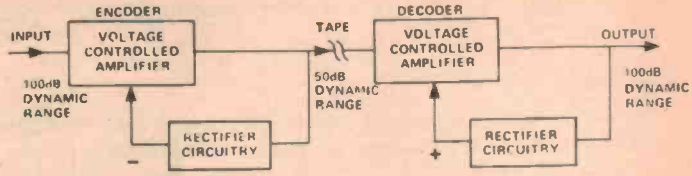


A compander circuit expander-compressor showing how a 2:1 compressor ratio function in practise to give, in theory, 1 100dB S/N ratio from a tape with a 50dB noise 'floor'.

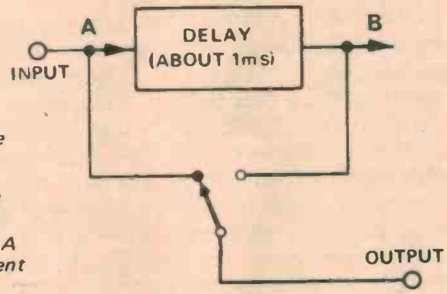
SOUND

Correlations

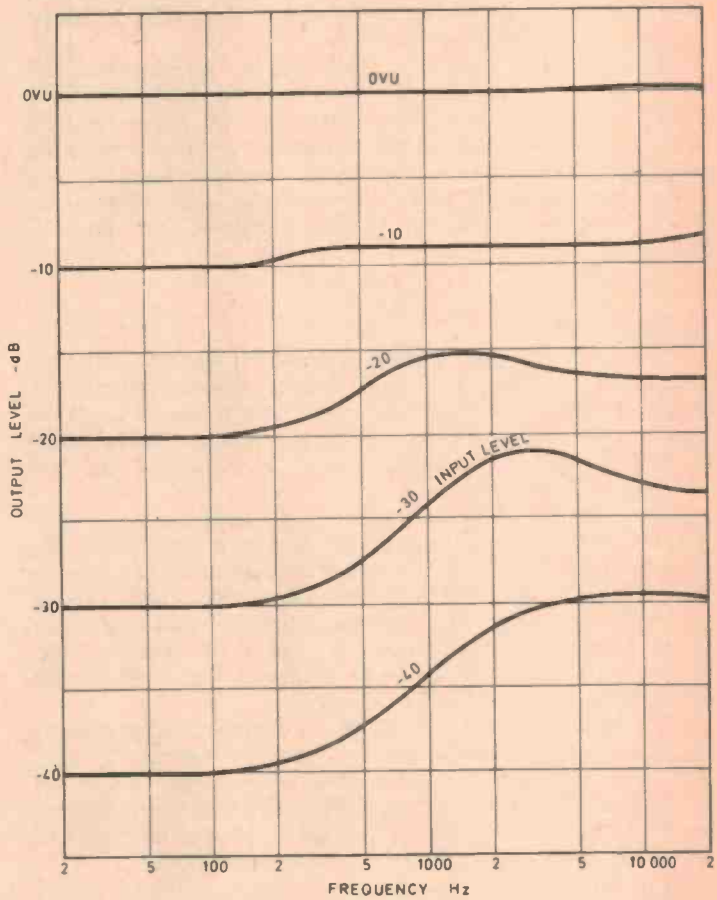
Phase Linear's Auto-correlator is an example of a very sophisticated non-complementary system. It consists of a series of bandpass filters that can be opened, to allow signal in the frequency range of the filter through or closed down to remove noise. The filters are controlled by the auto correlation circuitry. Music contains mathematically related tones and is highly coherent (or correlated) in nature, whilse noise tends to be random and has a low correlation coefficient. What the Auto correlator does is to calculate the correlation coefficient, and use it to determine whether a signal is noise or music. If a particular signal is determined to be musical in nature, the appropriate filters are opened up to allow it, and its harmonics and overtones through.



The dbx 122 unit is a refinement of the basic compander design. The addition of the rectification circuitry can be seen from the block diagram.

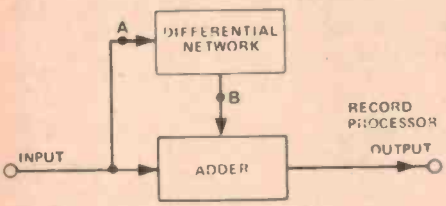


Simplified diagram of the workings of the SAE Impulse Noise Reducer. The 'switch' is the actual unit, which transfers the output connection from A to B when a click is present to eliminate the sound.



Variable compression ratio of Dolby B system; note how frequencies below 100Hz are unaffected.

(1)



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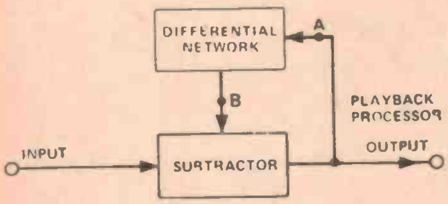

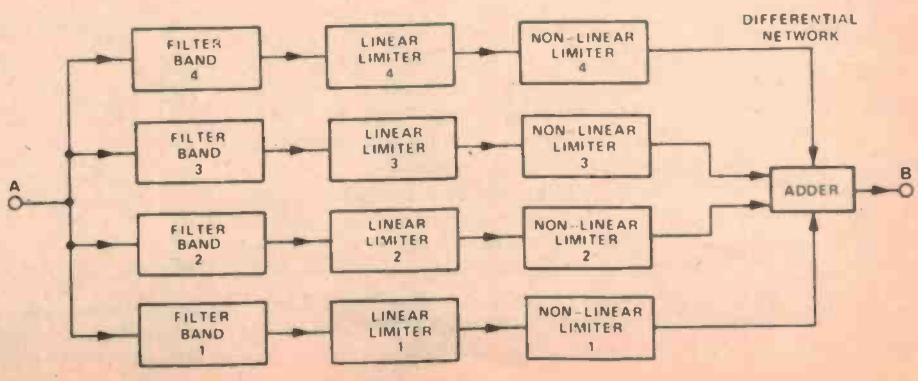

Top (1): Simplified diagram of a Dolby A deprocessor circuit.

Top (2): The processor circuit to match that shown above.

Right: Diagram of the Dolby A differential networks.

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33 uF	50v	PCB	0.11	0.10
47 uF	16v	PCB	0.10	0.09
47 uF	35v	PCB	0.12	0.11
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If the correlation is low, the signal is treated as noise and the appropriate filters are activated preventing noise from passing through.

These three non-complementary systems, because of the way they operate, will inevitably have an effect on the wanted audio signal, but if carefully set up can give a substantial reduction in noise with only a minor effect on the program content, and it must not be forgotten that while two-pass systems only reduce noise introduced between the processor and deprocessor, a non complementary one pass system can effectively reduce noise generated anywhere in the audio chain from the studio to device itself.

Snip The Crackle And Pop!

One recently developed type of noise reduction system, the SAE model 500 Impulse Noise Reduction System, has been designed to remove unwanted clicks and pops caused by scratches in discs.

The SAE device recognises clicks and pops by their fast rise and fall times. If a signal has a fast rise and fall time it is thus assumed to be an unwanted 'click', the click is removed and to prevent a period of silence disturbing the continuity, a small section of the preceding music is inserted in its place. This feat is accomplished using an analogue delay unit providing a delay of a few milliseconds, as the 'click' transient is about to enter the delay, the output of the device switches from the input of the delay to the output. Then, just before the click is about to leave the delay, the output of the unit again switches back to the input of the delay, thus removing the click. The typical click only has a duration of about a millisecond, and so the switching to the delay goes unnoticed, but the click vanishes.

Studious Future

What the future holds in store for "noise" is anyones guess; within a decade we may see digital tape-recorders as the standard in studios — using digital recording techniques will, if the sampling rate is high enough, eliminate noise induced in tape systems (or in broadcasts if we ever see pulse code modulation for broadcast stations) altogether, and will allow tapes to be copied any number of times without any extra noise being introduced. Already, it is possible to buy add on units for video recorders to enable audio signals to be digitally recorded onto tape!

For the moment, however, for the engineers in recording studios using multi-track machines where track width is small, and for the hi-fi enthusiast at home with his cassette system, noise reductions systems are a necessity, and will remain so for some time.

ill-informed criticism?

IN RECENT TIMES, ETI in common with most other electronics and audio magazines, has come under fire from a few British equipment manufacturers and their local agents for what they describe as 'ill-informed criticism'.

To some extent this can be interpreted as not going along with the cozy little 'you scratch my back and I'll scratch yours' arrangements that did — and with some magazines still does — exist. Ask when you last saw a poor review in ZXY Hi-Fi and you'll know which ones they are!

Nevertheless some of the industry's criticisms are valid. Certainly no magazine publishes reviews that a scientist would accept as scientific. To start with there's few agreed industry measurements standards — and even if there were agreement it's unlikely that publications could afford to take all the specified measurements to the degree of accuracy that would be required.

We do the very best we can. We use reviewers with years of experience in this field backed up by testing facilities which are often in advance of those used by most of the manufacturers themselves. But none of these reviews is scientific in the real meaning of that word — and nor are those conducted by most manufacturers.

Comparative Demonstration

In light of the above it was with a sense of wonder that we encountered a demonstration put on by Linn at Britain's recent Cunard hi-fi show.

Linn have long proselytised their belief that the turntable itself greatly influences the sound from a hi-fi system. Various demonstrations and reviews have 'shown' that a Linn turntable sounds better/different from others — although without exception the comparative methods used had more independent variables than an old-fashioned steam organ.

Rival manufacturers on the other hand suggest or openly state that if there *is* a difference it's caused by the Linn's platter resonating like a gong in a multiplicity of modes. 'The Linn's not so much a turntable — it's a musical instrument' says one eminent Japanese turntable designer, 'people may well like the sound but what they're hearing isn't on the record'.

At the Cunard Show, Linn apparently set out to prove that their deck really *was* better — but in attempting to do so they threw the faintest resemblance to scientific method right out of the window.

They set up two quite separate systems. The first had a relatively cheap (but good) Rega turntable and top everything else — the second had a Linn turntable but more modest everything else (compared with the first system).

System 1 had the Rega deck, Grace arm and Supex cartridge, Naim pre-amp and three (!) Naim power amps tri-amping a pair of Linn's Isobariks.

System 2 had the Linn deck, Rega arm, budget-priced ADC cartridge, Naim pre-amp and power amp and a pair of Mordaunt-Short's smaller speakers.

The demonstrator played very brief musical passages on one system and then the other interspersing these with assorted jokes and insults.

To our relatively unbiased ears it seems as if the cheaper system (using the Linn deck) *was* superior to the other. This was apparently the conclusion we were supposed to reach.

So terrific! A pair of small Mordaunt-Short's are better than Linn's own Isobariks? Or a Grace arm and Supex cartridge cannot improve a Rega Turntable? Or that using multiple Naim amps is a waste of time, money, power and space?

Or what?

Puzzling

The records were different. The speakers were in different positions. The equipment combinations were so varied as to be an impractical joke.

This demonstration seemed to puzzle the audio-educated members of the public and press alike. It compared one set of virtually unspecified variables against another whilst the demonstrator actively encouraged listeners to favour not just one system, but one part of one system against another!

Really Mr Linn! Just imagine the outcry if we or any other magazine reviewed your equipment using a comparison like that. Your fellow manufacturers may well have grounds for disputing some magazines' reviewing techniques – but a performance like Cunard isn't going to help that cause one little bit!

SOUND BRIEFS

Philips Belt-Drive

Philips have brought out two new **belt-drive turntables**, models AF777 and AF877, which incorporate a **speed sensor** mounted under the platter. Circuitry in the turntable uses speed information to calculate the acceleration required of the belt drive.

Pioneer Buys Phase Linear

New Jersey based US Pioneer Electronics Corporation, a subsidiary of Pioneer Electronics Corporation Tokyo, has bought Phase Linear Corporation. No change in marketing is envisaged.

Consumer Electronics Show

The date of the **4th** Australian **Consumer Electronics Show** has been set for **July 18th to 22nd** 1979. It will take place at the **Sydney Showgrounds**.

Power Amp Tone Control

Sansui have taken a rather unconventional step in the design of their TA500/300 range of tuner/300 range of tuner/amps. They have **incorporated the tone control circuitry into the power amp section** – presumably to reduce overall noise figures. Interestingly, their press release gives no noise figure for the amplifier stage.

Akai To Move Into Eden Park

Akai Audio/Video Australia Pty Ltd are to set up industrial premises in Sydney's **Eden Park Industrial Estate,** on the North Shore of the city.

Peak Programme Meter

Studio Electronics Pty Ltd have introduced two models of **LED peak programme meter.** The scales on the meters are non-linear (even in terms of dBs!) and comprise either 12 (model 112) or 30 (model 130) LEDs. The larger model also has remote-switchable characteristics, allowing either peak programme or VU operation. PO Box 1055, Burwood, NSW 2134, phone: 747.5686.

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- ENVELOPE GENERATOR 2
- Attack Time Control (1.5 msec-3 sec)
- Release Time (1.5 msec-8 sec)
- Gate Selector Switch (Gate/LFO)
- Modulator
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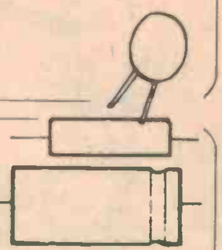

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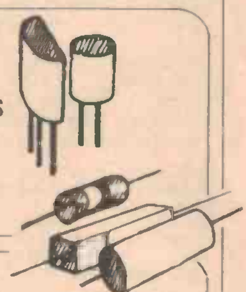

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Gain Control

Part 2

To conclude his survey of electronic gain control methods. Tim Orr presents us with more circuits which vary from a light bulb compressor to a markspace modulated universal filter unit, and a noise gate/expander.

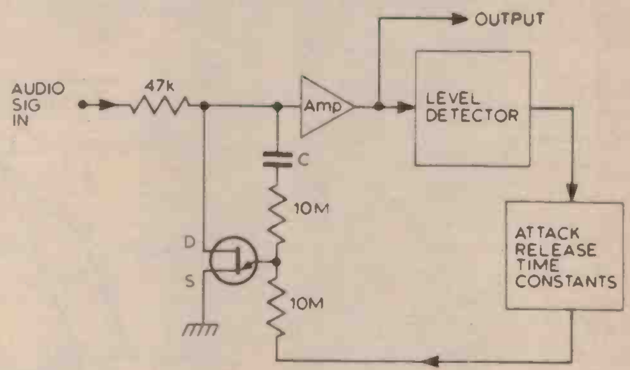
Basic Limiter Circuit

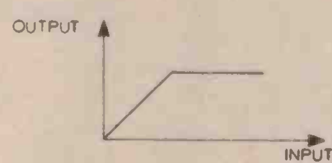
Most professional limiter circuits use a FET as the variable gain element. Relatively low distortion with a reasonable signal to noise ratio can be obtained. A basic limiter circuit is shown this being no different to previous circuits except for the variable gain element.

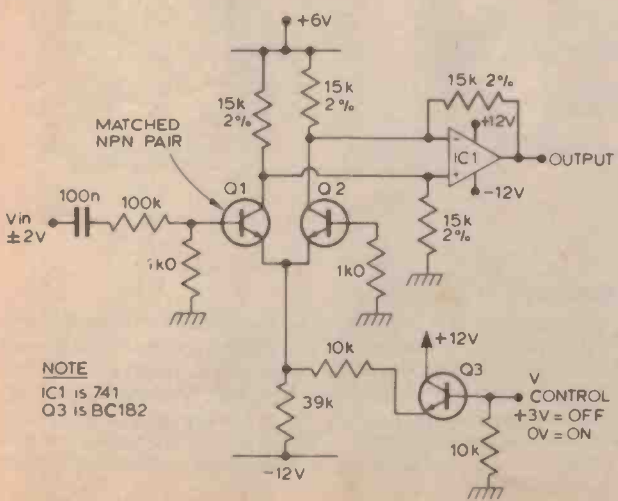
When a relatively small voltage (20 mV) is applied to the drain source of a FET, it acts like a fairly linear resistor. As the gate source voltage is varied, this resistor (RDS) also varies.

In fact the channel resistance RDS is inversely proportional to gate source voltage V_{GS}. When V_{GS} is OV, then RDS is at its generally minimum resistance (R_{ON}) which can be as low as 5R, but it is generally more like 100R. When V_{GS} exceeds the pinch off voltage (Vp or V_{GS} off) the channel resistance goes up to several hundred megohms. So a junction FET can be used as a voltage controlled resistor, except that R_{ON} and V_{GS} (OFF) tend to vary widely from device to device. However with a bit of perseverance suitable devices can be selected and made to work.

One circuit trick that greatly reduces distortion is shown here. Half of the audio signal at the drain of the FET is presented to the gate. This is superimposed on top of the control voltage and produces a distortion cancelling effect. Distortion levels below 0.1% can be achieved using this technique.

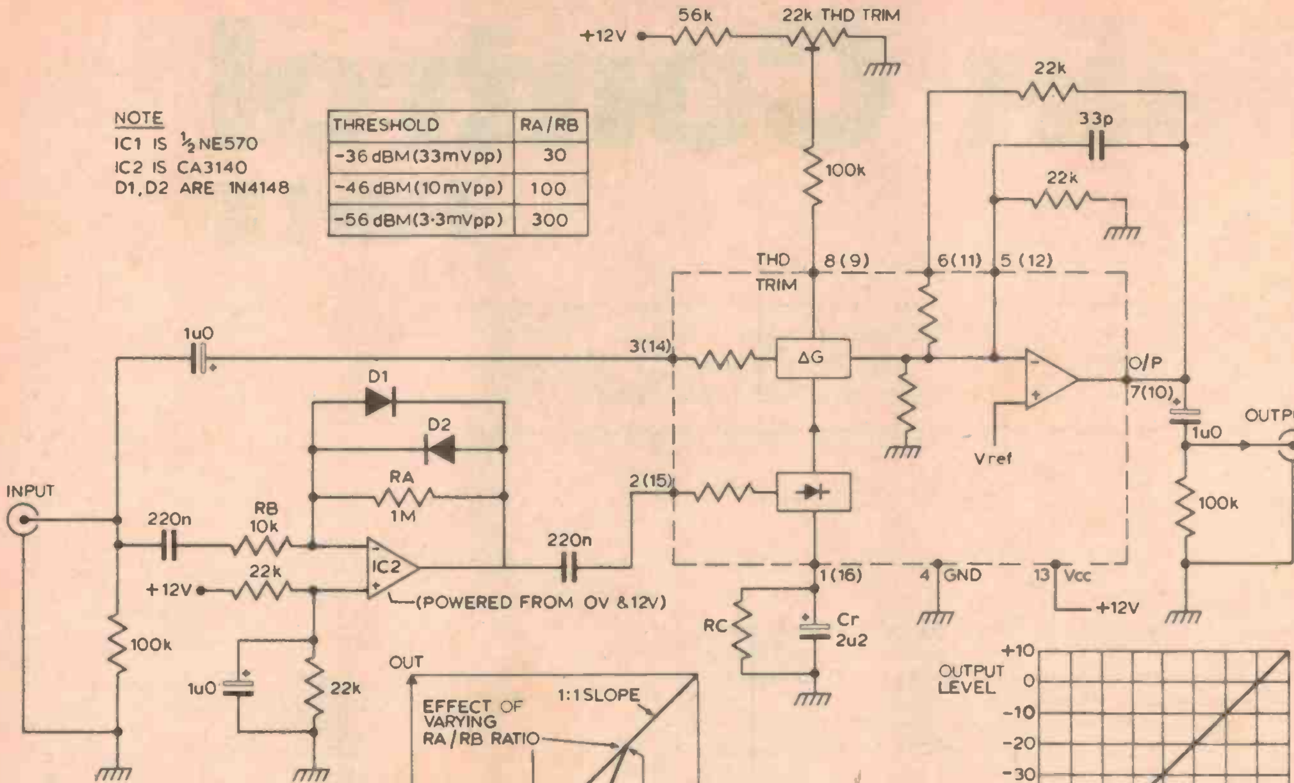




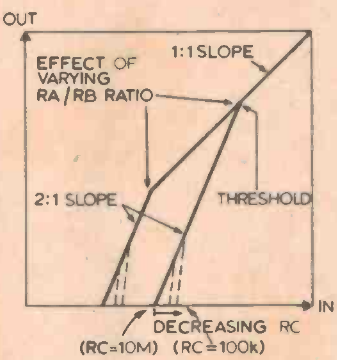


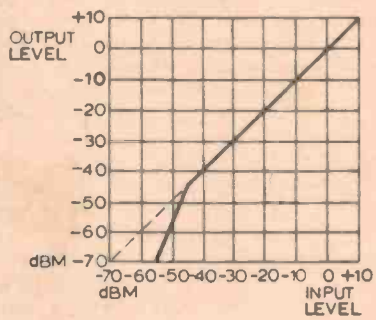
Transistor VCA

A circuit similar in operation to a CA3080 can be constructed with a matched pair of transistors and an op amp. Transistors Q1, 2 form a differential transistor pair which is used to steer whatever current is available between the two collectors, just as in the CA3080. The difference between the collector currents is equal to the product of the input voltage times the current I_{EE} times a constant. This difference is extracted by the differential amplifier IC1. The current I_{EE} is controlled by Q3. As the control voltage goes positive, Q3 robs most of the current flowing down the 39k resistor, and hence I_{EE} and the output of IC1 decrease.



THRESHOLD	RA/RB
-36 dBM (33mVpp)	30
-46 dBM (10mVpp)	100
-56 dBM (3·3mVpp)	300





Two Channel Low Level Expander/Noise Gate

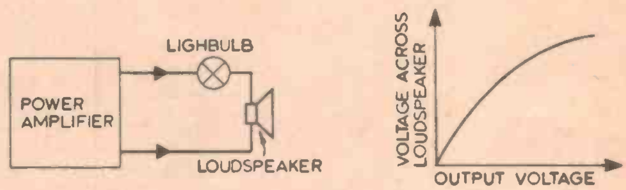
It is often required that a rather noisy signal be cleaned up a bit. This is not possible to do continuously, but it is possible to clean up noise in what was initially the gaps. The results of this cleaning up process can quite often be heard when telephone conversations from "foreign correspondents" are broadcast.

By turning down the signal level in the gaps, (by performing a low level expansion) the perceived sound quality improves dramatically.

The circuit performs just such an expansion. The inputs signal passes through the variable gain cell and then appears at the op amp output. The gain of the gain cell is controlled by the signal coming from IC2. This is a high gain amplifier with diode clamping, so that the output swing is limited to about 1VO ptp. Therefore for input signals of 10 mV pp to 10 V pp, the output of IC2 remains at about 1 VO ptp to 1V2 ptp.

So, for this range of input voltages the gain of the gain cell remains roughly static. Now when the input level drops below 10 mV, the output of IC2 will start to fall and so will the gain of the gain cell. This produces a 2:1 downwards expansion curve, which means that the output then gets quieter at a rate faster than the input. To accentuate this effect, a bleed resistor can be placed in parallel with Cr.

The resistor robs some of the current that would have otherwise gone to the gain cell and causes the input/output curve to roll off much more rapidly at low signal levels. Also, by varying the resistor ratio of RZ/RB, the expansion threshold level can be altered.

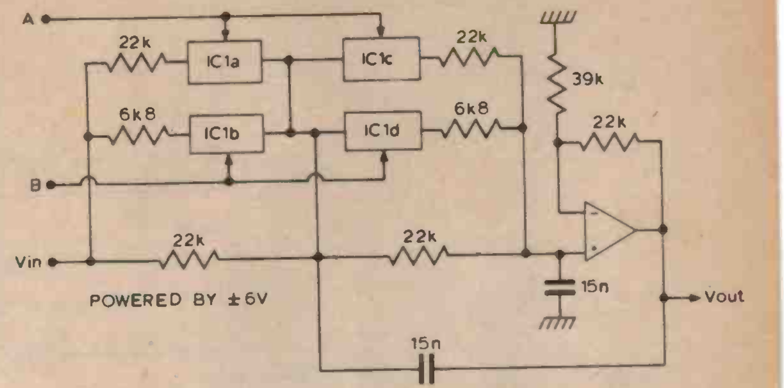


Incredibly Simple Compressor

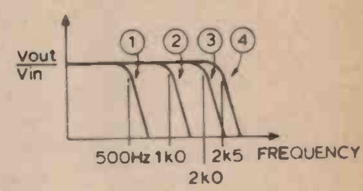
Not all gain control systems need to be complicated or indeed active. One product which I saw advertised was a compressor to help prevent loudspeaker/overloads. All it was was a lightbulb in series with the loudspeaker. When the power exceeds a certain level, the lamp will turn on, glow, its resistance increase dramatically and hence a bigger percentage of the power output is dissipated in the lamp. A nice, simple solution, but I think it would require some experimentation to find the right sort of car headlamp bulb!

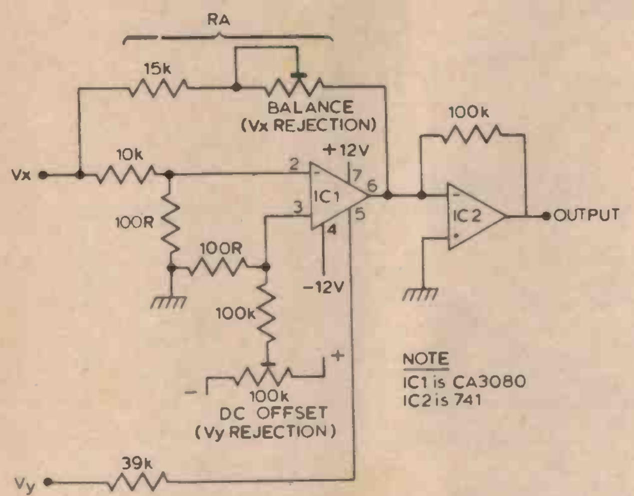
Switched Frequency Low Pass Filter

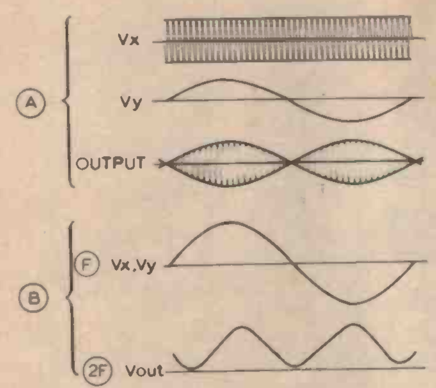
In this example the effective resistance is switched by using 4016 gates. The filter is a lowpass Butterworth and by turning gates A or B ON or OFF the cut off frequency can be altered. This allows the filter control to be physically remote or even to be computer controlled. Mark Space modulation of A and B would enable continuous control over the cut off frequency.



	①	②	③	④
A	OFF	ON	OFF	ON
B	OFF	OFF	ON	ON
Fc	500Hz	1kHz	2kHz	2·5kHz





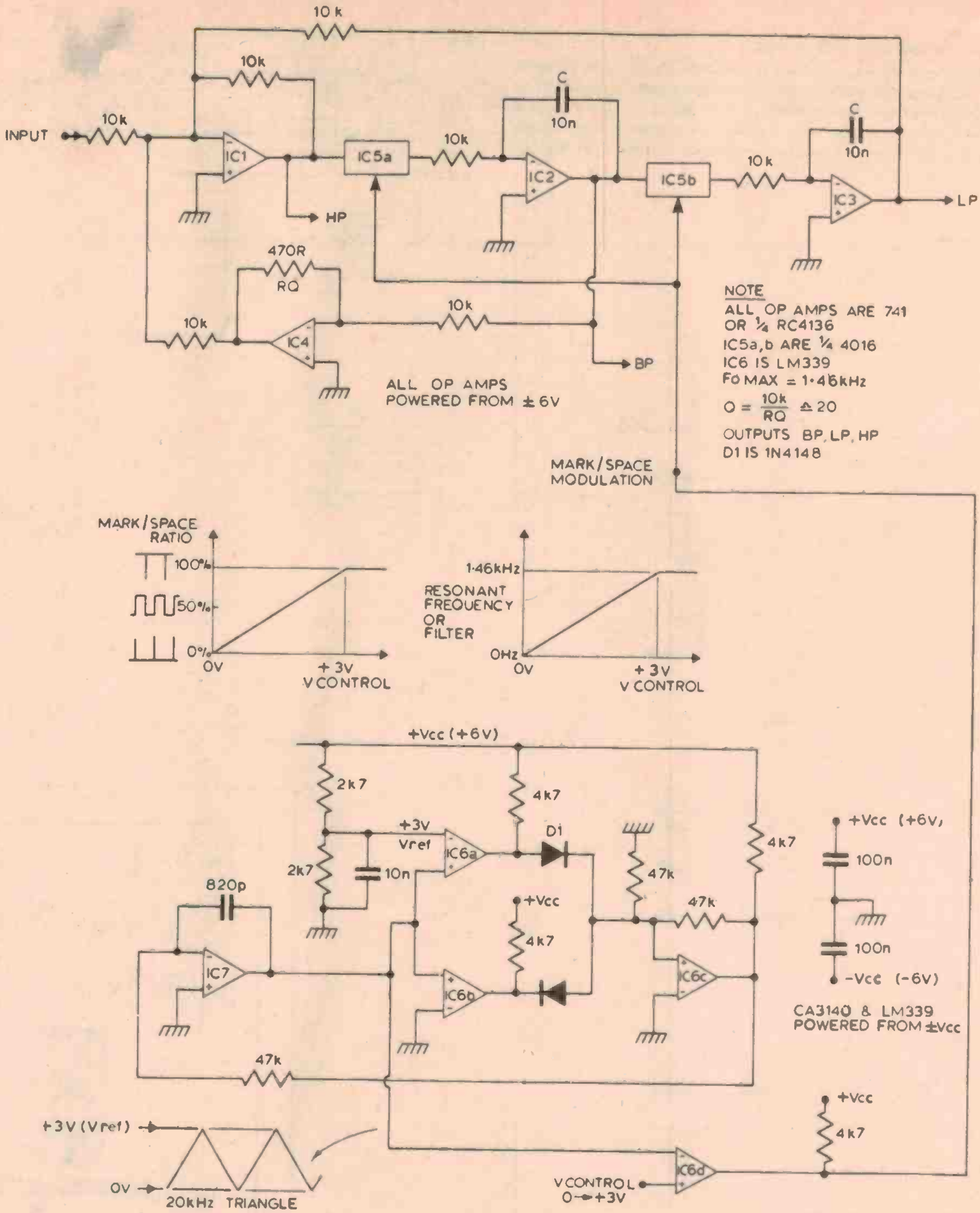


Four Quadrant Multiplication

By using a few circuit tricks, the CA3080 can be made to perform 4 quadrant multiplication. In fact the CA3080 performs 2 quadrant multiplication and the trick is to move the axis on the multiplying graph. If we ignore the RA resistor chain then we have a 2 quadrant multiplier circuit similar to that shown previously. Imagine that V_x is a 1kHz sine wave. 1 Vptp and V_y is a 0V. The output of IC2 is a sine wave of fixed amplitude. Now if we connect RA , and adjust the balance control, it will be possible to cancel out the output, because the signal coming from IC1 is out of phase with that from the RA resistor chain. So with V_y set at 0 V there is no output for IC2. If V_y goes + ve, the output of IC1 will become greater than the current via the RA chain and the output if IC2 will grow.

If V_y goes—ve the current through the RA chain will exceed that from IC1 and the output of IC2 will grow, the phase being opposite to that when V_y was a sinewave from an oscillator, then this circuit could be used to generate ring modulation effects.

When V_x is set at OV there may be some V_y breakthrough and this can be minimised by adjusting the V_y rejection preset.



Markspace Modulated Universal Filter

It is possible to change the gain of an amplifier by effectively altering the input resistor. This can be done by markspace modulating a voltage controlled switch in series with the resistor.

When the markspace ratio is low, the switch is 'off' most of the time and the effective resistance is large. When the markspace ratio is high the switch is 'on' most of the time and the effective resistance approaches that of the series resistor.

Having generated a markspace control waveform, it is possible to gang together literally hundreds of voltage controlled switches. This allows the control of large numbers of variables simultaneously.

The circuit consists of a modulated universal filter (ICs 1 to 5) and a markspace generator (ICs 6 and 7).

ICs 7 and 6a to 6c form a triangle/square wave oscillator. IC7 is the integrator whose output ramps up and down between 0V and +3V. IC6a and 6b are fast comparators which detect the end of the inegrator travel and switch the schmitt trigger IC6c, which in turn controls the integrator. The output frequency of the oscillator is about 20 kHz.

It is important that the frequency of the oscillator be relatively high. As a rule of thumb it should be 2½ times the highest frequency components of the signal you wish to process. The triangle output is fed into IC6d's inverting input, the control voltage being fed into the non-inverting one. The output of IC6d is the markspace modulation which is used to drive the switches IC5a and b. The filter's resonant frequency is directly proportional to the markspace ratio of the signal that drives the switches and thus is proportional to the control voltage.

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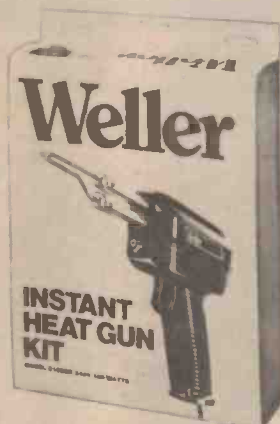

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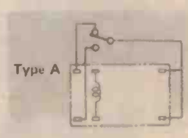

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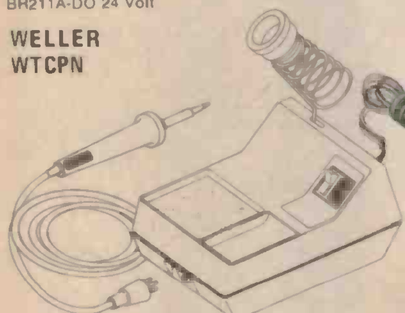

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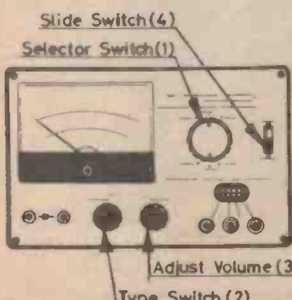

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Project 558

Masthead Strobe

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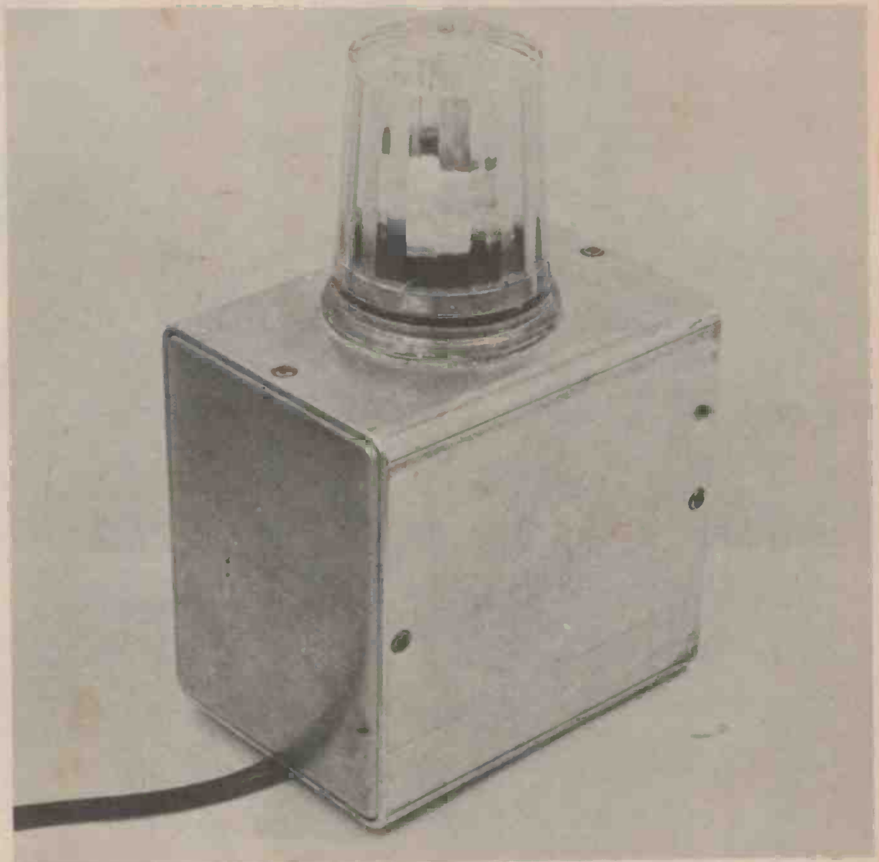


TO A YACHTSMAN, one of the greatest fears of either a long ocean passage or negotiating busy coastal waters is being hit by another, and probably much bigger ship at night. A large fast ship on computer steerage could pass over the top of a small craft without knowing it.

Conventional masthead lights are barely adequate, being typically 5 to 25 watts, and almost useless in a storm or fog. As the wattage of the light is increased the current drawn from the ship's limited battery capacity becomes prohibitive. The answer is to use a xenon flash tube giving an intense white flash about every two seconds. Equivalent to many thousands of watts, the flash can be seen for large distances, even in bad conditions. The average power of this beacon is only about 1.5 watts, similar to a torch bulb. The unit can be permanently mounted on the mast or kept portable for emergency use.

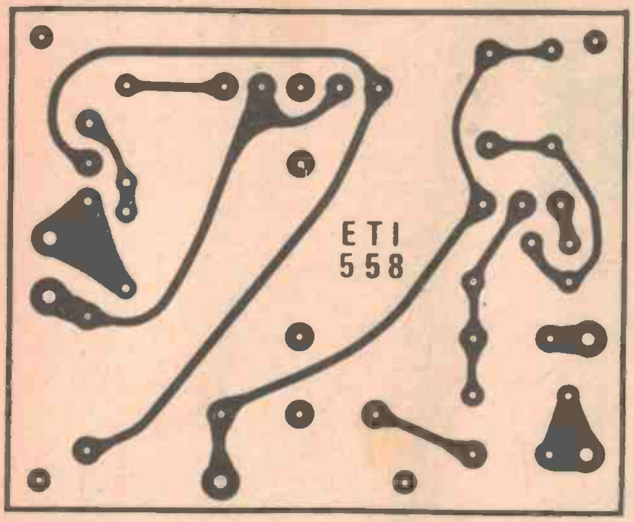
Construction

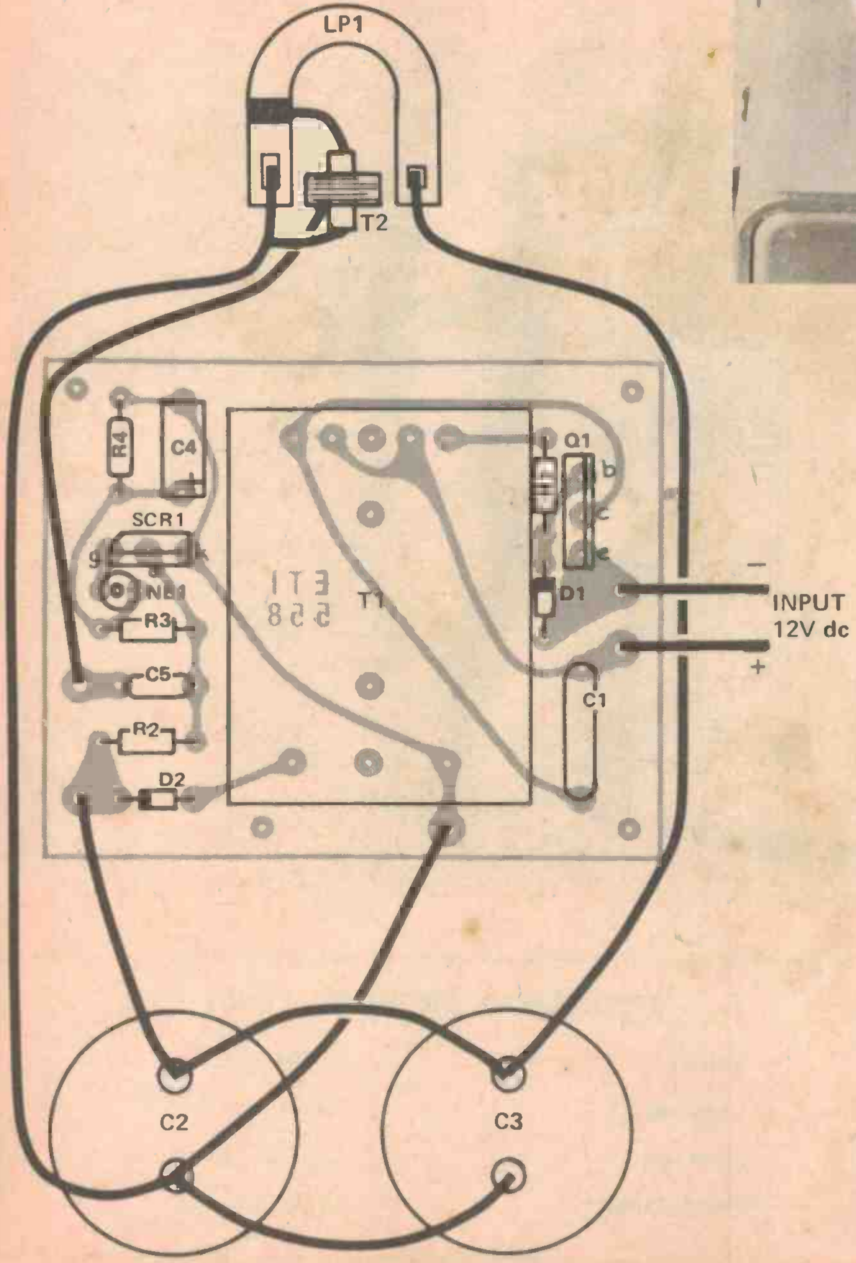
The assembled pcb together with the two storage capacitors are mounted in a Horwood Instrument case type 34/4/D. Styrofoam is used to hold the pcb in position to avoid having to drill extra holes in the case. The transformer used is a commonly available Ferguson type PL30/5VA, which mounts directly onto the pcb.

The storage capacitors used are designed for operation in fluorescent lights and are rated at 240 Vac. These capacitors which can withstand a high

SPECIFICATION PROTOTYPE - ETI 558

Voltage	11 - 15 volts
Light output	1 watt per sec
Flash rate	Approx. 1 every 2 sec
Supply Current	80 mA average





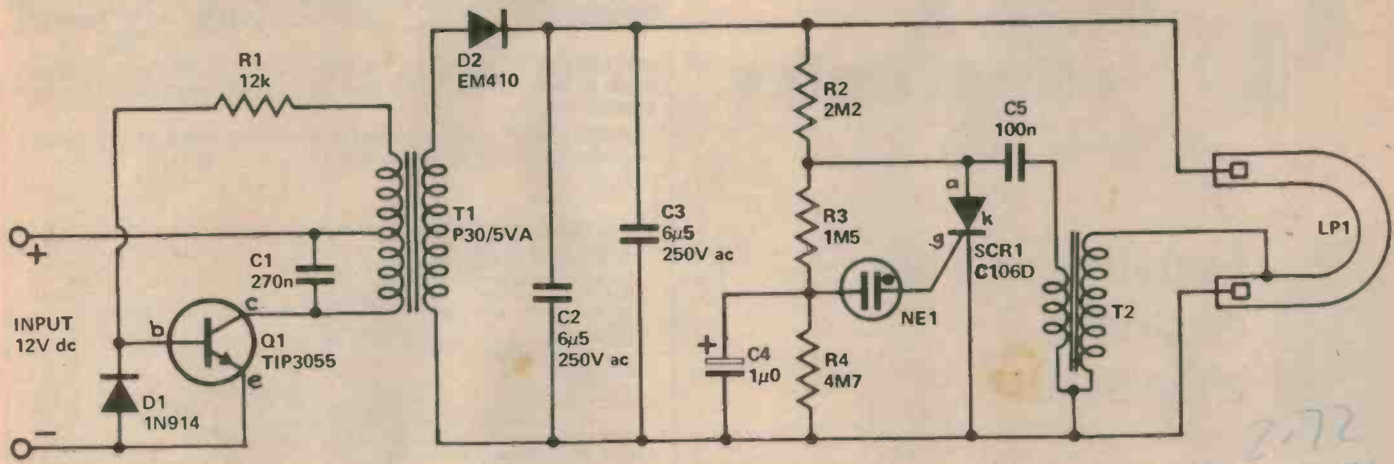
PARTS LIST – ETI 558

Resistors all ¼W, 5%
R1 . . . . . 12k
R2 . . . . . 2M2
R3 . . . . . 1M5
R4 . . . . . 4M7

Capacitors
C1. . . . . . 270n greencap
C2, 3 . . . . 6μ5 250 Vac (see text)
C4. . . . . . 1μ0 350 V electrolytic
C5. . . . . . 100n 400V polyester

Semiconductors
Q1 . . . . . MJ3055
SCR1 . . . . C106D
D1 . . . . . 1N914
D2 . . . . . EM410

Miscellaneous
T1. . . . . . Ferguson P30/5VA transformer
T2. . . . . . trigger transformer to suit strobe tube
NE1. . . . . NE2 neon
Strobe tube see text
Horwood box type 34/4/D, light fitting (see text), pcb ETI 558, Silastic adhesive/ sealant.



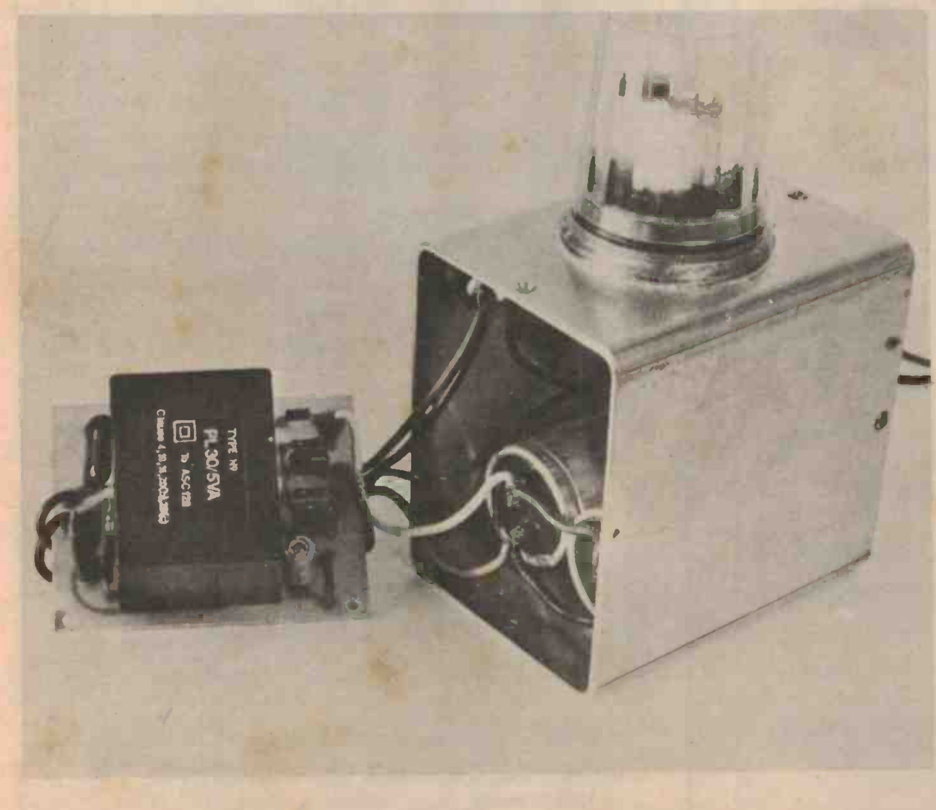
dc voltage, are suitable for use in fast discharge applications and are available in a variety of values from any electrical supplier or from Dick Smith Electronics.

Special attention must be paid to the light housing if the unit is to be left out in the open in all weathers. We purchased an easily available Hilite Marine masthead light from a local marine shop.

The tungsten light and its socket were removed and the strobe tube together with its trigger transformer were fixed into the base of the fitting with Silastic rubber. This light fitting has a lens which focusses the light, and a rubber 'O' ring which should be covered with silicon grease to prevent moisture penetration. If the beacon will not be left out in all weathers a cheaper automotive light fitting could be used.

To ensure long life from the strobe tube we used a 10 watt per sec. tube run at only a fraction of its full output. The tube we used was a CZT127 available together with a trigger transformer from *Circuit Components, 383 Forest Rd, Bexley, NSW.*

Finally the ends of the box and the light fitting were fixed into position with copious amounts of Silastic rubber to prevent moisture penetration. The battery lead should be taken out through a hole in the bottom of the box which also allows drainage if any water manages to get in.



HOW IT WORKS – ETI 558

The power transistor Q1, together with the transformer, T1, form a oscillator with a frequency of about 1kHz. Feedback is provided by one half of a centre tapped 30 volt winding. The output is taken from the normal 240 volt primary winding of the transformer. The amount of feedback and hence the output voltage is set by R1.

Output from the transformer is rectified by D2 and then charges the storage capacitors C2 and C3. The value of R1 should be selected to give a peak voltage across the storage capacitors of about 350 - 400 volts.

As the voltage across the storage capacitors builds up the trigger capacitor, C5, charges through R2 and the primary of the trigger transformer, T2. The timing capacitor, C4, is also charged through R2 and R3 until the voltage across the neon, NE1, reaches about 120 volts, when the neon fires, dumping the charge from C4 into the gate of SCR1. This fires SCR1 which then discharges C5 through the primary of the trigger transformer, producing a high voltage pulse to initiate the discharge of C2, 3 through the strobe tube.

The storage capacitors are then recharged and the process repeated for the next flash.

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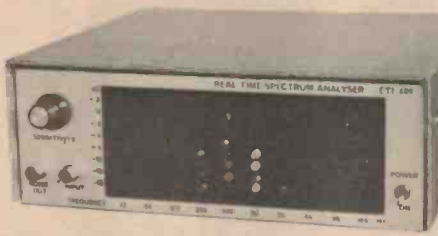

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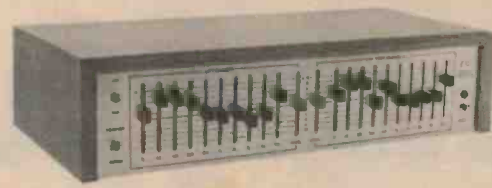

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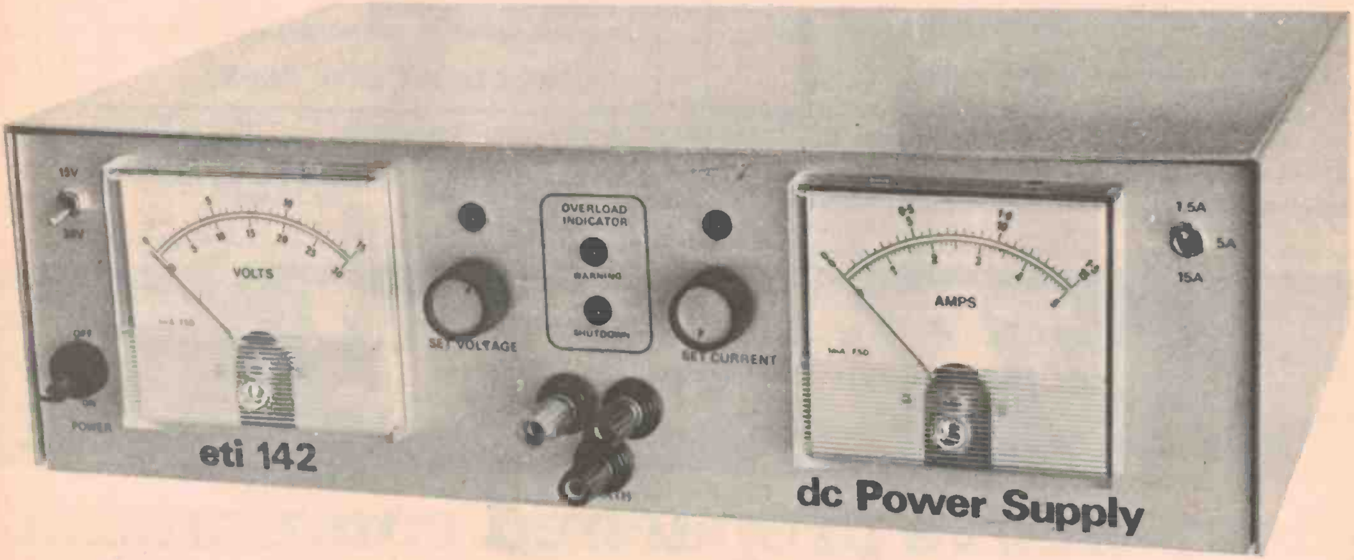
Project 142

dc Power Supply

This new power supply has high current, high voltage capability.



SPECIFICATION - ETI 142

Output voltage	0 - 30V
Output current	0 - 15A
Regulation	20mV (0 - 15A)
Ripple and noise	10mV
Metering	
Voltage	0 - 15V, 0 - 30V
Current	0 - 1.5A, 0 - 5A, 0 - 15A

Overload indication	
Warning	if run continuously in this mode supply may shutdown.
Shutdown	if transformer gets too hot due to a continuous overload the supply will shut down until it has cooled.
Maximum output (not continuously)	24V 15A 26V 12.5A 28V 11A 30V 8A

THIS POWER SUPPLY was designed to extend the range of dc supplies we have published over recent years. It is capable of supplying voltages from zero to 30 volts and current up to 15 amps. The techniques used allow a high power output while retaining a small physical size.

Design Features

Once again, as with all power supply designs, there is a choice to be made as to the technique of regulation to be used. Starting from the most efficient we have:

The switched-mode power supply

With this system the mains voltage is rectified to give 340 volts dc and an inverter using an inexpensive ferrite transformer gives the low voltage required. While regulation against line and load changes can be built in, it is not suitable where the output voltage has to be variable over a large range.

Switching regulator

This utilizes a conventional transformer/ rectifier but the regulation is done by switching the output at about 20 kHz with a variable markspace ratio. The output is filtered by an LC network with a diode protecting the switching transistor. This system is efficient but is fairly complex where good regulation is needed and some 20 kHz ripple appears on the output.

SCR regulator

This simply uses two SCRs in the rectifier circuit with the phase angle of their firing controlling the output voltage. This scheme has the disadvantage of having a slow response time and normally a choke input rectifier/filter is necessary.

Series regulator

This is the most common regulator in use today and has good response time, ripple rejection and regulation. Power dissipation however is high when drawing high currents at low voltages on a variable output unit. It is usually used up to about 100 watts with other systems used above this.

Shunt regulator

This is normally limited to about 10 watts, for, while the performance is very good, the dissipation is more than the maximum output on no load.

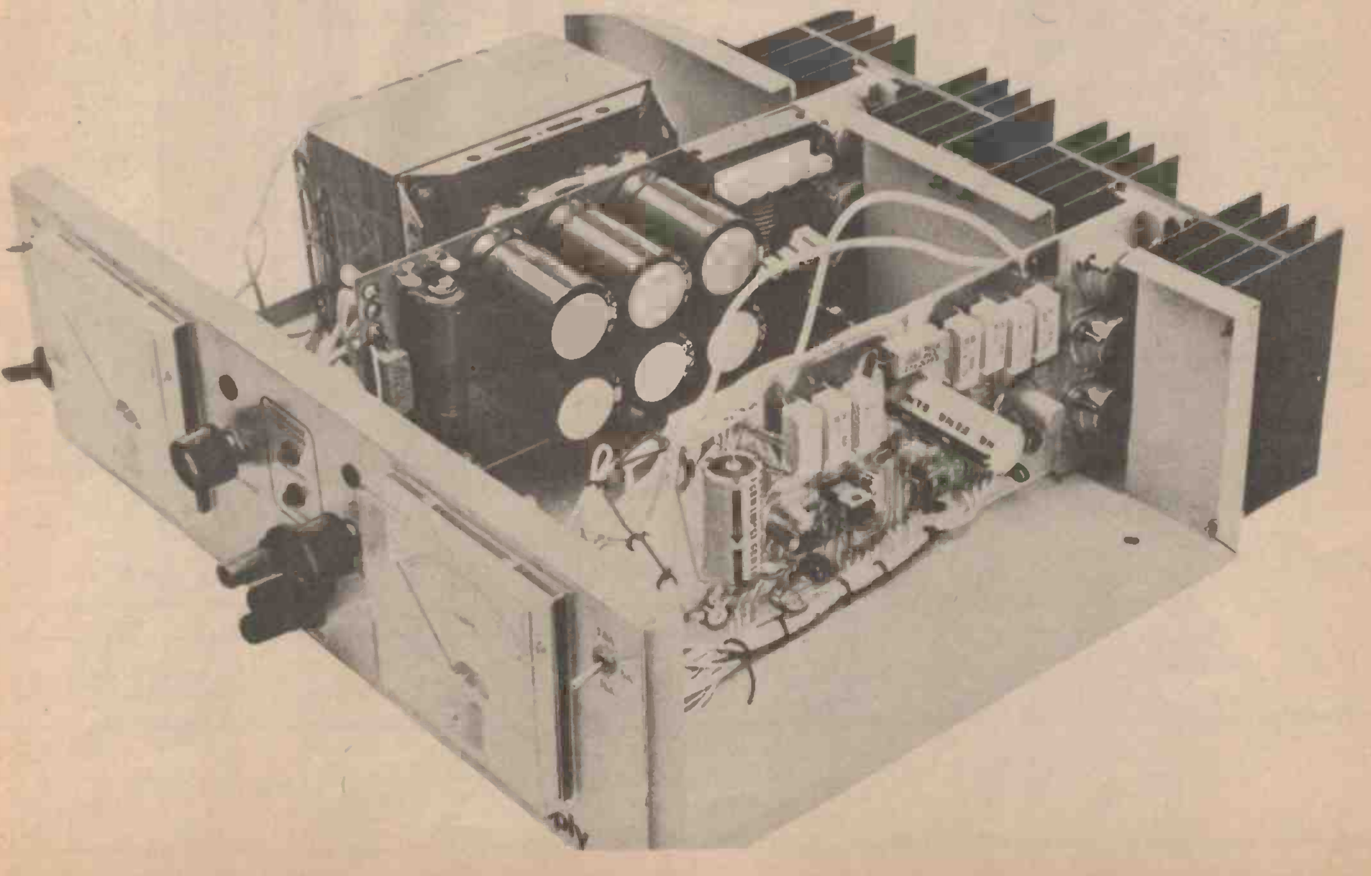
When we originally built the unit we intended using an SCR pre-regulator followed by a series final regulator. The SCR pre-regulator was to give an output about 5V above the required output. To reduce cost and size we chose not to use a choke input filter. While we could regulate the output the transformer became hot with low (dc) output voltage. The reason soon became apparent when some maths was done.

At low voltages a very short SCR conduction time is used and as the current out times time must equal current in times time for the main capacitor the input current can be 5 or 10 times the dc load current. As heating of the transformer is due to the current in the windings and not the thru-power it got hot.

We then changed to a switching preregulator with a series final regulator. With this design the transformer output is rectified and filtered before being regulated. This system allows higher load currents to be taken at lower output voltages without the necessity of a range switch.

Problems arising from the use of a switching regulator are mainly due to the high current and fast voltage transients generating radio frequency interference (RFI) and voltage transients in the output. The RFI problem was solved mainly by the use of an earthed shield on one side of the pc board and the addition of input and output filters.

Initially we intended to vary the mark-space ratio to compensate for the 100 Hz ripple making it easier on the series regulator. However the prototype exhibited a tendency to oscillate at around 1 kHz due to the delays in the output filter; either a more complicated control circuit would be needed or we should let the series regulator get rid of the 50 Hz ripple. We chose the second approach.



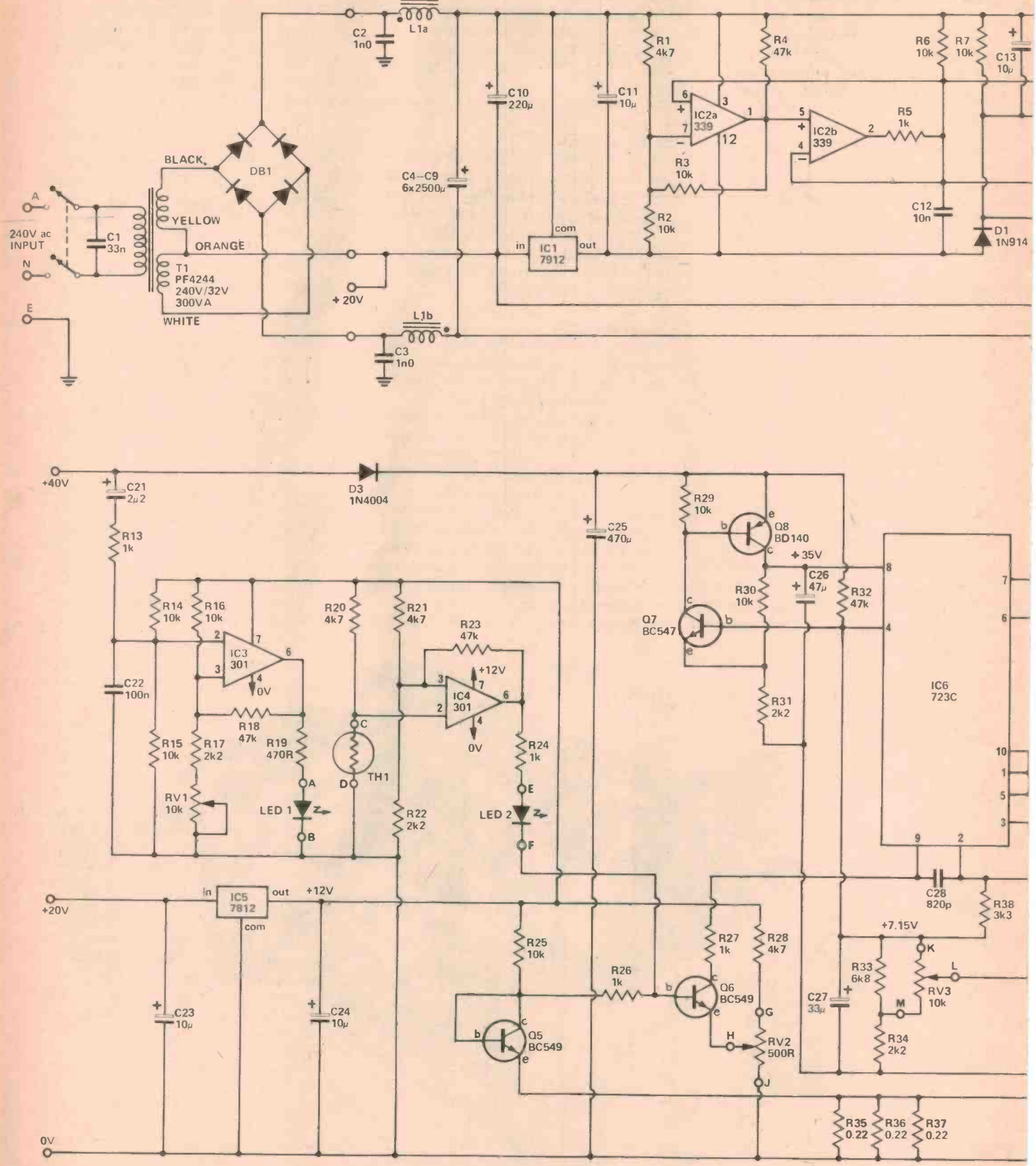
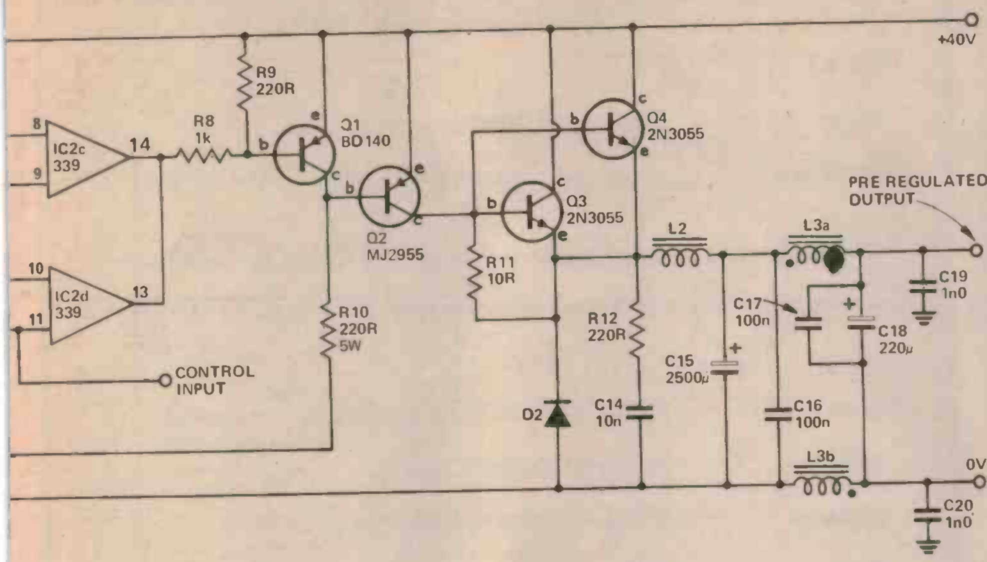
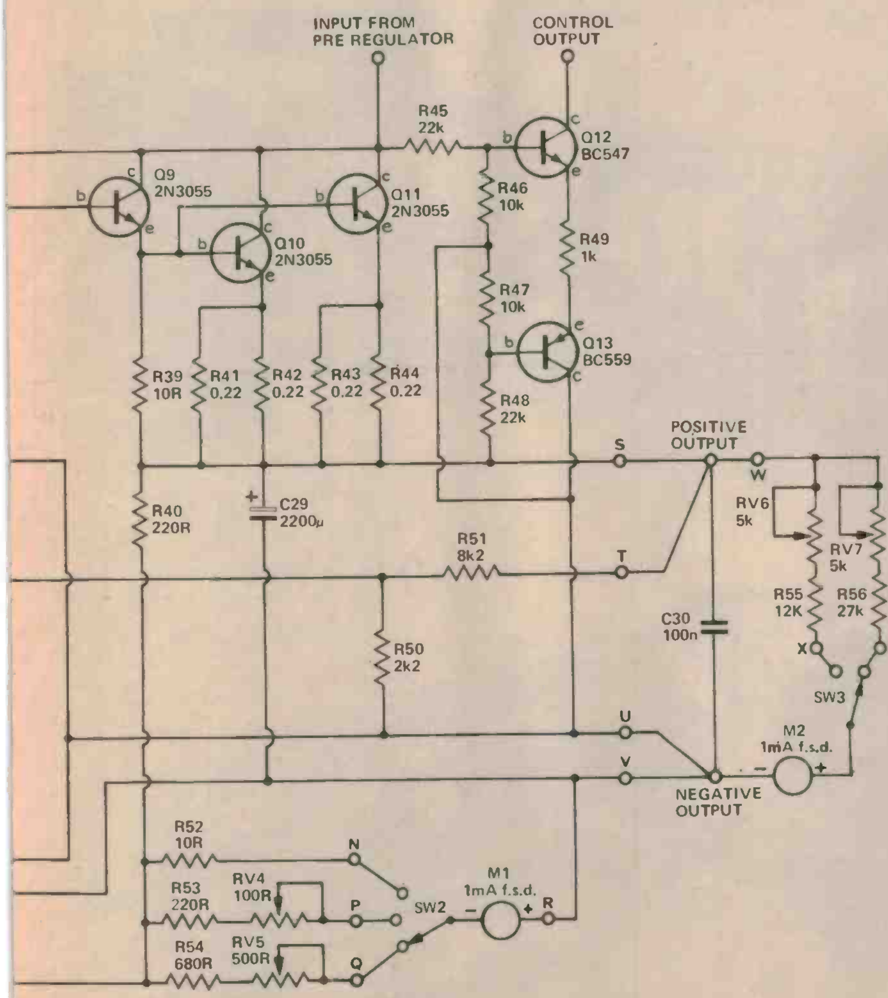


Fig. 1. The circuit diagram of the switching pre-regulator (top) and the series regulator (lower).





Owing to space limitations, it is not possible for us to print the printed circuit patterns or the metalwork drawings. However, these are available directly from ETI on receipt of a large, stamped self-addressed envelope. Send it to: PSU Drawings, Electronics Today, 15 Boundary Street, Rushcutters Bay, NSW 2011.

Construction

The two chokes on the ferrite rods can be wound according to table 1, and the appropriate diagram. Note that the two layers are wound in *opposite* directions and that the start and finish of each coil occurs on diagonal corners. After winding the first layer it is best to smear epoxy cement over it so that it will stay in place.

The main choke can now be wound with four close-wound layers of wire. Bring the start and finish out through the slots in the bobbin. Smear some epoxy over the outer layer to prevent movement and, after it has set, break the ends of the bobbin off as shown in the photograph. This is to enable the coil to be fitted through the hole in the pc board. Break the ends on the *opposite* side to the start/finish.

In the switching regulator the only emitter resistor used with the output transistors is a length of pc board track. It is necessary to ensure that the two transistors used have reasonably close base-emitter voltages. A selection can be made from the five used in the unit by joining the base and collector with a lead and passing 2 to 3 amps from collector to emitter (unless a current source is available it may be simplest to use a 12V battery with a 24-32W globe in series). The two which have the closest base-emitter voltages should be used.

Begin assembly of the switching pre-regulator board by mounting the board on the heatsink brackets with the transistors. As the current passes through the mounting screws it is recommended that 4BA or 4 mm brass screws be used. Also, tin the area where the screws contact the board. Some insulating tubing should be inserted in the holes to prevent the screws touching the sides. Mica insulation washers should be used under the transistors with silicon grease on *both* sides of each washer and also between the two brackets. Before tightening up, temporarily mount the brackets onto the heatsink to ensure that the mounting surface mates well. Tighten a couple of the screws holding the brackets onto the board remove the bracket from the heatsink, then tighten the rest of the screws on the board. As it takes the silicon grease some time to spread out it is best to re-tighten these screws again just before the unit is finally mounted on to the heatsink.

Check that the insulation washers are doing their job and solder the base and emitter leads of the transistors. The diode can also be mounted onto the heatsink using mica and insulation around the stud.

The rest of the components can now be mounted with the exception of the main choke, L2. Be careful that none

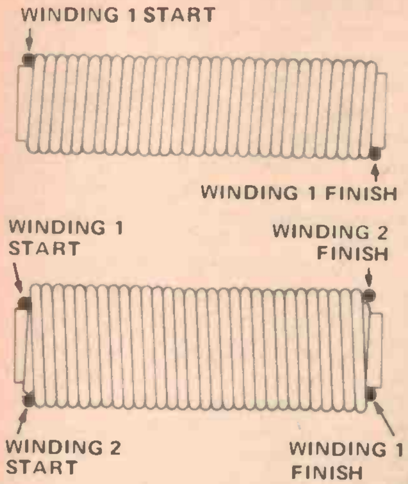
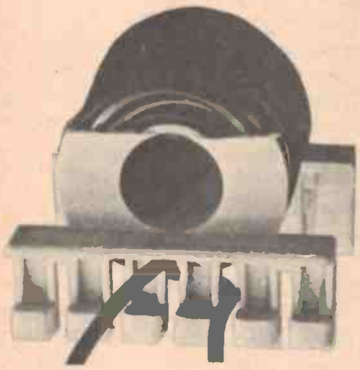


Fig. 2. L 1, 3 with the first layer wound (top) and with both layers wound (lower).



of the components touch the earth screen (with the exception of C2, 3 and C19, 20 which go to ground).

Mounting the Core

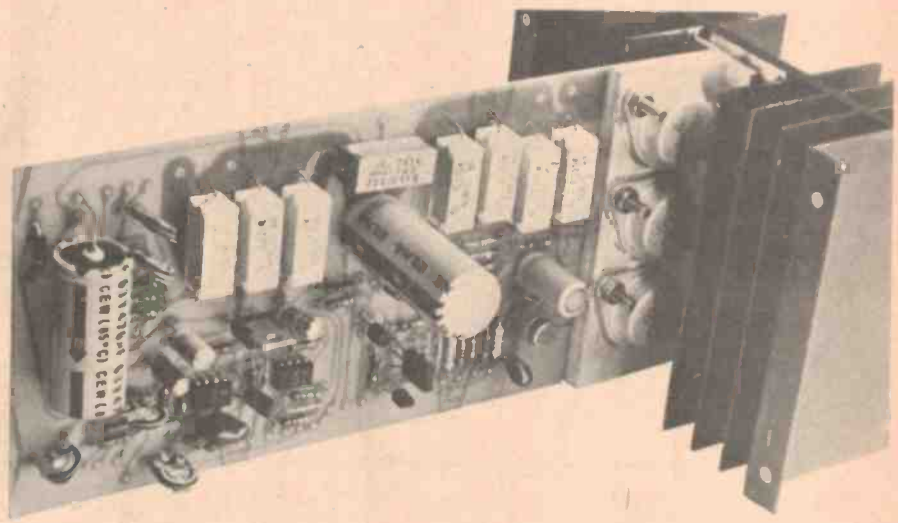
Cut two pieces of card or some other non-ferrous material, about 10 mm x 10 mm with a thickness of about 5 mm. These are glued onto the outer legs of one half of the core of L2. Several pieces can be laminated to give the required thickness if required. Slide both halves of the core into the former and bend the leads into such a position that the assembly will fit into the holes provided with no stress on the leads. Lift the coil out, clean the insulation off the leads where needed, place some epoxy on the side of the cores which contact the pc board and refit to the board. When the epoxy is set, the leads can be cut and soldered.

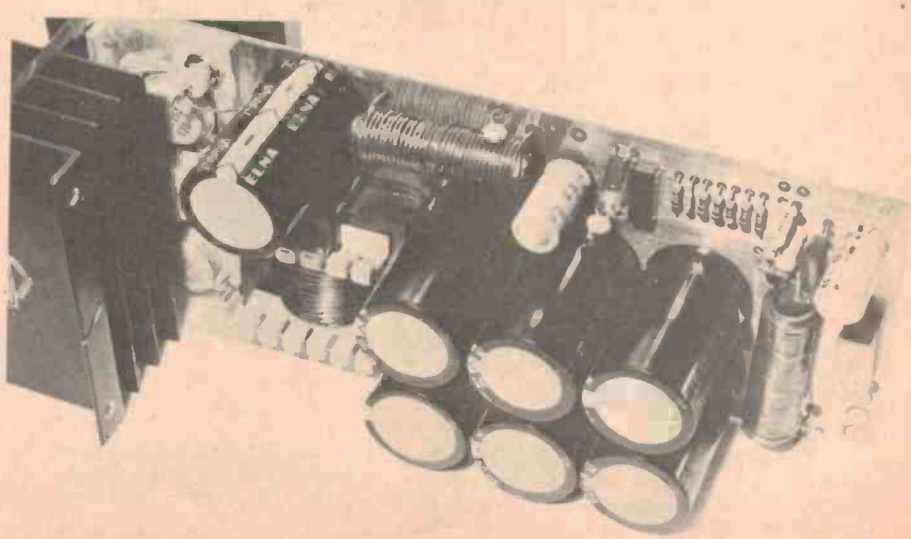
The start of the assembly of the series regulator board is similar to the first board with the exception that there is no power diode used. The board can be assembled according to the overlay — the only point to watch being that the 5 watt resistors should be mounted off the board by 1 or 2 mm, especially if anything but a fibreglass pcb is used (the resistors get warm!).

Start wiring by cutting 17 pieces of

Choke Winding Data   Table 1

L1, L3	
Core	50mm long, 10mm dia. ferrite rod
Winding 1	single layer, close wound, 1.25mm dia. copper wire
Winding 2	single layer, close wound, 1.25mm dia. copper wire
Note that the two windings are wound in opposite directions. See diagram.	
L2	
Core	Philips FX3740/4322 020 52520 (2 required)
Bobbin	Philips DT2740/DT2743
Winding	48 turns 1.25mm copper wire
Gap	5mm





hookup wire about ½ meter long, baring one end and soldering them into the lower row of holes in the series regulator board. Add similar wires to the switching regulator board for the +40V and control input connections. To the output pads on this board, add about 200 mm of wire capable of handling 15A.

Mark the ends of all these wires with the letter on the overlay (a small square of paper held on with tape is easiest). The two boards can now be mounted onto the appropriate heatsinks using silicon grease on the contact area.

Before fitting the pc board to the chassis, mount the transformer, rectifier DB1, 3 core flex, front panel and front panel components. The pcb/heatsink assemblies can now also be added. On our prototype unit the transformer had lugs on the transformer but others will have leads. Note that the wiring that carries the power must be capable of carrying 15 amps or more.

The front panel can now be wired in accordance with fig. 3. Note that C30 is mounted directly across the output terminals on the front panel and similarly C1 is mounted on the power switch. Insulate the bare connections of the power switch with insulation tape to prevent accidental contact.

The thermistor should be soldered onto the appropriate leads (C and D), initially cutting the leads to about 5 – 6 mm long. It should then be epoxied onto the side of the coil in the power transformer. Use the 'slow dry' type of epoxy as this normally works better at elevated temperatures.

Testing and calibration

With a power supply as big as this one, initial power-up is always nerve-wracking and sometimes dramatic. If one is available use a variac to bring up the voltage. If a variac is not available set both the voltage and current limit adjustments to about mid position and switch on.

The voltmeter should now read about 15 volts and it should be adjustable using the voltage control. Measure the voltage between the input and output of the series regulator — this should be about 6 volts. This checks the operation of the switching regulator.

Add a load to the unit to check the operation of the series regulator. If it is correct the meters can now be calibrated. For the low current range (1.5A) it is necessary to select R52 to calibrate the meter (the value is too low for a trim potentiometer).

To set the trim pot for the "warning" LED it is necessary to adjust the unit to 12V output and to load it to 10 amps. The potentiometer can now be adjusted until the led just lights.

HOW IT WORKS - ETI 142

Rectifier

The 240V AC is transformed to 32 V AC by T1 with DB1 rectifying it to give about 45V DC. On full load this voltage will fall to about 35 volts. For the purposes of this description we will refer to this as +40 volts (nominal value). The centre tap of the transformer is used to derive a centre tap DC voltage, reducing power dissipation in some of the electronics.

Switching pre-regulator

In this section, IC1 is used to generate a supply voltage 12 volts *below* the positive supply rail and this powers IC2. This IC has two functions: IC2a and IC2b form a triangular wave generator and IC2c and IC2d a comparator. The voltage on pins 8 and 10 of IC2 is the triangular waveform, varying from -3.6V to -6.3V (referred to the positive rail) with the rising part taking about 50 μs and the falling edge being about 4 μs. This gives a frequency slightly less than 20 kHz.

The comparators IC2c and d are connected in parallel simply to give additional drive capability. The output stage of the 339, for those unfamiliar with it, is simply an open-collector NPN transistor with the emitter joined to the negative supply rail. If the voltage on the control input is within 3.6V of the positive supply rail, the comparator output will be high and so Q1 will be off, Q2 on and Q3 & 4 on. Transistors Q3 and Q4 are in parallel to give additional drive and current sharing is helped by emitter resistance made up of about 60 mm of copper track on the pc board. These transistors should however be the same brand and selected to have similar base-emitter voltages.

If the control voltage is more than 6.3V from the supply rail the comparator output will be low, turning on Q1. This turns Q2, 3 and 4 off. The control voltage oscillates between -3.6V and -6.3V and so the transistors will be turned on and off at 20 kHz, the mark to space ratio being controlled by the control voltage. This effectively varies the output voltage.

The output of Q3, 4 is filtered by L2 and C15 to give a smooth DC voltage. A flyback diode, D2, is necessary and must be a fast recovery type to reduce power dissipation in the transistors. While the choke has an AC voltage across it the current is DC with an AC ripple. For this reason a substantial air gap is used to prevent the core saturating when the current rises to around 15 amps.

Series Regulator

The basis of the regulator is the familiar 723 monolithic regulator IC. The output of this IC is buffered by Q9-Q11 giving the required 15 ampere capability. Normally this IC cannot regulate to below 2V because of the limitations of the comparator. To get around this problem resistor R38 provides some bias current such that when the output voltage is zero the comparator input (pin 2) is above the 2V lower limit. Similarly the potentiometer which controls the output voltage varies not from zero, but from about 2 volts up to the reference voltage from the IC (pin 4) at 7.15 volts.

For those not familiar with the IC, it compares the voltage at pins 2 (inverting) and pin 3 (non-inverting) and adjusts the output on pin 6 to compensate. While this IC can vary the output voltage to within 3 volts of the positive supply rail, it does have a maximum supply of 40V. With this circuit, on no load the supply rises to about 45 volts, too high for the IC. To overcome this we have used a two transistor regulator (Q7, 8) using the reference voltage in the 723 IC to give about 35V on pin 8 of the 723. On full load the regulator ceases to operate as the ripple on the supply rail drops below the 35 volts required. An additional isolation diode and storage capacitor are used to maintain as high a voltage as possible.

Control of the preregulator is done by Q12 and Q13. The voltage from the preregulator and the actual regulated output voltage are both divided by three; if the differential voltage is greater than about 3.6 volts Q12 and Q13 will start to conduct. The collector of Q12 goes to the control input of the preregulator card to vary the voltage from the preregulator. The action of these transistors is to maintain about 5-6V differential between the desired output voltage and the preregulator output.

Current limiting is done by measuring the voltage across R35-37 using Q6. A second transistor Q5 is used to compensate for the 0.5-0.6 volt base-emitter voltage of Q6 and also to compensate for any temperature variations, in the base-emitter voltage.

If the current exceeds the preset value Q6 will start to conduct pulling current out of pin 9 of the 723 IC. This will reduce the output voltage to prevent the current rising above the preset limit.

Current measurement is done simply by measuring the voltage across R35-37. Three ranges are provided. Voltage measurement is done directly across the output terminals with two ranges provided.

The supply is capable of delivering high currents at high voltages for short periods; overload indication is provided by IC3 and IC4. The first of these, IC3, measures the amplitude of the ripple voltage on the main filter capacitors. This effectively gives an indication of the current being drawn from the transformer. When it exceeds a preset level, IC3 changes state, lighting up LED1.

The second indication is given by IC4 which measures the resistance at a thermistor glued onto the transformer. If the resistance drops below about 2.2k ohms the output of IC4 will go high, lighting LED2 and also shutting down the output by overriding the current limiting.

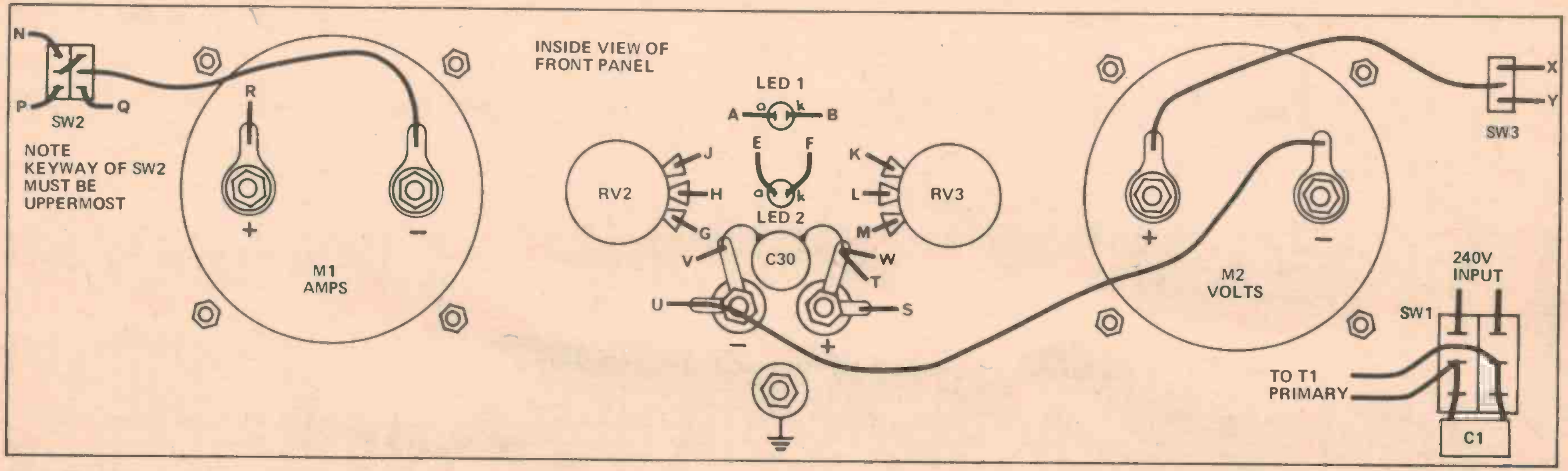


Fig. 3. The front panel wiring diagram.

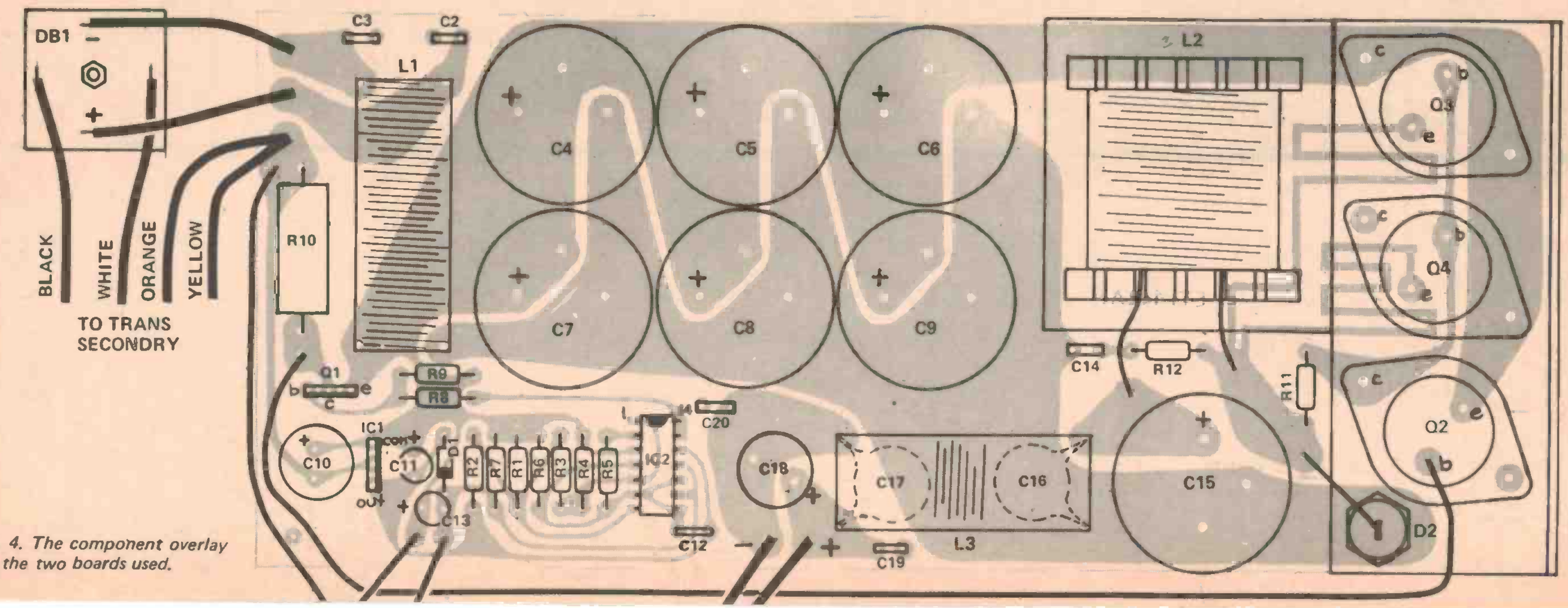
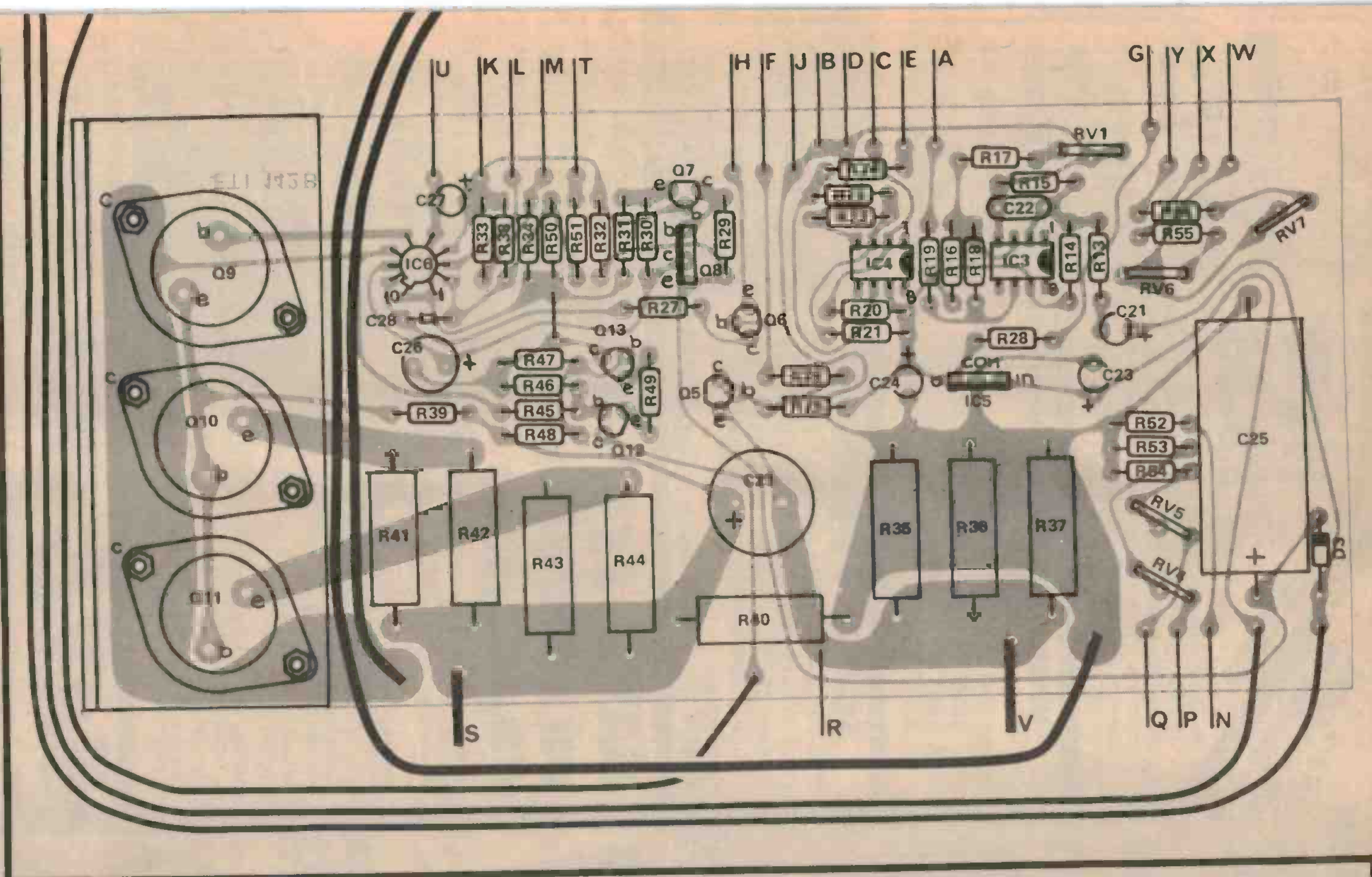


Fig. 4. The component overlay for the two boards used.



PARTS LIST – ETI 142

Resistors all ½W, 5% unless stated

R1	4k7
R2,3	10k
R4	47k
R5	1k
R6,7	10k
R8	1k
R9	220R
R10	220R, 5W
R11	10R
R12	220R
R13	1k
R14–R16	10k
R17	2k2
R18	47k
R19	470R
R20,21	4k7
R22	2k2
R23	47k
R24	1k
R25	10k
R26,27	1k
R28	4k7
R29,30	10k
R31	2k2
R32	47k
R33	6k8
R34	2k2
R35–R37	0.22Ω, 5W
R38	3k3
R39	10R
R40	220R, 5W
R41–R44	0.22Ω, 5W
R45	22k
R46,47	10k
R48	22k
R49	1k
R50	2k2
R51	8k2
R52	10R
R53	220R
R54	680R
R55	12k
R56	27k

Thermistor

TH1	Philips 2322 640 90004

Potentiometers

RV1	10k trim
RV2	500R lin rotary
RV3	10k lin rotary
RV4	100R trim
RV5	500R trim
RV6,7	5k trim

Capacitors

C1	33n 250Vac
C2,3	1n0 disc ceramics
C4–C9	2500µ 63V RP electro
C10	220µ 35V RB electro
C11	10µ 35V RB electro
C12	10n polyester
C13	10µ 35V RB electro
C14	10n polyester
C15	2500µ 63V RP electro
C16,17	100n disc ceramics
C18	220µ 50V RB electro
C19,20	1n0 disc ceramics
C21	2µ2 63V RB electro
C22	100n polyester
C23,24	10µ 35V RB electro
C25	470µ 63V RT electro
C26	47µ 63V RB electro
C27	33µ 16V tantalum
C28	820p ceramic
C29	2200µ 35V RB electro
C30	100n disc ceramic

Inductors

L1	see table 1
L2	see table 1
L3	see table 1

Semiconductors

IC1	7912
IC2	LM339
IC3,4	301A
IC5	7812
IC6	723C (metal pack)
Q1	BD140
Q2	MJ2955
Q3,4	2N3055
Q5,6	BC549
Q7	BC547
Q8	BD140
Q9–Q11	2N3055
Q12	BC547
Q13	BC559
D1	1N914
D2	1N3891R,BYX30-200R
D3	1N4004
DB1	MDA3502 or similar
LED1,2	Red LED with mounting

Miscellaneous

- PCBs ETI 142A, ETI 142B
- Transformer PF4244 (16+16V@300W)
- Two 1mA TD86 meters scalled to fig.5
- One 10A two pole power switch
- One 7101 toggle switch (SPDT)
- One 7211 toggle switch (SP3T)
- Three terminals posts (red, black, green)
- Two knobs
- Two 45D4CB heatsinks
- Two each, heatsink brackets
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- Front panel
- 3 core flex and plug
- Cable clamp
- Rubber feet etc.

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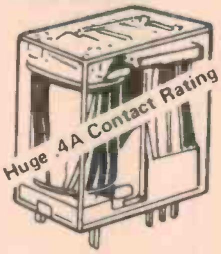

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Brand new and fantastic as always - the Electronics Today International Book of Top Projects (Vol. 5). Contains constructional details of many interesting and useful projects, e.g. Graphic Equalizer, Shutter Speed Timer, Dual Power Supply etc, etc. Add this superb volume to your shelf and improve your knowledge of electronics.

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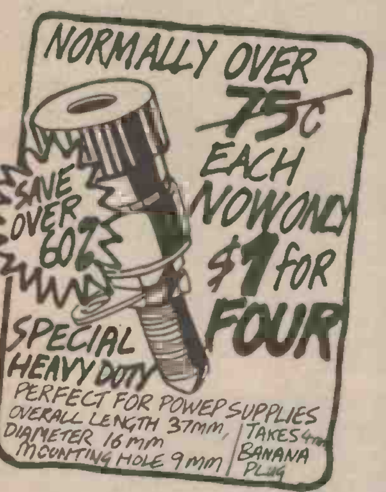

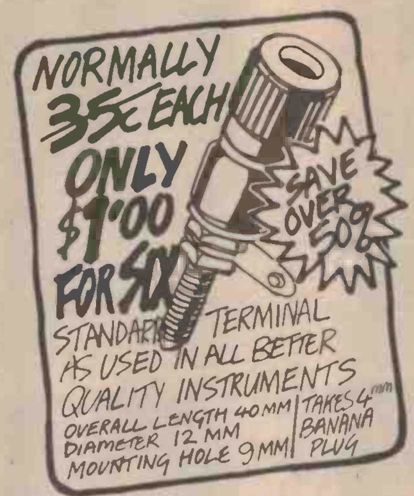

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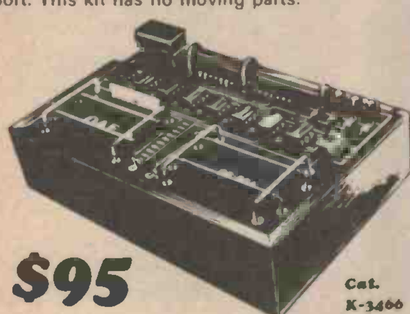

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Case to suit with mounting bracket & bezel	Cat H-3194	$3.60
AC Mains Adaptor	Cat M-9514	$5.25

PLAYMASTER AM/FM TUNER (See Nov/Dec EA)

Complete kit, including instructions	Cat. K-3494	$159.50
SEPARATE PARTS		
Pre-wired and aligned tuner module	Cat. F-4610	$59.00
Set of 4 PC boards.	Cat. H-8357	$9.75
Signal strength meter	Cat. Q-2100	$4.95
Tuning meter - centre zero	Cat. Q-2095	$4.95

Most other electronic parts for this project in stock.

MODEL TRAIN CONTROLLER (See Oct EA)

Not produced as a kit - all parts available from stock:

PCB only	Cat. H-8355	$3.75
Zippy box	Cat. H-2752	$3.75
2N3055 transistor	Cat. Z-2145	$0.95
2N3053 transistor	Cat. Z-2130	$0.80

FET INPUT AC-DC VOLTMETER (See Sept EA)

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PC board only.	Cat. H-8353	$2.75
1mA MRA-65B panel meter.	Cat. Q-2060	$12.50
Fabricate your own meter scale using the Scotchcal process:		
8005 black Scotchcal photo-sensitive aluminium	Cat. H-5694	$6.00
CA-3140 FET op-amp	Cat. Z-5417	$2.50

VARI WIPER Mk 2 (See Sept EA)

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C106YI SCR	Cat. Z-4315	$1.00
2N2646 (0S2646) unijunction.	Cat. Z-1786	$1.20

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MM-5369M IC (oscillator - divider).	Cat. Z-5781	$2.50
74C926 IC (4 digit counter)	Cat. Z-5414	$6.50
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PHOTO TACHOMETER (See Aug EA)

Although we do not produce a full kit for this project, all parts are normal stock lines at all of our stores.

PCB (only)	Cat. H-8352	$1.80
FPT 100 phototransistor	Cat. Z-1950	$2.00

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Complete kit, including instructions	Cat. K-3491	$49.50
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Lismore Kitronics	Magellan St & Bruxner Hwy Lismore NSW Ph 878 361
Langman's Sound Centre	Shop 15, Treasure Island, Coffs Harbour Jetty NSW Ph 521 570
Sumner Electronics	95 Mitchell Street, Bendigo VIC Ph 43 1977
Citcom Electronics	Hopkin's Arcade, West St, Mt Isa QLD. Ph 434-791
ADS Electronics	312 Oxley Ave, Margate QLD. Ph 204-1276
Advanced Electronics	5a The Quadrant, Launceston TAS. Ph 31-7075
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Gawler CB Centre	51 Hillier Road, Evanston SA. Ph 222-149
Altronics	105 Stirling St, Perth WA. Ph 328-1599
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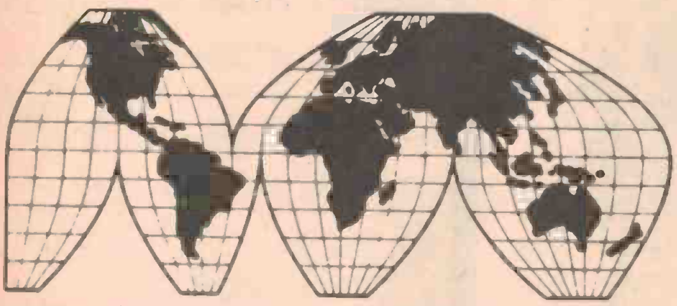
GENERAL INSTRUMENT



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Project 642

16K S-100 RAM Card

This is a project we feel we can be justly proud of — a fully S-100 compatible 16K RAM card with some very impressive facilities which will make it a flexible addition to any S-100 system.

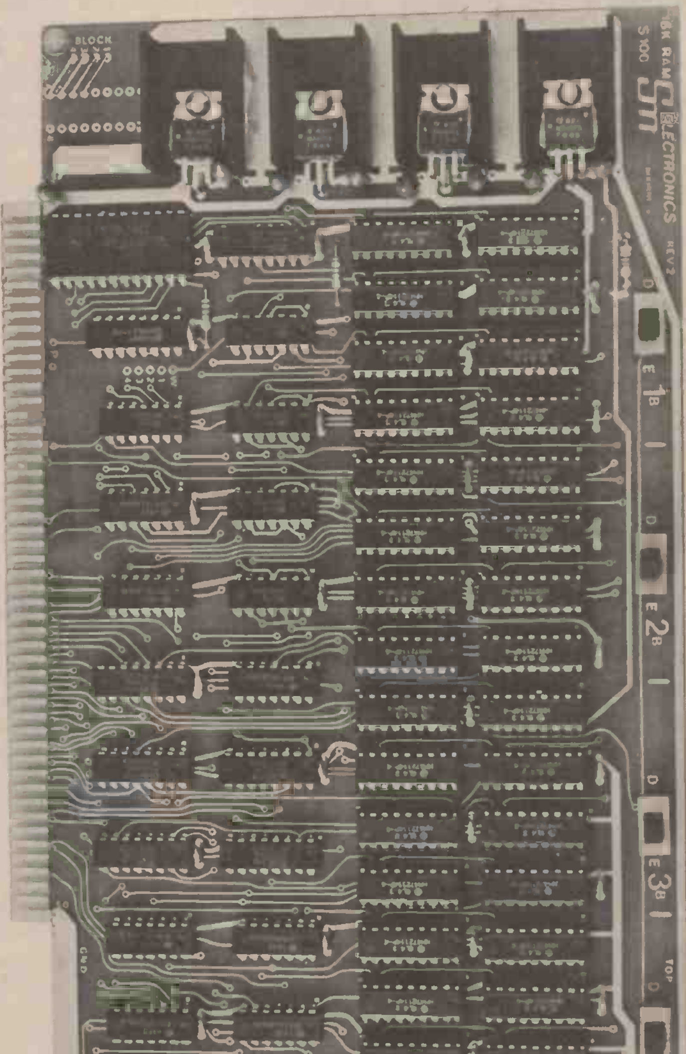
MOST OF ETI'S microprocessor-related projects are compatible with the S100 bus. Eventually we shall have a complete line of S100 cards so that readers may build up complete and powerful systems without having to scrap 'simpler' designs.

The majority of these projects are designed and developed by our own laboratory. We usually do it this way as we then have total control over design features and complexity and of course component choice. We like to think this is one of the major reasons why ETI projects are so popular.

On this occasion we've gone about it slightly differently: we'd had a 16K RAM under way for some months when we heard that Mike Pratt of S M Electronics was also working on almost identical lines. It seemed pointless to 're-invent the wheel' so we examined the feasibility of running Mike's design as an ETI project. Regular readers will be aware of a previously published design from Mike - his overwhelmingly popular ETI 318 digital tacho.

Here then is the result - we believe it's a beauty!

Projects of this complexity involve massive investments in time, effort and money; it seems only fair that Mike receives some return for his work. So Mike is retaining the commercial rights to the printed circuit board. Individual readers who wish to make their own are perfectly free to do so however and may obtain the patterns free of charge (see below). Ready made boards and all components may be obtained directly from S M Electronics, 10 Stafford Court, Doncaster East, Vic, tel: (03) 842.3950.



Description

The board carries up to 32 1K x 4 RAM

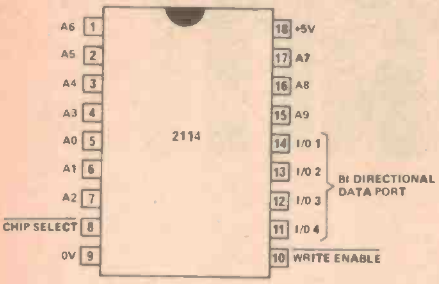


Fig.1. The pinouts for the RAM chips. These can either be slow or fast, tested or untested devices (see text) - they're all pin compatible.

chips. The ones supplied in the SM Electronics kit are Hitachi devices — HM472114P-4. These have an access time of 450 ns (typically). It is also possible to use the HM472114P-3 which is more expensive but has a 300 ns access time. Another alternative is the pin-compatible Intel 2114 device which is cheaper but has the disadvantage of not having been 'burnt in' (i.e. run for a time) and then tested completely, as the Hitachi device has.

All of the above devices require only a single 5 volt supply and the board derives this from the 8 volt preregulated line of the S-100 bus.

The RAM is split into four 4K blocks, each of which can be placed anywhere in the 64K memory space of the system This is done by connecting each of four points on the board (one for each 4K block) to one of sixteen possible points which correspond to the possible positions in the 64K. If the board is not fully populated (i.e. if you couldn't afford all of the RAM at the one time and left one or more 4K blocks of sockets empty) then connecting one or more of the four 'block select' lines to +5V via a pull-up resistor will take care of that too.

The board also carries four 'write protect' switches which allow the user to create what is effectively ROM by preventing the system from writing to a particular block or blocks.

Wait States

For some systems the memory is slower than the processor that when a read or write occurs, the processor must be told to wait while the memory works. On some earlier systems this time delay was achieved by using a monostable — this entailed 'tweaking' the monostable period until the system worked! Instead, this board counts a selected number of clock cycles (up to 4), giving a fixed and predictable delay.

The card also carries hardware to implement the Cromemco 'bank select' system of memory management. Basically, this allows eight blocks up to 64 Kbytes in size to be enabled or disabled by setting the appropriate bit of output port 100Q (40H). A DIP switch on the lower right corner of the board enables the user to specify which bit of the control word the card will respond to. This scheme allows a processor with a sixteen-bit address bus to access up to 512 Kbytes with fairly simple software.

The card can be set to be either enabled or disabled on system reset, before the memory management software has set up the normal memory allocation. In most systems, one card will be enabled on reset and all others will be disabled to avoid bus contentions.

Phantom Line (Pin 67)

In some situations, users may want to locate a ROM containing say a monitor program at an address which conflicts with the RAM card. One way to do this is simply to remove the RAM card, or at least those chips which would conflict, but a better solution is offered with this card. If ROM must share an address with RAM, then the user should arrange for the ROM's address decoding logic to pull the PHANTOM line of the S100 bus low. This signal is applied to the address decoding logic of the RAM card and disables it if another device has priority. In this way the ROM can be made to 'occlude' part of the RAM. A link on the board selects this facility.

Construction

A complete kit of parts for this project is available from its designer, Mike Pratt of S.M. Electronics, and we recommend its use for ease of construction and reliability. (Also its excellent price on special offer!) Alternatively, the experienced constructor who wants to save a few bucks can make up his own double-sided pcb, but as this will not be through-hole plated, the constructor will have to identify all points where a track goes through the board and insert a link, unless there is a component lead at that point. We do not recommend this for the faint of heart (seriously). However, printed circuit patterns will be available, on receipt of a large stamped self-addressed envelope from *ETI642 Patterns, Electronics Today, 15 Boundary Street, Rushcutters Bay, NSW.*

Remember also that the use of a non-through-hole-plated pcb prevents the use of IC sockets, and especially beware of feedthroughs which must go under ICs, sockets or the DIP switch.

Construction should be fairly straightforward — the only choice that has to be made right at the start is how many IC sockets to use. There are three possibilities: none at all — this means that a dead IC has to be removed by de-soldering; RAM only — to enable 'swap testing' of these expensive devices and also easy replacement should they prove defective; all ICs socketed — IC sockets tend to be rather expensive and putting sockets on all ICs may not be cost-effective.

All the ICs fit in with pin 1 in the top left hand corner, so there shouldn't be any problem getting them the right way round. The only orientation-sensitive components are the LED (the flat on the side of the package goes to the right) and the tantalum capacitors.

Any IC sockets should be soldered in first, followed by the resistors and capacitors. The switches should be fitted next, followed by the regulators and heatsinks. At this point, power should be applied to the board and the outputs of the regulators measured — if they are anything other than +5 V, you've got a problem, and should check the power supply circuitry before inserting the ICs.

If everything checks out, the ICs should now be inserted and the options strapped. The board is now complete and ready for use.

Fig.3. The overlay for the double-sided board used in the RAM card. Due to the size and complexity of the design, we have not published the foil patterns. These will however be available from us (see text).

PARTS LIST - ETI 642

Resistors all ½W, 5%

R1, 2	2k2
R3	1k
R4—R6	2k2
R7	1k

Capacitors

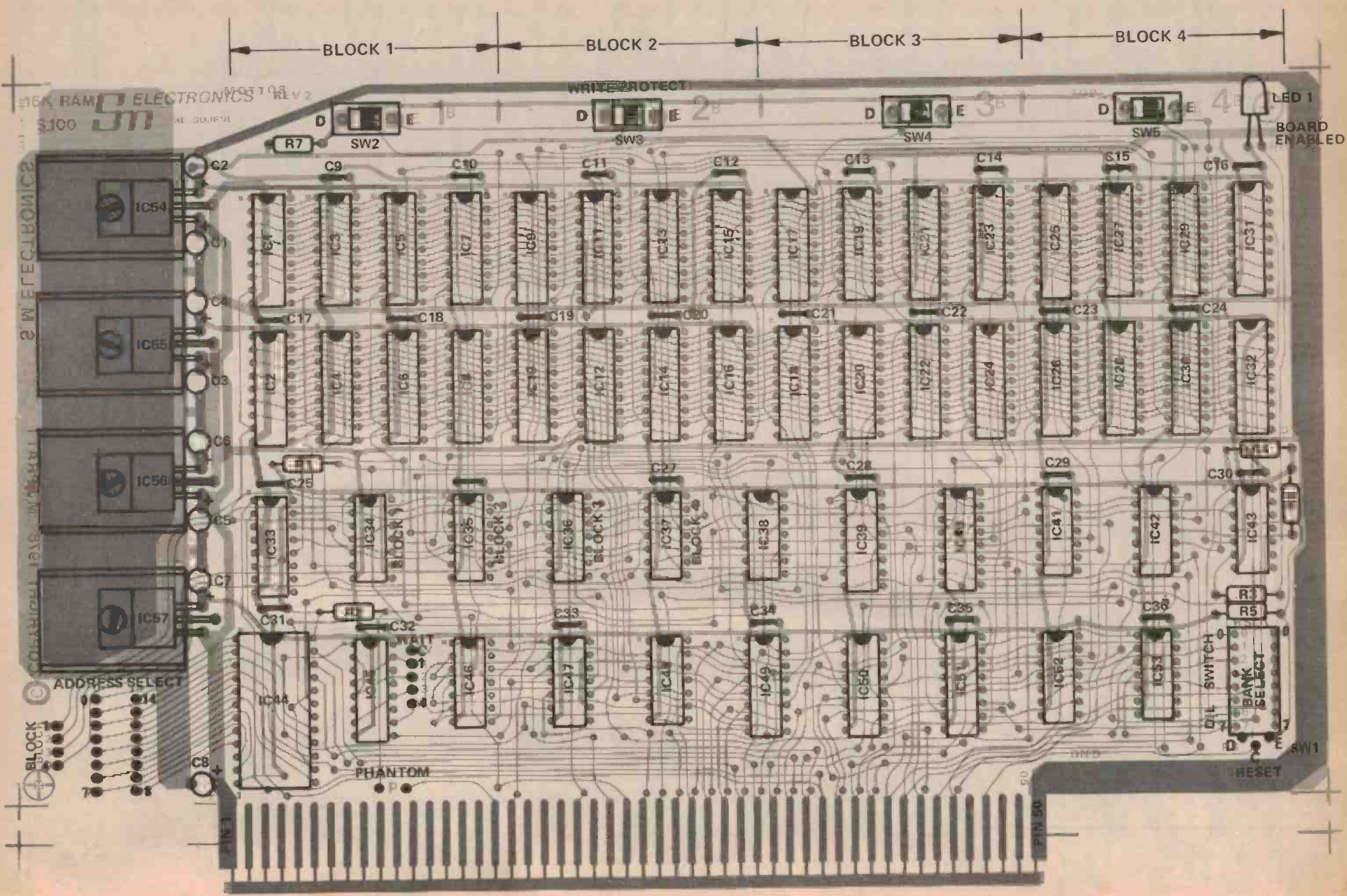
C1—C8	10μ 25V tantalum
C9—C36	10n ceramic

Semiconductors

IC1—IC32	2114 (see text)
IC33	74LS138
IC34—IC37	74LS32
IC38	74LS20
IC39, 40	74LS367
IC41	74LS10
IC42	74LS04
IC43	74LS74
IC44	74LS154
IC45	74LS175
IC46	74LS30
IC47, 48	74LS04
IC49—IC51	74LS367
IC52, 53	74LS05
IC54—IC57	LM340T5
LED 1	Red LED

Miscellaneous

pcb ETI 642
Four single-pole two-way slide switches
One eight-pole one-way DIL switch
Four heatsinks to suit regulators


BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
WRITE PROTECT
16K RAM
ELECTRONICS
$100
S.M. ELECTRONICS
ADDRESS SELECT
BLOCK
WAIT
PHANTOM
PIN 1
PIN 50
DIL SWITCH
BANK SELECT
RESET
SW1
LED 1
BOARD ENABLED

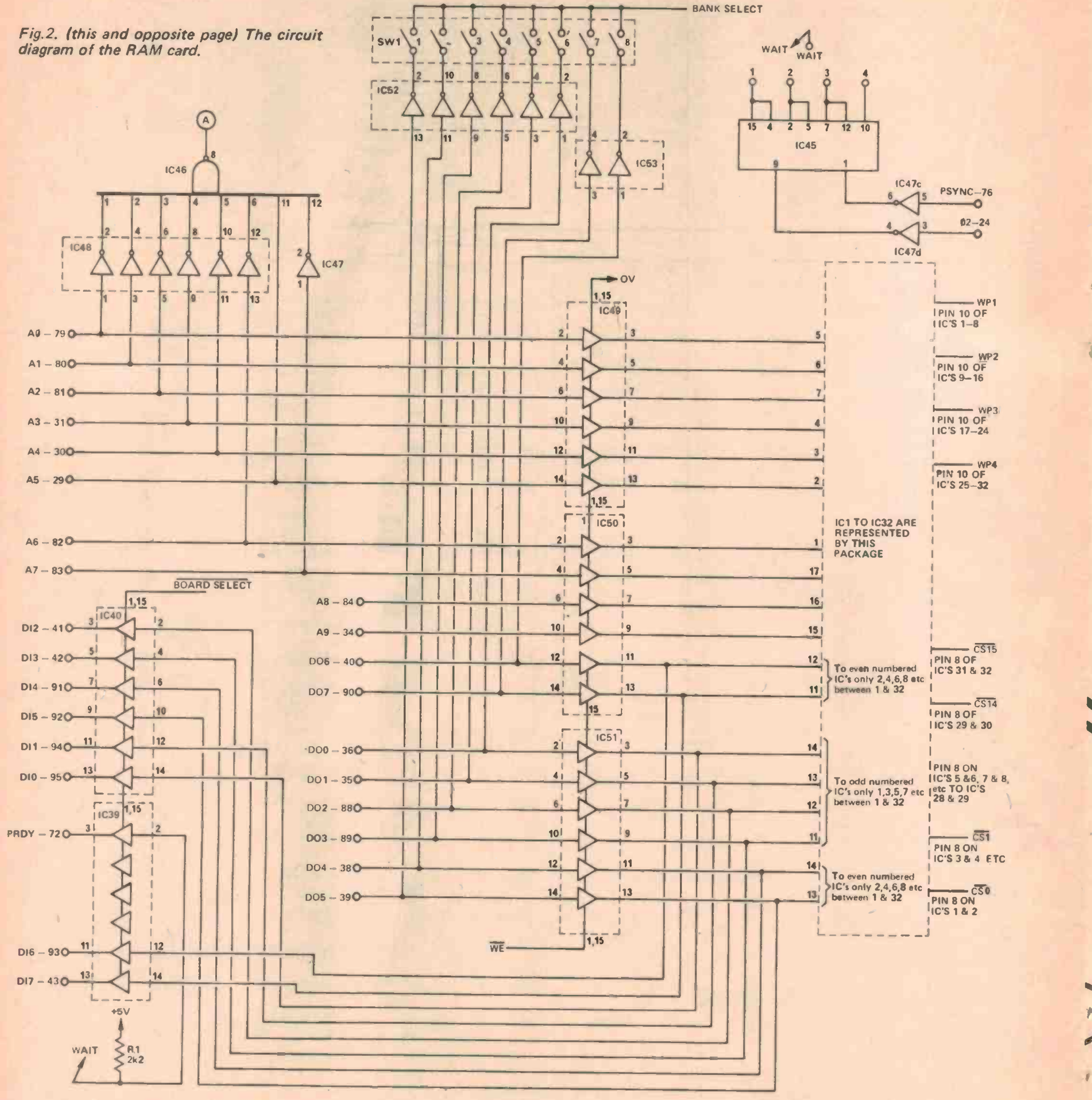


Fig.2. (this and opposite page) The circuit diagram of the RAM card.

HOW IT WORKS – ETI 642

An article on the S-100 bus system appeared in ETI September 1977. We suggest that you read it if you are unfamiliar with the system.

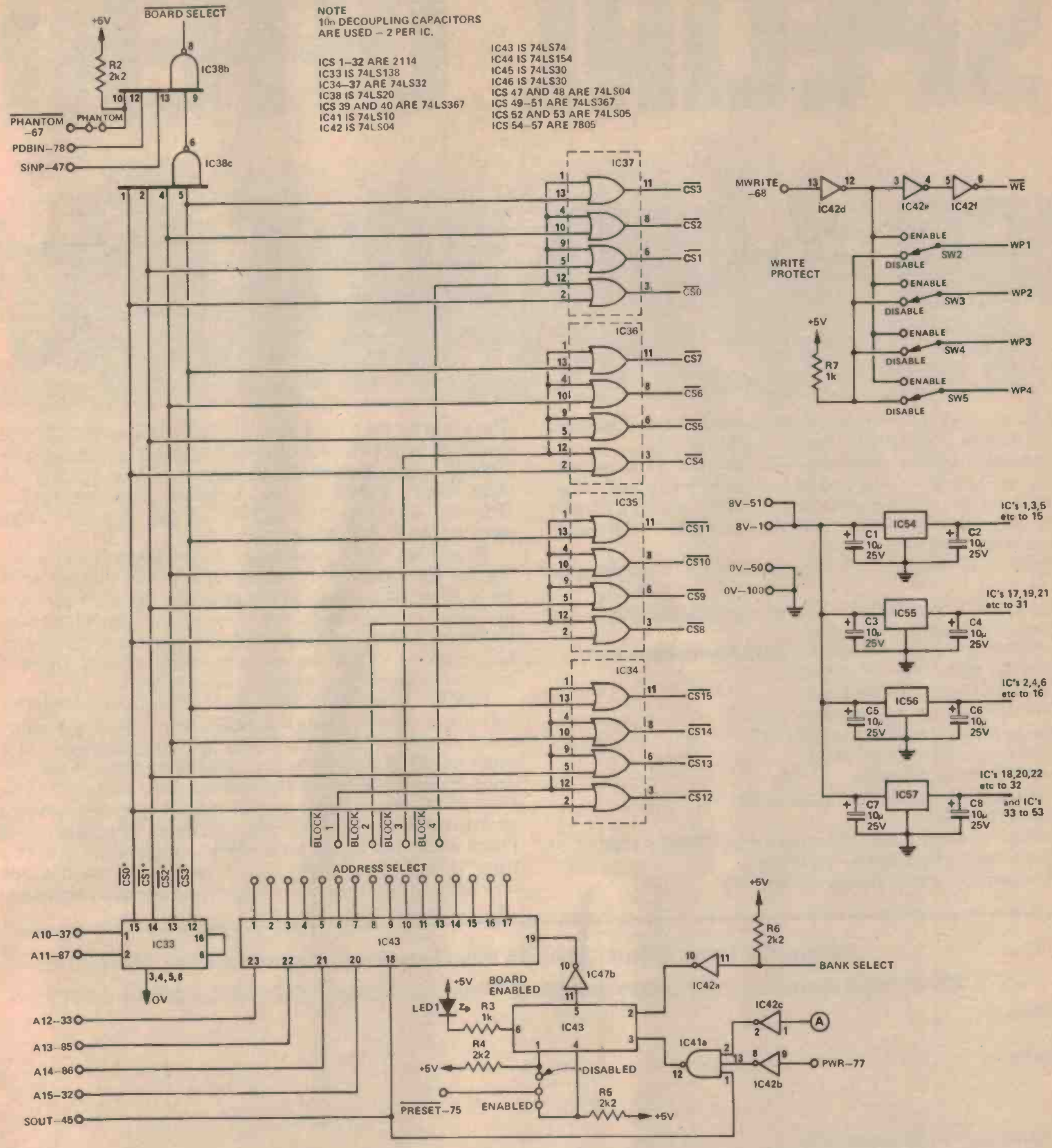
The address and data lines are tri-state buffered by ICs 39, 40, 49, 50 and 51 (74LS367). This means that the buffers have three possible output states – '1', '0' and high impedance (effectively disconnected).

The address lines to the RAMs are always active (i.e. not tri-state) – pins 1 and 15 of IC49 and pin 1 of IC50 are earthed to permanently enable the buffers. The data in (to the processor) and data out (of the processor) lines are connected to the same points on the RAMs and so the data out (of the processor) lines have to be tri-stated while the processor is reading. This is done by the $\overline{WE}$ line, which feeds the tri-state control input of IC51 and part of IC50.

This same $\overline{WE}$ signal is also fed via the four 'write protect' switches to the 'not write enable' inputs of the RAMs. Each of these controls one 4K block while these switches are in the 'disabled' position the ram contents will not change.

The high-order bits of the address bus are decoded by IC44, which is simply a 4 to 16 line decoder. The outputs of this IC are then wire-linked to the 'not block select' lines 1 to 4 to determine where each of the four 4K blocks is to reside in memory.

Bits 10 and 11 of the address are



decoded by IC33, a 2 to 4 line decoder which determines which pair of chips is being accessed out of the 4K block (a pair of chips constitutes 1K of RAM). This is combined with the 'block select' signals in ICs 34 to 37 to form the 'chip select' lines 1 to 16 which go to the RAM chips.

IC45 simply counts clock cycles (the S100 Ø2 signal) until the wait period is over. The number of cycles is determined by a wire link to one of the outputs of the IC and the counter is reset by the S100 PSYNC signal. A pull-up resistor selects 0 wait states if no link is present.

The cromemco 'bank select' hardware toggles flip-flop IC43. One output from this enables the outputs of IC44 while another drives the 'board enabled' LED.

An attempt to output to the 'bank select' port at 100 octal (hex 40) is detected by the address decoder, ICs 46 and 48 and part of 47. Detection of the right address, PWR ans SOUT signals causes IC43 to accept any signal which makes it through SW1, the bank select switch. This is fed from the data bus and effectively selects which of the eight possible 64K blocks the board will 'appear' in.

The PRESET line of the bus is connected via a wire link to IC43 and the position of the link determines whether the board is enabled or disabled on processor reset.

Lastly, the PHANTOM facility can be used by completing the link from line 67 of the bus to pin 10 of IC38. This will disable the board if the PHANTOM line is pulled low.

SPECIAL OFFER!

16K S-100 RAM Card

S M Electronics are offering the 16K S100 RAM card featured in this issue at a specially low price, to ETI readers.

The board is fully compatible with all other S100 projects which we have published and is well matched to our future S100 material - so it's a good idea to invest now in a bargain piece of equipment which will be compatible with many systems for a long time to come.

Some of the outstanding features of the S M Electronics kit are:

Fully S100 compatible — not 'pretend' compatible, as are many commercial units today
Independently addressable 4K blocks for system flexibility
Each 4K block is write-protectable
Standard Cromemco bank select
Selectable wait states for flexibility
450 ns access time (*300 ns* optional)
Gold plated edge connector
All holes *through-plated*
Fully buffered address and data busses
Phantom option
Reliable operation assured by the use of PDBIN strobe
Low power requirements - 1.2A (typ)
Kit assembled and sold only in *Australia*

The entire kit for a complete 16K S100 RAM board is available for **$299** (plus 15% sales tax plus $5 registered postage). Other optional extras include 32 18-pin sockets (i.e. for the RAM chips only) - $13.80 inc. tax, a full set of sockets for every DIL chip on the board - $23.00 inc. tax, or faster (300 ns) memory chips - $36.80 inc. tax.

If you are seeking exemption from sales tax, please insert the tax free prices on the order form (RAM Card kit $299 + $5 p & p, 32 sockets $12, full socket set $20) and either a) enter a Tax Exemption Number and sign the order or b) attach a company order form giving details of your exemption claim or c) if you are a full-time student, attach the appropriate certificate, signed by your tutor.

NOTE: This offer is made by S M Electronics and ETI is acting as a clearing house for orders only. Cheques should be made payable to 'RAM Card Offer' and sent, together with the order form or a copy thereof, to 'RAM Card Offer', Electronics Today International, 15 Boundary Street, Rushcutters Bay, NSW 2011. We will then process the orders and send them on to the sponsor who will send out the goods by registered mail. Please allow four weeks for delivery — there could be a longer delay if you have ordered 300 ns memories. The offer closes on Friday, 20 April 1979 and is open to Australian readers only.

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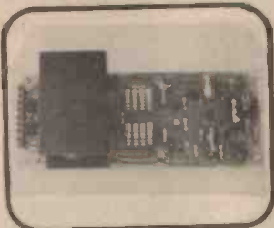
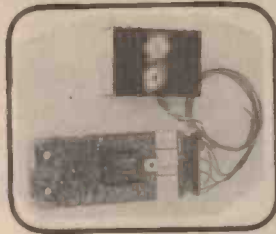
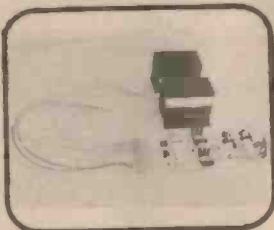


033 Very high quality 100 Watts R.M.S. Power Amplifier for studio work etc. Distortion almost unmeasurable. T.I. distortion almost nil. Produces a subtle difference in sound which has to be heard to be appreciated.



018 60 Watts R.M.S. at less than 0.1 percent T.H.D. Load 4 ohms. Fully short-circuit protected.



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ALICE SPRINGS: Farmer & Davies Electronics, phone 52-2967.
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NSW: President Sound, Wentworthville, phone 631-6689; WMR Electronics, Glenfield, phone 605-1203; Dawes Sound System, Blaxland, phone 39-4421. Hi-Fi Gallery, Tamworth, phone 66-2525; Ray Walsh Sound Systems, Albury, phone 21-1502.

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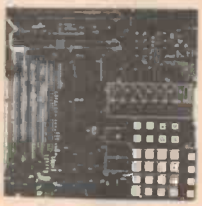

The ideal choice for the beginner, this is a complete Z80 system on a board. Includes 1k static RAM with sockets for another 1k, powerful 2k ZBUG monitor, extra PROM socket PLUS on-board PROM programmer. There's also a Kansas City standard cassette interface, hex keyboard and six digit display, twelve command keys, four counter/timer channels, two eight-bit parallel I/O ports, and room for you to expand: a generous 2½" x 8" wire-wrap area for custom circuitry AND S-100 INTERFACE WITH POSITIONS FOR TWO S-100 EDGE CONNECTORS ON BOARD.

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assembled and tested 189

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32k model (uses 4115 RAM)			64k model (uses 4116 RAM)		
Size	Kit	A&T	Size	Kit	A&T
8k	$199	$379	16k	$499	$595
16k	299	449	32k	689	849
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This unique product brings the number crunching power of the fabulous AM9511 arithmetic processing chip to the S-100 computer user. Full 32 bit floating point multiply in as little as 42 us. — and a full complement of transcendental functions, all far faster than software routines.

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Add 15 percent sales tax where applicable — we pay postage on pre-paid orders — orders accepted pre-paid or COD. **Dealer enquiries invited.**

Project 557

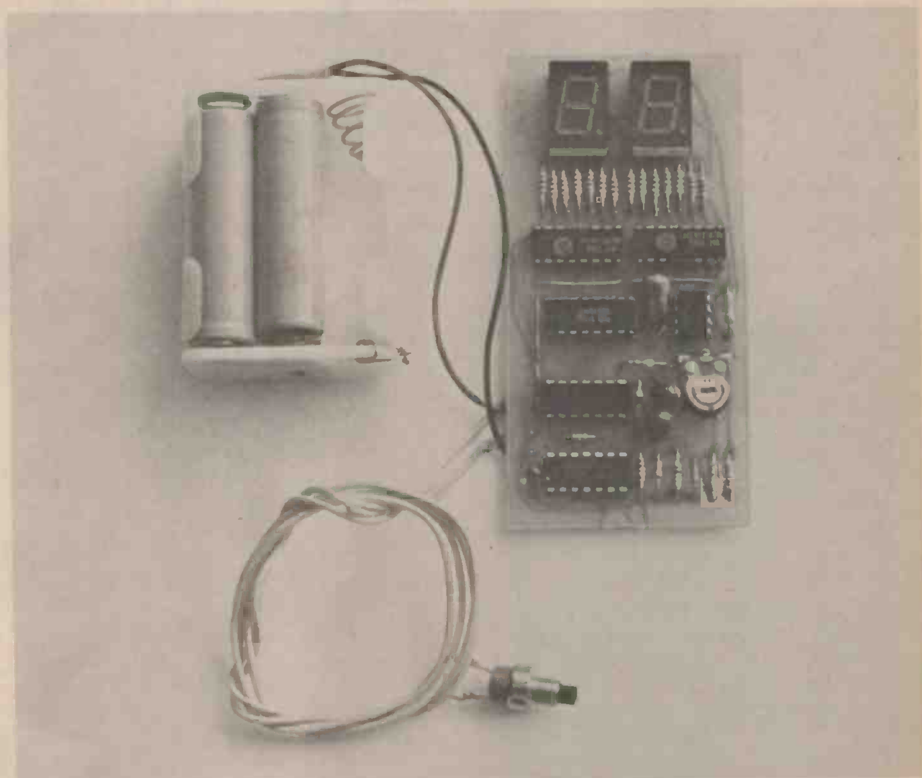
Reaction Timer

Check your reflexes with this simple project.

AT OUR LAST Synergistic Beer Drinking night, one of our readers brought along a reaction timer to prove that reactions *do* slow down during one of these nights! We were impressed with the timer and decided to publish it as a project.

While we have published reaction timers before, the feature which made this unit unique is that it gives a random time interval between tests. This prevents anticipation causing a shorter than actual reaction time. As the prototype was built on veroboard and used 9 TTL packages plus two of the nice (and expensive) HP displays (which have the decoder on board), we decided that at least one pc board was required.

On looking at the logic involved, we saw it could be simplified without any change in operation and with the use of CMOS the power supply is less critical than with TTL.



Operation

If the unit has not been used for more than 30 seconds the display will blank. Pressing the button and releasing it will initiate operation. When the display comes on again it will start counting from zero until the button is pressed. It should be held depressed while the time (in hundredths of seconds) is read. Releasing the button blanks the display for a random time before it comes on again, counting from zero for a second test. If the button is not pressed the display will blank after about 30 seconds to conserve power – no on/off switch is required.

Construction

We will describe only the electrical side of the project, leaving the mechanical side to the individual constructor.

SPECIFICATION - ETI 557

Reaction time	0 to 0.99 seconds
Delay between tests	½ to 10 seconds (random)
Power requirements	4 to 12 volts dc @ 50 mA (display on) @ 1.9 mA (display off)

Project 557

Assemble the pc board with the aid of the overlay in fig. 1. Start assembly with the resistors, diodes and the four links. The 555 IC should now be fitted and soldered, followed by the other ICs. These are all CMOS and their pins should not be handled more than is necessary. As an added precaution, solder the power rails first (pins 7 and 14 on ICs 8 and 16) using an earthed soldering iron. The rest of the components can now be assembled.

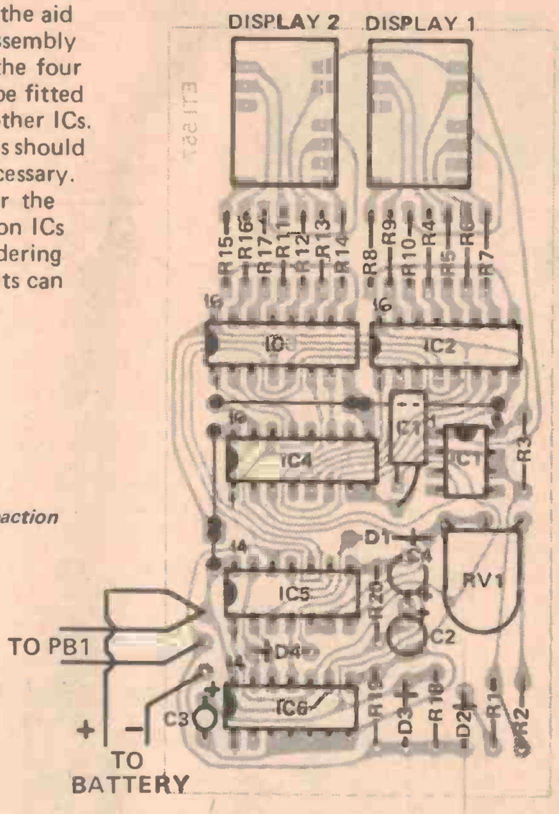


Fig. 1. Component overlay of the reaction tester.

PARTS LIST - ETI 557

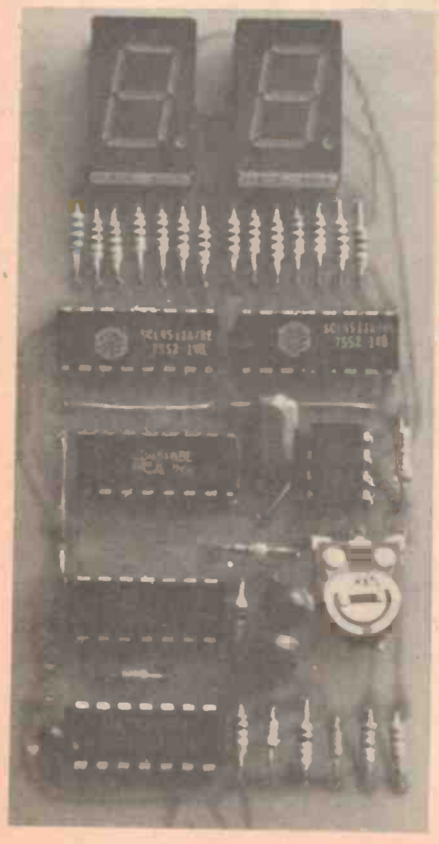
Resistors all ¼ W, 5%
- R1 . . . . 1k
- R2 . . . . 330k
- R3 . . . . 4M7
- R4-R17. . . . . 1k
- R18. . . . . 1M
- R19. . . . . 10k
- R20. . . . . 1M

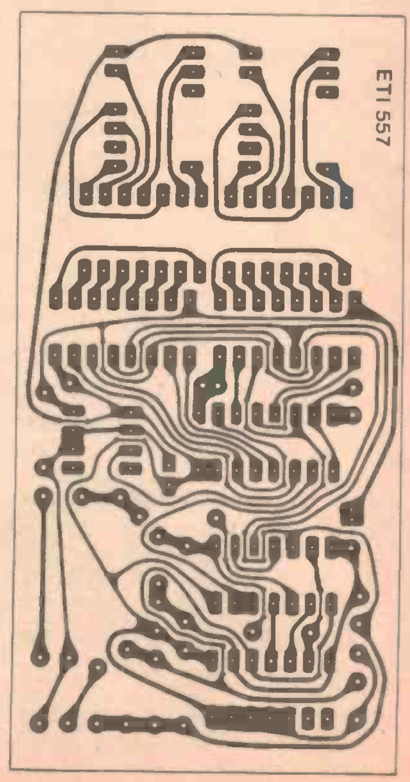
Potentiometers
- RV1 . . . . . . 500k trim

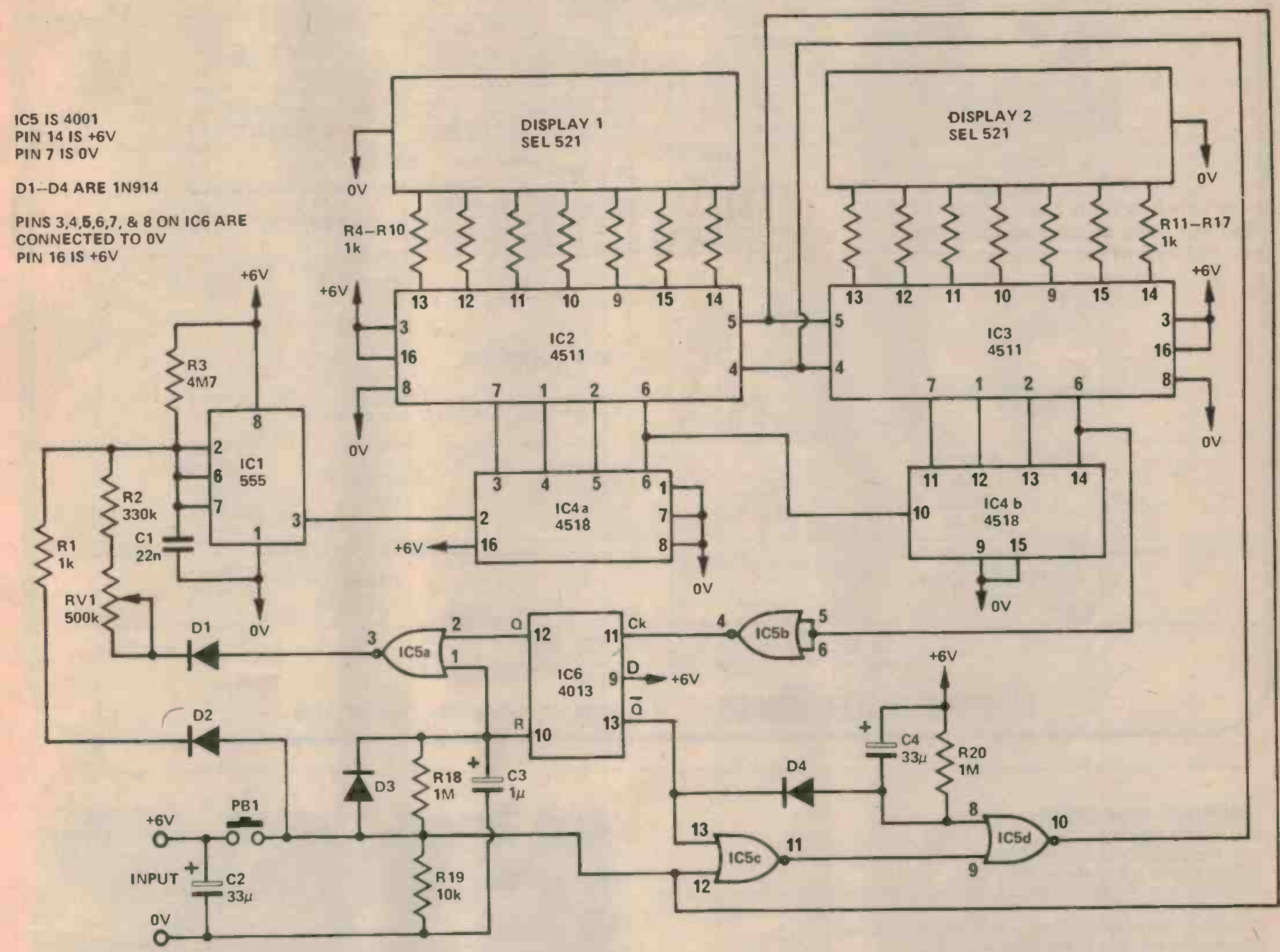
Capacitors
- C1. . . . . 22n Greencap
- C2. . . . . 33µ 16V tantalum
- C3. . . . . 1µ 16V tantalum
- C4. . . . . 33µ 16V tantalum

Semiconductors
- IC1 . . . . 555 or 7555
- IC2, 3. 4511
- IC4 4513
- IC5 4001
- IC6 4013
- D1-D3 . . . . . 1N914
- Display 1, 2 . . SEL 521

Miscellaneous
- pc board ETI 557
- push-button
- 6V battery







HOW IT WORKS - ETI 557

The unit is basically an oscillator, IC1, clocking two decade counters (i.e. ÷ 100), with their outputs being decoded by IC2 and IC3 and displayed on the LED displays. Control of the oscillator and displays is done by IC5 and IC6.

When the push-button is activated, IC6 is reset so that pin 13 is "0" and pin 12 is "1". Also, a "1" is applied to the latches in the decoders (IC2, 3) so that the number presented to the decoders at that instant is stored. It also applies a "1" to pin 12 of IC5/3, forcing its output low. As there is a "0" on pin 13 of IC6, the diode D3 brings the voltage on pin 8 of IC5/4 low. Two "lows" on these gates (NOR) make the output go high. As the output of this gate controls blanking ("0" = dark), the display will be on.

The push-button also (yes, it does a *lot*) causes the 555 oscillator to run at about 50 kHz. The oscillator clocks the counter ICs – they are completely cycled 500 times per second.

When the button is released, the oscillator frequency drops to about 10 Hz. The display blanks as IC5/3 now has both zeros on its input, a "1" on its output and hence a "0" on the output of IC5/4. The latches in the decoder ICs also open, although counting cannot be seen as the display is blanked.

After about ½ sec the voltage on the reset input of IC13 (pin 10) falls below the threshold level, allowing it to be toggled by the clock input (pin 11). As when the push-button was released, the counters (IC4) could have started at any count, the time until the voltage on pin 14 of IC4 goes low is random. The delay on the reset line going low is to prevent IC6 from being toggled too soon.

When IC6 is toggled (after ½ sec to 10 sec), pin 13 goes high and pin 12 low. IC5/1 now has two lows on its input, giving a "1" on its output. This raises the oscillator frequency to 100 Hz. The "1" now on pin 13 of IC5/3 gives a "0" on pin 9 of IC5/4 and a "1" on pin 10. This brings the display back on. As IC6 can only be toggled on the overflow of IC4, the display comes on at the zero count.

The display continues counting up at 100 Hz until the button is pressed, freezing the display to indicate reaction time. The whole thing is then repeated.

If the button is not pressed for more than 30 sec the voltage on pin 8 of IC5/4 will go above the high threshold, forcing the output low and thus blanking the display.

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Note:: Regular Prices not temporary specials — keep us in mind for that next order.

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Linear potentiometers rotary carbon 38c ea. 500 Ohm, 1K, 5K, 10K, 25K, 50K, 100K, 250K, 500K, 1M, 2M.

Quality Large red LEDS well diffused wide viewing angle. 17c each, $1.50 per 10, $110/K
Quality MOUNTING CLIPS 5c ea. $4/100

LEDS
$12 a 100
17c each

TRIMPOTS
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Values: 100, 250, 500 Ohm 1K, 2K, 5K, 10K, 25K, 50K, 100K, 250K, 500K, 1M, 2M

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METAL CAN TRANSISTOR
BC 108 - 13c
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1 Amp. DIODES

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100V	1N4002	7c
400V	1N4004	8c
1000V	1N4007	12c

10% off 100 SAME

$4 a 100 SIGNAL DIODE **IN4148**
$30 a 1000 **5c each**

ZENER DIODES 15c each 400 mW 5%
E24 values 3V to 33V

5c ELECTROS
(UPRIGHT)

(per 100 prices in brackets)

Cap.	16V	25V	50V
0.47 uF thru to	all	all	all
10uF	5c($3½)	6c($3¾)	7c($4)
22uF	6c($3¾)	7c($4)	8c($5)
33uF	8c($4)	9c($5)	10c($6)
47uF	9c($5)	10c($6)	11c($7)
100uF	10c($6)	12c($7)	14c($11)
220uF	12c($8)	16c($10)	35c($17)
470uF	16c($12)	22c($16)	45c($30)
1000uF	22c($18)	30c($25)	75c($50)

1000uF/16V axial — 20c ea. $8 per 50
2200uF/50V PCB — 95c ea. $9 per 10
Full axial price list — SAE

5c POLYESTER
FILM CAPS

E12 10% 100V
ALL VALUES .001 to 01 — 5c ea.

.01	5c	.1	10c
.012	6c	.12	11c
.015	6c	.15	12c
.018	6c	18	14c
.022	6c	.22	15c
.027	6c	.27	16c
.033	7c	.33	18c
.039	7c	.39	19c
.047	7c	.47	20c
.056	8c		
.068	8c		
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- **S100 Mother Board**, 11 slot 8" x 12" double sided: $36.00.
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- **Number Cruncher Kit**, uses MM57109 data and software: $56.00.
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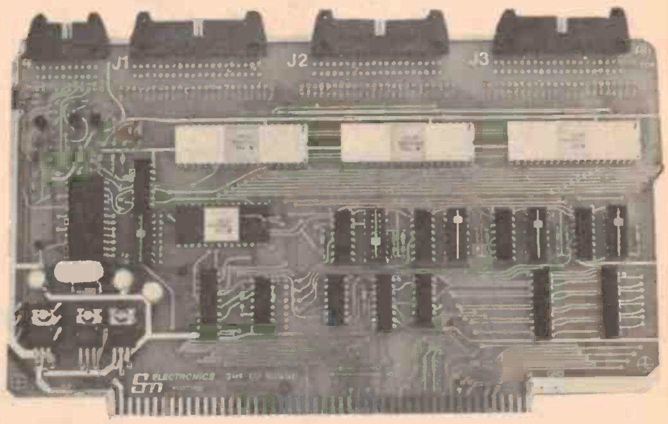
- **S100 16K RAM Board**, 2114's, 4K addressing, write protect, wait states, plated through holes, solder mask, bank select: assembled & tested $346 plus tax.



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The Heathkit H8 system from Warburton Franki.

Computer Show

We report on the extremely successful show held at Box Hill Town Hall in December.

ONE OF THE BIG 'personal computing phenomena' in the US is the home or personal computer show, which lets hobbyists and members of the public see and play with the latest hardware. While these have been running in the States for a couple of years now, they have only recently started in Australia. Over the weekend of 9th and 10th December last year, Box Hill Town Hall was the venue for Melbourne's first computer show, organised by Australian Seminar Services.

A large number of Australian importers, distributors and manufacturers of micro gear were there, along with some 'fringe' organisations like Box Hill Technical College and of course ourselves!

SM Electronics
Lots of S-100 units including a number-cruncher board.

Pennywise Peripherals
Prototyping kits and peripherals for Motorola and Intel devices, as well as cards to expand your D2.

AJF Systems & Components
PeCos, a 6502-based learning/development system.

Sontron Instruments/Byte Shop
Almost everything.

ASP Microcomputers
ASP System One is 8080-based. Also featured was a Selectric conversion kit.

Futuretronics
Micro-based games, including the excellent Atari system.

Abacus Computer Store
M100 Z-80 BASIC system from Sord.

Rod Irving Electronics
Small business system with Z-80 and disk, also including spooled printer software!

Strand Electric
Exorciser plus add-ons from this rather diverse company.

Dick Smith Electronics
Has introduced the Exidy Sorcerer — more of this in ETI at a later date, perhaps?

Delta Scientific Products
Wide range of TI calculators.

RML Computers
Research Machines 380Z with Z-80.

Computerland Australia
Apple II.

South West Electronics
MSI 6800-based system with disk.

Box Hill Technical College
Courses in electronics, microprocessors and programming.

Honeywell
Industrial computer components.

The Dindima Group
Altos Sun series of Z-80 computers with disks.

A J & J W Dicker
Vector MZ Z-80 S-100 system with disks.

Tandy International
TRS-80 with level II and software.

Warburton Franki Industries (Melbourne)
Heathkit range of educational micro-processor products.

Informative Systems
Large range of business systems and S-100 cards and low price Tandy add-ons.

Last, but not least, ETI was there. We were accompanied to Melbourne by Rod Whitworth of Automation Statham who displayed a Sol System IV with four floppy disks. Also on the stand we had the prototype of an S100 card cage from Acoustic Electronic Developments of Sydney — we will have more on this in a later issue. Naturally, we had a selection of ETI projects on the stand; the ETI 640 VDU and 641 printer, 635 power supply, and the 650 STAC timer. The hit of the stand (maybe even the show) was the ETI 639 SC/MP-based door-bell — it seemed that every kid (regardless of age) in the place was pushing the buttons, and of course this attracted more people.

To all the ETI readers who asked us questions on the stand — it was good to talk to you! We're only sorry we didn't have more time to discuss our projects and plans with you, but by Sunday afternoon we were getting hoarse anyway!

Dick Smith displayed the Exidy Sorcerer.

Rod Whitworth expounds upon the Sol System IV.

Futuretronics displayed a number of games.

The Vector MZ system was displayed by A J & J W Dicker.

Computerland displayed the popular Apple II and Appledisk.

Strand Electronics displayed a range of 6800 gear.

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- Displays up to 32x2k pages simply by changing contents of 8 bit page register.
- Hardware scrolling controlled by scroll register.
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- Inverse video (may be mixed with normal video).
- Coarse graphics.
- Link programmable character/line (48, 64, 80).
- Link programmable lines/page (20, 22, 24).
- Additional line at bottom of page for status information — uneffected by scrolling.
- Dot rate controlled by phase locked loop — automatically adjusts to different formats.

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24K	$469	$499
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The Yaesu FRG 7000

General coverage receiver features digital readout and Wadley loop front end.

THE FRG-7000 is Yaesu Musen's successor to their popular FRG-7 general coverage receiver.

Marketed as a high performance receiver, the FRG-7000 features the popular 'Wadley-loop' method of band selection covering the frequency range 250 kHz to 29.9 MHz and incorporates a LED digital frequency readout giving a 1 kHz resolution. It features selectable sideband reception (USB/LSB) and separate IF filters are used for AM and SSB reception. Also featured is a digital clock which can be set to display local or 'universal' (GMT) time. The clock also incorporates a facility for switching the receiver on and off at preselected times.

The Wadley-loop

As many readers may not be familiar with the Wadley-loop method of band selection, it would be instructive to examine the technique and its application in the FRG-7000 receiver.

The basic block diagram is shown in figure 1, along with the frequency relationships.

The 1 MHz crystal oscillator sets the basic tuning range or the 'baseband' — a 1 MHz baseband is almost universally used.

The Wadley-loop front end selects 1 MHz bands depending on the combination of the "MHz" oscillator and one output of the harmonic generator. The band selected will be converted to the range 2-3 MHz which is tuned by a conventional superhet incorporated in the complete receiver. This, the IF receiver, is tuned from 3 MHz *down* to 2 MHz to tune *up* the band selected; that is, reverse tuning. We shall see why shortly.

The "MHz" oscillator is a free-running VHF oscillator generally covering the range 50-80 MHz. The 'transfer' filter is usually around 40-50 MHz and has a bandpass of 1 MHz. The 're-mix' filter is below the transfer filter frequency (2 MHz below the lower frequency cutoff of the transfer filter). The re-mix filter provides the second injection frequency, f_2, to the 2nd signal mixer, attenuating all the other products produced by the pre-mixer.

To get a clear idea of how the Wadley-loop works, and the advantages it provides in practice let's substitute some numbers in figure 1 and see what happens.

In the FRG-7000, the MHz oscillator covers 55.5 to 84.5 MHz. The harmonic generator puts out 'spikes' every 1 MHz between 3 and 32 MHz and the second injection frequency, f_2, is 52.5 MHz. The transfer filter is centred on 55 MHz and extends from 54.5 MHz to 55.5 MHz.

Now, suppose we wish to tune in a signal on 7.900 MHz. First, the receiver's preselector would be set to the appropriate range (4-10 MHz in this case) and the MHz dial set to select the 7-8 MHz range. This sets the MHz oscillator (and thus the first injection frequency to the 1st signal mixer, f_1) to 62.500 MHz.

This will then heterodyne with the harmonic at 10 MHz, from the 1 MHz crystal, to produce an output at 52.5 MHz from the re-mix filter which is then applied to the 2nd signal mixer.

The signal on 7.9 MHz is heterodyned to 54.6 MHz (f_T) and passes through the transfer filter. When heterodyned with the second injection frequency (f_2) of 52.5 MHz the desired signal appears at 2.1 MHz. Tuning the IF receiver to this frequency will resolve the desired signal present on 7.9 MHz!

A signal on 7.100 MHz would be 'transferred' to 55.4 MHz and would appear on 2.9 MHz at the output of the 2nd signal mixer. Thus, it can be seen that the IF receiver tunes 'backwards' to tune the 1 MHz band selected.

The Yaesu FRG 7000

Problems

That's all very fine, but how is the MHz oscillator accurately set to the required frequency, and what happens if it drifts, assuming it can be set accurately?

Problem. What the Wadley-loop does is *cancel* the drift and setting errors in the MHz oscillator, obviating the necessity for a highly stable oscillator or series of oscillators. What happens here?

For the sake of argument, say we set the band oscillator 20 kHz high in frequency. That is, 62.520 MHz in the example detailed above.

The second injection frequency would then appear at 52.520 MHz and the signal on 7.900 MHz would be transferred up to 54.620 MHz. When this is heterodyned with the second injection frequency in the 2nd signal mixer, the output will be on . . . 2.1 MHz still!

The same story goes if the MHz oscillator drifts.

Obviously, there are limitations to the amount of error that can be tolerated in the MHz oscillator. In practice a figure of 60-80 kHz is settled upon.

Here comes the second problem. How to provide a re-mix filter at 50 MHz with that sort of bandwidth!

The solution . . . put the re-mix filter on 10.7 MHz, use a readily-available ceramic filter designed for FM receivers (+/-75 kHz), heterodyne the output of the pre-mixer down to 10.7 MHz and then reheterodyne it back up again! Cunning stunt, what?

At this stage, cast your eyes upon figure 2. This is what Yaesu have done in the FRG-7000 front end. A crystal oscillator on 62.5 MHz mixes the output of the pre-mixer down to 10.7 MHz where it is passed through a ceramic filter. The output of the filter is then mixed back up to 52.5 MHz, using the same 62.5 MHz crystal oscillator output.

The FRG-7000

The general block diagram is shown in figure 3. Note that the 'UNLOCK' detector comes off the input to the second mixer. When the MHz oscillator is set within about 70 kHz of the required frequency there will be an output from the reheterodyne re-mix filter and a high output from the following buffer amplifier. This output is detected and used to extinguish the 'UNLOCK' indicator lamp. If the MHz oscillator drifts outside the bandpass of the re-mix filter the output from the buffer amplifier will decrease rapidly, causing the UNLOCK indicator to light.

General commentary

The front panel of the receiver is generally well laid out, not cramped, and all markings and indicators are easily read when the receiver is in use. Accessibility of the controls is very good with the exception of the 'fine' tune knob which, to this reviewer, seems to be located too close to and on the wrong side of the main tuning knob.

The preselector tuning control operates very smoothly over the whole range. It is band switched in four ranges, each range being indicated by a colour-coded indicator related to the preselector dial. This is an excellent idea, enabling one to see what one's doing at a glance.

The main tuning control is a little fast for comfort for SSB tuning and a little more reduction ratio would improve matters greatly. This was a problem with the FRG-7 too. Band-scanning ability would not be compromised greatly if the reduction ratio were improved. The fine tune control has too great a range, it was felt, further exacerbating the problem of tuning SSB signals. However, the necessary 'skill' is easily acquired.

An attenuator may be switched in to reduce possible overload problems from strong signals and is a very handy addition — more general coverage receivers available could do with one. It provides 20 dB of attenuation, which is just about right in our experience. We only found occasion to use it when listening on the most popular amateur bands and the CB band; the receiver's performance handling strong signals certainly seems better than average.

The S-meter is easily seen and well lit and the digital display has good visibility. The latter is a decided advantage in a general coverage receiver, although the addition of an analogue dial of some sort would improve 'seeing at a glance' where you're tuned and gives a better 'feel' to a receiver's operation. However, that's probably a matter of personal preference.

It entirely escapes us why Yaesu put an on/off switch on the digital display. Can anyone enlighten us?

Separate Filters

The incorporation of separate filters for SSB and AM is a great improvement over the FRG-7. Selectivity of the FRG-7 (and its counterparts) was not all that could be desired and the FRG-7000 has excellent selectivity characteristics, particularly for SSB reception. It may prove a little 'sharp' for some tastes, particularly SWLing on the AM mode where you may wish to listen to station programs including music, but we found it not unpleasant. Adjacent channel 'monkey chatter' is greatly reduced so what you lose on the swings you pick up on the roundabout.

We note that a crystal-locked BFO is employed, with separate crystals for upper and lower sideband. This certainly aids SSB reception and stability is excellent, allowing an SSB signal to remain resolved for very long periods without requiring the operator to adjust the fine tune control.

Audio quality is quite good, particularly considering the small speaker used. The balance is 'even' with enough 'lows' to provide a smooth sound. However, an external speaker of good quality will markedly improve matters.

The tone control operates smoothly and proves useful on occasion. The volume control is smooth in operation without sudden increases in volume apparent across its range.

The FRG-7000 could well do with the addition of a noise blanker, especially at its price. This inclusion would top off an otherwise high performance receiver. We find the omission baffling as Yaesu's 'standard' noise blanker, as used in their amateur transceivers, performs well in our experience and would be a significant fillip to the receiver's overall performance and operation.

Technical report

Sensitivity of the FRG-7000 is very good, exceeding the manufacturer's specification except for the SSB mode at 950 kHz where our measurement indicated it was marginally worse. Curiously, the sensitivity improved at the higher frequencies. Evidently the noise figure degrades across the lower frequency range.

Overall, the sensitivity is more than adequate for the majority of situations in which the receiver will be used.

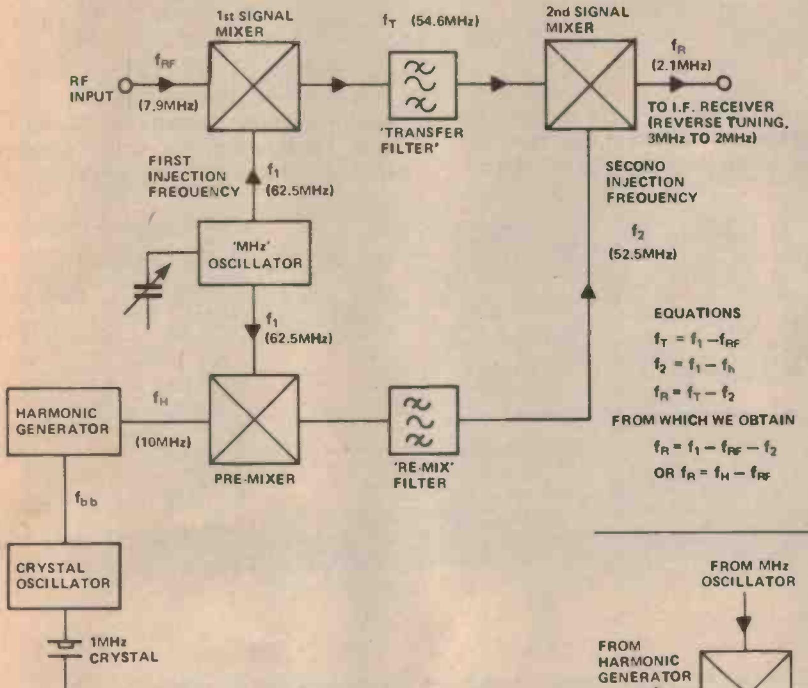
Selectivity is considered excellent, particularly on SSB, and generally is better than the specification.

The stability was measured from a cold start over a one hour, forty-two minute period. Initial drift was 700 Hz over the first 72 minutes and only 340 Hz in the final 30 minutes. Digital dial accuracy was good, any error being less than the final digit (1 kHz).

Crossmodulation and overload performance, while naturally not up to 'top shelf' standards, was nonetheless good and we found few difficulties in practice — nothing that the attentuator couldn't cope with in any case.

We thought AGC performance could be better, but in any case it seems superior to many general coverage receivers around in our experience. The S-meter could only be described as generous! Yaesu equipment usually

Fig. 2. The front end of the FRG-7000.



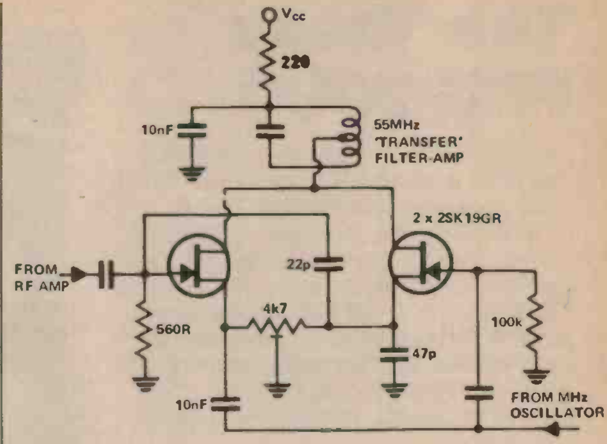


Fig. 4. The first signal mixer uses an unusual configuration of two JFETs.

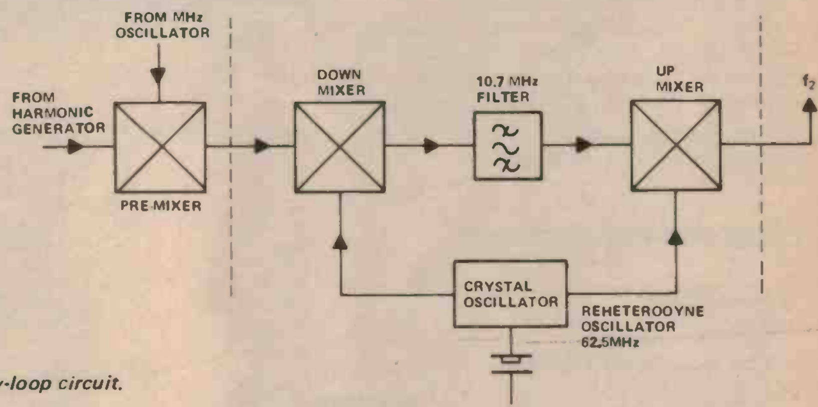


Fig. 1. Basic Wadley-loop circuit.

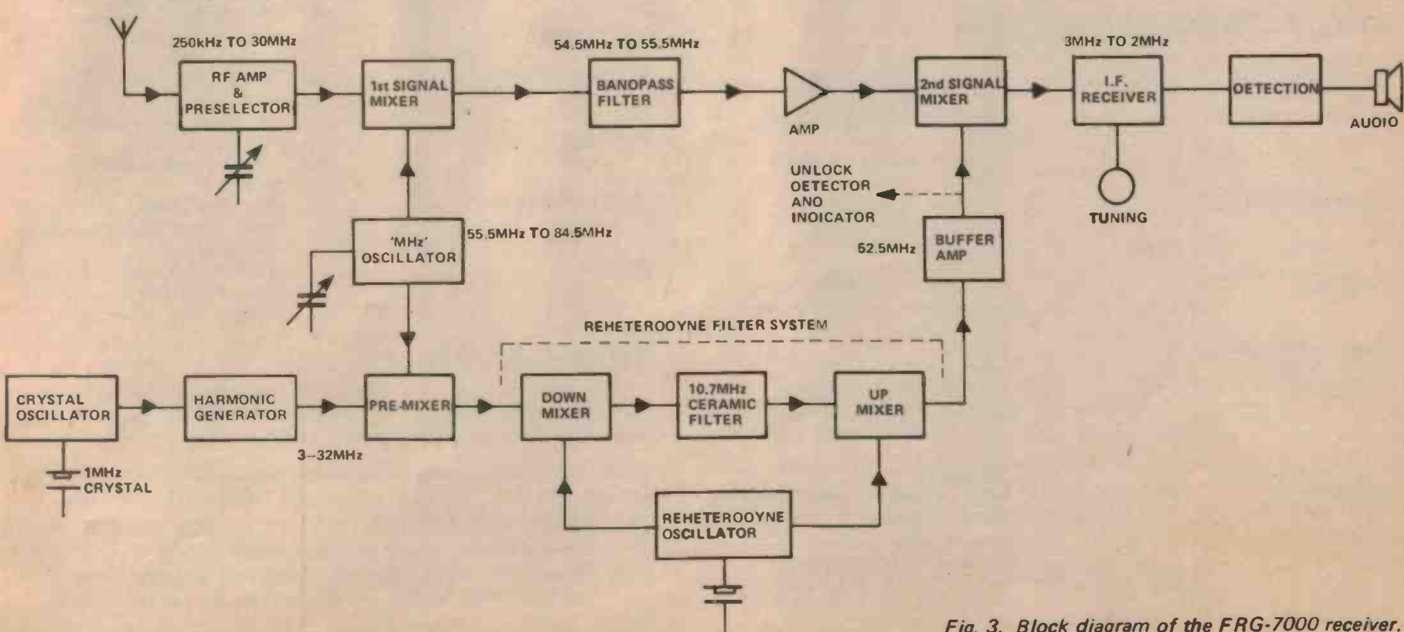


Fig. 3. Block diagram of the FRG-7000 receiver.

The Yaesu FRG 7000

has 'scotch' meters and the FRG-7000 was quite a surprise. We wondered why there were so many S9 signals about!

Examining the circuitry, it appears Yaesu have taken some trouble to provide good performance. Dual-gate FETs are employed in critical RF amplifier stages and two JFETs are used in an unusual configuration for the first signal mixer (see figure 4). The 3-2 MHz tunable IF receiver is fairly conventional.

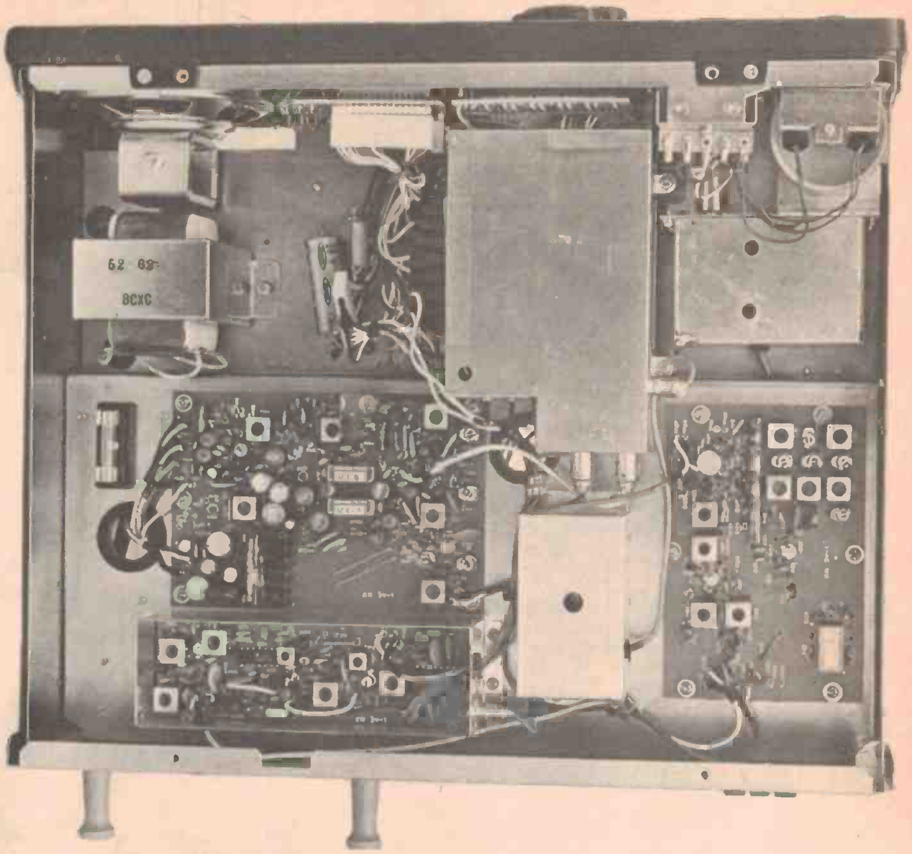
General construction is up to the usual Yaesu standard.

Summary

Overall, we'd consider the Yaesu FRG-7000 a top performer in its general class. It's a pleasure to operate (with the minor exceptions mentioned), whether used for general listening or serious DXing.

It's worth a considered look.

Many thanks to Keith Gooley VK2BGZ for assistance in performing the bench measurements and also to Fred Bail of Bail Electronics Services for kindly supplying the receiver for an extended period for the test.



Internal view of the FRG-7000 receiver. Construction is up to Yaesu's usual high standard.

YAESU FRG-7000 RECEIVER

- **Supplied by:**
  Bail Electronic Services
  60 Shannon St.,
  BOX HILL NORTH 3129
  (03) 89-2213
- **Serial No.:** 8G020005
- **Recommended Price:** $695.00

MANUFACTURERS SPECIFICATIONS

Frequency Range	250kHz – 29.9 MHz
Type of emissions	AM, SSB (USB), CW
Sensitivity: SSB/CW	better than 0.7μV at 10dB S/N
AM	better than 2μV at 10dB S/N
Selectivity: SSB/CW	+/– 1.5kHz at –6dB; +/– 4kHz at –50dB
AM	+/– 3kHz at –6dB; +/– 7kHz at –50dB
Stability	Less than +/– 500Hz during any 30 minutes after warm up
Speaker impedance	4 ohms
Audio Output	2 watts
Power supply	100/110/117/200/220/234 volts AC 50/60 Hz optional 12Vdc external/internal
Power consumption	25 watts
Dimensions	360mm wide, 125mm high 295mm deep.
Weight	Approx 7kg
Antenna	Random wire for 250kHz to 1.6MHz range 50 ohm unbalanced for 1.6–29.9 MHz range.

TEST REPORT

Sensitivity: (at 10dB SINAD)	*950kHz*	*AM: 1.8μV*	*SSB: 0.8μV*
	14.95MHz	*AM: 1.2μV*	*SSB: 0.22μV*
	29.95MHz	*AM: 0.54μV*	*SSB: 0.16μV*
Selectivity:	*at –6dB*	*AM: +/– 3.5kHz*	*SSB: +/– 1.1kHz*
	at –50dB	*AM: +/– 5.9kHz*	*SSB: +/– 2kHz*
Stability:		*340 Hz over 30 minute period following one hour's warmup.*	
Crossmodulation:		*A 200mV signal 50kHz separated from 1 μV signal increases audio output 6dB.*	
Overload:		*Output distortion commences at 45mV signal input.*	
AGC performance:		*Less than 6dB audio output change for 70dB change in signal level.*	
S-meter		*About 1.3dB per S-point; very generous! S1 = 2.5μV; S9 = 30μV*	

OTHER FEATURES

Fine tune control, internal speaker, optional internal/external battery operation, digital clock/time with local/GMT readout, tape recorder output socket, attenuator switch.

TEST EQUIPMENT:

Hewlett Packard signal generator model 8558B
Frequency meter: digital counter in HP sig. gen. above.
Hewlett Packard noise and distortion meter model 334A.

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- ★ completely socketed

Assembled and tested $185.00
Kit $129.95
Bare PC Board .... $ 34.95
★ For 4MHz Speed Add $15.00

IMS 16K STATIC RAM

- ★ Memory mapping
- ★ Phantom
- ★ Address 16K Bound
- ★ Use with or w/o front panel
- ★ Power 2.1 amps typ.
- ★ Uses 2114

ASSEMBLED & TESTED ONLY
450ns. $439.95 250ns. $495.95

MICRODESIGN MR-16 2716 EPROM BOARD (MR-8 Also Available at same price)

- ★ Individual Prom Address
- ★ Uses Low cost 16K TI EPROMS
- ★ Optional 1K RAM ★ Phantom control

Assembled and Tested 174.95
Kit 99.50

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2708-6 Eprom .... 8 @ $ 5.50 ea.
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S-100 32K STATIC RAM

- ★ Address 32K Boundary
- ★ Power 450ns. 2.8 amps typ.
- ★ No wait states on 2MHz
- ★ Fully Buffered
- ★ Phantom can be added
- ★ 2114/TMS4045 or 9135

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★ Power on Jump ★ Reset Jump
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NOTE: 2708-6 only $5.95

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Amateur News

New Atlas Dealer

G.F.S. Electronic Imports, Greg Whiter Esq. proprietor, informs us that he is now an Atlas distributor.

If you're after some of that you-beaut Atlas gear – compact, high performance (210x/215x etc), then he's the man to see. Give him a bell on the six hundred some time: G.F.S. Electronic Imports, 15 McKeon Road, Mitcham 3132 (03) 873 3939.

Russian Satellites

The Russian satellites showed their face for about a week around early November last – but we've heard nothing of them since.

There are two of them, RS1 and RS2, and both travel in polar orbits, similar to the Oscar series – but in the opposite direction. Evening passes run from North to South, RS2 running roughly 20 minutes ahead of RS1.

The 29.4 MHz (29.4012) is very strong – has anyone copied the 435.105 MHz beacon?

Maximum input to the transponder is requested to be limited to 10 watts ERP.

Channels 0 & 5A – a win!

Senator David Jull, Liberal member for Bowman (QLD), presented good news to the gathering throng at the Queensland WIA Division's convention last October.

He said, "The decision for channel 5A to be used in metropolitan areas has been completely shelved and won't happen.

"Furthermore, an investigation is now under way by the Department to elininate those areas that are using channel 5A for translator facilities in some sountry areas".

He gave the WIA considerable encouragement when he acknowledged their important role in the battle to curtail channel 5A allocations.

"I believe that if it had not been for pressure of members of your association throughout Australia the decision to go ahead which channel 5A would have gone ahead and we would have been in all sorts of troubles and got ourselves into a ridiculous situation, certainly internationally.

"The power of the people is something that is often debated . . . in Parliament House. It is very easy to get yourself cut off from the outside world.

"Consequently, we found out from the Institute's members of the very real concern that you were having about the possibility of channel 5A being used.

". . . (members) formed themselves into a very satisfactory and hard hitting lobby group".

Further on his speech, Mr Jull, commenting on the channel 0 allocation said that the original idea was to transfer channel 0 stations in Melbourne and Brisbane to channel 10. However, this was likely to cause problems in areas like Traralgon in eastern Victoria and Toowoomba, west of Brisbane, in Queensland. Channel 5A was then seen as a very real alternative.

On October 11 it was (quietly) announced that Channel 0 Melbourne was moving to channel 10 as soon as possible (Hurray – VK3s again proliferate on 6m!).

Mr Jull, ironically a one-time employee of Channel 0 Brisbane we are told, said, "I should think a similar announcement will be made in Brisbane about the fate of Universal Telecasters" (holders of the chanel 0 Brisbane licence).

During question time following his address, Mr Jull said that the moving of channel 0 indicated to him that Australian amateurs may be able to return to the 50 MHz portion of the international six metre band allocation.

He further indicated that the Special Broadcasting Service would not take up the channel 0 allocations, either.

Well, it seems like a reasonably satisfying 90% win for amateurs, and the others affected by the 'strange' 0 and 5A allocations.

Next move is to get channels 5A and 0 deleted altogether . . . followed by moving all the TV channels to UHF, releasing the most useful (and presently most wasted) part of the spectrum to those services who can make good use of it.

Dxpedition to Mellish Reef

Prime mover of last year's Mellish Reef DXpedition, HarryVK2BJL, has put it around the grapevine that another trip is in the offing – set for around September.

Learning from recent experience (!!), this one should run a lot more efficiently and VK6ZR should once again bring dogpiles (and we mean that metaphorically) to the bands.

More long distance TEP

This time the Pacific has been spanned Japan-Argentina. Another first in 20 years or so. Late October, JA8 to LU3 and LU7, followed by LU9 to JA8 and JA7, JA1 as well as KG6!

Interestingly, Japan-Australia signals were worked as late as December 10 which is a pretty healthy seasonal 'spread'. If this sort of propagation follows the patterns experienced in past cycles then this year looks like being quite good with conditions improving over the next few years.

Articles of Note

It seems that the US Ham Radio magazine has an almost inexhaustable front of good, solid technical articles (I'm going to be accused of venality, partisanship, plagurism, payola-taking, graft and corruption – I can see it coming . . . courtesy of the marginal finking department). Their October 78 issue is worth a good look if you've missed it or passed it by (. . . how you can do that, I don't know).

The article on "A high frequency communications receiver" contains some quite ingenious circuitry – best bit being the digital switching of the RF oscillator and mixed tuned circuits.

Close on its heels is a "Low Noise 432 MHz preamplifier". Circuit and construction simplicity are the high points here, as well as the 0.8 dB noise figure! The NE64535 device used may be obtained in Australia by those with sufficient knowledge of contacts in the trade – a minor drawback. Usually, with such quasi-exotic devices, it's a case of 'if you want it, you can get it'.

For the UHF/SHF buffs there's an excellent article of practical bent on a "1296 MHz local oscillator" by the well-known Paul Wade, WA2ZZF. Readily-duplicated stripline pc board is employed with readily available active devices. Spectrum analyser 'pictures' of the output illustrating the oscillator chain's "cleanliness' are given in the article along with a discussion of the techniques used.

The reciprocating detector created a lot of interest back in the early '70s but work on this technique seems to have been at a low ebb in recent times. It surfaces again in the October Ham Radio in an article by Stirling Olberg, W1SNN, titled "Second generation reciprocating detector". The article describes a detector that may be used with solid-state receivers with HF IF strips. Modern ICs are used and a pc board layout is given. A good one for the inveterate 'fiddlers'.

For the microwave enthusiasts an article on a new mixer technique, "Twin diode mixer" will be of interest. The technique described has a number of advantages: simplicity, very low local oscillator power requirements (–3 dBm) 6 dB noise figure, local oscillator frequency half that normally used, not

continued page 79

TS-820 TS-520

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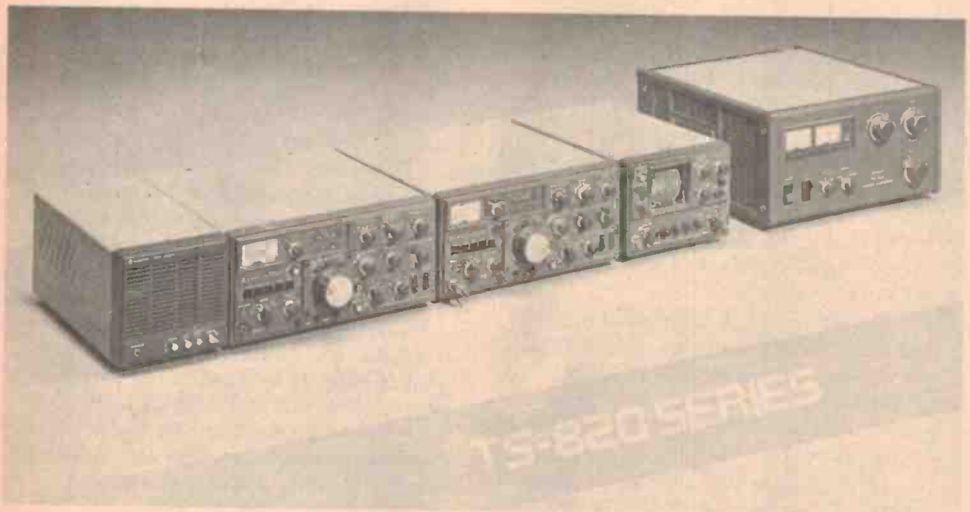

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SPEAKER, SP-520. $33
REMOTE VFO-520S. $163
DIGITAL DISPLAY, DG-5,
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tuning, no dc return required and high isolation between all ports. As it can be used as an up-convertor or a down-converter it would be of interest to those attempting to generate SSB on the SHF bands.

Whet your appetite? There's more.

VHF Auroral Propagation

THE AURORAL SCATTER excitement last August and September has generated an enormous amount of interest in the characteristics of this propagation mode and it would seem timely to detail a few of the known parameters.

Auroras are the visible result of charged particles entering the ionosphere and causing the rarified gasses to 'fluoresce' giving characteristic blue, green or red displays. The green colour is emitted by molecular oxygen while the blue and red colours are emitted by molecular nitrogen.

Auroras occur at heights ranging from around 100 km (95%) up to 800 + kilometres (rarely), measured to the well-defined lower edge of a display. This places the majority of auroras in the E-region of the ionosphere and propagation distances via auroral scatter will depend on the geometry involved according to the location of the display.

As auroras are a manifestation of heavy ionisation in the ionosphere it follows that radio wave reflections (or refractions (or refraction resulting in reflection or scattering) may occur without there being visible aurorae.

In fact, studies of auroral phenomena are carried out using 'auroral radar' which indicate many more auroral returns than visible aurorae.

Aurorae are most often seen (95% of the time) between the geomagnetic latitudes of 20° and 25° removed from the geomagnetic pole, although they may be seen as far south (geomagnetically speaking) as 85° and as far north as 45°. An auroral display was seen at a high angle over Sydney in 1957 — roughly 43° geomagnetic latitude.

Auroral displays appear to be seasonal, peaking roughly at the equinoxes (March 21, September 21) with a 'spread' through midwinter and a minimum during summer, although they can occur at any time. They are associated with strong magnetic storms that follow a solar flare. Auroral effects on propagation are generally observed most often during the afternoon through the evening.

During any single auroral event, the auroral displays are generally located near an 'auroral oval' (see fig. 1.) and most generally occur on the night side of the oval that is farthest removed from the geomagnetic pole. When a large number of these displays are averaged the most common area of occurrence is in the 'auroral zone' which is roughly circular around the geomagnetic pole.

The frequency, geographical extension and intensity of the aurorae follow the sunspot cycle fairly closely — although this is measured in a statistical fashion; the 'peak' of the auroral activity is somewhat 'spread' and may lag the sunspot peak by up to two years.

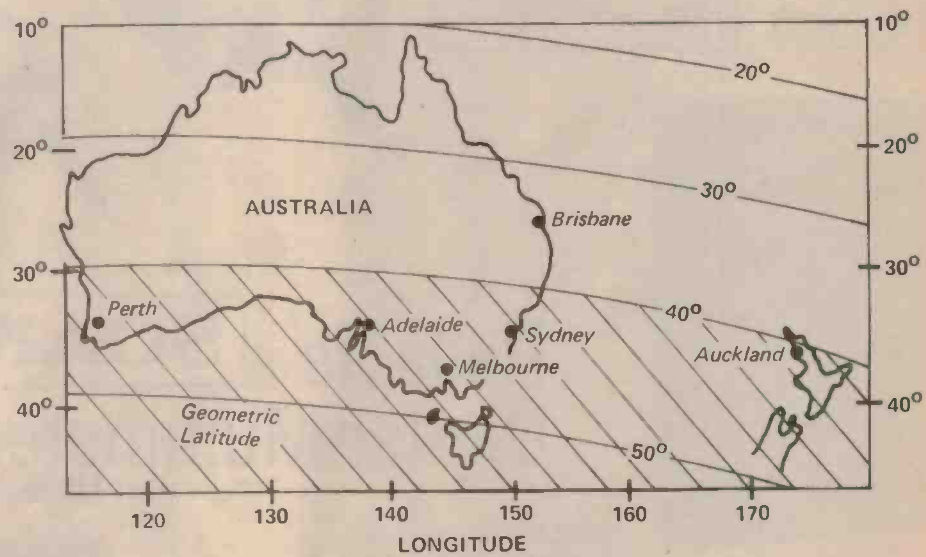
To take advantage of auroral propagation, keep a watch on the magnetic storm warnings — the IPS warnings and current activity are broadcast by at least the VK2 WIA Divisional broadcast each Sunday morning. Monitor the HF bands. Weak 'watery' signals between 5 MHz and 10 MHz in the early afternoon are good indicators — the effect becomes increasingly noticeable at higher frequencies as time progresses — particularly on paths with a great circle route that passes through the high latitudes south of Australia (from South Africa for example).

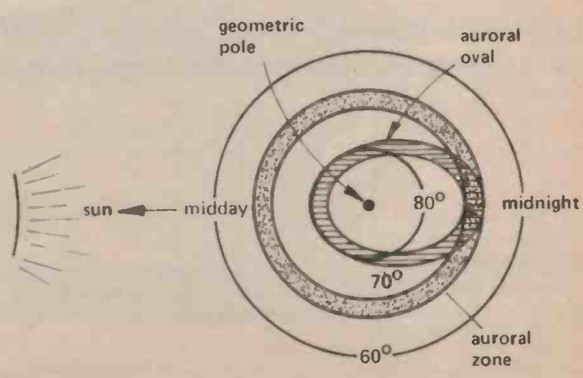
When distortion and flutter become apparent on signals at the upper end of the HF range it is time to start looking on VHF. Aim south, swinging your beam through a wide range of angles, calling at intervals, listening carefully.

The most likely area in which stations may communicate via auroral reflection is south of 40° geomagnetic latitude (see fig. 2.).

Distances may range up to 2000 km, but 500 — 1000 km is more usual according to observations from the USA and Europe. It should be possible to work New Zealand and Macquarie Island from S.E. Australia.

The rapidly varying nature of the auroral display gives rise to extreme multi-path propagation effects resulting in severe distortion of modulated signals. Obviously, and from much prior experience, the best mode for communications is CW, followed by SSB; although, at times auroral propagation may show characteristics distinctly similar to Sporadic-E.





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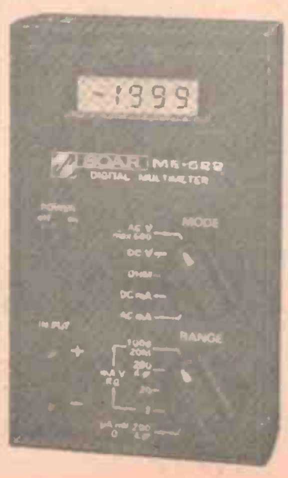

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SWL News

Compiled by Peter Bunn, on behalf of the Australian Radio DX Club (ARDXC).

All times are in Greenwich Mean Time (GMT), add 11 hours for Australian Eastern Summer Time. All frequencies are given in kiloHertz (kHz).

Turkey

The Voice of Turkey at Ankara is noted on two new outlets for the relay of the Home Service for Turks abroad. Both 11955 and 11965 kHz are noted between 0400 and sign-off at 0600 daily, with programmes of Turkish music. The English service is on air daily 2130-2300 on 11955, 6185, 7170 and 9515 kHz.

Indonesia

Two regional centres have introduced new frequencies for shortwave transmissions. Radio Republik Indonesia at Kupang in West Timor is now using 3260 kHz which is heard in addition to the usual Kupang frequency of 3385 kHz. Reception is possible in Australia between 1300 and 1430. RRI at Padang has recently switched from 3961 kHz to the new outlet of 4002 kHz for programmes in Indonesian in our late evenings here in Australia.

Yemen

Radio Sanaa in North Yemen is now using two transmitters simultaneously in the 60 metre tropical broadcast band. Both 4853 and 4975 kHz are currently being used for relays of the General Service in Arabic. Both frequencies are audible from about 1430 when signals from West Asia and East Africa begin to fade-in on the tropical bands as darkness slowly edges across these areas, thus providing an all-darkness path between these locations and Australia, with signals passing over the Indian Ocean.

Azad Kashmir

Summer in Australia means that signals from Asia tend to fade in earlier in our local evenings, as centres north of the equator experience earlier sunset times. One station which is audible as a result of this pattern is Azad Kashmir Radio in the Pakistani part of this disputed territory to the North of the subcontinent. Azad Kashmir Radio is audible at present on 6010 kHz, with signals fading in at about 1145. In winter, this station would not normally be heard in Australia, as far too much daylight would exist on the path across south Asia and the Indian Ocean, causing absorption of the signal.

Sri Lanka

The DX programme of the Sri Lanka Broadcasting Corporation (SLBC) known as "Radio Monitors International" has now been expanded to a 30 minute programme. Programme time has now been doubled due to the introduction of a new segment in the last 15 minutes of "RMI" which is known as "Window on the World".

"Window on the World" will consist of presentations by a number of co-operating international broadcasters and DX clubs.

The first Sunday of each month will feature "DX Digest" hosted by Ian McFarland of Radio Canada International.

The second Sunday of the month will see Clive Jenkins of the England based World DX Club presenting a European DX report.

The Australian Radio DX Club will produce the "Window on the World" segment on the third Sunday each month, with hosts Robert Chester and Bob Padula. The ARDXC segment will concentrate on DX tips and news of interest to Pacific and South East Asian DX listeners.

Both Radio Monitors International and the organisations presenting the special segments in "Window on the World" will issue special QSL cards for correct reception reports of the programme they produce. But remember that *all* reports should be sent to Radio Monitors International at Box 15 Poona 411 001, INDIA. "RMI" host Adrian Peterson will then forward the reports to the other programme producers who will issue their respective QSLs for correct reports.

The new, expanded "Radio Monitors International" may now be heard at these times and on these frequencies:
Sundays 1100-1130, on 11835kHz, 15120kHz and 17850kHz.
Sundays 1400-1430, on 6075kHz, 9720kHz and 15425kHz.

Overseas Club News

Two major associations of DXing clubs will be held during June. The ANARC, the Association of North American Radio Clubs, will be held in Minneapolis from June 22-24. The annual EDXC, European DX Council conference will be held in Vienna June 1-4. These conferences are important for inter-club contact within these regions, and often play major roles in setting hobby aims and maintaining high standards in the DX hobby. The ARDXC is an observer-member of the EDXC, with the right to be represented at the annual conference.

South Korea

Radio Korea, Seoul, is an international broadcaster which currently uses several out-of-band channels. English programmes may be heard on 7550 kHz 2000-2030, and again from 2300-2330. Also used currently is 9870 kHz, on air with English 0530-0600, and 1330-1400 daily.

Monaco

Trans World Radio Monte Carlo has a special DX programme in English on Saturdays between 0945-0955, using 9610 kHz. There is also a daily English service from Monte Carlo 0725-0900 on 7105 kHz. TWR also transmits via Bonaire in the Netherlands Antilles, with English daily on 11925 kHz 0030-0130.

Austria

The Austrian Radio (ORF) schedule effective until March, shows English programmes beamed to Australia 0430-0500 on 17770 kHz; 0830-0900 on 17720 kHz, 21555 and 15410 kHz; and also between 1230-1300 on 21715 kHz. The Saturday programmes include "The Week in Austria". DXers and SWLs will be interested in the special Sunday programme "Austrian Shortwave Panorama" heard in English 0915-0930 on 21715 kHz.

United Nations

United Nations Radio programmes are broadcast to Asia Tuesdays to Saturdays, with English and Japanese on 15250 kHz, 9565 kHz and 5955 kHz. These transmissions emanate from the Philippines relay (1525 kHz), from Delano (9565) and from Dixon, California (5955).

Zimbabwe

The Voice of Zimbabwe currently broadcasts via the facilities of Radio Mozambique in Maputo, and is audible from sign-on at 1800 until past 1845 on 4855 kHz. This programme is produced by the Zimbabwe African National Union, and is in English. At other times, 4855 kHz carries the normal Radio Mozambique programme in Portugese.

Yemen

Aden radio is now observed on the new outlet of 6005 kHz from evening sign-on at 1500 daily. This transmitter carries the General Service in Arabic, and provides excellent signals in Australia currently.

Compiled by the Australian Radio DX Club (ARDXC). For further information regarding shortwave radio and ARDXC's activities, write to either PO Box 67 Highett, Vic. 3190, or to PO Box 79, Narrabeen, NSW 2101, with a 30c stamp.

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sensitivity ---- 95 dB
max power ------ 25 watts
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CAT 1205 ------- $23.50

8" WOOFER
roll surround res. freq 40 Hz
frequency range Fo- 6KHz
sensitivity ---- 95dB
max power ------ 20 watts
impedance ------ 8 ohms
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8" FULL RANGE TWIN CONE.
roll surround res. freq 40Hz., frequency range Fo- 16KHz., sensitivity 95dB., max power 20 watts.,impedance 8 ohms ---CAT1215 $15.90

5¼"MID RANGE
res freq 600Hz., freq range 800-9KHz., sensitivity 97dB., max power 10 watts., impedance 8 ohms. CAT 1220 $5.80

3" TWEETER.
freq range 1000- 20KHz., sensitivity 94dB., max power 20 watts., impedance 8 ohms.
CAT 1225 - $5.95

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freq range 2000- 20KHz., sensitivity 102dB., max power 50 watts., impedance 8 ohms. CAT 1230 - $8.90

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suitable for above speakers or similar. cross over 5000Hz., max imput 30 watts RMS., rolloff 6dB/oct., dim 68x50x13mm. CAT 1250 $4.55
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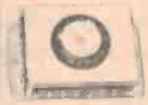

7 WAY STEREO SPEAKER CONTROL.
3 pairs of speakers can be selected in 7 different combinations. Full instructions
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Ganged wirewound volume control to adjust out put of two speakers. 5 watts RMS. -30dB to 0.5dB. CAT 1277 $7.80

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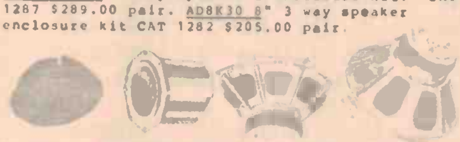
AD0160T8 1" high fidelity dome tweeter CAT 1232 $13.00. AD5060/SQ8 5" mid range (sqawker) CAT 1222 $18.00. AD8066/W8 8" high fidelity woofer 40W. RMS CAT1212 $22.00. AD12100 12" high fidelity woofer 40W RMS. CAT 1202 $59.00 AD12K12 12" 3 way speaker & enclosure kit. CAT 1287 $289.00 pair. AD8K30 8" 3 way speaker enclosure kit CAT 1282 $205.00 pair.



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CAR SPEAKERS.
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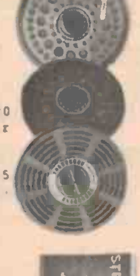
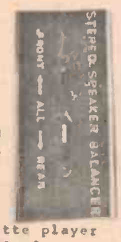
ENCLOSED CAR SPEAKERS.
Convertible wedge or flush mounting speakers for rear shelf or door mount. 5" speaker 5oz mag 10watts, 4/8 ohms CAT1245 $16.00 pair.



Flush mounting for rear shelf or door with red trim 5¼" speaker 3oz magnet 8watts max, 4/8 ohms. CAT 1246 $18.00 pair.
Dual cone flush mount, real sound quality freq responce 85- 18KHz, 20 watts max, 10oz magnet, 6½" speaker 4/8ohm. CAT 1247 $29.50 pair
Co Axial flush mounting speakers for really superb sound quality. 85 to 18KHz. black trim, 5¼"speaker 10oz magnet 20 watts max. CAT1248 $39.50 pair.



MONO FADER CONTROL
Fade between front & rear speakers on your car radio- full volume front or rear or both speakers on at the same time. CAT 1261 $4.50.
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For four speakers. Sound can be faded between front pair & rear pair or all four at once. CAT 1260 $5.90

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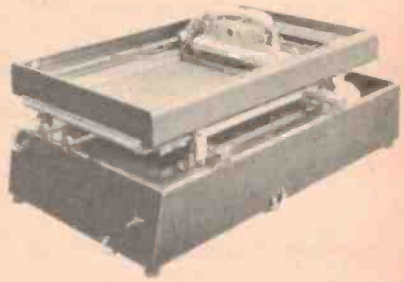
Dek

Model 250



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OR TWICE THE SIZE

That's roughly the promise of the new Dek 250 precision screen printer. Double benefits all round. Whether you are resisting P.C.B.'s, printing front panels or producing foil or plastic lables.

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Dek

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2N3055 — 75c
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XLP-3-31	$3.25
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7400	.20
7401	.25
7402	.28
7403	.28
7404	.37
7405	.37
7406	.50
7407	.50
7408	.34
7409	.34
7410	.20
7411	.37
7413	.54
7414	90
7416	.60
7417	.60
7420	.30
7422	.30
7426	.45
7427	.45
7430	.30
7432	.43
7437	.50
7438	.50
7440	.30
7441	1.50
7442	.70
7447	60
7448	60
7450	.35
7451	.35
7453	.35
7454	.30
7460	.35
7470	.65
7472	.45
7473	.60
7474	.65
7475	.65
7476	.45
7480	1.25
7483	1.25
7485	1.45
7486	.65
7490	.35
7491	1.00
7492	.75
7493	.35
7494	1.10
7495	.95
74100	2.45
74107	.65
74121	.60
74123	60
74132	1.25
74150	1.80
74151	1.10
74153	1.10
74154	1.70
74157	1.10
74160	1.55
74164	1.55
74165	1.55
74173	2.75
74175	1.65
74180	1.35
74192	1.40
74193	1.40
74221	1.50
74367	1.40

74LS

74LS00	.30
74LS01	.30
74LS02	.30
74LS03	.30
74LS04	.35
74LS05	.35
74LS08	.30
74LS09	.30
74LS10	.30
74LS11	.30
74LS12	.30
74LS14	1.20
74LS20	.30
74LS21	.30
74LS27	.30
74LS28	.40
74LS30	.30
74LS32	.33
74LS37	.45
74LS38	.45
74LS40	.30
74LS42	1.20
74LS73	1.20
74LS74	.50
74LS75	.70
74LS78	.50
74LS85	1.50
74LS86	.50
74LS90	1.20
74LS92	1.20
74LS93	1.20
74LS95	1.50
74LS109	.50
74LS113	.55
74LS114	.55
74LS138	1.20
74LS151	1.20
74LS154	1.60
74LS157	.90
74LS163	1.20
74LS164	1.30
74LS174	1.00
74LS175	1.00
74LS191	1.20
74LS192	1.20
74LS193	1.20
74LS194	1.20
74LS195	1.20
74LS196	1.20
74LS221	1.20
74LS253	1.85
74LS279	.65
74LS365	.80
74LS367	.80
74LS368	.80

CMOS

4000	.40
4001	.25
4002	.25
4006	1.40
4007	.25
4008	1.25
4011	.25
4012	.25
4013	.55
4014	1.35
4015	1.20
4016	.50
4017	1.40
4018	1.40
4019	.75
4020	1.60
4021	1.40
4022	1.60
4023	.25
4024	.90
4025	.40
4027	.80
4028	1.25
4029	1.90
4030	.40
4040	1.30
4041	1.25
4042	1.25
4043	1.50
4044	1.50
4046	1.95
4049	.60
4050	.60
4051	1.20
4052	1.20
4053	1.20
4060	2.65
4066	1.00
4068	.40
4069	.35
4070	.40
4071	.40
4072	.40
4073	.40
4074	.40
4076	1.85
4077	.40
4078	.40
4081	.40
4082	.40
4510	1.30
4511	1.30
4518	1.30
4520	1.30
4528	1.20
4555	1.20
14553	7.50
14584	1.25
74C00	.40
74C02	.40
74C04	.40
74C08	.40
74C10	.40
74C14	1.90
74C48	2.55
74C73	1.20
74C75	1.20
74C76	1.35
74C90	2.25
74C93	2.25
74C175	1.85
74C192	2.25
74C193	2.25

LINEAR

301	.35
307	.65
308	1.35
311	.85
324	1.35
339	.90
349	2.25
356	1.65
380	1.20
381	2.00
382	2.00
386	1.95
555	.35
556	.85
565	1.95
566	2.50
567	2.65
709	.75
723(VR)	.55
741	.35
747	1.25
3900	.90
3909	1.25
CA3130	1.95

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309	1.50
317	2.90
323	8.25
325	2.60
723	.55
7805	90
7806	1.30
7808	1.30
7812	90
7815	1.30
7818	1.30
7824	1.30
7905	1.50
7912	1.50
7915	1.50
78L05	.50
78L12	.50
78L15	.50
79L05	.85
79L12	.85
79L15	.85

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FND507 C/A	1.70
FND 357C/C	1.40
FND 500C/C	1.40
Red LED	.22
Green LED	.35
Yellow LED	.35

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IN4004	9c
IN5625 5A 400V	45c

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14 PIN DIL	.33
16 PIN DIL	.35
18 PIN DIL	.55
24 PIN DIL	.70
28 PIN DIL	1.20
40 PIN DIL	1.40

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KITS FOR ETI PROJECTS

WE GET MANY enquiries from readers wanting to know where they can get kits for the projects we publish.

We have only listed the projects published in the last two years, with their dates of publication, so this page can also be used as an index, even though kits are not available for some of them (as far as we know). We will repeat a complete list every 6-12 months depending on space limitations. Any companies not included in this list should phone Jan Collins on 33 4282.

Key To Companies

- A Applied Technology Pty Ltd, 1A Paterson Avenue, Waitara, NSW 2077.
- C J R Components, PO Box 128, Eastwood NSW 2122
- D Dick Smith Electronics P/L, PO Box 747, Crows Nest NSW 2065
- E All Electronic Components, 118 Lonsdale Street, Melbourne Vic 3000
- J Jaycar Pty Ltd, PO Box K39, Haymarket, NSW 2000
- K S M Electronics, 10 Stafford Court, Doncaster East, Vic 3109
- M Mode Electronics, PO Box 365, Mascot NSW 2020
- N Nebula Electronics Pty Ltd, 15 Boundary Street, Rushcutters Bay NSW 2011
- O Orbit Electronics, PO Box 7176, Auckland, New Zealand
- P Pre-Pac Electronics, 718 Parramatta Road, Croydon NSW 2132
- R Rod Irving, PO Box 135, Northcote Vic 3070
- T Townsville Electronic Centre, 281E Charters Towers Road, Rising Sun Arcade, Townsville Qld 4812
- V Silicon Valley, 23 Chandos Street, St Leonards NSW 2065

Project Electronics

041. . . . .Continuity Tester . . . . .T, D
042. . . . .Soil Moisture Indicator. . . . . .T, D
043. . . . .Heads or Tails Circuit . . . .Oct 76. . .T, D, E, A
044. . . . .Two Tone Door Bell . . . . .Oct 76. . .T, D, E, O, A
045. . . . .500 Second Timer . . . . .T, D, O, A
047. . . . .Morse Practice Set . . . . .T, D, O, A
048. . . . .Buzz Board . . . . .T, D, A
061. . . . .Simple Amplifier. . . . . . . .Oct 76. . .T, D, O, A
062. . . . .Simple AM Tuner . . . . . . .Mar 77 . .D, E
063. . . . .Electronic Bongos . . . . .D, A
064. . . . .Simple Intercom . . . . .Nov 76 . .T, O, A
065. . . . .Electronic Siren . . . . .D, O, A
066. . . . .Temperature Alarm . . . . . .Dec 76 . .T, D, E, A
067. . . . .Singing Moisture Meter. . . . . .D
068. . . . .LED Dice Circuit. . . . . . . .Oct 76. . .T, D, E, A
070. . . . .Electronic Tie Breaker . . . .Jan 77
071. . . . .Tape Noise Limiter . . . . . .Jan 78. . .E
072. . . . .Two-Octave Organ. . . . . . .Jun 78. . .D
081. . . . .Tachometer . . . . .Mar 77 . .T, E, O
082/528 .Intruder Alarm . . . . .T, E, A
083. . . . .Train Controller
084. . . . .Car! Arm . . . . .D, A
085. . . . .Over-rev Alarm
086. . . . .FM Antenna
087. . . . .Over-LED
088. . . . .Hi-Fi Speaker

Test Equipment

132. . . . .Experimenter's Power Supply . . . . .Feb 77 . .E
133. . . . .Phase Meter . . . . .Apr 77 . .E
134. . . . .Ture RMS Voltmeter . . . . .Aug 77 . .E
135. . . . .Digital Panel Meter . . . . . .Oct 77. . .E
136. . . . .Linear Scale Capacitance Meter . . . . .Mar 78 . .E
137. . . . .Audio Oscillator . . . . .May 78 . .E
138. . . . .Audio Wattmeter. . . . . . . .Nov 78
139. . . . .SWR/Power Meter . . . . . . .May 78
140. . . . .1 GHz Frequency Meter-Timer . . . . .Mar 78 . .C

Simple Projects

243. . . . .Bip Beacon. . . . . .Apr 77
244. . . . .Alarm Alarm . . . . .Feb 77
245. . . . .White Line Follower . . . . .Nov 77
246. . . . .Rain Alarm . . . . .Apr 78
248. . . . .Simple 12V to 22V Converter. . . . . .Jul 78

Motorists' Projects

316. . . . .Transistor Assisted Ignition . . . . .May 77 . .K, O, E
317. . . . .Rev Monitor Counter . . . . .Jul 77 . . .E
318. . . . .Digital Car Tacho . . . . . . .Jul 78 . . .K, E
319. . . . .Variwiper MK II . . . . .Sep 78. . .E

Audio Projects

448. . . . .Disco Mixer . . . . .Nov 76
449. . . . .Balanced Microphone Amp . . . . .Nov 76 . .J, E
450. . . . .Bucket Brigade Audio Delay Line . . . . .Dec 77 . .
480. . . . .50-100 Watt Amp Modules. . . . . .Dec 76 . .J,E,D,O,R,A
481. . . . .12 V 100 Watt Audio Amp . . . . .May 77 . .E
481. . . . .High Power PA/ Guitar Amp . . . . .Jun 77. . .O
482. . . . .Stereo Amp . . . . .Jan 77. . .O, E
482. . . . .Stereo Amp Part 2. . . . . . .Feb 77 . .O, E
483. . . . .Sound Level Meter. . . . . . .Feb 78 . .E
484. . . . .Simple Compressor Expander . . . . .Jul 77 . . .E, A
485. . . . .Graphic Equalizer . . . . . . .Jun 77. . .J, E
486. . . . .Howl-round Stabilizer . . . .Nov 77 . .J
487. . . . .Audio Spectrum Analyser . . . . .Feb 78 . .E
489. . . . .Audio Spectrum Analyser 2 . . . . .Apr 78 . .J, E
495. . . . .Transmission Line Speakers . . . . .Aug 77

Miscellaneous

546. . . . .GSR Monitor . . . . .Mar 77 . .E
547. . . . .Telephone Bell Extender . . . . .Jun 77. . .E
548. . . . .Photographic Strobe . . . . .May 77 . .E
549. . . . .Induction Balance Metal Detector . . . . .May 77 . .E
550. . . . .Digital Dial. . . . . .Aug 78 . .E
551. . . . .Light Chaser. . . . . .Sep 78. . .E
552. . . . .LED Pendant . . . . .Sep 78. . .A
553. . . . .Tape/Slide Synchroniser . . .Oct 78. . .E
581. . . . .Dual Power Supply . . . . . .Jan 77. . .E
582. . . . .House Alarm . . . . .Jul 77 . . .T, O, E, A
House Alarm — Installation Instructions . .Aug 77
583. . . . .Marine Gas Alarm . . . . . . .Aug 77 . .M, E
585. . . . .Ultrasonic Switch . . . . . . .Sep 77. . .R, O, E, T
586. . . . .Shutter Speed Timer . . . . .Oct 77. . .E
587. . . . .UFO Detector. . . . . .May 78
588. . . . .Theatrical Lighting Controller . . . . .Nov & Dec 77. . .N
Jan & Mar 78
589. . . . .Digital Temperature Meter (PCB135) . . . . . . .Dec 77 . .E
590. . . . .LCD Stopwatch . . . . .Oct 78. . .N
591. . . . .Up/DownPresettable Counter . . . . .Jul 78 . . .E
592. . . . .Light Show Controller . . . .Aug 78 . .E

Electronic Music

602. . . . .Mini Organ. . . . . .Aug 76 . .O, E, D, A
603. . . . .Sequencer . . . . .Aug 77
604. . . . .Accentuated Beat Metronome. . . . . .Sep 77. . .E
605. . . . .Temp Stabilized Log-exponential Converter . . .Sep 78

Computer Projects

630. . . . .Hex Display . . . . .Dec 76 . .E, A
631. . . . .ASCII Keyboard . . . . .Dec 76 . .O, E, A
631. . . . .Keyboard Encoder. . . . . . .Apr 77 . .O, E, A
632. . . . .Video Display Unit . . . . . .Jan- . . . .O, A
Mar 77
633. . . . .TV Sync Generator . . . . . .Jan 77. . .E, A
634. . . . .8080 Educational/ Prototyping Interface . . . .Jul, Aug 78
635. . . . .Microcomputer Power Supply. . . . . .Sep 77
637. . . . .Cuts Cassette Interface . . . . .Jan 78. . .V, O, E, A
638. . . . .Eprom Porgrammer . . . . . .Jul 78 . . .E, A
639. . . . .Computerised Musical Doorbell . . . . .Mar 78 . .A
640. . . . .S100 VDU . . . . .Apr- . . . .V, O, A
Jun 78
641. . . . .S100 Printer. . . . . .Sep 78
650. . . . .STAC Timer. . . . . .Nov 78 . .A

Radio Projects

712. . . . .CB Power Supply . . . . . . .Jun 77. . .O, E
713. . . . .Add-on FM Tuner . . . . . . .Sep 77
714. . . . .VHF-Log-Periodic Antenna. . . . . .Feb 78
Mar 78
715. . . . .VHF Power Amplifiers . . . .Nov 77
716. . . . .VHF Power Amplifiers . . . .Jan 78
Feb 78
717. . . . .Crosshatch Generator. . . . .May 78 . .E, A
718. . . . .SW Radio. . . . . .Oct 78. . .E
719. . . . .RF Field Strength Indicator . . . . .Nov 78

Electronic Games

804. . . . .Selectagame . . . . .Nov 76 . .O
804. . . . .Selectagame (Rifle Project) . . . . .Mar 77 . .O
805. . . . .Puzzle fo the Drunken Sailor . . . . .Oct 77
806. . . . .Skeet . . . . .Jan 78
810. . . . .Stunt Cycle TV Game . . . .Jun 78. . .O, D
811. . . . .TV Tank Game . . . . .Oct 78. . .O, E, D

MXR Professional Products

The MXR Auto Phaser is designed to be the finest phasing unit available for professional applications. The Auto Phaser's low distortion, low noise, and wide range of effects enables it to fill every studio phasing need.

Ease of operation, low power consumption, and wide supply range makes it ideal in any portable mixing or P.A. application.

Packaged in a compact and durable case, its controls are set up in a user-oriented fashion.

The subjective audible effect of phasing is a product of a phase-shift created response characteristic resulting in a series of "notches" in the audio spectrum similar to reel flanging, but differing from flanging in the sense that these notches are not harmonically related.

The MXR Mini Limiter is designed as a cost-effective answer to meeting the wide variety of audio limiter applications.

Its wide supply range, low power consumption, and input-output characteristics enable it to interface with a diversity of equipment, from portable high impedance mixers to custom low impedance consoles.

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The Mini Limiter is supplied in a sturdy and compact case which can easily be incorporated into any console or rack.

The MXR Auto Flanger is the first professional audio delay line capable of producing true flanging—repeatably and economically, designed for both portable use and custom installations, the Auto Flanger reliably meets the most demanding of professional audio needs.

The front panel layout and control functions are designed to be as versatile as possible while maintaining ease of operation.

Due to the precise mathematical relationship between the time delay and the resulting comb filter response, the Auto Flanger causes random program material (i.e. drums, cymbals, and other percussion) to take on musical tonality, a characteristic not found with phasing.

The MXR Professional Products Rack is a compact, self-contained enclosure for mounting, powering, and interfacing up to four Auto Flangers or Auto Phasers in any combination. Its unique power supply design allows operation over a wide range of line voltages.

Packaged in a rugged and attractive case, the Professional Products Rack is designed for standard half-rack mounting. It may also be used in a freestanding configuration for studio effects on location. A versatile control arrangement permits independent operation of each unit or synchronous operation in a wide variety of master-slave combinations. Conveniently grouped phone jacks make it possible for units to be patched individually or in series. This complete flexibility allows a wide spectrum of creative effects.

For more information see your MXR dealer.
The Music Distillery, 503 Pittwater Road,
Brookvale NSW 2100. 938-2372

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TI58/59, HP25/25C programs. Roulette, golf, sniper, wumpus. Also biorhythms, mastermind, hilo (HP only); nim, lunar-landing, blackjack (TI only). $3 each. Or 7 for $15. I Webber, 92 Royal Pde, Qld 4060.

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WANTED old 78 record lists and catalogues HMV, Regal, Zonophone-Capitol, London, MGM, Decca, Columbia, etc. Allen Goodwin, Bagdad Sth, Tas 7407.

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TRS-80 computer programs available, mainly exchange but will sell. Also 4k-16k upgrade kits. Write for more info C/- PO Box 122, Bondi Beach, NSW 2026.

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WANTED desperately Phillips 506 C443 5 pin pentode valve suit old Phillips wireless type 2510. Garry Holmes, 7A Joseph St, Sale, Vic 3850, phone: (051) 44.4639.

SELL: Back issues of EA and ETI from '74 to '78 and also 5 folders suitable for above magazines. Ring AH (03) 465.7553.

FOR sale: Motorola MEK D2 kit with extra RAMs fully wired, free power supply, documents, perfect condition hardly used, $200, bargain 337.2317, AH 337.2317.

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TECHNICS RP3210E stereo microphone, brand new in original packing. New price $47.50 - sell $25.00. Tel (02) 89.4645.

S-100 16k EPROM board, 0-3 waits, 16k boundry, 1k disables 2k blank 2708 installed assembled. Tested. $110 ONO. Steve Dart (03) 92.1765.

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WANTED: Circuit diagram for Phillips TCA 1676 6M transceiver, buy or copy. Contact Tony, 5/6 Lantaie Ave, Croydon, 3136.

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SELL two vintage receivers (1) STCTRF 5 valve types 235/224 etc. (2) Kreisler 6 valve types 6A7/6D6/6E5, etc. Speakers no cabinets. Stewart, 1/309 Windsor Road, Baulkham Hills 2153 (02) 639.1927.

FOR sale: Unimetrics Stingray II SSB AM 23 channel CB radio. Very good condition, $100 ONO, 8 Macintosh Street, Mount Gambier, SA 5290.

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predictions

The Ionospheric Prediction Service have kindly developed propagation predictions for us, in the form of a computer printout, which we can reproduce directly. These predictions are known as GRAFEX and contain a lot more information than those we published previously.

The left hand vertical column of each printout lists the frequency, in MHz, for each horizontal row of characters. Each vertical column of characters represents one hour, commencing at 00 UT on the left-most column going to 23 UT on the extreme right column.

Each printout is for a particular path, named at the bottom. The month to which the predictions apply, the mean path distance and the great circle bearing are also listed beneath each printout.

A variety of up to ten characters may appear on the printout and their meanings are listed in the table reproduced here.

The form of the GRAFEX predictions allows the indication of several 'modes' of propagation. The *first* mode is that requiring the least number of 'hops'. This will mean *two* hops on paths of length 4000 to 6000 km or so, *three* hops on paths around 7000 to 10,000 km in length, and so on. The *second* mode for a path will be the next integral number of hops that may be required to propagate a signal over the path.

Thus, the second mode for paths around 4000 to 6000 km in length will involve *three* hops and for paths 7000 to 10,000 km long will involve *four* hops, and so forth.

Mixed modes may also be indicated (symbols M, S and X). That is, a combination of hops involving both first and second modes perhaps (this indicates that considerable fading may be experienced on signals); a mixture of hops involving both the E and F layers of the ionosphere, etc. (See "Propagation, a Closer Look", the July 1978 issue of ETI, pages 112 to 114.).

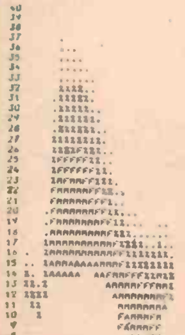
For ultra-reliable predictions follow the times and frequencies indicated by the F characters on the printouts. For a bit of adrenalin in your operating, use the % symbols area of the printouts. But, for a real 'buzz' look to the dot symbols area and hang around during the month of the predictions for those magic days when the higher frequency DX starts pouring through!

Six metre band amateur enthusiasts should scan the printouts for those that have characters extending into the 40 MHz region and operate accordingly.

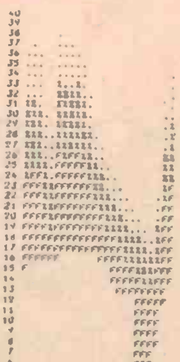
Co-ordinated Universal Time (UT) is used on all predictions. For most people's purposes that's equivalent to the well-known GMT. Thus, times for Eastern Australia will be 10 hours ahead (Eastern Australian Standard Time or E.A.S.T.); for central Australia, 9½ hours ahead and for Western Australia, 8 hours ahead. Don't forget to take into account Daylight Saving Time where and when it applies. Oh, heck, save yourself all the hassle and run a clock in the shack set to Universal Time!

For information on the areas served by the prediction charts, see ETI July 1978, page 113.

' '	A blank means no propagation is possible by a normal first or second mode.
'.'	A dot indicates that propagation is possible but probably on less than 50% of the days of the month. This normally applies for the first F mode but under some circumstances the first mode may not be propagated because the layer is too low (usually for hops greater than 3000 kilometres) in which case the symbol applies to the second mode.
'%'	Propagation is possible between 50% and 90% of the days of the month. It should be noted that the median F MUF for each hour lies between the lowest '.' and the highest '%' for that hour.
'F'	Propagation is possible by the first F mode on at least 90% of the days of the month unless there is a severe ionospheric disturbance. For frequencies on the highest 'F' for the hour the probability is 90% but this will increase slightly on lower frequencies.
'E'	Propagation is possible by the first E mode and on less than 50% of days by the first F mode. This symbol overrides '.' if present.
'P'	Propagation is possible by the first E mode and between 50% and 90% of days by the first F modes. This symbol overrides '%'.
'B'	Propagation is possible by the first E mode and by the first F mode on more than 90% of the days. This symbol overrides 'F'.
'M'	Propagation is possible by both the first and second F modes. The strongest mode is normally the first mode but the vertical aerial pattern may influence the mode received. It should be noted that the second F mode MUF is just about the highest frequency showing 'M'.
'S'	Propagation is not possible by the first mode but it is possible by the second mode. It should be remembered that propagation may be possible by other modes, e.g.: the third F or mixed E and F modes at these frequencies. This symbol does not occur very often.
'A'	High absorption i.e.: above the ALF but probably too close to it for good communication.
'X'	Complex mixture of modes including the second E mode (the vertical angles of the first F and the second E modes are often very close).



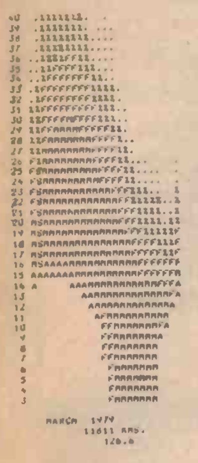
East Coast — South Africa (also serves South Central)



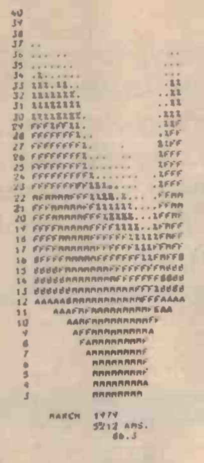
East Coast — North Africa (also serves South Central)

East Coast — South America (also serves South Central)

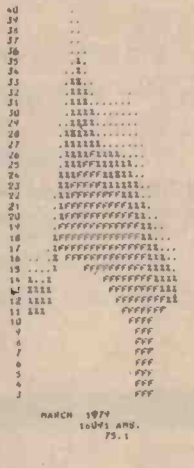
East Coast — North America (also NE and South Central).



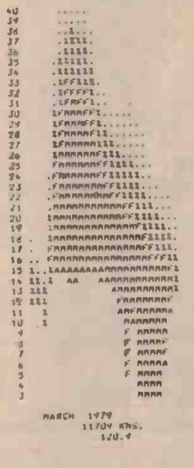
East Coast — Japan (also serves NE and South Central)



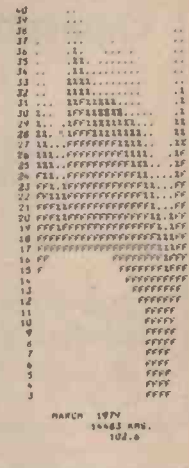
East Coast — South Pacific



East Coast — Europe (Short Path)

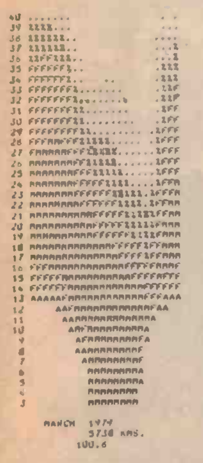


North East — South Africa

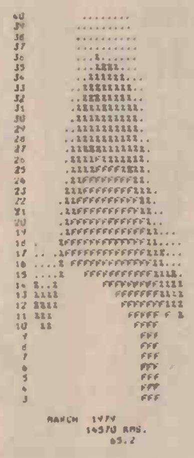


North East — North Africa

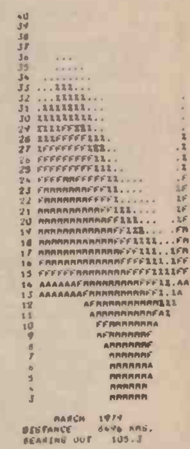
SWL and AMATEUR COMMUNICATIONS



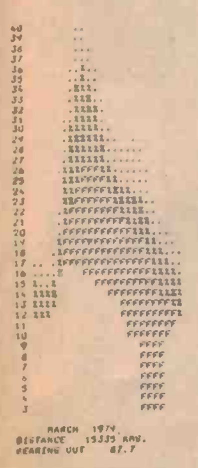
North East — South Pacific (also serves South Central)



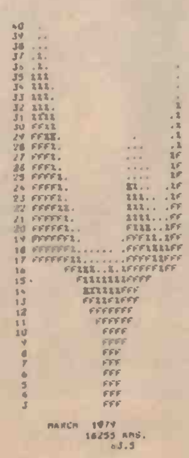
North East — Europe (Short Path)



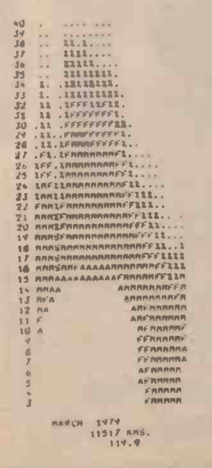
West Coast — Japan



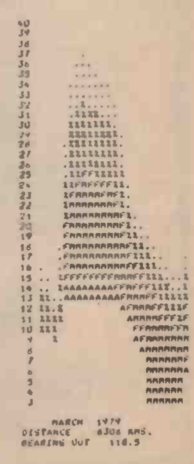
South Central — Europe (Short Path)(also West Coast)



West Coast — North America

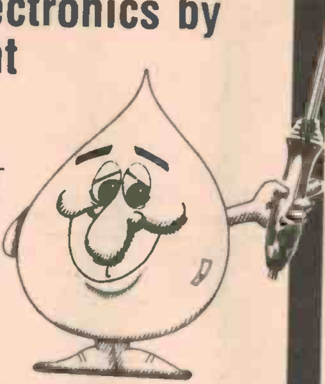


West Coast — North Africa



West Coast — South Africa

Blob — Board for Digital Electronics by Experiment



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	4014	.75
	4015	.75
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	4017	.75
	4018	.75
	4019	.35
	4020	.85
	4021	.75
	4022	.75
	4023	.20
	4024	.75
	4025	.20
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	4028	.75
	4029	1.15
	4030	.30
	4033	1.50
	4034	2.45
	4035	.75
	4037	1.80
	4040	.75
	4041	.69
	4042	.65
	4043	.50
	4044	.65
	4046	1.25
	4048	.95
	4049	.45
	4050	.45
	4052	.75
	4053	.75
	4066	.55
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	MC14419	4.85
	74C151	1.50

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	MCT2	.95		LM323K	5.95		LM380 (8-14 Pin)	1.19
	8038	3.95		LM324	1.25		LM709 (8-14 Pin)	.35
	LM201	.75		LM339	.75		LM711	.45
	LM301	.45		7805 (340T5)	.95		LM723	.40
	LM308	.65		LM340T12	.95		LM725	2.50
	LM309H	.65		LM340T15	.95		LM739	1.50
	LM309K (340K-5)	1.50		LM340T18	.95		LM741 (8-14)	.35
	LM310	.85		LM340T24	.95		LM747	1.10
	LM311D	.75		LM340K12	1.25		LM1307	1.25
	LM318	1.75		LM340K15	1.25		LM1458	.65
	LM320H6	.79		LM340K18	1.25		LM3900	.50
	LM320H15	.79		LM340K24	1.25		LM75451	.65
	LM320H24	.79		LM373	2.95		NE555	.45
	7905 (LM320K5)	1.65		LM377	3.95		NE556	.85
	LM320K12	1.65		78L05	.75		NE565	.95
	LM320K24	1.65		78L12	.75		NE566	1.25
	LM320T5	1.65		78L15	.75		NE567	.95
	LM320T12	1.65		78M05	.75			
	LM320T15	1.65						

– T T L –

QTY.			QTY.			QTY.			QTY.		
	7400	.10		7482	.75		74221	1.00		74LS02	.30
	7401	.15		7483	.75		74367	.95		74LS04	.30
	7402	.15		7485	.55		75108A	.35		74LS05	.35
	7403	.15		7486	.25		75491	.50		74LS08	.35
	7404	.10		7489	1.05		75492	.50		74LS09	.35
	7405	.25		7490	.45		74H00	.15		74LS10	.35
	7406	.25		7491	.70		74H01	.20		74LS11	.35
	7407	.55		7492	.45		74H04	.20		74LS20	.30
	7408	.15		7493	.35		74H05	.20		74LS21	.35
	7409	.15		7494	.75		74H08	.35		74LS22	.35
	7410	.15		7495	.60		74H10	.35		74LS32	.35
	7411	.25		7496	.80		74H11	.25		74LS37	.35
	7412	.25		74100	1.15		74H15	.45		74LS38	.45
	7413	.25		74107	.25		74H20	.25		74LS40	.40
	7414	.75		74121	.35		74H21	.25		74LS42	.75
	7416	.25		74122	.55		74H22	.40		74LS51	.45
	7417	.40		74123	.35		74H30	.20		74LS74	.45
	7420	.15		74125	.45		74H40	.25		74LS76	.50
	7426	.25		74126	.35		74H50	.25		74LS86	.45
	7427	.25		74132	.75		74H51	.25		74LS90	.65
	7430	.15		74141	.90		74H52	.15		74LS93	.65
	7432	.20		74150	.85		74H53	.25		74LS107	.50
	7437	.20		74151	.65		74H55	.20		74LS123	1.20
	7438	.20		74153	.75		74H72	.35		74LS151	.85
	7440	.20		74154	.95		74H74	.35		74LS153	.85
	7441	1.15		74156	.70		74H101	.75		74LS157	.85
	7442	.45		74157	.65		74H103	.55		74LS160	.95
	7443	.45		74161	.55		74H106	.95		74LS164	1.20
	7444	.45		74163	.85		74L00	.25		74LS193	1.05
	7445	.65		74164	.60		74L02	.20		74LS195	.95
	7446	.70		74165	1.10		74L03	.25		74LS244	1.70
	7447	.70		74166	1.25		74L04	.30		74LS367	.95
	7448	.50		74175	.80		74L10	.20		74LS368	.95
	7450	.25		74176	.85		74L20	.35		74S00	.35
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	7453	.20		74181	2.25		74L47	1.95		74S03	.25
	7454	.25		74182	.75		74L51	.45		74S04	.25
	7460	.40		74190	1.25		74L55	.65		74S05	.35
	7470	.45		74191	1.25		74L72	.45		74S08	.35
	7472	.40		74192	.75		74L73	.40		74S10	.35
	7473	.25		74193	.85		74L74	.45		74S11	.35
	7474	.30		74194	.95		74L75	.85		74S20	.25
	7475	.35		74195	.95		74L93	.55		74S40	.20
	7476	.40		74196	.95		74L123	.85		74S50	.20
	7480	.55		74197	.95		74LS00	.30		74S51	.25
	7481	.75		74198	1.45		74LS01	.30		74S64	.15
										74S74	.35
										74S112	.60
										74S114	.65
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										74S140	.55
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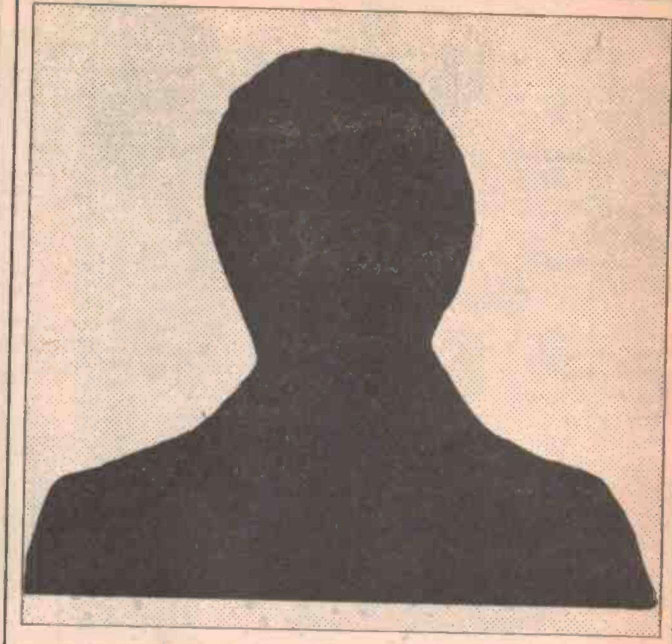


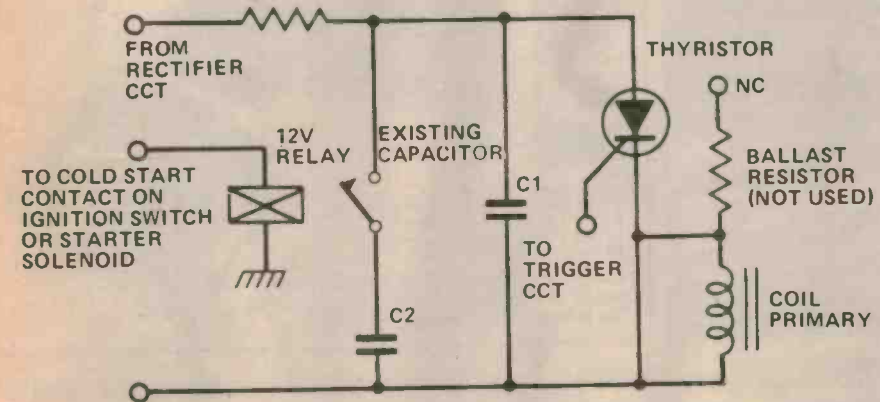
Ideas for experimenters

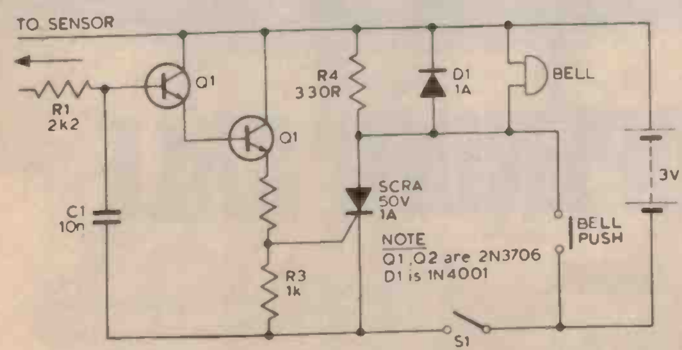
These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.
Electronics Today is always seeking material for these pages. All published material is paid for — generally at a rate of $5 to $7 per item.

'Cold-start' For CD Units

Many cars are fitted with cold-start coils, which operate at full current only on starting, then are fed via a ballast discarded when CD ignition is fitted, and the coil is run at 'full power' all the time. It's a simple matter to arrange for the cold-start circuit to operate a relay inside the CD unit which switches in a second capacitor C2 across the main one, thus increasing the energy of the spark when the engine is starting. After starting, C2 is no longer in circuit and the main capacitor C1 alone supplies current to the coil, thus alleviating any charging problems with attendant loss of power at high revs.

RLA is any 12 volt relay, and C2 can have the same value as the existing capacitor C1, usually 470n or 1μ0.

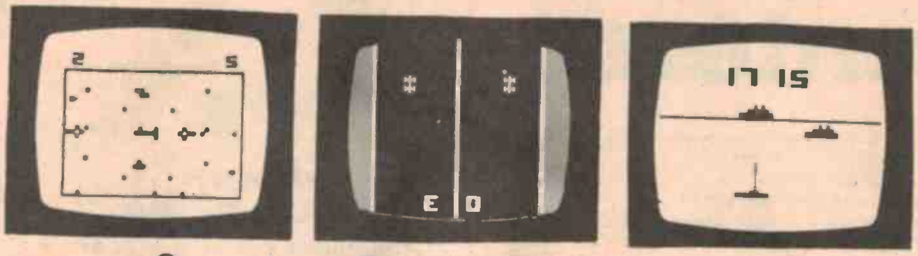




Rain Alarm/Door Bell

With S1 open the circuit functions as a doorbell. With S1 closed, rain falling on the sensor will turn on Q1, Q2 and the thyristor will trigger activating the bell. R4 provides the holding current for the thyristor while D1 prevents any damage to the thyristor from back EMF in the bell coil. The sensor is made from 3 square inches of copper clad board with a razor cut down the centre. C1 prevents any pickup in the sensor leads.

COLOUR TV GAMES



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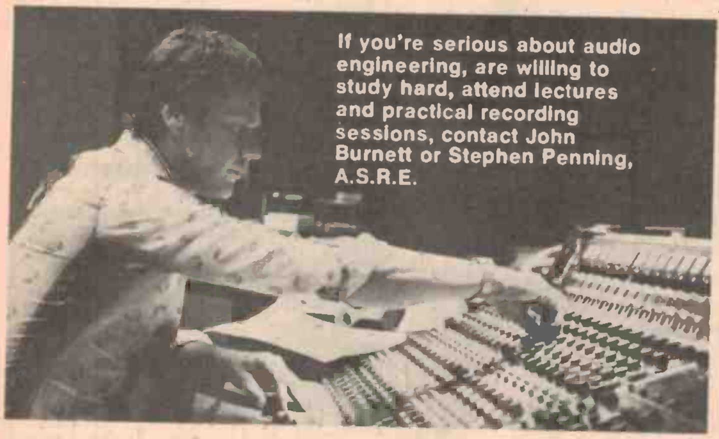

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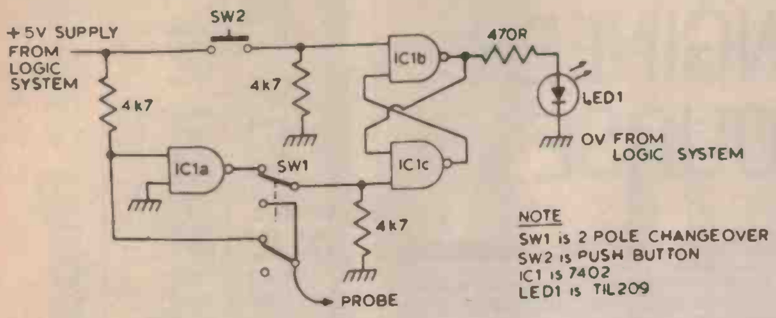
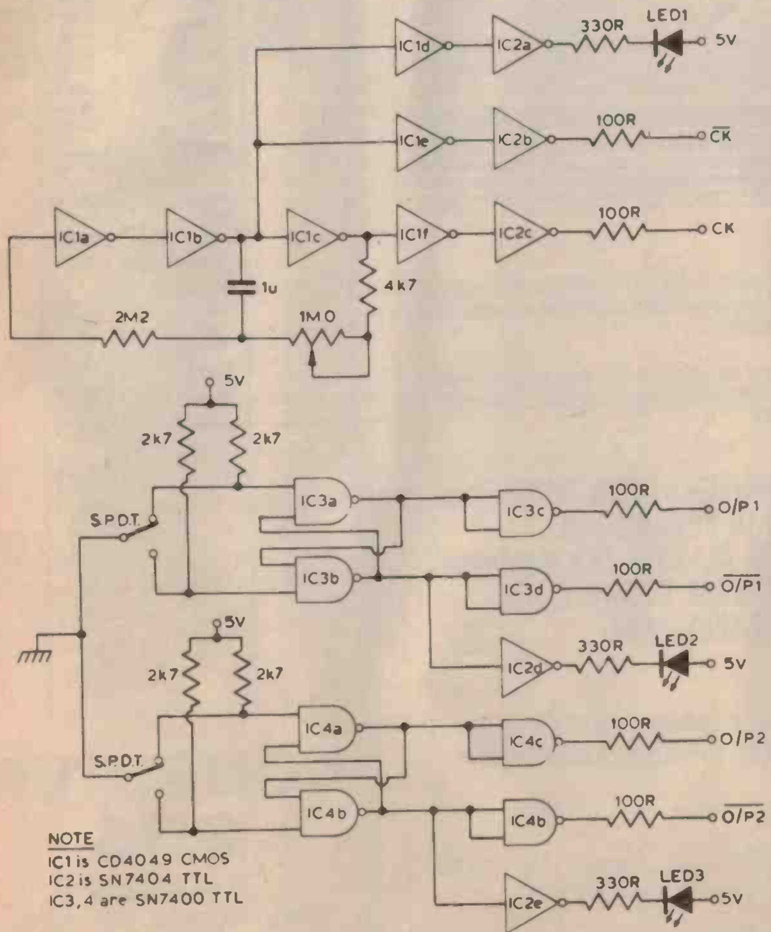
Ideas for experimenters



Logic Noise Detector

Ever since the advent of binary logic, spurious noise spikes and pulses have been the curse of the designers of even elementary systems. This circuit will help detect 'noisy' logic levels. With SW1 in position I, any logic zero spikes occurring on a steady logic 'I' will set the R-S latch and the LED will be illuminated. With SW1 in position 2, an extra inverter is brought in, and the circuit will be triggered by any logic 'I' spikes.



Test Unit for Sequential Logic

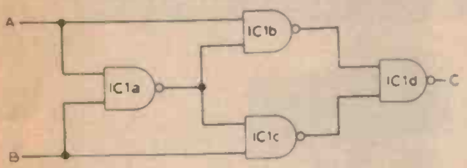
Any one testing a sequential logic circuit requires input pulses free of contact bounce. This unit does this, providing two switched, jitter-free outputs and a 'slow' variable speed clock. The complements of these signals are also provided.

The components shown give the clock a frequency range of 1-200 Hz. The clock's buffered output will drive up to two TTL inputs.

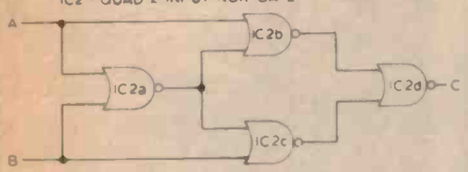
The 100R resistors on all outputs provide some measure of accidental short circuit protection.

Ideas for experimenters

IC1 – QUAD 2 INPUT NAND GATE



IC2 – QUAD 2 INPUT NOR GATE



Exclusive OR and NOR gates

When constructing logic circuits which need either an exclusive OR or exclusive NOR gate, and one is not available, the following arrangement of NAND or NOR gates can produce the required results. The circuits can be constructed using standard TTL or CMOS gates.

IC1 TRUTH TABLE

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

IC2 TRUTH TABLE

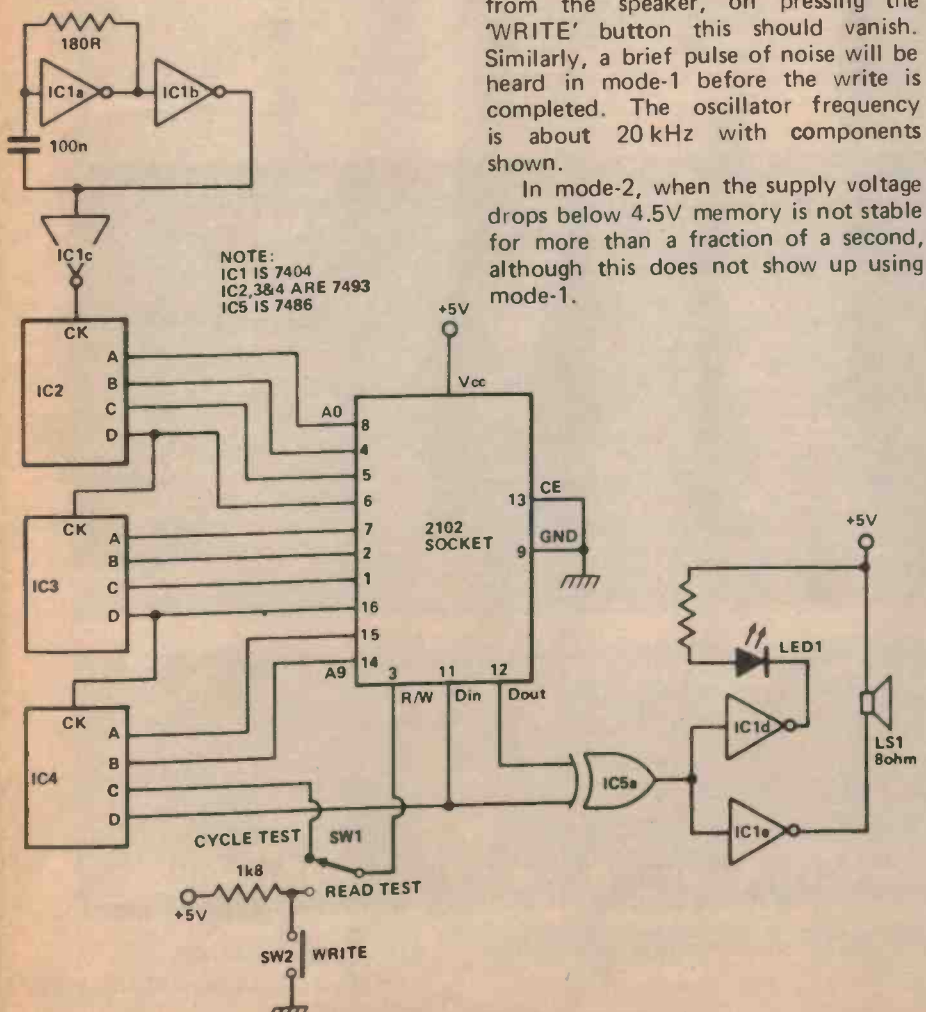
A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

2102 Memory Tester

This circuit provides for the testing of 1024 bit X 1 memories, such as the 2102 series, in two modes. Mode-1 cycles the memory continuously through write and read, alternately writing zeroes and ones then reading to ensure the write was successful. Mode-2 allows the write of a signal onto the memory, then continuously reads it to ensure the data is stable.

In both modes, the output from the memory is compared with what should be there, and if there is a difference, an LED flashes, accompanied by a click from the speaker. In mode-2, on power on, a continuous noise will be heard from the speaker, on pressing the 'WRITE' button this should vanish. Similarly, a brief pulse of noise will be heard in mode-1 before the write is completed. The oscillator frequency is about 20 kHz with components shown.

In mode-2, when the supply voltage drops below 4.5V memory is not stable for more than a fraction of a second, although this does not show up using mode-1.



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