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electronics today

AUGUST 1978 INTERNATIONAL

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REMOTE TUNING DISPLAY

Building your own Robots

Light show controller

How to design audio amplifiers

The competition don't like the sound of this at all.

For quite some time, other manufacturers have been trying to produce tape with the qualities of the Maxell UD-XL. At the same time, Maxell have been quietly perfecting an even better series.

The UD-XL I and UD-XL II tapes are designed to attain maximum performance at the ferric and chrome position on your tape deck. Whichever tape position you choose, Maxell can give you a better performance.

UD-XL I TAPE, FOR FERRIC (norm.) POSITION (120*us*)

UD-XL I offers an excellent sensitivity of 1 dB higher than even UD-XL. MOL performance is also 1 dB higher over the entire audio frequency spectrum. The result is a new standard in ferric tape, with wider dynamic range and less distortion than ever before.

How does the UD-XL I compare then, with ordinary low-noise tapes?

Sensitivity is higher by 2.5 dB, and MOL performance by as much as 6 dB.

Yet, for all this UD-XL I requires no special bias or equalization. Simply set your tape selector as you normally would at the ferric position – but there the comparison ends.

UD-XL II TAPE, FOR THE CHROME POSITION (70*us*)

UD-XL II tape is such a dramatic improvement on most other tape that can be used in this position, that comparison is really unfair.

For example, if you're familiar with conventional chromium-dioxide tape, you'll know of the associated problems of poor output uniformity – plus low maximum output level and rather high distortion.

UD-XL II tape offers you excellent MOL, sensitivity, and an output improvement of more than 2 dB over the entire frequency range.

Maxell's unique 'Epitaxial' process gives you absolute sensitivity and stability, and no drop-out problems. What's more, the shells are moulded in diamond cut dies, and made to tolerances 5 times greater than the Philips standard. And, like all Maxell tapes, UD-XL II has the 5-second cleaning leader.

In short, if you're recording in the chrome position, you can now achieve all the advantages – with none of the drawbacks.

A prospect we think you'll find very exciting – even if the competition don't.

maxell®
simply excellent

For details on all Maxell Recording Tape write to Maxell Advisory Service, P.O. Box 49, Kensington, N.S.W. 2033

WT3/79

AUSTRALIAN OWNED AND PRODUCED

August 1978, Vol.8 No.8

electronics today INTERNATIONAL

Editorial: Les Bell

Publisher: Collyn Rivers

DICK SMITH OFFERS ETI READERS A FREE CATALOGUE: SEE PAGE 13.

Cover: Our Digital Dial design in this issue offers drivers clear, accurate, head-up indication of which station they are tuned to. Photograph by George Hofsteters.

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THE LOUDSPEAKER WITH A TOUGH ACT TO FOLLOW: JBL's NEW L40.

For the past 2½ years, we've been making a two-way bookshelf loudspeaker called the L26. The critics loved it. The dealers loved it. The customers loved it. 250,000 times to be exact.

The smart thing to do would've been to just keep cranking out those L26's for the next hundred years. Never change a winner, right? Not if you're JBL.

Meet JBL's brand new L40. It's one of the best two-way loudspeakers you can buy. Here's why:

The L40 has tremendous power handling capability. Don't let its size fool you. It'll play right up there with loudspeakers twice its size.

Every sound is clean and clear. Listen to the snap of a rimshot, the crash of a cymbal. Pure. Accurate. Perfectly defined. (If you'd like the technical information on the L40, write us and we'll send you an engineering staff report. Nothing fancy except the specs.)

Go listen to the L40. And ask for it by its first name: JBL. You'll be getting the same craftsmanship, the same components, the same sound heard in the very top recording studios in the world.

If you've been thinking about getting into high performance high fidelity, we know a great place to start: JBL's new L40. It's a whole lot of JBL for not a whole lot of money.

Ranked by the number of Top Fifty albums they produced last year, seven of the ten leading recording studios in the world used JBL to record or mix their music. They used our sound to make theirs.

Source: Recording Institute of America

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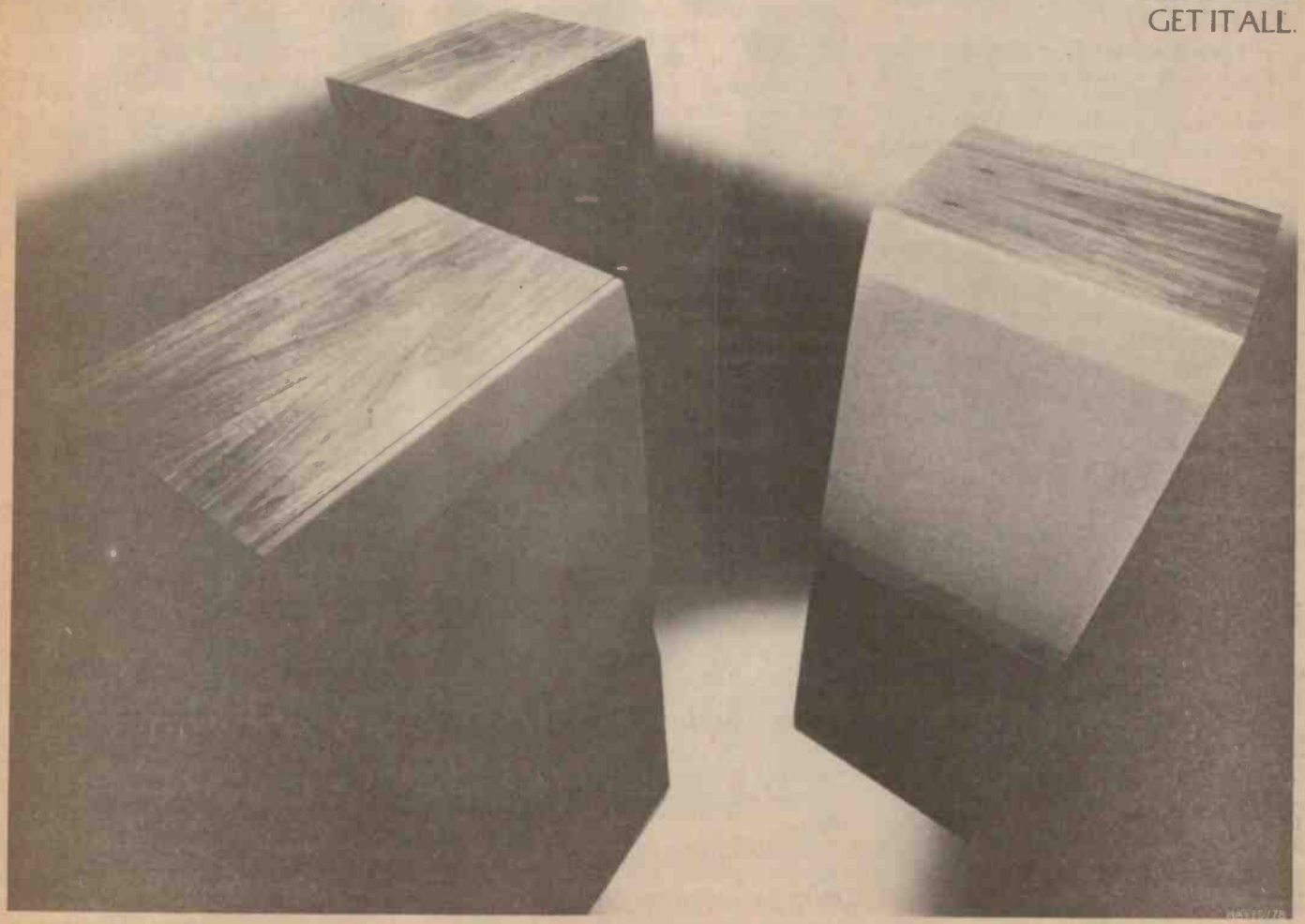

News Digest

Sub-One-Minute Facsimile

Sub-one-minute facsimile broadcasting was recently demonstrated at the National Press Club in Canberra by 3M Australia.

The demonstration machine, a yet-to-be released Express 9600 'Digital Relay Broadcasting Unit', is capable of transmitting an A4 size, high quality page in under one minute. More akin to an on-line computer VDU or plotter, the machine runs at 300 bauds using multiple handshakes.

Unlike sequential facsimile broadcasting systems, the machine can simultaneously command up to 60 receivers, drastically cutting operating time and increasing message handling capacity. Potential markets may be found in the high speed EDP message switching industry which, to date, has been the sole preserve of computer based data transmission.

The 3M Company has been providing analogue facsimile broadcasting for the past three years over their customers' private line networks. One such system has been installed for Qantas, and consists of 3 broadcast networks, one of which can also be used as a "soft fail" back-up should the main broadcaster fail.

The partly Australian designed system, which has been in continuous operation for 19 months, is considered to have a five year life span. Other networks, tailored to individual needs, have been installed for the Commonwealth Employment Service in South Australia and the NSW Maritime Services Board.

Storage Solar Cell

Optel Corp have developed a solar cell capable of storing electrons in a transparent layer of refractory metal oxide. The stored power can then be used when needed, eliminating the need for a storage battery.

Computerised Organ

The sound from a computerised electronic organ developed in Britain resembles that from a traditional pipe organ more closely than has been possible so far. The instrument is programmed to reproduce the sound of every note from any rank of pipes found on a typical church organ.

Programming data for the Bradford Computing Organ was derived from information obtained by analysing tape recordings of every pipe in all known ranks of many large pipe organs all over the world. The analysis includes attack and decay characteristics and all harmonics.

Mr. Graeme Mann, 3M Australia graphics system engineer, checks the response time of the simultaneous facsimile broadcast equipment.

This means that the electronic instrument can reproduce faithfully any sound a church organ can make. The manufacturers claim that sound reproduction is such that not even an expert can tell the electronic from the conventional organ.

The built-in computer on the prototype instrument utilises RAM so that reprogramming is possible. The organ contains three digital computers, each controlled by a program stored in its ROM. Organs can be supplied with a choice of Continental - either a typically French or a typically German instrument - or British 'sound memories'.

Digital counters on the instrument stop rail indicate the amount of transposition and also monitor the speed of playback of the digitally recorded tapes. Separate analogue channels feed the individual loudspeakers from each of the keyboards (up to four) and the pedalboard.

A digital cassette recorder can be incorporated on the larger organs so that hymns may be recorded by the organist for later playing by any church member. Operation of the organ swell pedal enables this music to be played back with no change in pitch at any speed from half to four times that of the original recording.

If the player is not sufficiently skilled to play in the original key of a hymn, he can play in C major and use a button to transpose his playing into the appropriate key.

Further information from: Keyboard Music Distributors Pty Ltd, 103 Glenferrie Road, Malvern, Vic 3144.

Universal Synthesiser

The Philips group is to launch a digital programmable "universal frequency synthesiser" for two-way-radios which will allow them to operate on any frequency from 27 to 520 MHz with channel spacings between 12.5 kHz and 30 kHz.

The device is in two chip form and used in conjunction with a voltage controlled oscillator.

Due to the very low signal-to-noise ratio, which is claimed to be 1000 times better than comparable devices, the basic oscillator can be divided many times without unmanageable distortion and allows millisecond channel acquisition times.

All Pye transceivers will be fitted with the device by the mid 1980s and it has been suggested that every domestic TV and radio will be equipped with such chips, only requiring simple programming before being ready for service under the particular frequency conditions that exist in the envisaged country of operation. The advantages of this for multinationals like Philips are apparent.

Dual Polarity Regulators

How many times have you reached for two single-polarity regulators, and wished that both were in the same package?

Signetics have released dual-polarity voltage regulators to replace both 78M and 79M devices at a considerable saving in cost. The SE/NE 5551/2/3/4/5 series 14 pin DIL regulators come in all standard voltages and can deliver up to 300mA with a heatsink.

Organ IC Cuts Component Count

The TDA1008 gating/frequency divider for electronic musical instruments, available from Philips Electronic Components & Materials, is a monolithic, bipolar integrated circuit based on I^2L, with frequency dividers directly coupled to the gating matrix. In electronic organs using a top octave synthesizer directly coupled to twelve TDA1008s, only one busbar per manual is needed to obtain five octave-related tones per key.

In addition to simplification of key contact construction and tone generator designs, features like sustain and percussion can be obtained by adding only a few resistors and capacitors. Overall component count is reduced, with consequent greater reliability and easier servicing.

The outputs of the dividers, together with the input signal, are applied internally to nine gate inputs. By activating a key input, five successive signals out of the nine are selected and transferred to the outputs. Five key inputs are available, each selecting a different combination. The output voltage is proportional to the voltage on the key inputs; this output voltage has no dc component, so clicks and plops don't occur.

For further information, contact Philips Electronic Components and Materials, 67 Mars Road, Lane Cove, NSW.

Orbiting Antenna Farm

Move over OSCAR 8.

An Orbiting Antenna Farm concept, called the multifunction satellite or geostationary platform, may solve the problem of on-orbit congestion in space. The plan, utilizing the capabilities of the space shuttle, will provide a variety of services at different frequencies (such as TV relay, data links, navigation, etc.), and will be used in conjunction with small earth-stations.

Space Solar Power

A US Congressional Committee gave the go ahead recently for a research programme into orbiting solar collecting panels, to obtain energy without incurring losses through atmospheric interference. The 50 satellite system costing US$500 billion would transfer power to earth via a high energy microwave beam, could be operational by the turn of the century.

Huge Radio Telescope

The world's largest radio telescope is due to be completed in 1981 on the plains of New Mexico. The telescope, which is regarded as the ultimate in radio astronomy, will have an array of 27 dish antennas in a Y configuration.

Pictones are produced by interference techniques using signals from various antennae pairs, to which two-dimensional Fourier transforms are applied, producing a radio intensity image. Radio image data is then interpreted by an interactive digital image processing and display system, using a PDP-11/40 computer.

You blew it, PAL

Monolithic Memories of Sunnyvale, California are soon to release a family of 15 bipolar LSI logic circuits called PAL (Programmable Array Logic). Designed to replace 1400 series TTL, the PAL devices will be in high volume production by mid year with full production of all 15 circuits by year end.

Customers using PAL circuits can program their own logic on a chip by employing standard PROM programmers and inserting PAL personality cards, thus obtaining benefits such as security, flexibility, and the ability to rationalise stock holdings and therefore reduce the problem of lead time or non delivery of critical product.

With typical propagation delay of 25nS, PAL's are much faster and cheaper than FPLA's which also have the disadvantage of being more complex.

The unit price will be lower than MPU's or Custom Logic, and PAL circuits will be packaged in standard 20 PIN D.I.P.'s.

Sole agents in Australia for Monolithic Memories products are R & D. Electronics, 23 Burwood Road, Burwood., Vic. 3125.

555 Goes CMOS

The 555 timer, which is probably one of the most widely used ICs is now available for the first time as a CMOS device from Intersil of Cupertino, California. The new ICM7555 and ICM7556 (CMOS substitute for the 556) are *exact* equivalents of the popular bipolar ICs.

As is to be expected, their advantages are lower supply current, typically 80 μA for the 7555 and 160 μA for the 7556, plus the capacity to work with higher resistance timing elements than the bipolar timers. These assets make the new CMOS parts especially attractive in applications for battery powered portable instruments. Intersil are represented in Australia by R & D Electronics, 23 Burwood Road, Burwood, Vic. 3125.

Voice Recognition Security

Texas Instruments has developed a security system using a voice recognition computer. The system is claimed to be flexible, fast and efficient and resistant to imposters.

Upon inserting an ID card, a recorded voice utters four words in a random pattern - the person waiting to be admitted then repeats the words. The voice pattern is then compared with information contained on the card and if satisfactory the waiting person is admitted.

The system characteristically has 1% user rejection, 3% improper acceptance and 6.2 sec verification time.

Hong Kong into View-Data

The Hong Kong Telephone Co will start a pilot project within the next year which uses television CRT's and standard telephone lines for information retrieval on a customer's premises.

Viewdata, a UK Post Office development, has also been purchased by West Germany, and sales in other European Nations and the US are expected. France reportedly is developing its own system.

500 MHz Counter

A new locally-made frequency counter, marketed by Radwan Communications, features compact size, seven-digit readout and a frequency range extending from 1 MHz to 500 MHz.

The instrument operates from 13.8 Vdc supply and is intended for field or bench operation. It can be connected 'in-line' in a transceiver installation or can be used in the usual fashion. The input includes protection from high-level signals.

Radwan Communications are looking for dealers and would welcome enquiries. For more information contact Raswan Communications at 1 Keith Street, Moorabbin, Vic., 3189; phone (03) 95-8805.

Continued on page 9...

Radwan Communication's 500 MHz seven-digit counter.

NEW FROM JAPAN

SORD

M100
PERSONAL COMPUTER

SPECIFICATIONS:

CPU
Using a Z-80 microcomputer chip.

ROM
Up to 8K bytes capacity.

RAM
16K bytes (M110) or 32K bytes (M120).

KEYBOARD
Full ASCII keyboard and 20- BASIC command keys.

CONTROLLERS
Audio cassette 2-channel. CRT monitor controller.

INTERFACES
Modern interface (RS232C) with edge connector. 8-bit digital input output. Journal printer interface. 8-bit 2-channel AD converter and joystick.

SPEAKER
2 octave output speaker.

S100
Bus signal edge connector.

CLOCK
Provided.

OPTIONAL UNITS
- Power Supply: Input 230 V 50 Hz, output5 V, 4 A and 12 V, 0.5 A for M100 CPU.
- Colour graphic (256 x 192 dots) display controller.
- Black & white TV monitor (24 lines of 64 characters).
- SNO100 Bus extension cabinet.
- 8 outlet power control box.

THE M200 SERIES FAMILY

• *M220 Standard Model with optional dual mini-floppy disk drive.*

• *M230 Laboratory Model and printer.*

• *M252 Cash Register Model.*

• *M270 TSS Model, coupler and printer.*

Z-80 on S-100: In the low price system range, SORD introduces a versatile computer . . . fully packed four key components and powerful software . . . Z-80 CPU on S-100 bus, CRT monitor display, mini floppy diskette and discharged-type printer . . . High speed extended BASIC for data processing. It's SORD SMALL BUSINESS COMPUTER M220.

SPECIFICATIONS:

CPU: Using a Z-80 microcomputer chip.
ROM: Mask programmable variety.
RAM: 48K bytes capacity. Accessed by Z-80 through CRT display priority.
MINI FLOPPY DISKETTE: Compact in size, 5-inch diskette with 35-track, 71.5K bytes format capacity. Each track is of 8 sectors with 256 bytes, 125K bit per second and 300 RPM. Standard floppies available on Model M230.

KEYBOARD: Easy-to-operate, multi-purpose, intelligent-type 124-key system, 26 designated keys with four commands for frequently used characters in BASIC. Four mode and five shift keys. LEDs prevent operational errors. Normal-Reverse mode. Special keyboard arrangements available on request.
CRT DISPLAY: Built-in 12-inch flat face braun tube. 24 lines of 80 characters. 186 different alphanumerics and signals for aa total of 1920 characters by means of dot matrix. Normal-Reverse mode. Graphics on a character-by-character base.

PRINTER: Built-in Discharged type. Max 2 lines of 40 characters per second. All 1920 characters in BASIC.
I/O SERIAL PORT: 2 RS 232C serial ports for MODEM, Teletype, and a switch selectable additional audio cassette interface.
SOFTWARE: SORD Extended BASIC Plus.
OPTIONAL UNITS: A to D, D to A converters, high speed line-printer, DI/DO, IEEE 488 Interface Bus (HP-IB) MODEM. Typewriter keyboard on M222.

All models have powerful software available, SORD extended basic, and Fortran 1V, commercial accounting, word processing and property management systems.

Australian Distributors:

ABACUS EDP SERVICES Pty. Ltd.
66-68 Albert Road,
Sth. Melbourne. Victoria. 3205.
Tel (03) 699-8555
and at
2 O'Connell Street,
Sydney, NSW. 2000.
Tel (02) 232-8899.

To: ABACUS EDP SERVICES 66-68 Albert Rd, Sth. Melbourne. Vic. 3205.

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High Power VMOS

Siliconix has released the first in a family of second-generation, high-current, high-voltage VMOS power FETs for digital and analog applications.

The VN84GA is rated for 12.5 amps at 80 volts which represents a sixfold current increase over their previously available units. Applications include switching regulators, motor controllers, audio and RF amplifiers to 80 watts and 30 MHz and logic interface. The device interfaces directly with CMOS, TTL, DTL and MOS logic families.

The VN84GZ should be available through IRH Components Ltd, but expect a long delay initially.

New BI-FETS

National Semiconductors have developed a BI-FET II process for fabricating well machine high voltage JFET's on the same chip as standard bipolar op-amps. This is an improvement over earlier BI-FET processes. The range includes 13 op amps in 4 groups based on offset voltage range, price, package and temperature range.

Nationals LF13741 is a direct replacement for the 741 op amp and excels in applications which require low input current, moderate speed amplifiers or comparators, such as high impedance transducer amplifiers or buffers in sample and hold circuits.

Radiation-Resistant CMOS

As satellite probes travel deeper into space and must therefore operate for longer periods, it has become increasingly essential for their electronic equipment to withstand high doses of radiation.

RCA Solid Stade Division (USA) have begun delivering of space-oriented high-radiation-resistant CMOS IC's, produced by a new process, able to withstand 1 mil rads.

Trio Multi-display Oscilloscope

The new Trio 130 mm dual-trace, triggered-sweep Model CS-1575 oscilloscope just released for sale in Australia by Parameters permits observation of "left/right" waveforms in addition to the conventional "upper/lower" channels. Furthermore, simultaneous observation of CH1, CH2, Lissajous and Phase 0° is also possible: i.e. four displays on the screen at any one time.

This multi-purpose oscilloscope is designed for use in the measurement in the audio range and due to its high sensitivity (1 mV/division) is suitable for observation of minute waveforms in professional laboratory work, diagnosis of stereo receivers and other equipment in common use in the broadcasting industry.

The bandwidth of the oscilloscope is DC-5 MHz (at -3 dB), sensitivity 1 mV/div (at x 10 mag) and sweep time 0.5 micros/div - 2 ms/div.

For further information contact Parameters, 68 Alexander Street, Crows Nest, NSW 2065, phone: 439.3288.

Ambisonic Microphone

A new departure in microphone technology has resulted in a sound field microphone which provides unprecedented operational flexibility and accuracy of stereophonic recording. The British Calrec microphone utilises the principle of mathematical sampling. Its designers have employed a closely spaced array of capsules and associated matching electronic circuitry to characterise completely the first-order directivity of the sound reaching the microphone.

Four outputs are generated which are proportional to the sound field pressure and to the three components of pressure gradient - left minus right, front minus back and up minus down. From these four signals, known as 'B format', any first-order microphone characteristic can be synthesised (that is to say, any combination of omni-directional, cardidoid, hyper-cardidiod or figure of eight). Any number of such microphones can be synthesised simultaneously, and the microphone control unit provides, in addition to mono-and multi-channel feeds, the output of a stereo pair.

Controls enable both the angle between the two microphones of the pair and the directivity patterns of the individual microphones to be varied, and the stereo pair can then be panned or tilted in any direction.

These controls can be exercised either live or in post-session processing of the 'B format' type. This facility goes far beyond the capability of the usual kinds of variable-pattern microphones.

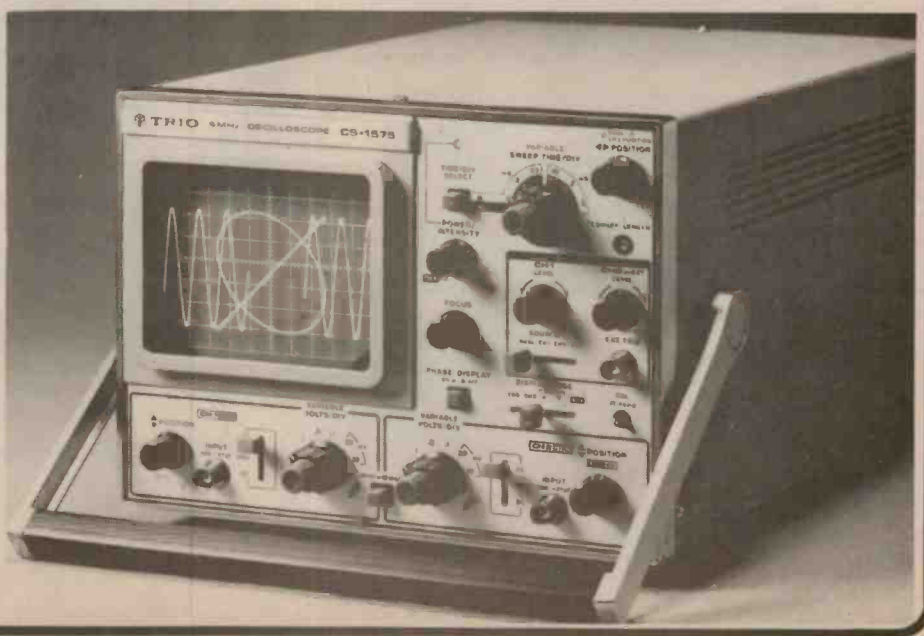
An additional advantage is that the virtual microphones of the stereo pair are strictly coincident over most of the audio spectrum. This gives worthwhile improvement over the usual kind of close-spaced stereo pair in which phase errors can exceed 180° at the top of the audio band.

Further details from Strand Electric Division Rank Industries Australia, PO Box 127, Burwood, Vic 3125.

Switched Tape Audio System on a Single Linear Bipolar Chip

An integrated circuit that will significantly change the way both portable cassette and reel to reel tape recorders are designed has been developed by National Semiconductor. Designated the LM1818, the device is a linear bipolar integrated circuit containing all the active electronics necessary for building a tape audio system.

One of the main features of the LM 1818 is electronic switching between record and playback. This is presently done via a multi-pole double throw switch which acts as a logic/controller, allowing a number of different functions to occur: it switches the head from record to playback, the bias oscillator on and off, the preamplifier from a variable output in playback to a constant output in record, the audio amplifier from the speaker to the record driver



Now. Two 3-way 40 watt speakers with nine tonal choices

Save about $50 per hour while you assemble them

Even if you didn't know them by number, you probably heard about the Philips AD12K12 MK11 Speaker Kits.

Because they are now a no.1 best-seller.

And here is the compact AD8K30, 8" 3-way compact system, with fine electronic and acoustic components (1" domed tweeters, 5" mid-range, super 8" bass drivers). Brilliant clean sound, with a frequency response closely following the ideal Bruel & Kjaer curve for hi-fi equipment measured in an actual listening room, using the "Third Octave Pink Noise Method".

Plus 9 combination tonal choices to adjust to the acoustics of your own listening-room.

You can assemble the AD8K30's in about two hours. You will get a professional result and save about $100 per pair over a comparable system.
Phone or send coupon now for full details of this and all our kits.

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ETA

PHILIPS

Electronic Components and Materials

BA.EL.3

amplifier, and the equalization around the amplifiers.

With the LM1818 all these functions are now performed on-chip, according to the position of the single pole double throw record/playback switch.

There are two identical preamplifiers with one common output: one amplifies audio inputs such as a microphone in the record mode and the other amplifies the signal from the playback head in the playback mode. On the playback amplifier, the collector of the input device is made available so that an external low noise device can be connected in certain very critical low noise applications.

The monitor and record amplifiers share common input and feedback connections, but have separate outputs. During playback, the input signal is amplified and appears only at the playback monitor output. During record, the input signal is amplified and appears only at the record output. Because the outputs are separate, different feedback components can be used and, as a result, totally different record and playback responses can be set.

Automatic level control circuitry provides relatively constant output level for a wide range of record source input levels.

The LM1818 also contains circuitry to suppress pops when switching between the record and playback modes. In essence, the output amplifier, either in record or playback, is shut off prior to switching and carefully re-biased after switching takes place.

Further details from N S Electronics, PO Box 89, Bayswater, Vic. 3153.

ETI TV Game Kit From Dick Smith

Dick Smith has produced a kit for the Stunt Cycle TV Game (ETI Project 810) featured as a constructional project in July ETI.

As well as the electronic parts and hardware, the kit includes a punched anodised front panel which gives the project a very professional appearance. Co-ax cable and plugs for connecting the control box to a colour or monochrome TV set are also included.

Dick has included a "Sorry Dick it doesn't work" coupon. For a fee of $5, his service department will fix the fault and get it working. The $5 service fee covers everything except replacement of the IC, should this be necessary.

The kit (catalogue number K-3474) is priced at $29.50 and is obtainable from all Dick Smith stores, or $32.50 posted from Dick's Mail Order Department, Box 747, Crows Nest, NSW 2065.

ETI/Unitrex Calculator Contest

The ETI/Unitrex calculator contest in the June issue posed the problem of playing out a full pack of cards in the correct order following a particular playout pattern. The solution is too long to give here, but starts 5H, 10D, AH, 3S, 7D, AD . . . so if you haven't got this, you were wrong.

The winner this month is in fact a two-man(?) team of Mr Fred Guy and Mr IBM 370/168 of Elizabeth South, SA 5112. While Mr Guy provided a plan of attack on the problem, written in APL, Mr 370/168 did the actual legwork of solving the problem and completing the entry. They'll have to sort out between themselves who keeps the calculator!

This month's problem makes a great bedtime story for the kiddies . . .

Once upon a time there was a big bad king called Everquick who sought to unite and rule a country inhabited by 13 dukes and their respective households. The king knew that if he united Nokabod with Belchalot he would then be able to control the remaining dukedoms.

His advisors, wishing to retain their heads, advised him as follows . . .

If Nokabod allies with Belchalot, Upalip will ally with Flogaserf. If Flash Harry allies with Scrachalot then Bopanave will ally with Elsanor. If Tiltalot allies with Flash Harry then Durtibottom will ally with Sanserif. Of course if Upalip allies with Flogaserf then Tenpoint will immediately ally with Durtibottom.

If Nokabod allies with Belchalot then unless Flash Harry allies with Scrachalot, Bopanave will ally with Elsanor. If Durtibottom allies with Sanserif then naturally Bopanave will not ally with Elsanol. If Tenpoint allies with Durtibottom then, if Emsworthy allies with Belchalot, Duritbottom will ally with Sanserif.

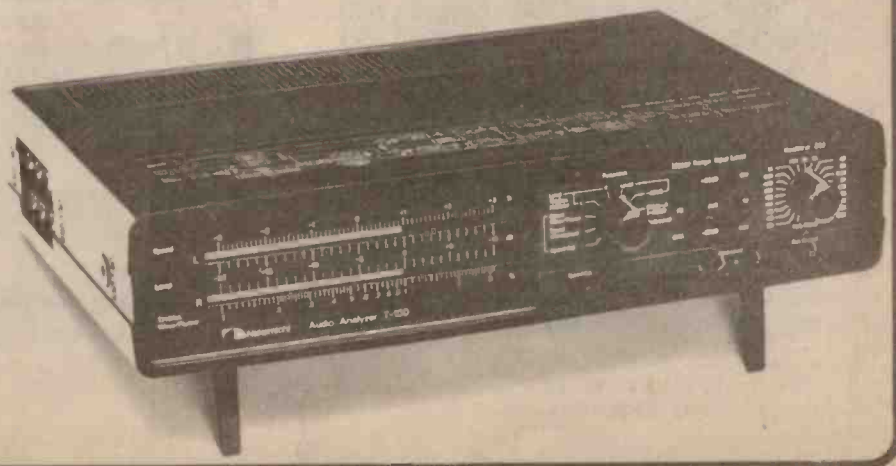
Mind you, if Upalip allies with Flogaserf and Tiltalot does not ally with Flash Harry then it goes without saying that Emsworthy will ally with Belchalot.

The advisors came from the ancient kingdom of Boolea so were both logical and truthful. Knowing that their statement that 'if a then b' does not imply either 'if b then a' nor 'if not a then not b' - will the king be able to unite Nokabod and Belchalot and thus expand his domain?

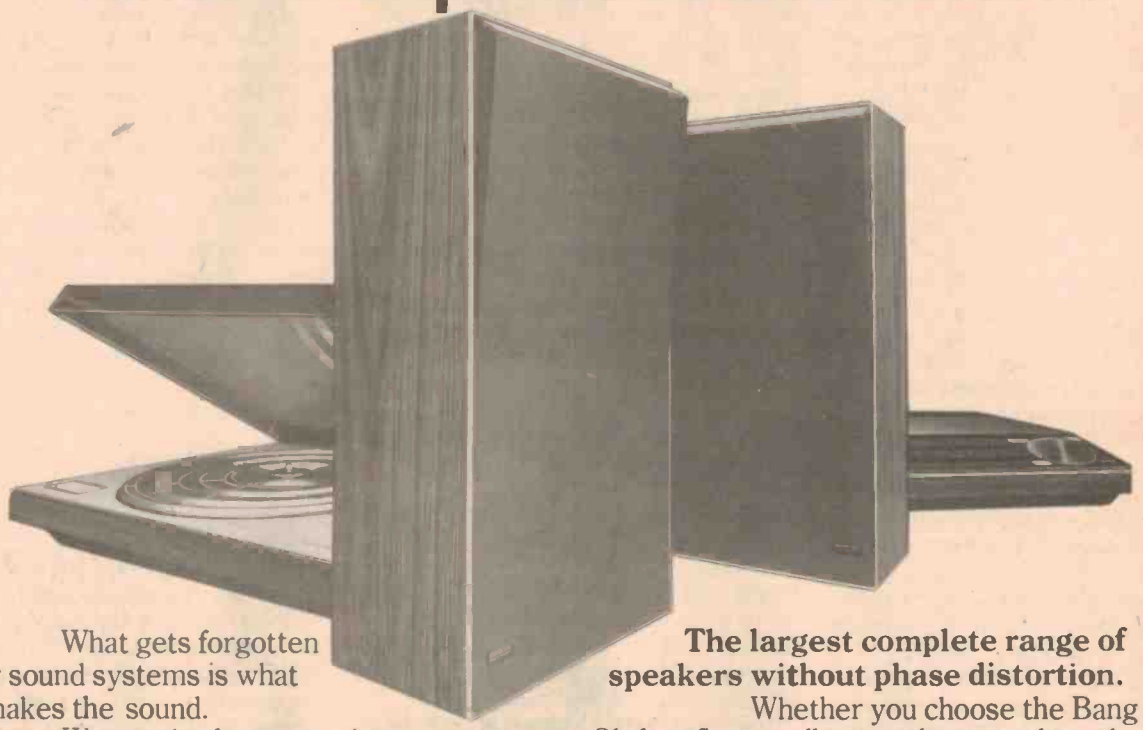
Seal an empty envelope, write your answer on the back of it, and send it to: Unitrex Calculator Contest (August), ETI Magazine, 15 Boundary Street, Rushcutters Bay, NSW 2011. The closing date is Friday, 15 September.

Nakamichi Analyser

The new T-100 Audio Analyser from Nakamichi is an extremely versatile yet compact audio test instrument. Using two plasma panel bar graph displays, the T-100 can measure frequency response, audio levels and voltages, speed deviation, wow and flutter and total harmonic distortion. Suitable for either portable use or permanent connection into an audio system, the 4.3 kg T-100 would be a useful tool for serious hi-fi listeners and tape recordists. Further information is available from *Convoy International Pty ltd, 4 Dowling Street, Woolloomooloo, NSW 2011.*



$300 is so little to spend to make your records sound better, your tapes sound better, your turntable, tuner & amplifier sound better...



What gets forgotten in many sound systems is what finally makes the sound.

We speak of your speakers.

Because your speakers are probably not as good as the rest of what you've got.

In the past, phase distortion was considered a necessary evil.

The greatest enemy of pure sound is phase, or time distortion; evident in almost all conventional loudspeakers. The result of this is blurred sound with poor definition of individual instruments.

B & O, with the help of the giant NASA computer, developed their unique range of Uni-Phase loudspeakers eliminating the problems of phase distortion forever.

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The improvement in sound quality is audible.

The largest complete range of speakers without phase distortion.

Whether you choose the Bang & Olufsen floor, wall or panel mounted speakers, you will enjoy all the sound advantages of the Uni-Phase technique in significantly smaller cabinets than those of other manufacturers.

This is made possible by using a special acoustically superior A.B.S. material in cabinet construction — plus the highest quality drivers. There is a choice of teak, pallisander, or white cabinet finish.

From eight different models in the Uni-Phase range, Bang & Olufsen provide a loudspeaker that **must** improve your present music system — whether you spend $300 or up to $1,800.

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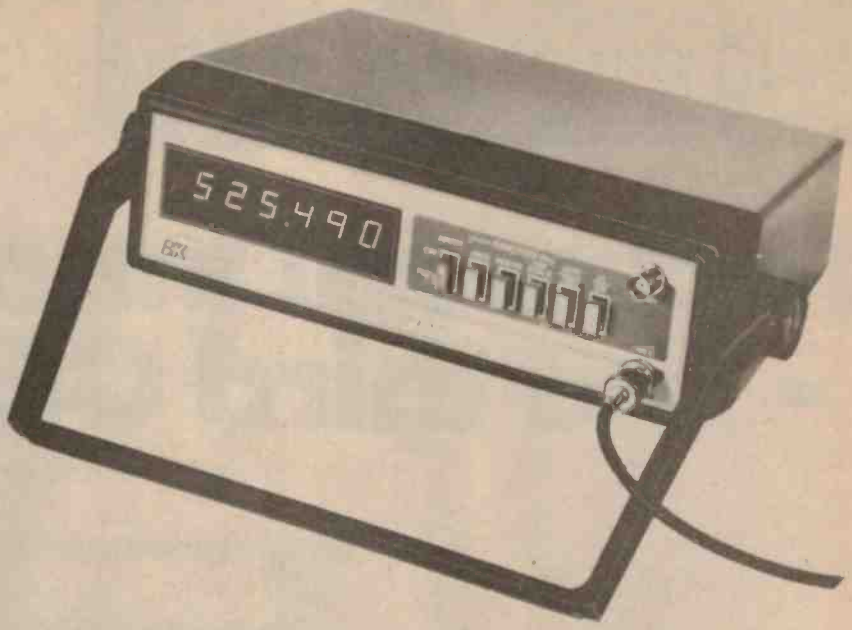
520 MHz Counter

The new B&K-Precision Model 1850 Frequency Counter recently released for sale in Australia is designed for engineers and technicians requiring accurate frequency measurement extending into the UHF range. The Prescale range covers 10 to 520 MHz, while the normal range is from 5 Hz to 60 MHz. Autoranging is featured on both normal and prescaled ranges. Gate times from 10 ms to 1 second are automatically selected in the prescale mode, and the normal range. For manual gate time selection, 1 second operation in normal and 10 seconds in prescale are selectable.

For further information contact Bruce McCarthy, *Parameters Pty. Ltd., 68 Alexander St., Crows Nest, NSW 2065.*



360° Magnifier

The new Zi-Tech Inspector is a unique pocket-sized prism magnifier which shows a full 360° inside view of holes. It automatically focuses on contact with the surface and requires no operator training. It allows potentially costly drilling imperfections such as spiraling, roughness, and burring to be instantly detected. In electronic production, checks on printed circuit board holes for plating voids, smoothness and solder flow can now be made quickly and inexpensively.

The Zi-Tech Inspector is a valuable quality control tool for any industry where checks on precision drilling are required. Its low cost and ease of usage facilitate better inspections at an earlier point in the production process and avoids the high expense and inconvenience of fish-eye lens microscopes.

Knowing our readers, they can probably think of thousands of other uses for this gadget!

For further information please contact:– *C & K Electronics (Aust.) Pty, Limited, Office 2, 6 McFarlane Street, Merrylands, 2160.*

General Radio Representatives

Elmeasco Instruments Pty Ltd, importers and manufacturers of electronic testing and measuring instruments for industry, research and communications, have been appointed Australian sales and service representatives for the Time Data, Acoustic and Electronic Instrument Divisions of Genrad Incorporated of Massachusetts, USA (formerly known as General Radio Company).

Elmeasco Instruments, with sales offices in Sydney, Melbourne, Brisbane and Adelaide, are represented in Perth by Cairns Instruments Services.

Apple Stock Information

US owners of Apple II computers are now being offered a new service – 15-minute delayed stock and bond quotations from Dow Jones' stock reporter service. A one-time fee of $25, plus a charge of $3 for the first three minutes and 50c a minute thereafter, enables the use of Apple-supplied peripheral equipment to determine current portfolio value, gains and rate of return.

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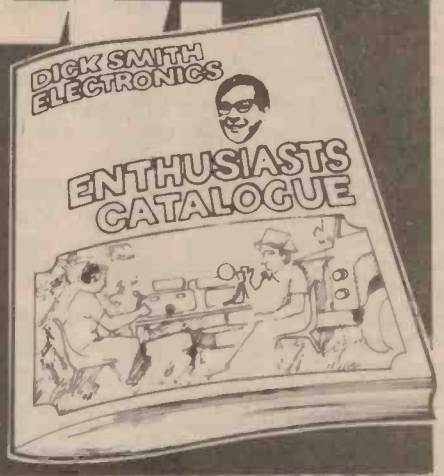

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ETI

SOUND

Technical innovations - the third CES

Pioneer's new CT-F900 microprocessor controlled cassette deck has all-electronic three-head transport system.

THIS year's CES was housed in the Commemorative and Manufacturer's Pavilions at the Sydney Showground from July 13th to July 16th.

The name of the game as far as the consumer was concerned was convenience and the home entertainment centre. Convenience through multiple pre-programming of memory banks for changing records, selecting even one track in up to 350 with the Sharp RPX-1 microprocessor turntable fitted with infrared remote control to assist relaxation. Sharp also introduced further refinements on their original cassette 'brain child' with a sophisticated 3-in-1 desk top home music centre SG.500. This combination package also uses remote control with manual touch overriding controls.

Moderate and high power receivers are becoming a greater part of the Australian music lover's equipment selection - and following the American pattern. When more FM station licences are granted the receiver boom will really begin. Awaiting this increased turnover are hundreds of watts packaged out of sight behind the gleaming faces of tuning dials and pre-amplifier controls.

Quartz synthesised tuning was the in thing and few of the top receiver manufacturers were without it.

One of the Show's major attractions was the Superscope Pianocorder developed under the direction of Joseph Tushinsky, well known musicologist and owner of Superscope in the USA. Tushinsky's love of piano music and the past age of piano playing virtuosi led him to develop a miraculous library of piano rolls which were made by these legends of pianism. Tuning has always been a problem with reproducing pianos and Tushinsky had enough capital to fulfil a lifetime wish for modern day electronics to join the piano mechanism.

In the large open air of the pavilion the sound was rather limited. There did not seem to be sufficient dynamic range possibly due to poor regulation.

Nevertheless the Pianocorder's ability to demonstrate the playing techniques of virtuoso performers is absolutely invaluable and we hope Superscope will continue to develop this product.

Direct Cut Discs

Techniques with disc recording are coming under closer examination due to wider public acceptance and demand for the direct cut method which bypasses the normal taped original. Not that there's anything new about direct cutting - all records were made that way until the advent of multi-track tape recorders in recording studios!

Several stands were using Sheffield and Crystal Clear direct cut discs. In addition, a few exhibitors used the locally made direct cut disc of the music group Crossfire.

This joint venture disc was recorded at RCA by Don Bartley on the Neumann cutting lathe, Bruce Sheldrick at the Neumann cutting console and staff of the Trafalgar Studios at the mixing console.

During the cutting, Don Bartley had to turn the cutter control electronics to face the lathe and use the current metering as indication of safety margin. This rather unusual procedure for locally made disc recordings was necessary as the music content and power levels were generally unknown factors.

As with the majority of direct discs the music content is of a 'popular' nature. (The Crossfire recording is available now, the number is D2D001).

Two Sheffield direct cut discs available at the CES were Erich Leinsdorf and the Los Angeles Philharmonic Orchestra's

Modern expertise and computer technology have created a fine piece of equipment.

The NEW B&W DM7

The DM7 complements a remarkable range of monitor loudspeakers from B & W.

DM7 is the first of a new loudspeaker family reflecting our computer-aided research programme. It is a compact 3 unit system employing entirely new drive units in an enclosure engineered to exceptionally high standards. Many advances have been incorporated to reveal new horizons in loudspeaker performance, making possible a standard of musical reproduction unequalled in an enclosure of this size. The DM7 gives almost perfect amplitude linearity throughout the entire audio spectrum, and produces phase-coherent sound within a broad listening area. The drive units are purpose-designed and manufactured entirely in our own factory, employing new technology in order to achieve incredibly low distortion levels – typically less than 1% THD from 30Hz to 200Hz and less than 0.5% above that frequency. Another new feature in the DM7 is a variable energy control giving four frequency weightings – different to those obtainable from the control unit – to accommodate widely varying room acoustics.

Hear the B & W DM7 – you may well agree that this is the finest small speaker in the world today. Guaranteed for 5 years.

The B & W DM6 is Britain's first linear phase loudspeaker. A dynamic system that will reproduce sound with transient accuracy usually achieved only by the very best electrostatic designs.

The DM4 is a 3-unit monitor loudspeaker system that produces high quality results from an incredibly small cabinet (20.8 litres) making it perfect for home or small studio use where space is at a minimum.

Only 28" x 9" x 9¾". Despite its compact size, DM5 speakers can be rated as a system of very high quality. The design philosophy of John Bowers – "To design loudspeakers that reproduce in your home sound as you would hear in the concert hall"

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recordings of extracts from Wagner operas and the Prokofieff ballet Romeo and Juliet.

Absolutely stunning sound and dynamic range is cut into the direct disc releases of Crystal Clear. High fidelity music enthusiasts will already know the Crystal Clear label from earlier releases of Direct Disco, San Francisco and Laurindo Almeida. More recent issues include discs recorded, "live" onto lacquer, of course, by Peter Nero and another by Cal Tjader and his group.

The Arthur Fielder Capriccios Italien and Espagnol with the Boston Pops Orchestra is interesting on first hearing and will be reviewed subsequently.

There will be no disappointment with the recorded sound of the mighty Fratelli-Ruffatti organ at Golden Grove Church in California. It is played by that wizard, Virgil Fox well known for his "heavy organ" recitals for students in the USA.

Music included on this pair of discs is by Bach (yes, the famous Toccata and Fugue in D minor), Cesar Franck, Wider, Dupre and Vierne. Do not be frightened by the unknown composers. Buy these discs for the sound and come to love the music.

Purist organists may not agree with interpretations or the occasional hysterical atmosphere but they will certainly appreciate the most staggering organ sounds on disc. The records contain a caution concerning the high energies stored between 16 Hz and 1,500 Hz.

The Pianocorder was controlled by a standard audio cassette.

Cartridge Transformers

Moving coil cartridges are gaining acceptance but their inherently low output presents a very real problem to the enthusiast . . . should he buy a pre-amplifier with a suitable low level input or a separate pre-pre-amplifier or step up transformer to boost the signal level to that required by conventional pre-amps.

The trend is by no means clear for whilst several manufacturers exhibited integrated amplifiers, pre-amps and even receivers with moving coil inputs, both Yamaha and Technics showed transistorised separate pre-pre-amps, and several exhibitors either offered or used transformers.

Whilst it's not at first very obvious, step up transformers are very suitable for the purpose. Pre-amplifier input stages are generally bi-polar solid state devices with optimum source impedances in the low thousands of ohms for minimum noise generation.

A moving coil cartridge with an output of around half a millivolt at a winding resistance of, say, 20 ohms requires the maximum gain and voltage build up with least noise and distortion being introduced with the required signal.

A transformer not only steps up the output voltage but also provides this voltage at the optimum source impedance for the minimum noise figure. For instance, the Dynavector DV-6 transformer's gain is stated to be 13 with an input impedance of 40 ohms, an output impedance of 9000 ohms, and a preferred load impedance of 30 000 to 50 000 ohms.

This specification tells us that the actual step up ratio is slightly less than the theoretical 15 times (the voltage ratio of 40 to 9,000 equals 225 with a square root of 15).

If an RIAA stage has a specific 47 000 ohms input impedance then the ratio of 47 000 divided by 13^2 shows the cartridge looks into the transformer and sees an actual load of 278 ohms.

The impedance ratio of 13^2 (169) multiplied by the 20 ohm pickup coil impedance presents 3380 ohms to the pre-amplifier input circuit. So the input stage is happy. The nominal 47 000 ohms looks back into 47 000 divided by 169 which equals 278 ohms.

JVC introduced the impressive-looking model JR-S501 DC Integrated Receiver at the Show.

Consider the ten or so preferred minimum output to input impedance ratios and it is obvious that the requirements are met by the figures 20, 278 and 3380 ohms.

The Dynavector, DV-6 is necessarily expensive as no short cuts are taken with the basic raw materials of transformer manufacture. The wire is 99.99% pure silver for the transformer coils, wiring material and right through the connecting leads to the RCA terminations.

Innovative Electronics

Megasound introduced several new amplifiers and pre-amplifiers including an analogue (and spring) delay unit.

New electronics were to be seen on almost every stand. Sharp introduced their 7000 series in a static display. The 250 watt per channel power amplifier (SM7000) uses output triples in complementary push-pull. Liquid crystal metering and switched mode power supply should make this an interesting unit for early next year. The pre-amp has a moving coil input with sensitivity of 80 microvolts. The ST7000 FM tuner completes the matching format of the 7000 series.

Technics introduced a staggering number of new preview electronics and speakers. Apart from the updating of components there were several innovative items.

The company's SB10 000 loudspeakers have been mentioned in ETI recently. Matching in awesome size and specifications are the A1 and A2 electronics. The A1 features an automatically variable power supply feeding a stereo pair of 350 watt class amplifiers.

The A2 pre-amp is a big heavy unit with enormous toroidal power transformer. The controls are silent operating via micro-relays. Facilities include a square and sine generator plus pink noise and warble tone output. A universal frequency equaliser also doubles as a comprehensive tone control. Pickup inputs are switchable to magnetic and moving coil with several choices of matching.

Technics M85 cassette deck is a world first with slimline styling, and horizontal direct-drive motor. Complete with quartz lock servo control and fluorescent light beam meters this M85 looks a winner.

Users of the open reel tape deck, RS.1500.US will be pleased to note the cordless remote control operating via an infrared link.

Cassette decks from Teac and JVC are also competing for number one spot on the consumer index.

The Teac C-1 is presented in a severe military, almost mil-spec format with plug-in bias and EQ cards for several tape formulas. This unit is a belt driven three-motor unit with three head operation. The record and playback coils are in a combined housing thereby easing alignment.

A matching DBX system will soon be available for the C-1. Apparently, this noise reduction system can be fitted to other decks as required.

Two of the JVC models feature their new five frequency spectro peak indicator led strips. Ranging from +6 dB to -10 dB these augment the built in stereo meters when recording. Sen-Alley gaps are bonded to permalloy laminations in the head configurations.

Rigid cassette clamping is claimed for the JVC developed twin ball bearing arrangement.

JVC and many other companies features home video centres built around one or two basic formats. JVC presented their three hour format at one end of their three-section stand. The basic unit is $1,250 and three hour blank cassettes are $28.

The Nakamichi Test Set T-100 is destined to earn itself a good name among retailers specialising in tape deck alignment. This audio analyser has fixed spot frequencies generated by capacitor-resistor networks allowing noise and distortion measurements as well as the more difficult wow and flutter analysis.

One very busy stand favoured by adults and children was the simple, but thoughtful, arrangement of calculators and learning devices by Texas Instruments. Children's teaching aids for maths were shown in two styles. For ages five to about ten, the Little Professor tempted the unwary with up to ten calculations of multiplication, division, addition and subtraction. Three answer attempts are allowed before disqualification. The owl motif is distinctive. Price, $18.60.

Older age groups suffered at the hands of the Star Wars type Dataman with scoreboard illuminations when correct answers are punched into the futuristic keyboard. Price, $27.90.

Older brains writhed after calculating interest payments on programmable calculators both desk type and pocket. The programmable TI.59 offers the normal card insert as well as a 25 programme plug-in.

Finally, for the computer types, there is the pocket calculator/programmer with hexadecimal, decimal and octal calculator/converter. Just the thing for every computer man at $60.80.

Texas Instruments are inaugurating their PPX Club soon. Professional Programme Exchange will be available in separate programme format or in full loose leaf book form known as Pakette. (Enquiries to Claudio Ellero at Texas Instruments, 5 Byfield Street, North Ryde, NSW 2113. (02) 887.1122).

All in all the 1978 CES was an inspiration of thought and planning with several manufacturers scooping large orders.

Quartz lock of horizontal direct drive motor is a feature of Technics' M85 cassette deck.

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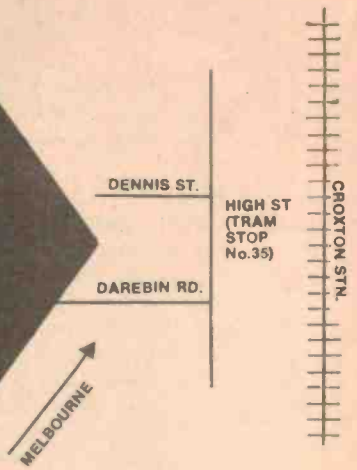

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4.7uF 35V	.25	.22
6.8uF 35V	.30	.25
10uF 16V	.25	.23
10uF 35V	.30	.28
15uF 16V	.30	.25
15uF 35V	.50	.45
22uF 16V	.38	.35
47uF 16V	.65	.60
68uF 16V	1.20	1.10
100uF 6.3V	.70	.65

MINIATURE TRIMPOTS

	1-9	10 up
0.1 watt, .1" spacing		
100, 250, 500, 1K, 2K, 5K, 10K,	.20	.17
25K, 50K, 100K, 250K, 500K, 1M	.20	.17

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22 uF	16v	PCB	0.08	0.07
22 uF	35v	PCB	0.10	0.09
33 uF	16v	PCB	0.09	0.08
33 uF	50v	PCB	0.11	0.10
47 uF	16v	PCB	0.10	0.09
47 uF	35v	PCB	0.12	0.11
100 uF	10v	PCB	0.11	0.10
100 uF	16v	PCB	0.12	0.11
220 uF	25v	PCB	0.15	0.14
470 uF	16v	PCB	0.17	0.16
1000 uF	25v	PCB	0.38	0.36
2500 uF	50v	Axial	1.95	1.85
2200 uF	25v	PCB	0.55	0.90
6800 uF	50v	LUG	4.75	
5600 uF	40v	PCB	2.90	
4700 uF	35v	Axial	2.10	

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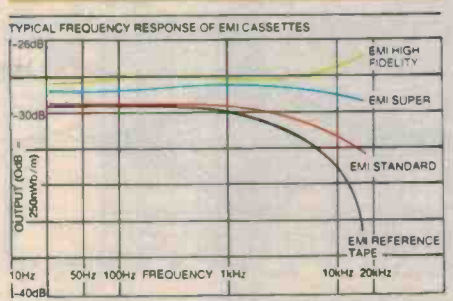
1. Measured using the EMI recommended 2.5dB overbias at 6.3kHZ, derived from the reference batch C521V (the value of bias internationally used by the majority of domestic recorder manufacturers).
   Tape speed 4.76cm/s (1⅞ in/s)
   Track width 0.6 mm
   Record head gap length 2μm
   Replay head gap length 2μm
   Replay amplifier characteristics: 120μsec and 3180μsec
   (In accordance with IEC Publication 94 Edition 3, BS1568 Part 1 and DIN 45513)
2. The Frequency Response is obtained when the record amplifier characteristic has been adjusted to give a flat frequency response (25Hz – 15Hz) from the reference tape batch C521V of –30dB (Ref. 1*).
   **Ref 1. Relative to an RMS Flux of 250nWb/m Tape Width (25mMx/mm) at a frequency of 315Hz (in accordance with IEC Publication 94 Part 2).*



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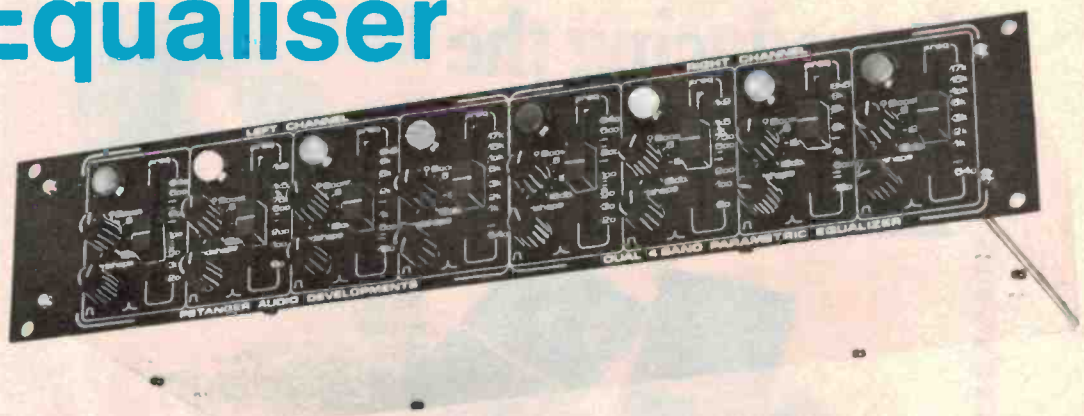
Petanger Parametric Equaliser



The Petanger Dual 4 band Parametric is a state of the art stereo equalizer consisting of 4 independent filter sections in each channel. Each filter is capable of continuous adjustment of amplitude, frequency and bandwidth.

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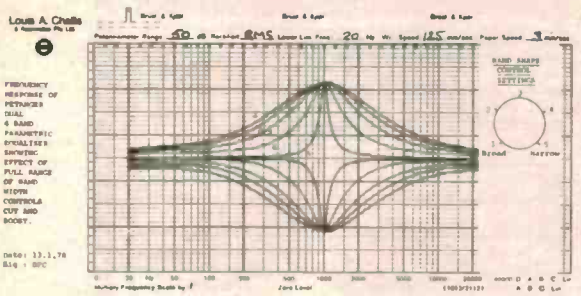

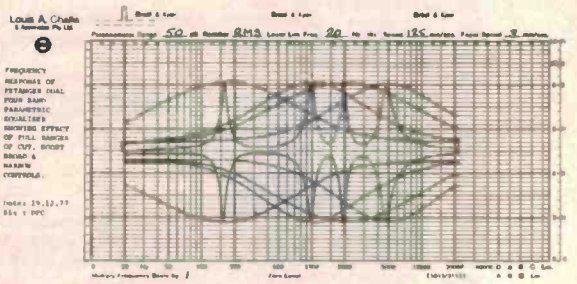

Actual unretouched frequency sweeps

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SOUND BRIEFS

The Very Top Records

Could you name the ten very best classical records available today?

Our associate magazine Hi-Fi and Music has done just that. Their August issue lists the ten recordings which a panel of record reviewers and representatives of the recording industry agree (well – almost agree!) are *the* very best.

Compiling the final list was extraordinarily difficult and took six people nearly 50 meetings to decide! The results may surprise you. The very top recording is staggeringly good. If you're really into good music reproduction don't miss this feature in August's Hi-Fi and Music.

Advanced Tape From 3M

The USA's 3M company has introduced a very advanced audio cassette which the company states has maximum output 5 – 10 dB greater than typical chrome tapes and 3–7 dB more than 3M's own premium Scotch 'Master II' cassette.

This means that the output is at least double that of most other top quality tapes. Retentivity is claimed to be 3400 gauss for Metafine compared to 1500 gauss for 'Master II', coercivity is 1000 oersted (550 for 'Master II').

One drawback is that whilst the new formulation cassettes can be played back on existing machines, modified bias levels and much higher erase levels are required for optimum performance.

Production of 'Metafine' cassettes will start later this year – by which time, say 3M, suitable machines will be available.

Ortofon Cartridge Capacitors

Magnetic cartridges generally require an amplifier input impedance of about 47 000 ohms and an input capacitance of about 400 pF (per channel) for correct matching.

Ortofon believe that whilst impedance is generally about right, load capacitance is often too low. The company has accordingly introduced a special cartridge mounting capacitor for their M20 and all Mk II series cartridges. The capacitor simply slips across the connecting pins – no soldering is required. The result is the elimination of the characteristic roll-off in the mid-range and the smoothing of the high frequency peak. The capacitors (CAP 210) are available from Ortofon dealers – you need just one per cartridge.

Zerostat Patent

A new British patent (1 500 492) has just been awarded to Zerostat Instruments, makers of the Zerostat antistatic pistol. The patent, which is extremely broad in scope, would appear to cause major problems for the many companies now producing 'Zerostat look-a-likes'.

Australian Suc-CES

Official attendance at the 1978 CES was a record 25,803 public plus a further 2,500 or so trade visitors. The magnitude of this achievement may be gauged by Britain's recent Cunard Hotel audio exhibition which attracted some 13,000 public plus about 2,000 trade visitors. The Cunard show was open for roughly the same length of time as our CES.

Plessey May Sell Garrard

In Britain, Plessey has reported that its profits last year have been severely reduced by a $9.25 million loss at its Garrard audio equipment subsidiary. The parent company are believed to be seeking a buyer for the ailing plant.

Sanyo Manufacturing In USA

Sanyo are planning to build a plant in San Diego California to make audio equipment under the Fischer brand. Fischer is now wholly owned by Sanyo. The new factory will produce some 25,000 amplifiers, tuners and cassette decks a month starting early 1979. Whilst several Japanese companies produce colour TVs in the USA, Sanyo are the first to manufacture audio equipment there.

Auto FM Indication

A visual indication system which tells one automatically which station is tuned in has been introduced by Philips and the Dutch Broadcasting Corporation.

The system works by superimposing a coded signal onto the transmitted programme material – coding being different for each station.

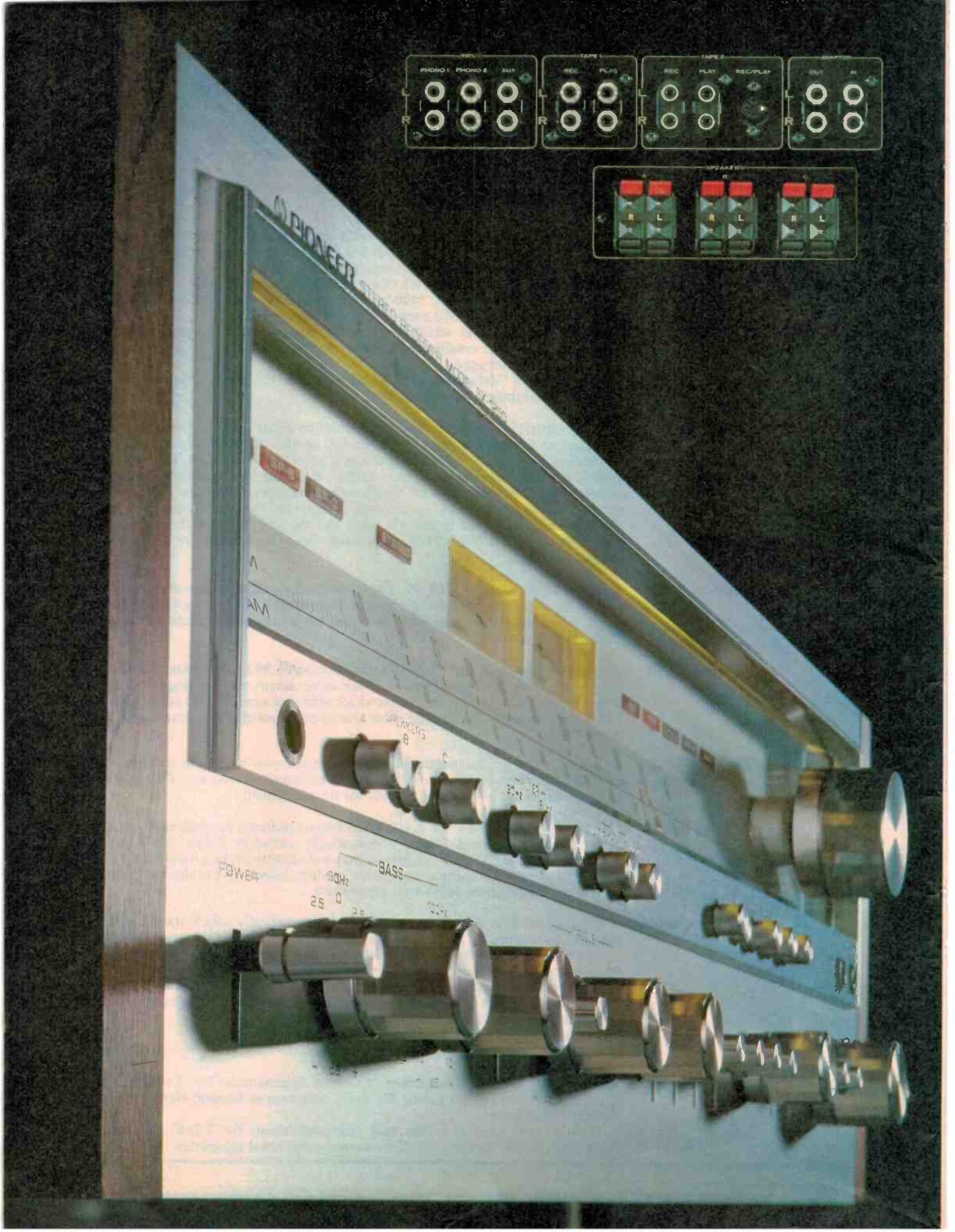
A decoder built into each receiver displays the decoded signal in the form of the station ident. Philips hope for international agreement and cooperation to get the system off the ground (into the air?).

In the meantime ETI has developed a remote AM indicator – see the project section – and there's an even cleverer one to follow!

New Convoy General Manager

In a re-organisation of management at Convoy International Pty. Ltd., Mr. Malcolm Goldfinch, Chairman, has named Mr. John Anderson as General Manager, reporting directly to the Board.

Convoy International is the sole Australian agent for T.D.K. tape products, Nakamichi, B & W speakers and Electrosonic audio visual equipment.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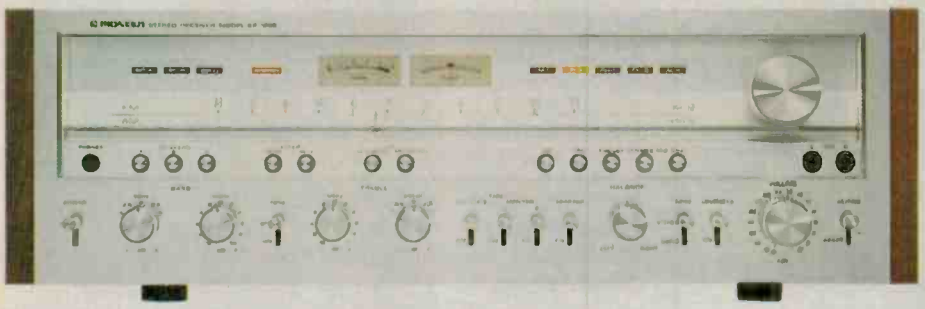
"The world's first super receiver is naturally the finest."

The Pioneer SX-1250 started this trend to the so-called super receiver. And as the trend-setter, there is none other to compare with its technological artistry, stereo efficiency and total performance.

Receivers we've always had. In fact, in the United States and probably throughout the world, Pioneer's range of receivers outsells all others. But super receivers are a different matter. They were born when Pioneer combined the qualities of an exceptional tuner with those of an all-powerful amplifier.

Even in the AM stage, it was and possibly still is, the only receiver (or tuner for that matter) to pay genuine attention to signal quality.



Pioneer rates the SX-1250 at 160 watts per channel (min) RMS at 8 ohms. While Stereo Buyers' Guide* tested the SX-1250 at 190 watts per channel under the same conditions. So on this basis, there's more than ample for even the most power-hungry speakers.

Power however is only one facet of technological artistry. You must also listen closely to the SX-1250 to appreciate its wealth of features and facilities.

In the critical area of FM stereo reception, this receiver embodies the very latest in electronic circuitry. There is no skimping.

A twist of the station selector knob confirms a degree of engineering expertise possessed by few other receivers. Watch the flywheel-powered cursor travel effortlessly along the widely calibrated dial and you'll know the same attention to detail is found throughout the SX-1250.

In the same way, a glance along the control panel reveals an unusually ordered elegance. A complete command facility where power and precision come together in beautiful harmony.

In the world of stereo receivers, the SX-1250 stands supreme as the complete masterpiece.

Amplifier Section

Frequency response	5 Hertz – 100,000 Hertz + 0 dB – 1 dB
Power output	160 watts per channel min RMS at 8 ohms.
Total Harmonic Distortion	no more than 0.1% (continuous power output)

Tuner Section

Usable sensitivity	Stereo, 14.5 dBf (2.9μV)
50 dB Quieting sensitivity	Stereo, 36.0 dBf (35μV)
Alternate channel selectivity	83 dB
Distortion (at 65 dBf): 1 kHz	0.1% (m) 0.2% (s)

All Pioneer receivers are covered by warranty for two years. Excellent service facilities are available throughout Australia via a network of Pioneer outlets.

To Pioneer Electronics,
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*Australian Hi-Fi Stereo Buyer's Guide '77 Manual pages 182-184.

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Six functions in 26 ranges
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DC Current ..... 1μA to 1A
AC Current ..... 1μA to 1A
Resistance .... 1Ω to 20 MΩ
Diode test .... 0.1μA to 1mA
10MΩ input impedance

Reading rate	2½ per second
Temperature coefficient	<0.05/°C of applicable accuracy specification
Dimensions	10" x 5.8" x 1.6"(255 x 148 x 40mm)
Weight	Less than 1½ lbs (640 gms)
Sockets	Standard 4mm for resilient plugs, ¾" (19mm) spacing
Power Requirements	Four 'C' or R14 size disposable cells, or approved AC adaptor or Sinclair rechargeable cell pack

Supplied Complete with test leads and prods, and operator's instruction manual

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AUDIO AMPLIFIERS

Designing an amplifier is like re-inventing the wheel. There are thousands of published designs and possibly as many as 100 different types of monolithic amplifiers as well as lot of off-the-shelf modules to choose from. If you design the amplifier yourself (or use someone else's design) you will probably encounter problems such as heat, noise, instability, distortion, power rating etc, etc. In this article Tim Orr sets out to help you cope.

NOT SURPRISINGLY, power amplifiers get hot. When they are delivering power to a load the amplifier is also dissipating a considerable amount of heat itself. A reasonable rule of thumb is that both the amplifier and the load dissipate the same power, except when there is no output signal. Then the amplifier is the only thing that is getting hot.

To get very low crossover distortion it is usually necessary to run the output transistors in an amplifier in class A or AB. This means that the transistors are biased on (or partly on for AB operation). Thus they consume lots of current and get hot. Therefore designing power amplifiers is a compromise between heat production and distortion.

IC power amplifiers, because of their small size, go for low heat generation and hence higher crossover distortion. Discrete component power amplifiers can use large heat sinks sometimes with forced air cooling and thus obtain THD figures from 0.1% to 0.01%.

Some IC power amplifiers get rid of their heat down the IC legs to suitably large areas of copper on the printed circuit board. There are also 'Stick On' heat sinks for DIL packages. Also, when the going gets a bit hot some amplifiers employ a thermal shutdown mechanism. Generally though, high temperature operation means that the device life time is greatly shortened. Thus it is not surprising that the components that fail most regularly are the power transistors in amplifiers and power supplies.

Stability

The only difference between amplifiers and oscillators is the phase of the feedback and so it is hardly surprising that problems can appear. When the phase of the feedback becomes positive then oscillation can occur if the gain of the amplifier is then greater than unity. The gap between a good amplifier and an oscillator is known as the phase margin. When the phase margin is reduced to zero, oscillations will occur.

More feedback when the phase shift is positive will increase the risk of instability. Less feedback when the phase shift is positive will make the amplifier more stable.

However, less negative feedback means more distortion. It is a compromise between stability and distortion. It is possible to increase the phase margin and thus stabilise the amplifier with a suitably placed capacitor. However, in the IC (monolithic) design this is not possible because this capacitor would probably occupy twice the area as the rest of the integrated circuit. So, the designers of IC power amplifiers usually make this stabilising capacity small and set the amplifier gain high (less negative feedback).

You end up with a power amplifier that is only stable with high values of gain and which has a relatively high distortion. Even so, most monolithic designs need additional capacitors on their inputs and their outputs to maintain stable operation. Other stability problems are:

1) Amplifier gain and phase margin depend on power supply voltages. Thus, an amplifier may not be stable under varying conditions of supply voltage. Turning the power up, the amplifier may emit a squeak or a whoosh, due to high frequency instability.

2) Amplifier gain and phase margin depend on temperature. Thus as the amplifier warms up it may then become unstable, oscillate, the output transistors get very hot and the amplifier burn out.

Alternatively, the amplifier may be unstable only when cold. So you switch on and it squeaks (oscillates), warms up, stops oscillating, cools down, oscillates (squeaks), warms up, etc. etc. (Breaks the ice at parties!).

3) The load put on an amplifier will affect the phase margin. Designing an amplifier that will drive any load is difficult. Often a power amplifier will have a capacitor resistor network from its output to ground. This network is used to increase the phase margin.

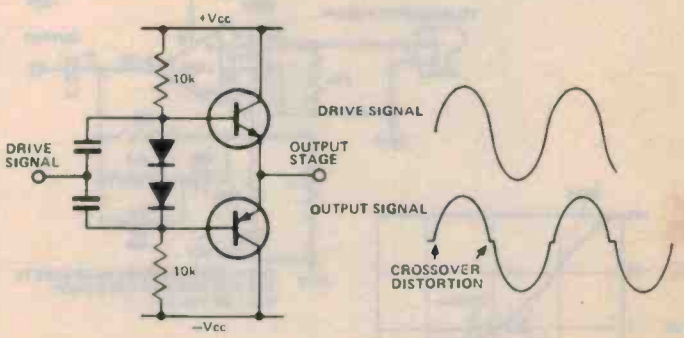


Fig 1 (above) is the classical output pair that produces the equally classical crossover distortion illustrated below. Carefully biasing of the output pair can reduce the effect but it is usually present in most amplifiers of this type.

Distortion

If you put a pure sinewave into an amplifier and you get out of it the same sinewave plus some harmonics, then you have got distortion. Any other spurious signals are not distortion products and are not included in THD calculations.

Crossover distortion is usually generated by the output transistor pair (Fig. 2). This is caused by one of the transistors switching off before the other one can switch on. The result is a 'lump' in the output waveform which gives the sound a 'buzzy' quality. The distortion can be reduced by turning the output transistors on a bit more, by biasing their bases further apart. This increases the quiescent current and thus more power is dissipated: Also, overall negative feedback can be used to iron out the kinks, but this will increase the chance of instability.

Another type of distortion is harmonic distortion. An amplifier, used in open loop is usually fairly non linear. This non-linearity will cause any signal passing through the amplifier to be distorted. Negative feedback is used to iron out the non-linearities and so reduce this source of harmonic distortion.

It is interesting to note that the hi-fi market wants low THD figures of 0.1% to 0.01% but the music market actually prefers (in some cases) higher figures of about 2%.

Noise

Noise is generally not a problem in power amplifiers but it is in the pre-amplifier stages of an audio system. An overall system signal to noise ratio of 70 dB (3 000 to 1), is quite good and not very difficult to achieve. Better than this is studio or professional quality. When amplifiers are used to reproduce stored signals, such as from a disc, radio or tape recorder, then an overall S/N ratio of 70 dB is quite adequate. This is because the S/N ratio for these storage or transistor systems is quite low.

For example the best disc technology will only give us a 60 dB S/N ratio. The best studio quality tape recorder (unprocessed), will give 56 dB. Radio transmissions are about 50 dB on FM, and cheap cassette players only clock up 30 dB's.

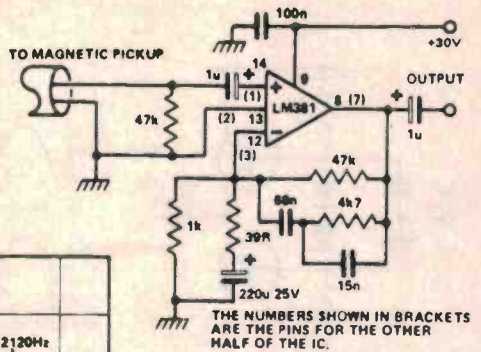
The most demanding situations where the noise of a pre-amplifier will be important are in amplifying the signals from low impedance microphones, magnetic cartridges for record players and tape recorder pickup heads. In the following sections there are several examples of low noise pre-amplifier designs.

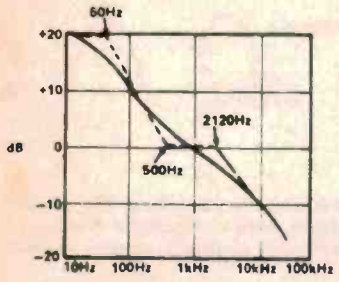
As tapes and discs are used then their S/N ratio deteriorates. Also, most listening environments have a high background noise level (air conditioning, street noise, jets etc.).

Record Player – Magnetic Pickup

If you were to amplify the signal from a magnetic pickup on a record player and listen to it the sound would be terrible. It would be all treble and no bass. This is because the pickup is magnetic and gives an output voltage which is velocity sensitive. That is the faster the needle wiggles in the record groove, the larger the output voltage, or rather the output voltage (for the same amplitude of excursion) is proportional to frequency. To restore the natural sound, the signal must be equalised with a frequency response as specified by the RIAA.

This play back equalisation gives 20 dB lift at low frequencies and 20 dB attenuation at high frequencies and is 0 dB at 1 kHz. No equalisation is required if you use one of the cheaper ceramic pickups, which have a flat response.

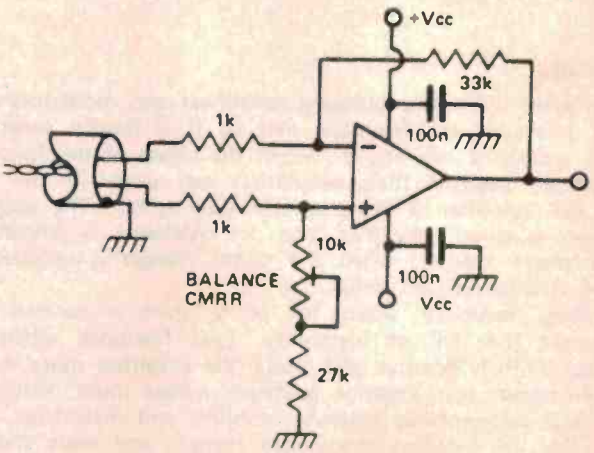




Graph illustrating the non-ideal approximation to the ideal RIAA equalisation curve, the response flows smoothly unlike the 'defined' RIAA response.

Electronic Balanced Input Microphone Amplifier

It is possible to simulate the balanced performance of a transformer electronically with a differential amplifier. By adjusting the presets the resistor ratio can be balanced so that the best CMRR is obtained. It is possible to get a better CMRR than the one you would obtain from a transformer. Also, a transformer can itself pick up mains hum, it is expensive and heavy. So electronic balancing can be quite competitive. One problem is obtaining a truly differential low noise amplifier. I would suggest a RC4136 which is a quad low noise op amp.



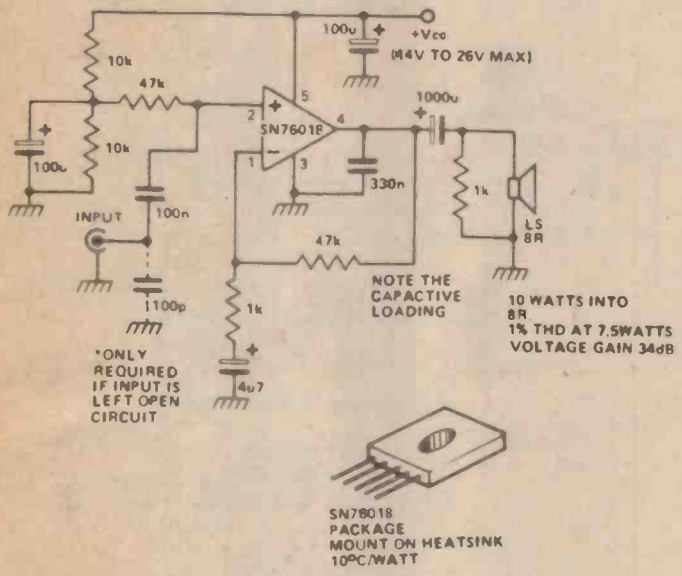
10 Watt Power Amplifier

This is a very simple and inexpensive monolithic power amplifier made by Texas Instruments. It comes in a package that looks like a plastic power transistor with five legs. Thus it can be screwed down to a heat sink without any problems.

The THD specifications for this device are:

10 W at 10% THD (R1 = 8 ohm)
7.5 W at 1% THD (R1 = 8 ohm)
0.5 W to 6.5 W at 0.2% THD (RL = 8 ohm)

No isolation from the heat sink is required. It should be used in applications where high fidelity is not required. Note that it requires two stabilising capacitors.



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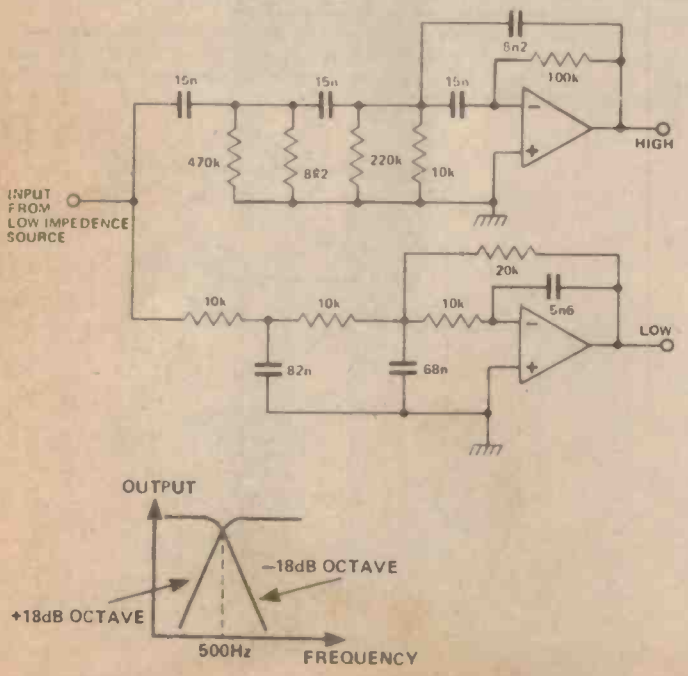
Active Crossover Unit

The circuit shown is for a two speaker system having a crossover frequency of 500 Hz. The filter structures are third order Butterworth multiple feedback, low pass and high pass. (Third order implies that roll off slopes of ±18 dB/octave are obtained.)

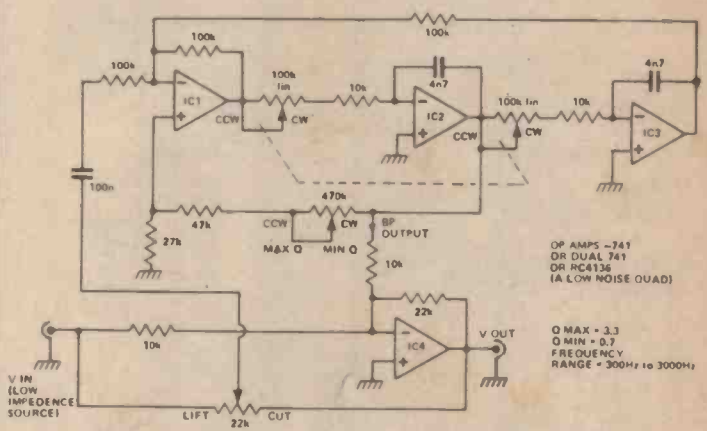


Parametric Equaliser

This is possibly the equaliser for the amplifier system that has everything. The parametric equaliser has got three controls. It is a bandpass filter which can have variable cut or lift, so that a particular freuqency band can be enhanced or rejected. The resonance can also be controlled so that area of frequency affected can be broad or narrow. Also the centre frequency of the bandpass filter can be varied so that it can be tuned to operate at a particular frequency. The circuit operation is quite simple.

Op amps IC 1,2,3 form a state variable filter, the Q and centre frequency of which can be varied. Op amp IC4 is a virtual earth amplifier. When the equaliser is in the lift position, the signal is fed into the state variable filter. It then comes out of the bandpass output and into IC4. In this feed forward position the equaliser has got a peak (lift) in its response. When the equaliser is in its cut position, the bandpass filter is in the feedback loop of IC4 and so there is a notch in the frequency response.

Care must be taken not to cause overloading and clipping when using high Q lifts.

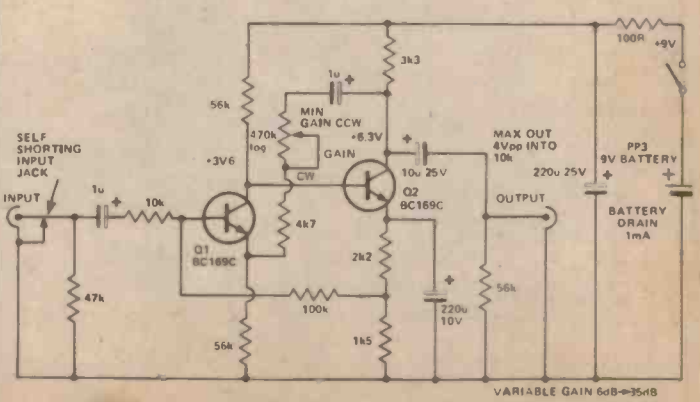


Low Noise High Gain

Mains hum is easily picked up with high impedance microphones, particularly if the microphone cable is long. Also, a treble cut occurs when using long cables. The output impedance of the microphone and the capacitance of the cable produces a low pass filter which cuts off the high frequencies, so that a high impedance microphone should only be used on a short cable.

For low impedance types, a low-noise high gain amplifier is needed, as output is much lower, and the circuit above is such an amplifier. The noise generated by transistors is a function of collector current. The current through Q1 has been optimised to give low noise operation.

The amplifier has an open loop gain of more than 60 dB. Negative feedback is applied, via a variable 470 k pot, so that the closed loop gain is controllable from 6 dB to 35 dB. This allows the gain to be tailored to suit different types of microphone and hence get the best overload and S/N ratio conditions. A maximum signal output of 4 V into a 10 k load is obtained and the current drain is 1 mA making it possible to run the amplifier from 9 V battery.

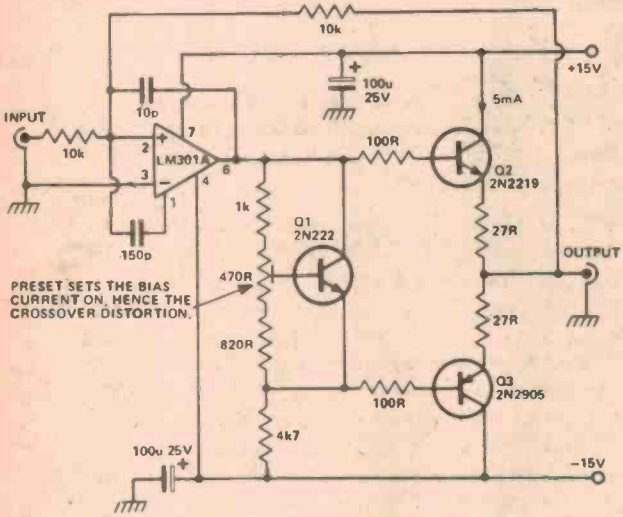


AUDIO AMPLIFIERS

Unbalanced Line Driver

The high open loop gain of an op amp is combined with the power handling capabilities of discrete transistors to produce a line driver amplifier. The output driver stage (Q1,2,3) is included in the overall feedback, and acts as a power booster on the output of the op amp. Transistor Q1 is used as a VB_{RE} multiplier. That is, it sets up a voltage of about 1.5 V between its collector and emitter. The actual voltage can be set by the preset connected to its base. Thus the bases of Q2 and Q3 can be biased apart by a set amount, just sufficient to make them work in class B operation.

If there are any ambient temperature changes, Q1 automatically adjusts the bias voltages to Q2,3 to maintain a constant bias current. There is overall negative feedback from the output, providing a voltage gain of 0 dB (x1). The output is partly short circuit protected by the 27 ohm emitter resistors. This amplifier can deliver high level, low distortion signals into low impedance loads. It could be used as an output driver in an unbalanced audio mixer.

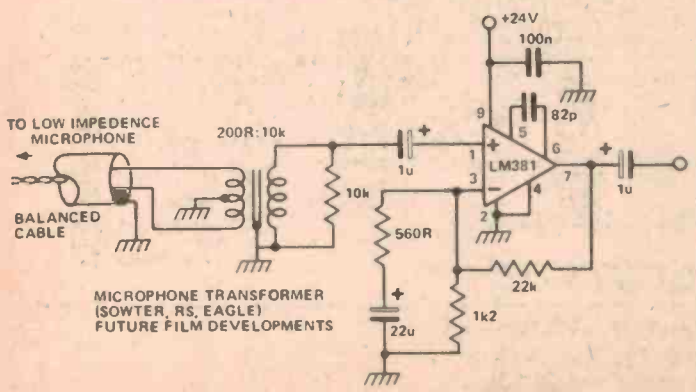


Balanced Microphone Preamplifier

Professional audio equipment generally uses balanced inputs and outputs. This means that the inputs and outputs are differential, which is usually obtained by having balancing input and output transformers.

The advantage of using a balanced system is that any unit can be connected to any other unit without any ground loop problems. A balanced system eliminates these problems. Also, mains hum pick up is reduced. A balanced audio cable has an outer screen and a twisted pair of wires in the centre. Any mains hum (or other signal) which is picked up on the twisted pair will have the same amplitude on each of these central wires. This is a common mode signal. The microphone signal applied to these two wires is a differential signal. Thus, when the microphone signal plus mains hum is connected to the transformer, the differential signal appears at the output windings and the common mode signal is rejected. Thus the mains hum is suppressed.

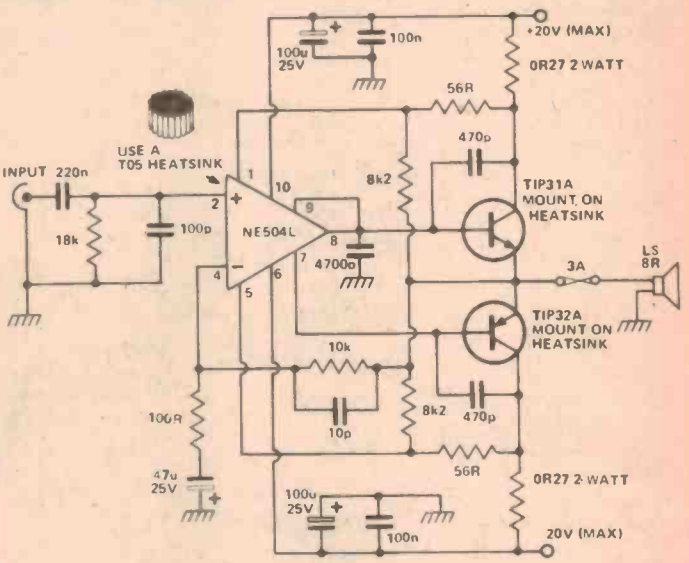
The transformer also provides a voltage gain, and the LM 381 provides a low noise amplification of about 32 dB (x40).



20 Watt Amplifier

An audio power amplifier can be constructed from a power driver op amp plus a pair of transistors. The power driver is a NE540 made by Signetics. It generates quite a bit of internal heat and so a T05 heat sink is required. Note that this design uses five stabilising capacitors.

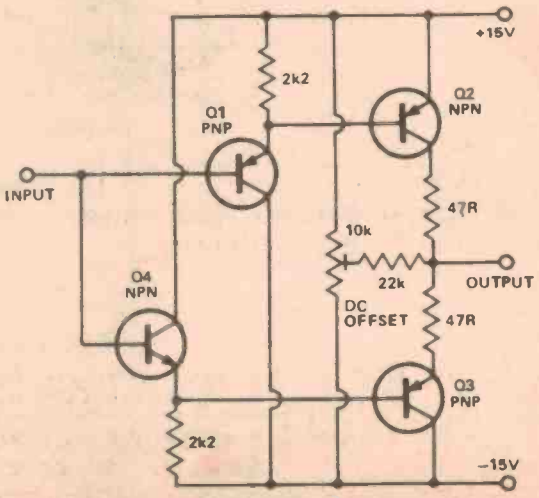
The amplifier works quite well once any stability problems have been sorted out and the power output is quite adequate for a domestic amplifier system.



50 Ohm Driver

When you want to buffer a test generator to the outside world it is often very difficult to get an amplifier with sufficient bandwidth and power handling to do the job. The circuit is a very simple unity gain buffer. It has a fairly high input impedance, a 50 ohm output impedance, a wide bandwidth and high slew rate.

The circuit is simply two pairs of emitter followers. The base emitter voltages of Q1 and Q2 cancel out, and so do those of Q3 and Q4. The preset is used to zero out any small dc offsets due to mismatching in the transistors.



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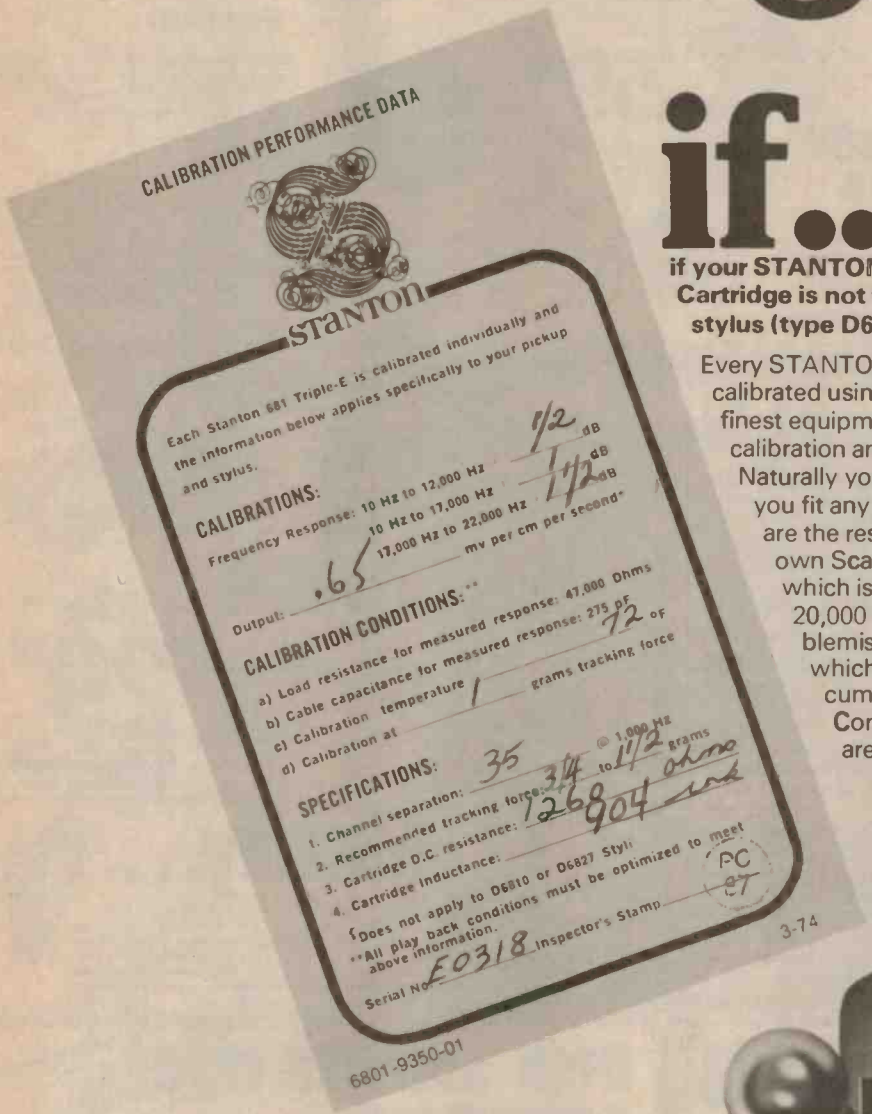

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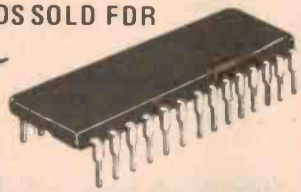

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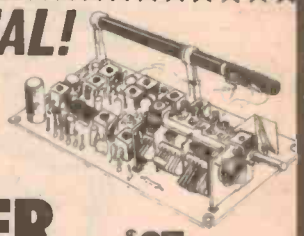

~~$37.50~~ $29.50 SAVE $8.00

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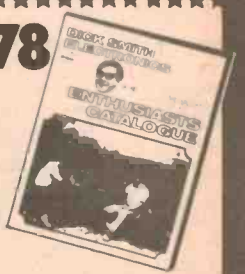

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All other components are normal stock lines at all of our stores.

PHOTO TACHOMETER (See August E.A.)
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
FPT100 phototransistor .. .. Cat Z-1950 .. $2.00

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NEW 10 GAME TV GAME KIT (See July E.A.)
Complete kit, including instructions .. .. Cat K-3491 .. $49.50
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Complete kit, including instructions .. .. .. Cat K-3469 .. $25.00
SEPARATE PARTS:
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VK POWERMATE (Short form) See May E.A. Electronics, but no metalwork, terminals. Cat K-3449 .. $32.00
SEPARATE PARTS:
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R-C-L BRIDGE (See March E.A.)
Complete, with printed un-punched panel. Cat K-3468 .. $34.50
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SIMPLE 12V TO 22V CONVERTER (See E.T.I July)
Not produced as a kit, but all parts are available as normal stock lines except the PC boards. You can make your own PC boards using the Scotchcal process & resist – see our adverts last month for details.

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Not a full kit. Special parts:
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STUNT MOTORCYCLE TV GAME (See E.T.I. June)
Full kit, including instructions .. .. Cat K-3474 .. $29.50
SEPARATE PARTS:
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Fully built RF modulator .. .. Cat K-6040 .. $3.00
AY-3-8760 IC .. .. Cat Z-6854 .. $19.50
3.58MHz crystal (new low price) .. .. Cat K-6031 .. $3.00

AUDIO OSCILLATOR (See May E.T.I.)
Not produced as a kit. Make your own front panel with Scotchcal – see our adverts last month for details. Most parts for this are normal stock lines.
PC Boards (set of 2) .. .. Cat H-8614 .. $3.65
ICL-7106 evaluation kit for digital readout .. .. cat K-3450 .. $39.50

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Electrets in Audio

Electrostatic 'phones are generally acknowledged as the best but need a high voltage supply. Now, electret headphones are claimed to have the same performance without the need for a separate supply. Cartridges and microphones too now use electret technology.

But what exactly are electrets? What do they do and how do they work? And did you know you can even make your own? Ian Sinclair explains. .

IN its simplest form, a capacitor consists of two parallel metal plates insulated from each other by air or some other non-conducting material between the plates. If an electric charge, meaning a few electrons, is taken from one of the plates and put on the other, so (charging the capacitor) a potential difference will appear across the plates.

The ratio of the amount of charge to the value of voltage is the quantity which we call capacitance. The relationship can be described more formally as Q=CV, where C is the capacitance in farads, Q is charge in coulombs, and V is the voltage in volts (see Fig. 1). When a capacitor has charged, the charge will remain unless conduction between the plates allows the electrons to travel back to where they started. While the capacitor is charged, energy will store in the form of an electric field between the plates.

For any simple capacitor of this type, the value of capacitance is proportional to the area of the plates and mathematically this is:—

$$C = \frac{\epsilon_o A}{d}$$ (see Fig. 2)

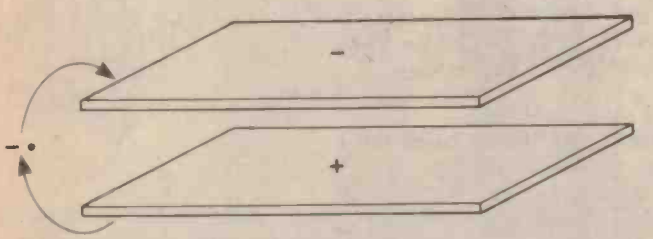
The above formula is correct only where the plates are separated by air. If any other material is used, then a numerical multiplier, called the relative permittivity, of this constant will also appear, making the formula:

$$C = \frac{\epsilon_o \epsilon_r A}{d}$$

In each of these formulae, A represents the area of overlap of the plates in square metres, and d is the spacing between the plates in metres. The effect of the relative permittivity is to increase considerably the capacitance between two plates which were formerly air-spaced.

The reason for this behaviour of insulating materials is that the electric field between the plates of the capacitor acts on the atoms of the dielectric, that is the insulator which is placed between the plates, so that there is a force trying to separate the electrons from the remainder of each atom in a direction which is towards the positive plate of the capacitor. These electrons cannot shift very far; if they could, the material would not be an insulator but a conductor. The result of this slight shift is to "polarise" each atom or molecule, meaning that one end of the molecule is slightly negative and the other end slightly positive, and the amount of this polarisation which takes place depends very much on how the atoms of the material are constructed.

Polarisation causes another electric



QUANTITY	SYMBOL	UNITS
CHARGE	Q	COULOMBS
VOLTAGE	V	VOLTS
CAPACITANCE	C	FARADS

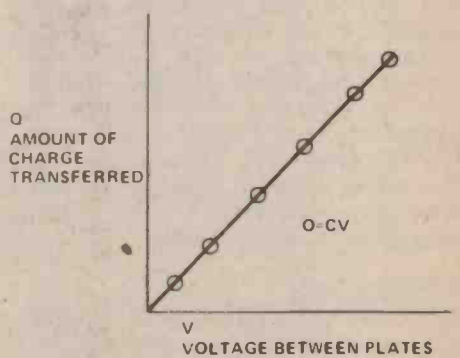


Fig. 1. The parallel - plate capacitor. (a) Charging consists of shifting electrons from one plate to the other. (b) A graph of charge transferred plotted against voltage is a straight line and its slope is the value of capacitance.

Electrets in Audio

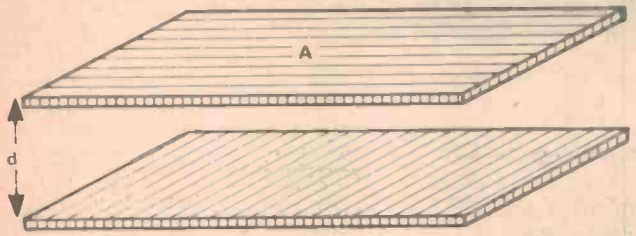


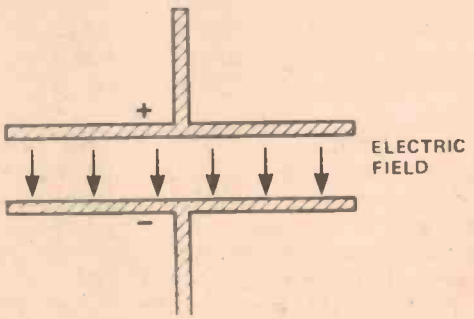
Fig.2. Capacitance values. The value of capacitance of a parallel-plate capacitor is decided by the area of the plates and the spacing (when no dielectric is used). Tubular capacitors are simply parallel plate types, with a thin film dielectric, which are rolled up with another layer of insulation.

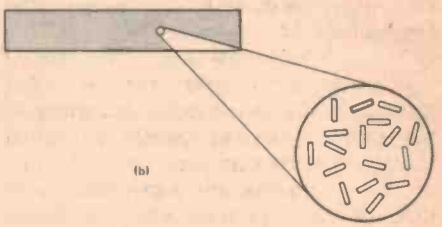
$$C = \frac{\epsilon_0 A}{d}$$

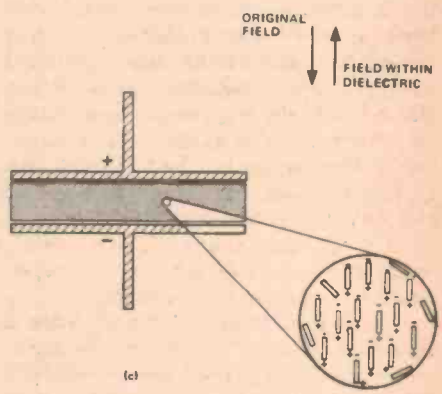
QUANTITY	SYMBOL	UNITS
CAPACITANCE	C	FARADS
AREA	A	METRES^2
SEPARATION	d	METRES
PERMITTIVITY OF FREE SPACE	ϵ_0	FARADS/METRE

$\epsilon_0 = .0895$ F/m

Fig.3 (Below). Dielectrics. (a) The electric field between the plates of a capacitor. (b) Representing a dielectric; the molecules are randomly arranged. (c) In a polarised dielectric, the direction of the field inside the dielectric opposes the field (of the capacitor plates) which has created it.







field to appear, this time inside the material and in the opposite direction to the field between the plates. Because these two fields are in opposite directions, their effect subtracts, and the total electric field between the plates is less than it would be if the dielectric were not present. Because the field is less, so is the voltage and so the capacitance is *greater.*

Sensitive to size

The use of dielectrics in this way makes it possible for us to manufacture capacitors of comparatively large values in a reasonably small size, but can cause problems, one of which is voltage sensitivity.

We may find, for example, that the amount of the shift between the atom and the electrons of the dielectric varies with the voltage we apply to the plates of the capacitor, in which case the amount of polarisation will change as the voltage is changed. A capacitor like this will be voltage-sensitive, and its capacitance will change as the applied voltage changes. If such a capacitor, typically the high-K ceramic type, is used as a by-pass, this variation of capacitance is of no great consequence, but it makes such capacitors useless for tuning resonant circuits. A very thorough treatment of this subject appeared in ETI April 1976.

Causing a spark

Most observable effects work in both directions, and dielectrics are no exception. In this case, the opposite of the normal action of the dielectric occurs in piezo-electric crystals, where we apply a force which shifts atoms slightly out of place relative to their electrons, and cause a voltage to develop across the crystal of the material. This voltage can be detected by connecting to metal plates formed on opposite sides of the crystal. In this case it is the force which causes the field, and the field which then causes the voltage.

In many types of piezoelectric crystals, the voltages which are generated can be quite high, high enough to cause a spark, which is why piezoelectric crystals can be used as igniters.

Another variation of this effect, of course, is the familiar piezoelectric crystal pickup cartridge, where a force is applied from the stylus through the cantilever, and the voltage between the plates is the signal output.

Piezoelectric effects last only whilst the normal structure of the material is distorted, and they disappear as soon as normal conditions are resumed. Electrets are materials which have a structure which has been changed *permanently*, and which therefore have permanent amounts of charge displaced. Such materials have been known for sixty years or so.

If we use an electret as a dielectric in a capacitor then there will be a permanent dc voltage between the plates of the capacitor, though we will not be able to draw any measurable current if the plates are connected together.

There are many materials which have molecules with a natural and permanent polarisation, water is one of them, yet are not electrets. The reason is that in such materials these permanent polarisations are not held in one particular direction, so that the electric fields which are caused by one molecule simply cancels each other out, with no overall effect. What makes a material an electret is the combination of a polarised molecule with a fairly low melting point and a very high resistivity, so that the material can be heated, the molecules brought into line by an external field, and the material allowed to solidify again so that the molecules are permanently "frozen" into position again. The high resistivity then ensures that there is no movement of charge which could reverse the process.

Electrets in Audio

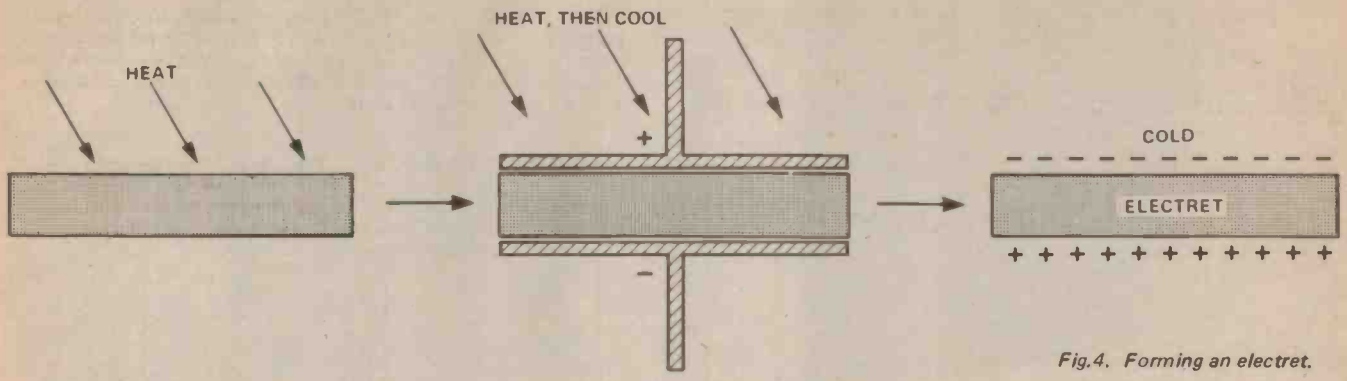


Fig.4. Forming an electret.

Getting into hot plastic!

Many modern plastics materials are ideal electrets, some even have their charges established during the manufacturing process simply because of the electric fields which exist while the material is cooling. In most cases, however, the plastic has to be made into an electret by a combination of heating, applying an intense field, and cooling while the field is applied.

Such plastics sheets will "stick" tightly to each other and to other plastics, will pick up dust, and show all the other behaviour which is normal to electrets. (It may well be that some of the problems we experience with modern vinyl phonograph records are due to partial electret formation during pressing.)

As far as the applications of electrets to electronics is concerned, these arise because an electret is sensitive to anything which disturbs the arrangement of its molecules. A capacitor containing an electret as dielectric, for example, should be sensitive to vibration, i.e. microphonic. The opposite effect should also be true; if we apply ac between the plates of an electret capacitor we should be able to cause vibration of the electret material (if it is free to move) the capacitor thus acting as a loudspeaker.

As well as these ac effects, there is also a dc effect. Any electret capacitor will have a steady voltage between its plates which is caused by the field which permanently exists across the electret.

This voltage can be detected only by an electrostatic voltmeter or by a very high input resistance electrometer, because the internal resistance of the capacitor is extremely high. The voltage will change as the temperature difference between the surfaces of the dielectric material changes, and this is particularly obvious when the electret is struck by radiant heat; the effect is called the pyroelectric effect.

Hot air and telephones

A pyroelectric detector consists of an electret sandwiched between a solid metal plate and a metal gauze, or between two transparent conducting plates, with an electrometer connected between the plates. Changes in air temperature will not cause any change in the voltage reading if they affect both sides of the electret. If we shine radiated heat on to one side of the electret a difference in temperature will exist across the electret, causing a difference in voltage. The sensitivity is quite remarkable. Placing your hand at a distance of about 1 metre from such a pyroelectric detector radiates enough energy to cause a reading of about 1 V.

With some dc amplification, a temperature difference of a millionth of a degree caused by radiated heat can be detected, so that the pyroelectric effect has immense possibilities, for measurements. Even without amplification, detectors using the pyroelectric effect have applications in burglar alarms, fire alarms, detecting hot spots in machinery, even possibly for replacing fuses.

It was recently announced that some phone companies intend to replace the old, carbon microphone in telephones by an electret type, and presumably the earpiece will be replaced similarly. Some electret pickup cartridges have now appeared, but we still waiting for a range of electret loudspeakers which would need no polarising voltages and hence no ac supply.

Stock question

This is one of the fields of modern materials research in which it is possible for almost anyone to get into the act. So many modern plastics form electrets easily that it is not impossible to manufacture them for yourself, though the effort would hardly be worthwhile on a one-off basis. Ready made electret materials are by no means easy to obtain, though there is always a possibility of manufacturers of plastics sheeting for electronics use, or capacitor manufacturers, having small quantities in stock. (Perhaps one of our enterprising surplus dealers might be able to obtain some of this material.)

Finally, suppose one were able to manufacture capacitors with a permanent voltage across them, how much would this save us on high value bias resistors for FETs?

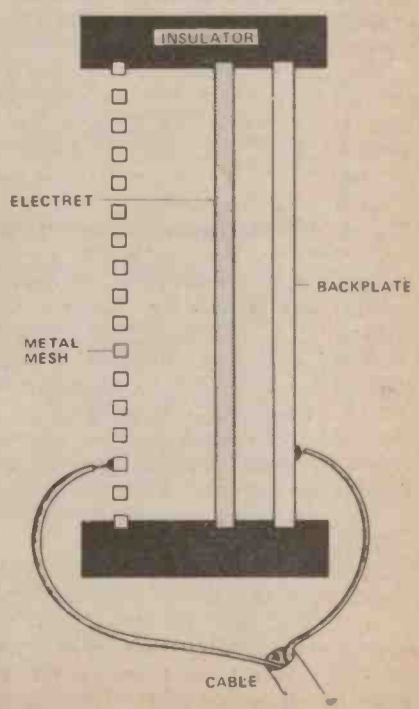


Fig.5. An electret microphone or loudspeaker in cross-section.

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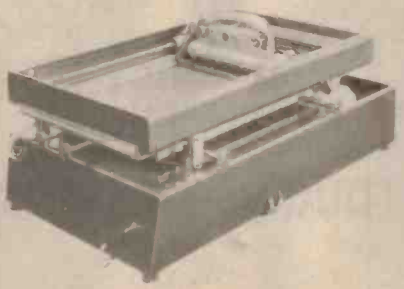

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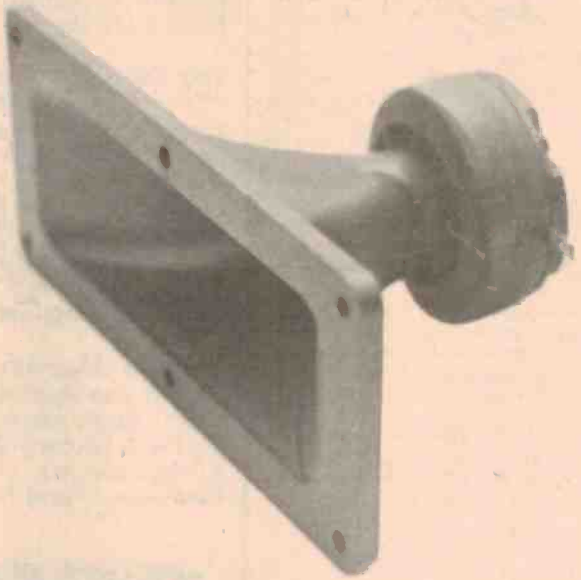

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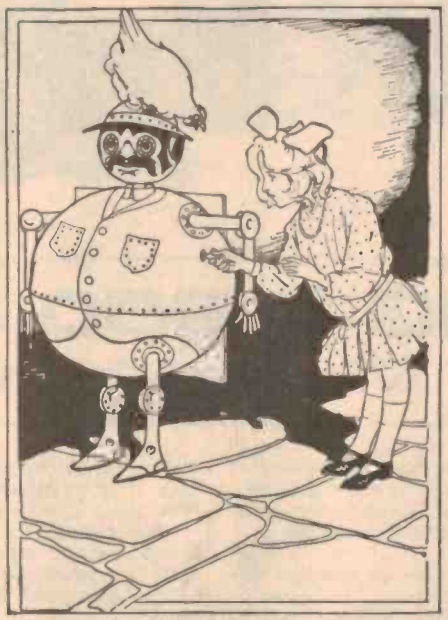
Robots–how to build your own

Here's a complete guide to robot design and construction written by people who know — Dr. Michael Larcombe of Warwick University's Robot Laboratory and ETI's special correspondent Associate Professor Peter Sydenham of New England University.

PROBABLY the most important thing to realise is that successful robots do not grow as can a electronic circuit. Mechanical structures and components are vastly more time-and money-consuming to alter as changes are seen to be needed. Because of this the deficiencies of mechanical elements incorporated into a robot tend to be retained. Add a few of these shortcomings together and the device will not perform as expected.

Thus planning is vitally important from the word go. Many decisions must be made before money or time is committed to specific hardware. The ability to imagine and synthesise the finished product before it is built is the skill that humans have over the robot — so use it well.



Getting under way

The imaginative process of design is greatly aided by the use of diagrams, sketches, plans and written results. A tidy report file must be kept going from the start of the project.

After deciding what functions the robot is to fulfil, the next step is to develop a master system diagram of the whole, detailing the various subsystems and their interaction with other sub-systems. Figure 1 is an example. Wherever practicable, try to develop the overall system as one built from basic system units that can be developed and tested as separate units in isolation.

Keep the master schematic block diagram updated each time major changes are incorporated. For each block, or group of blocks, there should be further diagrams showing more detail of the construction and circuitry. Even the simplest robots can soon become too complex to record as a whole. An orderly hierarchy of records is needed.

When the stage of realisation of adequately basic schematic diagrams is reached the design can then progress to the creation of the blocks, designing each sub-unit to suit the specifications decided earlier. At this juncture (and later) several earlier decisions may turn out to be inadequate so, once the final change is agreed upon, go back and modify the master system and other blocks as is necessary.

It is always preferable to design the sub-units so that they can be tested easily. It helps build confidence in the design as they can be pre-tested before final assembly of the whole. It also makes good sense to be able to isolate a unit easily when a fault occurs that must be traced. Pre-testing gives useful test results for later comparison.

Assembly should be designed to allow all major subcomponents to be easily removed for maintenance and repair. There is nothing so frustrating as a fault occuring right down inside the structure where layer upon layer of mechanics and electronics must be removed to get to it. Make use of hinged panels, plug-in circuit boards, easily bolt-on drive and sensor assemblies with removable circuit connections. For one-off prototypes there is good sense in building in far more flexibility of assembly and disassembly than could be tolerated in a mass-produced, well-tested design. Where possible, build the working unit as a second one, retaining all developmental work for possible later comparison.

Always attempt to design sub-units so that they do not interact with other sub-units. For example, a manipulator arm must be sufficiently stiff in bending and torsion to retain its shape when loaded. If it bends, the position of the hand could differ from that indicated by position sensors which, in turn, will try to correct out an error that was not there by the ideal design standards. If the power supply droops when a load comes on to an actuator, this may alter the supply voltage to circuitry, altering the performance of other components. Where interaction results it may alter the fully-assembled units' performance in ways that are not easily discovered at the testing stage of the sub-units.

As sub-units are created, their circuit drawings must be laid out neatly with all component values marked thereon. Good mechanical sketches should be made. It is all too easy to forget that a few months later, after working on other aspects of the robot, one does not remember the detail tackled previously.

Choice of components

As the sub-systems harden in design so will the specifications of the elements needed. They will generally be of optical, mechanical or electronic nature. At some stage each specific component must be located, if procurable, or made, if not. Circumstances will largely decide the choice. Optimally one chooses the best available unit, but in reality such factors as cost, availability, life and replaceability will force the designer to make compromises. The cheapest may

suffice. Usually, but not always, the more expensive mechanical component is the best to use. Mass-produced components from construction kits and popular toys, such as aero models and model trains, are good value. Bicycles, domestic appliances and motor car parts are another source of quality low-cost assemblies. Specialised electromechanical construction kits, such as Meccano. Fisher-Technic, FAC and Presto, are easy to employ, but they can be expensive to get started with. They also can lack the rigidity of structure often needed.

One thing to avoid is the use of complex components (such as motors) that you possess already but which cannot be replaced or repaired easily.

Choice of alternatives is less important with electronics as most solid-state devices now have many roughly equivalent alternatives, but, even so, steer well clear of using devices that are not currently marketed at low cost on an extensive basis with double or more sourcing.

Structural Frames

The robot's functions are made possible through actuators and sensors causing the whole and the limbs to move as desired in a dynamic sense. The structures holding the limbs and the limbs themselves must be adequately stiff – that is, they must not deflect or twist more than is allowable under load. There is no such thing as a totally stiff structure, for no material known to man is inelastic. A basic aim of structural design for a robot is to provide an inelastic structure having minimum mass. This rule especially applies at the extremities of rotating arm-like structures where rotational inertia increases more rapidly than linear elastic deflection as the distance from the centre of rotation increases.

Elasticity of a structure can introduce many unwanted interactive couplings – weak gear train mounts may allow the gears to unmesh as the frame twists with increasing load. Smaller misalignments will usually introduce increased frictional losses.

The principle of triangulation enables rigid light structures to be built. It says that each segment of a panel or beam required to be stiff in the plane of its flatness is made from triangles of connected limbs. Open squares and rectangles must be made into triangles by the addition of a central cross member. Linear rigidity is relatively easy to achieve; torsional rigidity is much harder to obtain for that mode of flexure requires stiffness at 45° to the linear axis.

Stiff and floppy members

Solid thin sheets obey the triangle rule and are always theoretically stiffer than a sheet which is lightened with holes or made from elemental bars. However, the solid, thin 2D members are rarely better than the same weight of the material re-arranged as a 3D member which will possess torsional rigidity as well.

Structures can be made incredibly stiff and light if the maker is prepared to put enough work and cunning into their design.

Triangulated structures work on the principle that members are either in direct axial torsion or compression. If in tension they can be as thin as their strength requirements allow, but if in compression a long thin member will buckle and fail well before it collapses through lack of compressive strength. Compression members are, therefore, kept as short as possible and have stiffness to increase their buckling strength. Tubes and angles are commonly used. (Think of early aircraft structures using struts and wires.)

Fig. 3. This working model of RIVET explores an ingenious method of transport. It can go over obstacles twice its own height.

Structural choice

The choice of materials is not always easy, for light strong materials, such as aluminium alloys, are not easy to join by the amateur – rivets or bolts must be used, as welding and soldering are not possible without special equipment. Avoid pure aluminium for structures – it is too soft. Aluminium does not need a protective coating but looks better if it has one.

Steel is more easily joined by welding and hand-soldering or brazing, but, although having the greatest stiffness of common metals, it is one of the heaviest. It corrodes easily – plating or painting is a must for all steel parts of a well-made robot. It is a mistake to think steel parts can always be painted after the robot is finished – there are usually too many wires and components attached to do a good job afterwards. So

paint or plate as you proceed before assembly.

Plastics are a relatively new element of structural design. Very respectable jobs can be made using modern adhesives and plastic formulations. The catch is that they are comparatively flexible and heat-sensitive. As they get hotter, they may sag, will certainly get more elastic and, worse still, may deteriorate completely in the long term. Great care must be exercised about the choice of plastics used.

Wooden materials have their place, but always opt for waterproof qualities that are well seasoned or treated to retain shape.

Modern glues, such as instant-epoxy kinds and filler-based epoxy resins, are often an ideal choice for fastening members. But, again, care is needed in their use. If in doubt, conduct tests on test specimens before embarking on the real job. The simplicity of glues often leads one to make quick joints that are impossible to open when the unit requires disassembly. The easy path is not always the best in the long run.

An important point often overlooked is that robot frameworks may be subjected to excessive loads and forces during the testing and development stage. Transportation of the whole, or merely picking it up or having limbs moved by external forces such as prying children's hands, can often break assemblies that are well within their design limits of need. If this is the case try to incorporate safety features, such as clutch drives, that will slip for excessive load.

Motoring

Most motors used are cylindrical and use permanent magnets to supply the field. They will have a relatively small number of commutator segments and are best run at quite high speeds. For slow speed shafts a gearbox is needed to reduce the motor speed and increase the drive torque available. High ratio gearboxes, however, introduce backlash and friction problems that reduce the effectiveness of tight servos. Avoid high-ratio gear trains and any other kind of drive with slop in it. Worm drives can also present problems as they cannot be driven by the output shaft. The better systems use anti-backlash gear wheels, but these are expensive. High gear-up ratios amplify the rotational load inertia seen by the motor, so keep high-speed loads light if good response is needed.

Fastest energy exchange occurs when the load inertia seen by the motor equals its own value — similar to the energy transfer law for electrics.

The printed armature, radial shape, motor is well suited to robot work as it has many commutator segments, great

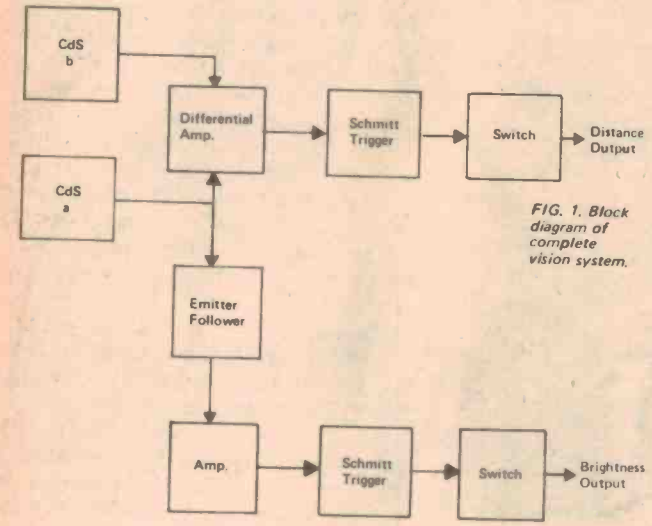


FIG. 1. Block diagram of complete vision system.

Still very much up-to-date in general concepts, this robot called 'Merv' won the 1970 School Science Research prize for occasional ETI contributor Peter Vogel. The device was described in detail in the very first issue of ETI — April 1971.

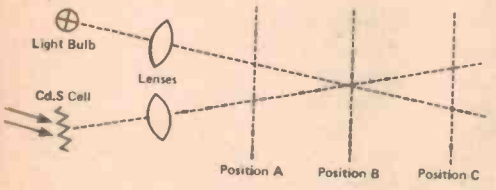
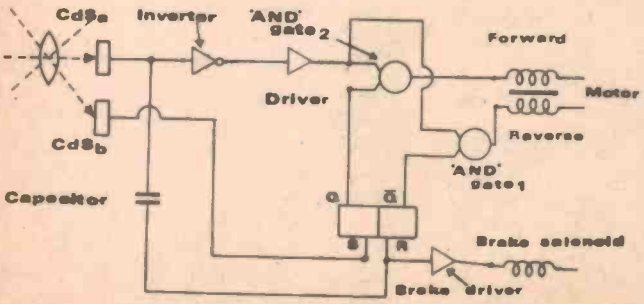


FIG. 1A. How optical system measures distance from objects.

FIG. 1B. (below). This system enables Merv to track a light source.



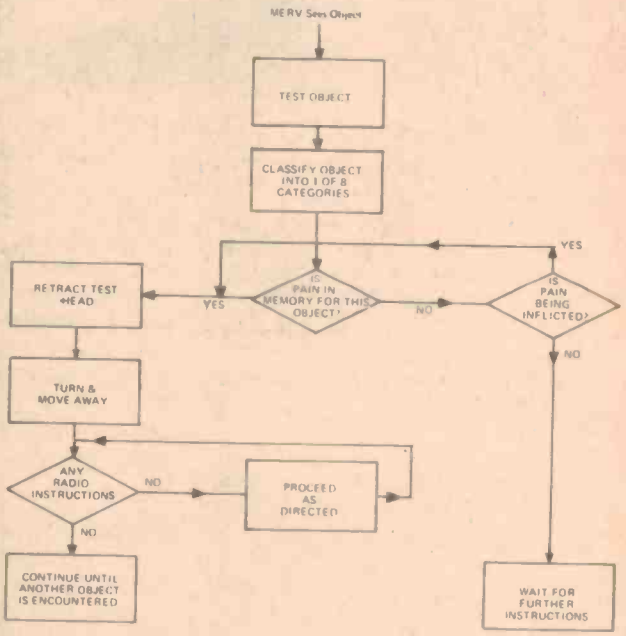


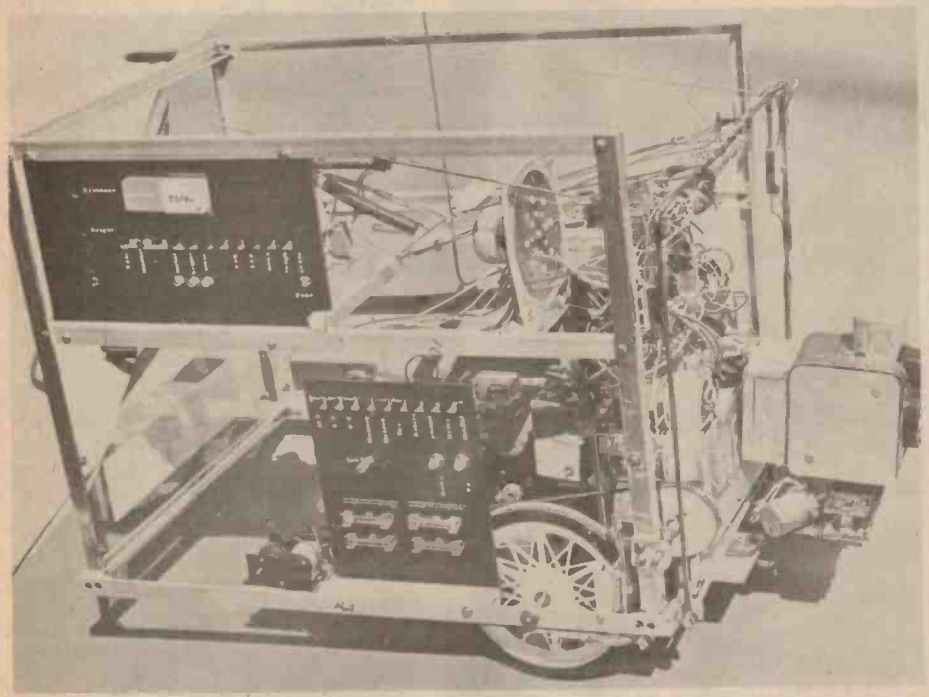
FIG 2. Flow diagram shows MERV's sequence of operations.

overdrive capability for use in transients and excellent low-speed performance. Gears are often unnecessary with servos built of these. Inexpensive versions are available (car fans, for example), but they usually lack a second output shaft or an inbuilt tacho. Versions with inbuilt tachos are really satisfying to use but are priced for professional robot designs.

Simple motors from toys are rarely adequate. They are not designed to last. The extra cost of better motors will be found worthwhile.

Remote control

Control from a position away from the robot can be achieved most easily by using a wire link in the case of fixed manipulator machines and limited movement mobiles. Wires are certainly the cheapest and most reliable link, but in the case of mobiles and some special applications, non-contact telemetry is



needed to and from the robot.

Radio control would be the obvious choice as many marketed systems are available at reasonable prices. Model aeroplane control, and more recently model car and boat controls, are easily adapted to form command links. As most robots work at power levels greater than the actuators used in model planes, it will be necessary to add power amplifier stages (relays for simple on-off control, linear amps for proportional controllers) at some convenient output point of the telemetry system.

Acoustic senders working at around 30 KHz can be used for systems needing detection from any direction of robot orientation. Optical beams are restricted as links to situations where the beam remains aligned with the robot receptor.

See me, feel me . . .

The basic senses of human beings are touch, sight, hearing, smell, taste. These provide many ideas for robot sensors. Other senses exist, such as ultrasound, radio waves, infra-red and ultra-violet radiation, that are not given to humans.

When finalising a sensor stage ensure that its output signal level, impedance and frequency response suit the stage, or stages, it must drive. Most sensor outputs need amplification, and it usually makes best cost sense to use an integrated linear circuit to obtain the gain. IC stages generally have low output impedance and set voltage swing limits. Typical values will be + 10 V with a zero bus for linear devices (higher are available but are more expensive), zero bus with + 5 V for TTL logic and a wide range of choice for CMOS logic. There are few standards so it is not possible to categorically define signal levels. Choice of levels is, however, worth serious study before the design goes too far, as the fewer the bus voltages used the better. They must also match the chosen supply source. Try to avoid the need to create numerous bus voltages from basic supply rails — zener and series regulator units waste power.

The cost of low resolution analogue to digital and digital to analogue converters (low resolution will usually be adequate in robots) is now such that the output form of the basic sensor can easily be converted to the other signal form if it is more appropriate.

Space permits only a brief account of a few typical sensors used in robot devices.

Touch me . . .

Simple touch sensing is easily done with a light arm or feeler that operates either a microswitch for on-off control or a linear or rotary potentiometer for proportional control. Whereas virtually instantaneous signal changes can be created in electronic circuits, the same is not true of mechanical systems. A touch-bar moved as warning that the robot must stop immediately should be able to deflect sufficiently as the unit comes to rest. Either make the bar flexible or give it a spring joint where it can bend elastically. The amount of deflection needed depends upon braking effort, speed of robot and its mass. As a guide, a 20 kg unit moving at walking pace and being braked by a reversed connection 100 W motor may require as much as 500 - 100 m of overtravel, depending upon the frictional force existing between its wheels and the surface it is on (decided by coefficient of friction, weight on the wheel and braking force on the wheel axle.)

Tactile sensing, such as is needed to control the clamping force of a closing hand, requires proportional measurement of closure force.

A rubber or plastic tube filled with air makes a good protective buffer. Addition of a pressure-sensitive switch into an outlet enables the buffer to cut power supplies or reverse the velocity drive. Obviously, imagination and innovation can produce many more touch sensors.

See me

Human sight is sensitive to only a very narrow band of the available electromagnetic radiation spectrum. Robot 'sight' can extend much further to make use of infra-red and radio frequencies as well as those in the visible region. Certain infra-red sensors can detect the thermal radiation of room temperature bodies and resolve them against backgrounds at a different temperature, if at the same temperature as the background, however, the object can go undetected. This effect, called 'washout', exemplifies just one of the many kinds of sight problems that robots need to tackle.

Most worthwhile seeing conditions resolve to those of pattern recognition once the 'visual' picture is transduced

by appropriate sensors into electrical signals. In robots the higher order seeing problems to be tackled require extensive data processing facility. The microprocessor now promises to provide the kind of power needed at realistic prices for amateur robot projects.

The easiest to invent and build is the photodetector that responds to an increased intensity source using the dc level change as the sensed signal. This kind of sensor is suitable to move the robot toward or away from bright lights or to increase or decrease its activity as the ambient light level changes. It is of little value in applications where the robot has to seek out a certain 'marked' place or beacon or follow a moving light marker.

In these cases, the source light can be coded by amplitude modulating it to at least 10% depth at some convenient frequency which is not a multiple of mains frequency (or it may well fall in love with all fluorescent and incandescent mains-fed lights).

Similar principles work for infra-red and microwave and also for acoustic methods. Seeing is usually taken to mean line-of-sight working only. Strategies may have to be programmed to ensure the robot obtains a line of sight long enough for it to learn of the direction to move to. (A sample and hold store of position is a must for such applications.) Modulated systems, although generally unresponsive to moderate ambient background illumination, will usually be affected by severe ambient levels, for these may saturate the circuitry. In such cases the output produced should be a fail-safe kind. (Many a robot has been made camera-shy when powerful flood lights are turned on for the public debut on television or film.)

Hear Me . . .

Sound waves behave in much the same way as electromagnetic waves, but with one big exception — they travel much slower. For this reason acoustic senses and senders are a popular choice for robot sense of position and for detecting presence. Their use is mostly based on the radar principle of sending a pulse (or continuous wave) and monitoring the time (or phase) delay of its return. Acoustic radars give good positional sensitivity at room and workshop size ranges. Use of ultrasonic (above the 20 kHz limit of human hearing) frequencies help avoid signal-to-noise ratio problems in acoustically noisy environments. Beware, however, of ultrasonic sources produced by machinery.

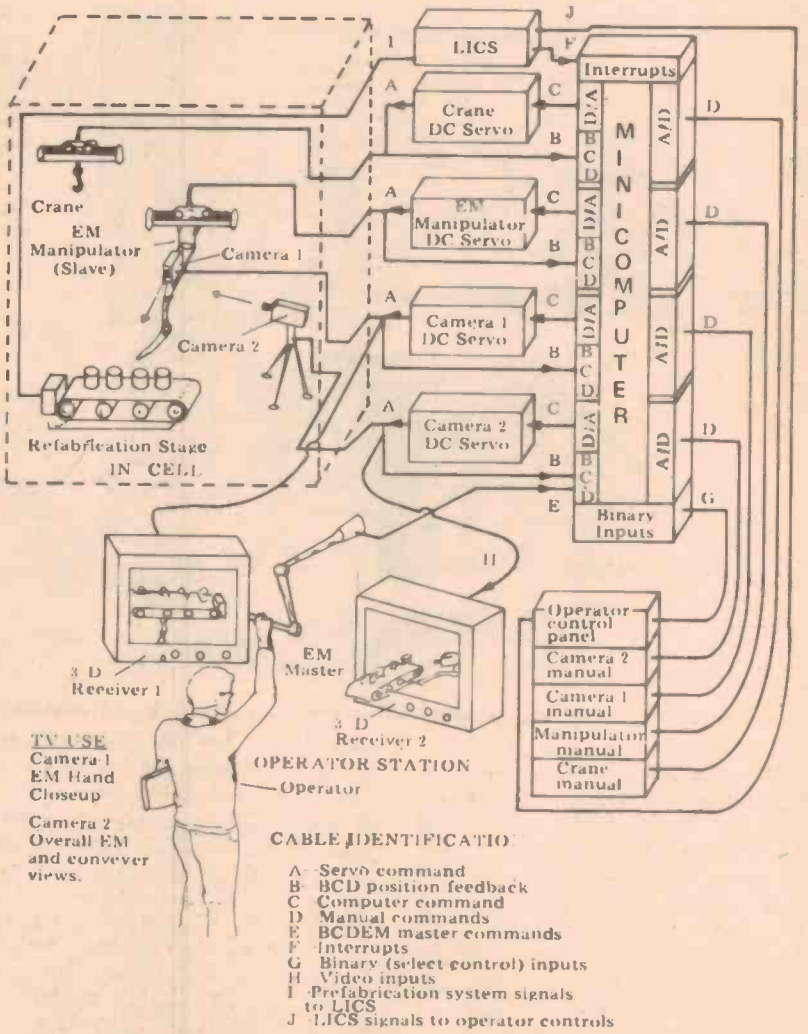
An array of inexpensive piezo-electric crystal receivers mounted in a pattern across the breadth and width of the robot frame can, after some signal processing, detect the location of a single source. Two units mounted on a tracking robot antenna can be used as a binaural position sensor. A single send-cum-receive unit mounted on the robot is capable of locating obstacles for a survival mode of robot operation.

Smell me, taste me . . .

Of the human senses these two have barely been developed in hardware form. Both are related to the presence of chemicals and therefore the methods of chemical analytical instrumentation are relevant. However, few analysers exist cheaply enough for the hobbyist pocket. Certain measurements, such as CO^2 CO and O^2 detection, can be achieved cheaply by sensing a simple effect of these gases on the temperature of a heated resistance (CO^2, CO) or via the voltage generated by a special cell (O^2). Smoke is more easily sensed as an attenuator of light than by the presence of its chemicals. An analyser capable of detecting smells such as rotten fruit, individual people, or the finest perfumes requires the use of a mass spectrum analyser or other sophisticated methods costing huge amounts of money and weighing many kilograms. In short, smell and taste are not very profitable senses to use as yet. An exception is robots already made commercially that seek out the centre of fires for extinguishing purposes.

Acting out a role

Sensors that produce the input signals tell the robot what is hapenning. To get the robot to act on such commands these signals are processed and used to drive power output devices, called actuators. These convert, in the main, the power source energy into mechanical



work. Actuators for robots usually require electrical signal (analogue or digital) inputs providing linear or rotary motion via wheels, gears, belts, tracks and what have you to do work.

Robots require motions that give speeds and positions. Basic motions needed, depending upon use, are continuous linear motion (wheels driven by motors, cables wound up by motors, rack and pinion), short-stroke linear motion (solenoids, restricted length rack and pinion), unlimited rotary motion (direct motor output, geared up or down motor motion), and limited angle rotation (rotary solenoids called torquers, pinion and wheel or rack). Chains, belts, pulley and flat flexible strips are elements used to provide various kinds of motion, including converting rotary motion to linear and vice-versa. The commonest and cheapest actuators are solenoids and motors. Where controlled variable torque is needed, dc systems are usually used.

Wheels are predominantly used to move mobiles. Walking is a spectacular method, but is far more difficult to design. Wheeled systems must be able to steer easily — car-like methods require intricate movements to escape a blind corner. Rapid response drives will require as much of the robot's weight on driven wheels as is possible. All wheels supporting weight but not being driven reduce the tractive effort available. The coefficient of friction of drive surfaces must be chosen to suit each applicatiion, or else excessive wheel spin will occur.

Open and closed loop

At this point it is worth devoting some time to the concept of closed-loop actuator systems, for all worthwhile robots use these.

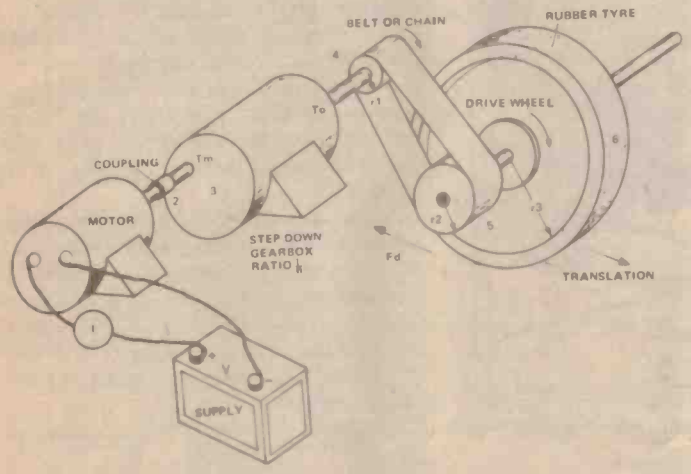
Consider a small motor coupled to drive a robot via wheels through a step-down gearbox. To get the robot moving requires more initial power than when it is running under steady load because friction of the static drive is greater than when running. Thus, as soon as it begins to move, the input must be reduced or else it tears away. Also, when the robot comes to a rise, the input voltage setting must be increased to give more power. This kind of controller is called an open-loop case. The real aim is usually to have the robot run at any given time at a steady known speed, over the range from zero to full speed, for all conditions of load.

This is done in a closed-loop system by sensing the actual speed of the motor (in electrical terms, by generating a voltage with a separate generator called a tacho coupled to the motor shaft) and comparing this value with that which represents the desired speed. The difference, called the error signal, is used to increase (or decrease) the motor current so as to bring the speed up (or down) to the correct value, where the generator output equals the reference level. Motor speed will, within available power limits, be held closely at that set by the input reference voltage level, despite changes in load. If the motor current can be reversed by the circuitry, a command for zero speed (zero reference voltage) given at, say, full speed, will attempt to reverse the motor giving quite impressive braking. As the speed approaches zero due to the braking, the error falls to zero and the motor comes to rest.

Good servos can provide tight control with rapid response to new commands. Their slight disadvantages are a need for a more sophisticated (but well worthwhile) system that costs a little more if the right motor is chosen, the chance of instability if it is too highly tuned and the possibility of having too responsive an action that may shear parts and slop liquids (but at least this is easily slugged or smoothed by appropriate integration of the error signal within the control loop). Overall, however, the performance of a closed-loop servo is vastly superior to the open-loop equivalent.

Position Servo-System

Position controls also should be closed-loop in operation. Here the actuator that brings about a positional change is fed an error signal generated from a position-sensitive sensor. An arm elbow joint, for example, would have a potentiometer rotating at its pivot axis. The voltage produced by the potentiometer is compared with the given reference signal providing the error to drive the actuator accordingly. This servo will ensure that the arm goes to the angle desired by the input reference voltage value, regardless of load (within limits of maximum load capability). If the arm overshoots the correct position, the error reverses bringing it back by reversing the actuator. Servos can be adjusted to approach the final value in a quick



At 1	Power input = V.I = W
At 2	Power from motor = W. motor efficiency = W. Torque at output shaft Tm from data sheets
At 3	Coupling may lose up to 5% of energy transfer, but not torque unless slip occurs
At 4	Torque at gearbox output To = Tm × n Shaft speed = Input shaft speed / n Power available = Power at input × Gearbox efficiency
At 5	Torque at wheel shaft = gearbox output torque × r_2/r_1 Wheel speed = gearbox output shaft speed. × r_1/r_2 Power to move robot = power out of gearbox × efficiency of belt or cahin drive
At 6	Force at wheel perimeter shaft torque / r_3 = F_D

Power available is as at 5 unless bearings lossy
Speed of robot translation = wheel speed $X2\Pi r_3 X$ slippage allowance
Force of translation = F_D × coeff of friction × load vertically on wheel

Table 2: Calculations for a hypothetical drive system

fashion with overshoots, or slowly without overshoots.

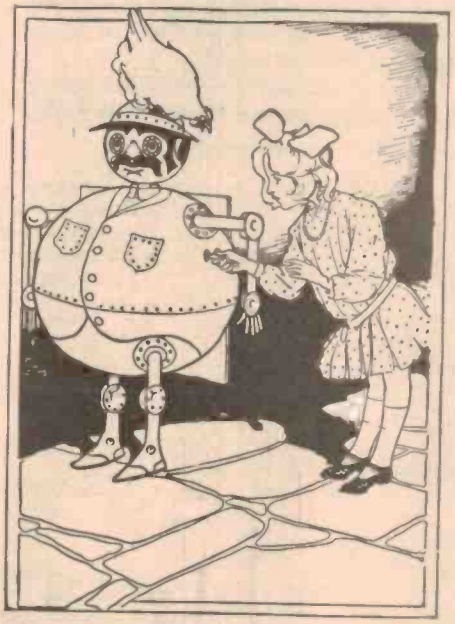
Position servos benefit by the use of a tacho-generator driven by actuator. The tacho signal is used to feed a rate of error reduction signal into the closed loop, making it move faster when wildly wrong in position and slower when nearly at the correct place, thereby giving it a chance to stop at the right place. This mechanism is known as damping.

As the gain around the servo loop is increased, the response gets tighter, smartening up. However, a point is eventually reached when the loop will begin to oscillate, first giving small dither around the correct place and then as the gain is further increased, rising to massive oscillations. Reducing the gain is the easiest way to combat this but not the cleverest. Compensation is the technical name used for the process of adding an integration and/or derivative of the error signal to the error so as to obtain higher gain with reasonable stability. The tacho of a position-servo does just that. Explanation of this is beyond this account, but is well treated in many books on linear control systems. The above explanation is somewhat simplistic but adequate as a basis. In reality the velocity servo described will run at slightly lower speeds than called up, as an error must exist to generate the torque needed to hold the speed.

Final testing and maintenance

The development of the robot should proceed in an orderly manner, each sub-unit being pretested and made as acceptable as thought necessary before final assembly begins. As each unit is added to the final whole, checks should be run to see that it still works as it should. See that the other units still work properly, as unexpected interaction is common in robot development. It is much easier to test for this as you go from stage to stage than to try and find which unit alters what at the end. As defects are detected – bugs always occur – rectify them before moving on. There is a natural tendency to rush on to the apparent end, only to be disappointed because it does not work properly. In other words, be patient; it is worth it.

Once the whole robot is "all systems go", the next stage is to conduct some field-trials. Put it through its paces doing the tasks it was intended to, but in situations where damage is minimized



if the behaviour is not as expected.

Monitor the initial hours of work carefully looking for overheating or electronic and mechanical components, and listening for odd mechanical noises that indicate too much slop or friction. These may lead to premature failure if left unmodified. Limbs and other members that appear weak are more easily strengthened before they break than after! Smoothness of operational sound is a good indicator of satisfactory mechanical design.

Unlike electronic circuits that, once made, are initially maintenance-free except for faults, dynamic mechanical systems require regular attention. Lubricate bearings, slides, cables and pivots regularly, but do not overdo the oil or grease. Dry graphite may be better than oil in some applications. Areas of wear will need adjustment with use. Build this into the design to begin with, where possible, as retrofit is always harder.

Too often ignored is the final documentation. When the project is seen as complete, go back to the master diagram and files on the whole system and sub-system modules and update them to the latest stage. If you feel the robot will be used regularly over several years, or if it was built for the use of someone else at a time after its details have been forgotten by its builder.

Creating a robot is fascinating and rewarding. How well it operates is a matter of your design sense plus ability to execute the design in a professional manner. We hope the above, albeit brief, introduction will help, and wish all robot constructors rewarding successful projects.

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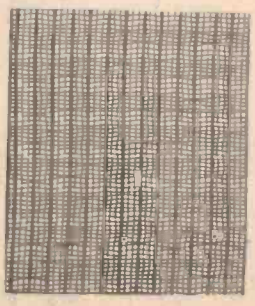

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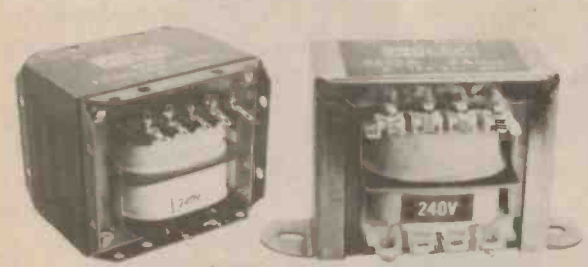

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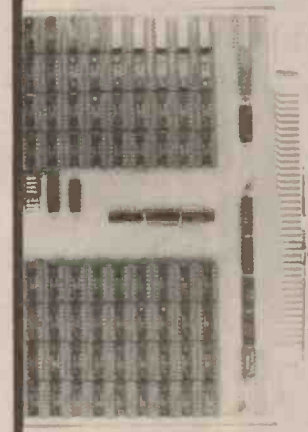

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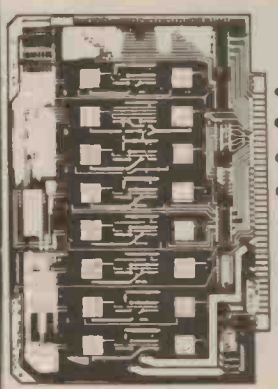

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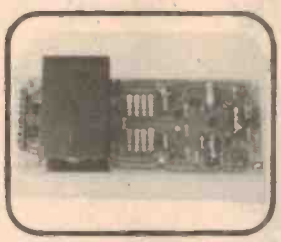

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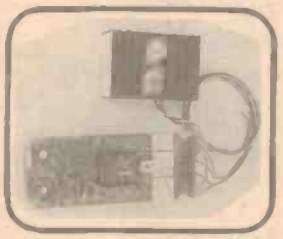
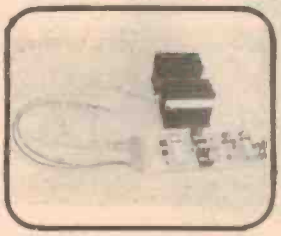
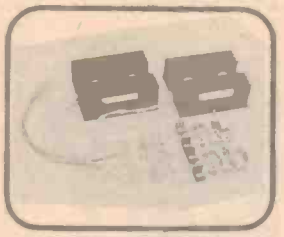


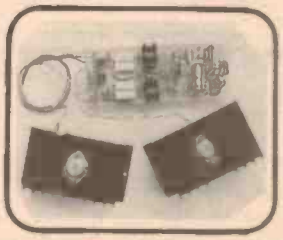
018 60 Watts R.M.S. at less than 0.1 percent T.H.D. Fully short-circuit protected.



027 250 Watts R.M.S. power amplifier module at less than 0.2 percent T.H.D. Fully short-circuit protected. 8 ohm balanced output.



009 120 Watts R.M.S. at less than 0.1 percent T.H.D. Fully short-circuit protected.



019 25 Watts R.M.S. power amplifier at less than 0.1 percent T.H.D. Powered directly from 12 volt car battery.

AGENTS:
MELBOURNE: Zephyr Products, phone 568-2922.
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ADELAIDE: Neil Muller Pty Ltd, phone 74-1162.
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DARWIN: Darwin Communications Systems, phone 85-3184.
ALICE SPRINGS: Farmer & Davies Electronics, phone 52-2967.
ALBURY: Ray Walsh Systems, phone 21-1502.
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NSW: President Sound, Wentworthville, phone 631-6689; WMR Electronics, Glenfield, phone 605-1203; Dawes Sound System, Blaxland, phone 39-4421.

For descriptive leaflets on these modules call phone or write to:

AUDITEC AUSTRALIA PTY. LTD.
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LM387N 8 pin dil dual preamp 2.63
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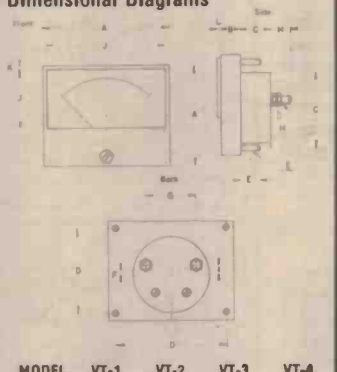
VT4 SERIES
Ranges available: 0-50uA, 50-0-50uA, 0-100uA, 100-0-100uA, 0-200uA, 0-500uA, 0-1mA, 0-5mA, 0-100mA, 0-500mA, 0-1A, 0-5A, 0-50V DC Plus 0-300V AC. All one price $5.98 ea. incl. sales tax.

Dimensional Diagrams



MODEL	VT-1	VT-2	VT-3	VT-4
A	86	78	56	46
A1	78	66	51	44
J1	50	42	31	26
C1	69	55.5	46	37.5
C	24	25	24.5	23.5
B	14	12	10.7	10.5
E1	13	13	10	10
E	3	3	3	2.3
H1	5	5	4	4
H	4	4	3	3
D	57	47.5	28	32.5
D1	57	48	(2 studs)	33

ZENER DIODES 400 MW

All 20c each including sales tax

BZX79-C4V7	BZX79-C10
BZX79-C5V1	BZX79-C11
BZX79-C5V6	BZX79-C12
BZX79-C6V2	BZX79-C15
BZX79-C6V8	BZX79-C16
BZX79-C7V5	BZX79-C18
BZX79-C8V2	BZX79-C24
BZX79-C9V1	BZX79-C27

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BC107	0.32	BD137	0.65
BC108	0.31	BD139	0.77
BC109	0.31	BD140	0.79
BC148	0.18	BF115	0.71
BC178	0.43	BF167	0.91
BC179	0.46	BF173	0.97
BC321	0.23	BF180	0.97
BC327	0.20	BF200	0.87
BC328	0.20	BF336	1.02
BC337	0.20	BF337	1.02
BC338	0.22	BF338	1.05
BC547	0.20	BFY50	0.48
BC548	0.20	BFY51	0.56
BC549	0.20	BU208	5.05
BC557	0.24	TIP31A	0.82
BC558	0.24	TIP32A	0.84
2N1613	0.74	2N3568	0.29
2N2102	0.82	2N3638	0.24
2N2218	0.74	2N3638A	0.29
2N2219	0.61	2N3643	0.31
2N2222	0.48	2N3644	0.24
2N2270	0.84	2N3645	0.36
2N2369	$0.59	2N3819	0.82
2N2904	0.66	2N3903	0.36
2N2904A	0.79	2N3906	0.33
2N2905	0.69	2N4032	1.12
2N2905A	0.74	2N4033	1.07
2N2906	0.54	2N4036	1.07
2N2907	0.71	2N4037	0.93
2N2907A	0.84	2N4354	0.46
2N3019	1.30	2N4355	0.24
2N3053	0.66	2N4403	0.43
2N3055	1.07	2N5459	0.61
2N3565	0.28	2N6027	0.88
2N3566	0.33	Prices include sales tax	
2N3567	0.36		

SILICON DIODES — 1 AMP

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IN4003 — 200 PIV 0.13
IN4004 — 400 PIV 0.14
IN4005 — 600 PIV 0.17
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SINCLAIR PDM35

Specifications:— Sensitivity: 3½ Digit LED Display (10 Meg input DC); DC Voltage: 1MV to 1000V (Four Ranges); AC Voltage: 1V to 500V (40 Hz-5 kHz); DC Current: 1 MA to 200 MA (Six Ranges); Resistance: 1 Ω to 20 Meg Ω (Five Ranges); Dimensions: 153 x 76 x 39 mm; Power: 9 volt Battery (e.g. 216 Eveready). $61.89 including sales tax

FLUKE 8020A

Specifications:— Sensitivity: 3½ Digit Liquid Crystal Display (10 Meg all ranges); Dimensions: 180 x 86 x 45 mm; Power Requirement: 9 Volt Battery e.g. 216 Eveready (Further information available upon request). $205.28 including sales tax

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11 to 16 volts adjustable. Ideal where long continuous use and excellent regulation are required. All supplies are totally short-circuit proof.

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TMK TP5SN

$25.18 including tax. Specifications:— Sensitivity: 20K Ω /Volt DC, 8K Ω /Volt AC; DC Voltage: 0.5V, 5V, 50V, 250V, 500V, 1000V; AC Voltage: 10V, 50V, 250V, 500V, 1000V; DC Current: 0-50 µA, 5MA, 50MA, 500MA; Resistance: x1, x10, x100, x1K (60, 600, 6K, 60K Centre Scale); Capitance: 50 µµf to 0.1 µf (in two Ranges); Decibels: —20 to plus 36dB; Dimensions: 135 x 95 x 40 mm.

TMK200

$27.91 including tax. Specifications:— Sensitivity: 20K Ω /Volt DC, 10K Ω /Volt AC; DC Voltage: 0.6V, 6V, 30V, 120V, 600V, 1200V; AC Voltage: 6V, 30V, 120V, 600V, 1200V; DC Current: 0.06MA, 6MA, 60MA, 600MA; Resistance: 0-10K Ω, 100K Ω, 1M Ω, 10MΩ; Capacitance: .002 µf to 0.2 µf Decibels: —20 to plus 63dB; Dimensions: 130 x 90 x 35 mm.

TMK500

$41.22 including tax. Specifications:— Sensitivity: 30K Ω /Volt DC, 13K Ω /Volt AC; DC Voltage: 0.25V, 1V, 2.5V, 10V, 25V, 100V, 250V, 1000V; AC Voltage: 2.5V, 10V, 25V, 100V, 250V, 500V, 1000V; DC Current: .05MA, 5MA 50MA 500MA, 12A; Short Test: Internal Buzzer; Decibels: —20 to plus 56dB; Dimensions: 160 x 85 x 70 mm.

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BD 140 — 50c ea.
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T03 Mounting Kits — 5c ea.

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7401	.28
7402	.28
7403	.28
7404	.37
7405	.37
7406	.50
7407	.50
7408	.34
7409	.34
7410	.30
7411	.37
7413	.54
7414	1.03
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	1.25
7448	1.25
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
7489	1.20
7490	.75
7491	1.00
7492	.75
7493	.75
7494	1.10
7495	.95
74100	2.45
74107	.65
74121	.60
74123	1.10
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
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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	1.50
4511	1.50
4518	1.50
4520	1.45
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

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301	.40
307	.65
308	1.35
311	.85
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356	1.65
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381	2.00
382	2.00
386	1.95
555	.35
556	.85
565	1.95
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567	2.65
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7805	1.30
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7808	1.30
7812	1.30
7815	1.30
7818	1.30
7824	1.30
7905	2.25
7912	2.25
7915	2.25
78L05	.50
78L12	.50
78L15	.50
79L05	.85
79L12	.85
79L15	.85

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THE SUCCESS of the ETI 588 Theatrical Dimmer prompted this simplified dimmer system, which, while maintaining much of the flexibility of the 588 design, is lower powered and much more economical. Unlike very simple designs, the control circuitry is isolated from the mains and control of light level is effected by a variable voltage between zero and ten volts.

As the dimmers are voltage controlled they are useful not only as 'stage' type dimmers but also as the basis of colour organs, colour sequencers and chasers etc. It is partially for this reason that we have built three dimmers on one PC board.

SPECIFICATION – ETI 592

Number of channels	3
Maximum load per channel	1000 Watt
Control method	phase control
Rise time	10μs
Control voltage	0 to 10V*
Input impedance (control)	> 470k ohm
Protection	5 Amp fuses
Dimensions	310 x 270 x 80mm

*The control voltage range can easily be modified if required.

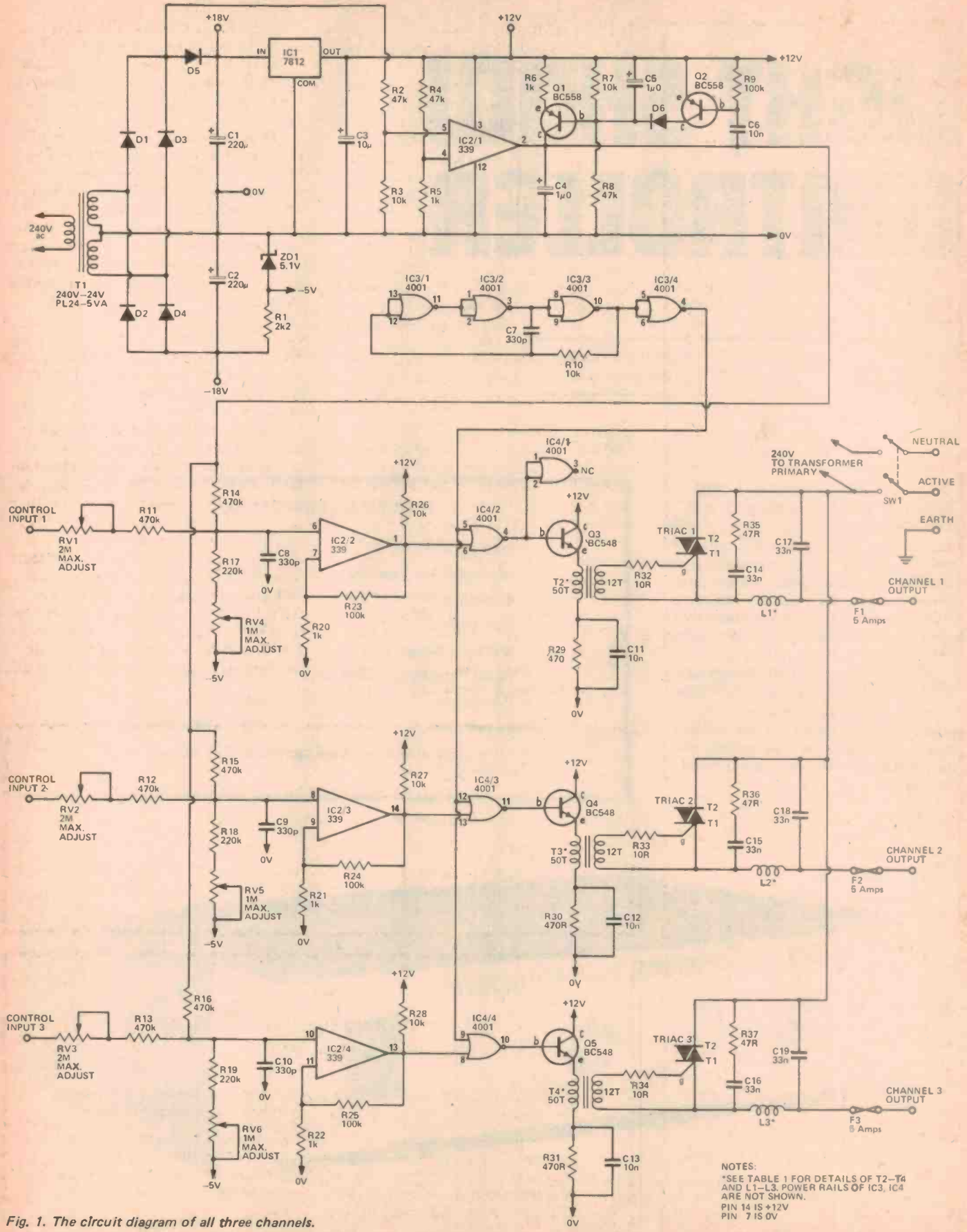


Fig. 1. The circuit diagram of all three channels.

HOW IT WORKS – ETI 592

The output of the transformer is full wave rectified to provide ∓18 V dc on C1 and C2. An isolating diode D5 is used in the positive supply line and a full wave rectified (but not smoothed) voltage is available at the junction of D1, D3 and D5. The positive supply is regulated to +12 V by IC1, while the negative supply is regulated to −5 V by ZD1. We have provided ∓18 V outputs to allow for any additional circuitry which may be attached.

The first section of IC2 compares the voltage on pin 4 (about +250 mV) with that on pin 5 which is the full wave rectified signal. When this signal drops below that on pin 4 (which occurs only for about 100 μs at the zero crossing of the sine wave), the output of IC2/1 goes low discharging C4. The output stage of this IC is an open collector NPN transistor which can only sink current and not source any. The capacitor C4 is charged by the constant current source Q1, and discharged every 10 ms, forming a sawtooth waveform. On the discharge of C4, capacitor C6 turns on Q2 which discharges C5 to about 700 mV. This reduces the current supplied by Q1, with it slowly building up again over about 3 – 4 ms. Thus the charge waveform of C4 is modified from what would normally be a straight line. This waveform is used as the synchronising cum timing waveform, and is common to all three dimmers.

Also common to all the dimmers is a high frequency oscillator formed by IC3. This runs at about 150 kHz.

The synchronising waveform is added with the control input voltage and an offset current from the −5 V supply; when the sum is zero the comparator IC2/2 detects this and its output will go low, allowing the high frequency from the oscillator to be gated through IC4/2. The transistor Q3 is used to buffer this output and drives the pulse transformer. The output of the pulse transformer drives the triac gate, turning it on.

By adjusting the voltage on the input the time at which the voltage on pin 6 crosses zero can be varied, thus adjusting the output light level. The capacitor C8 is needed to stop the high frequency signal from IC3 being picked up in the high impedance circuitry at this point.

All three dimmer sections are identical except for component numbering.

RF suppression is provided by L1/C17 which gives about 10 μs rise time. If a fluorescent load is to be used, R35/C14 are needed to ensure the triac does not turn off between pulses from the pulse. No resistive load is needed for a fluorescent load although a special ballast (or an additional filament transformer) is needed in the fitting.

Design Features

When we decided to design an economy version of the 588 dimmers we had to decide what features should be retained and which discarded. The most obvious is the 'plug-in' facility which adds greatly to the cost. Also reducing the power rating to 1 kw allows a saving of about $8.00 per channel in the triac cost!

In the control circuitry a common power supply, sync generator and high frequency oscillator were used but the control tone filter was deleted. Still maintained however was the ability to handle either fluorescent or incandescent loads and individual maximum and minimum adjustment, although they are no longer externally adjustable.

The use of fully isolated control circuitry and voltage control had to be maintained for safety and convenience.

Construction

All the electronic components are mounted on the pc board and this can be assembled with the aid of the overlay in Fig. 3. The chokes and pulse transformers can be wound as per the winding details in Table 1. The main point to watch is the insulation of the triacs from the heatsink. The correct mica insulators should be used with great care to remove any burrs, etc., and possibly double insulators to be sure. The heatsink should be earthed if it is in a position where it can be touched. In the box we used we screwed the heatsink onto the lid of the box to help get the heat out and an earth is essential! For 1000 watts per channel about 15 000 sq mm of heatsink is needed to keep the temperature rise of the triacs around 50°C.

When wiring the unit use wire of adequate size as the input current will be 12A at full load. We have given a wiring diagram in Fig.4 showing how we fitted it in to the "Horwood" box. The earth wire should be continuous all the way and not just links. This is to ensure that if one connection comes loose the earth is not lost to any other part of the circuit.

Adjustment

The only adjustment is the setting of maximum and minimum light levels. With lights plugged in and everything switched on, rotate the level controls to the minimum or reduce the control voltage to 0V and by using RV4-RV6 adjust the lights to the desired minimum level. Now rotate all the level controls to maximum or raise the control voltage to its maximum, then adjust RV1-RV3 to give the desired maximum level. If all the presets are wound up to maximum level the triacs will be on continuously and there will be no (or little) noise from the chokes. Now by reducing the level using the maximum presets until the chokes start to make a noise the maximum control range will be achieved.

TABLE 1

CHOKE WINDING DETAILS L1–L3

Core	65mm long 10mm dia. ferrite rod
Winding	55 turns close wound, 1mm dia. enamelled wire

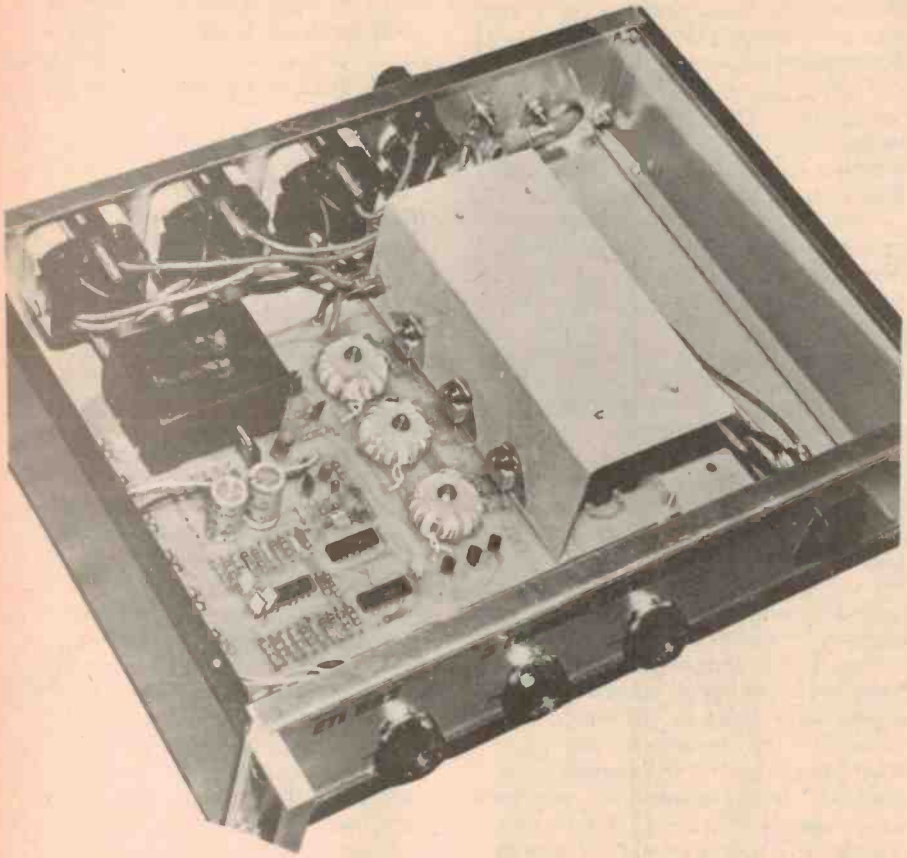
Tape ends of coil to prevent it unwinding and when fitting it to the board space it about 1 mm above the board. Pour some epoxy cement over the coils to help prevent noise.

TABLE 2

PULSE TRANSFORMER WINDING DETAILS T2–T4

Core	Philips 4322–020–36633
Winding	
Primary	50 turns, 7/0.20pvc insulated wire (about 1.5 meters)
Secondary	12 turns, 10/0.20pvc insulated wire (about 300mm)

These pulse transformers are wound on a toroidal core and with the primary it is easier to start the winding by feeding the wire through the centre about half way and winding one end first, coming back to the other end when down to about 30mm of wire. There is about 30 turns on the first layer using 7/0.20 wire.



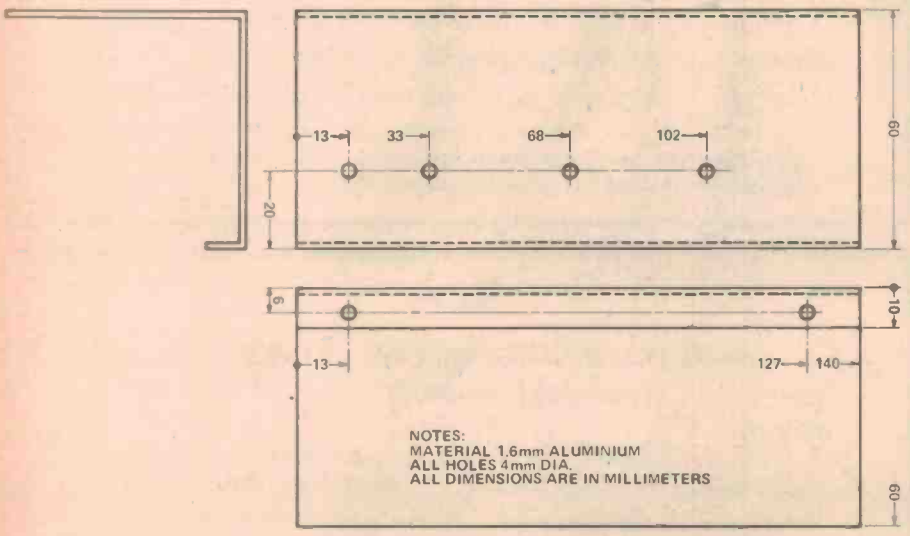


Fig. 2. The heatsink used on the prototype.

PARTS LIST – ETI 592

Resistors all ½W, 5%
R1 . . . . . 2k2
R2 . . . . . 47k
R3 . . . . . 10k
R4 . . . . . 47k
R5, 6 . . . . . 1k
R7 . . . . . 10k
R8 . . . . . 47k
R9 . . . . . 100k
R10. . . . . 10k
R11–R16 . . 470k
R17–R19 . . 220k
R20–R22 . . 1k
R23–R25 . . 100k
R26–R28 . . 10k
R29–R31 . . 470R
R32–R34 . . 10R
R35–R37 . . 47R

Potentiometers
RV1–RV3. . 2M trim
RV4–RV6. . 1M trim
RV7–RV9. . 47k lin*

Capacitors
C1, 2 . . . . . 220µ 35V electro
C3. . . . . 10µ 35V electro
C4, 5 . . . . . 1µ0 tantalum
C6. . . . . 10n polyester
C7–C10 . . . 330p ceramic
C11–C13 . . 10n polyester
C14–C19 . . 33n 250Vac

Semiconductors
IC1 . . . . . 7812 regulator
IC2 . . . . . LM339 quad comparitor
IC3, 4. . . . . 4001 quad NOR gate

Q1, 2 . . . . . BC558
Q3–Q5. . . . BC548

Triac 1–3 . . SC151 (with insulation kit)

D1–D5. . . . 1N4004
D6 . . . . . 1N914
ZD1. . . . . 5.1 volt 400mW

Miscellaneous
PC board ETI 592
L1–L3 chokes (see text)
T1 transformer PL24–5VA
T2–T4 pulse transformer (see text)
Case to suit
3 core flex and plug (15A)
Heatsink (see Fig. 5)
3 Fuse holders
Three 5 Amp 3AB Fuses

*These are the main faders and may be slide or rotary and the value may be from 10k to 100k.

WARNING

While the control circuitry of these dimmers is isolated from the mains, there is 240V on the PC board and care should be taken to prevent accidental contact with this area. Also take care to segregate the low voltage wiring and ensure that if a wire does come adrift that it cannot touch the 240 V side (or vice versa).

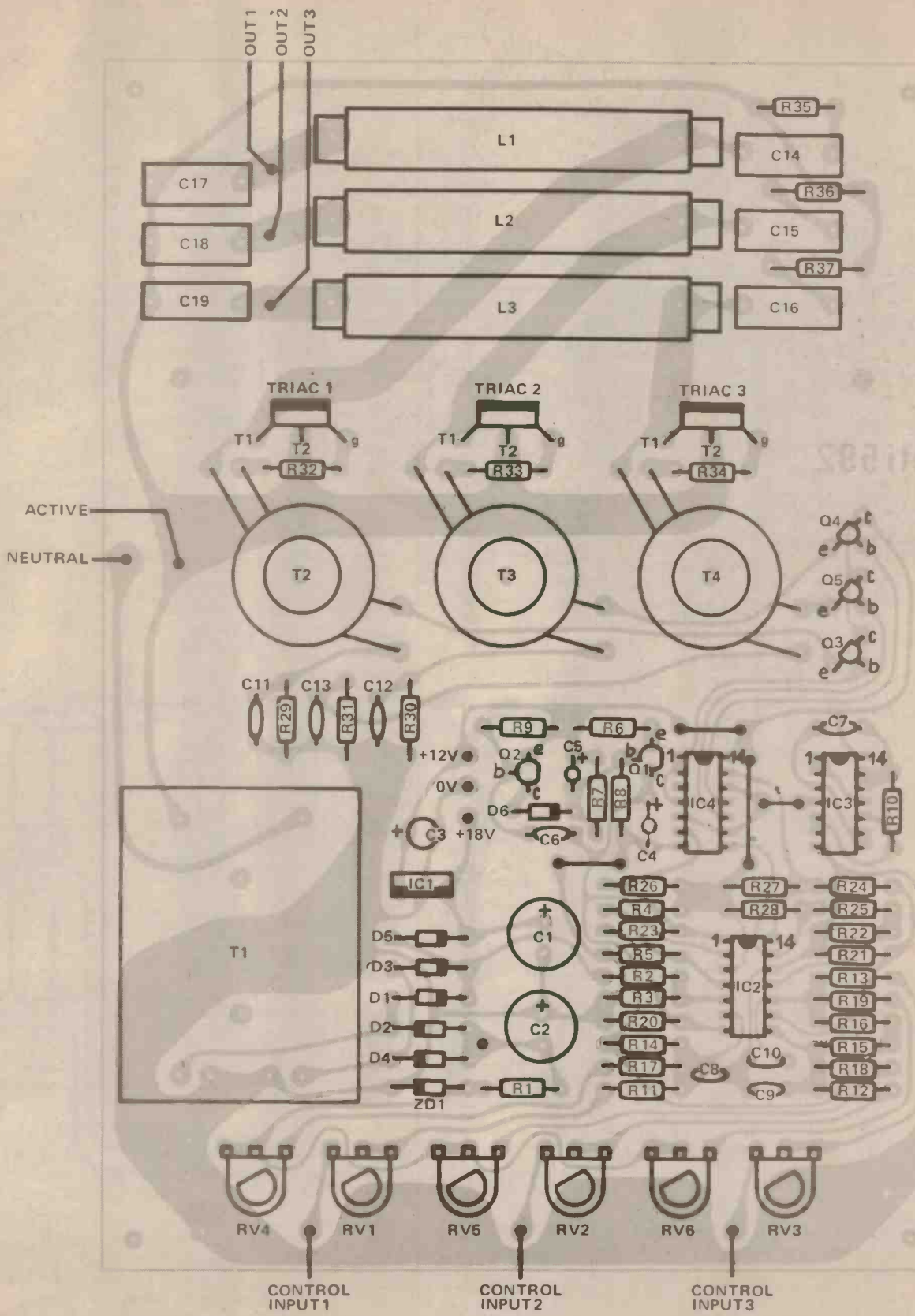


Fig. 3. The component overlay of the board with the heatsink removed.

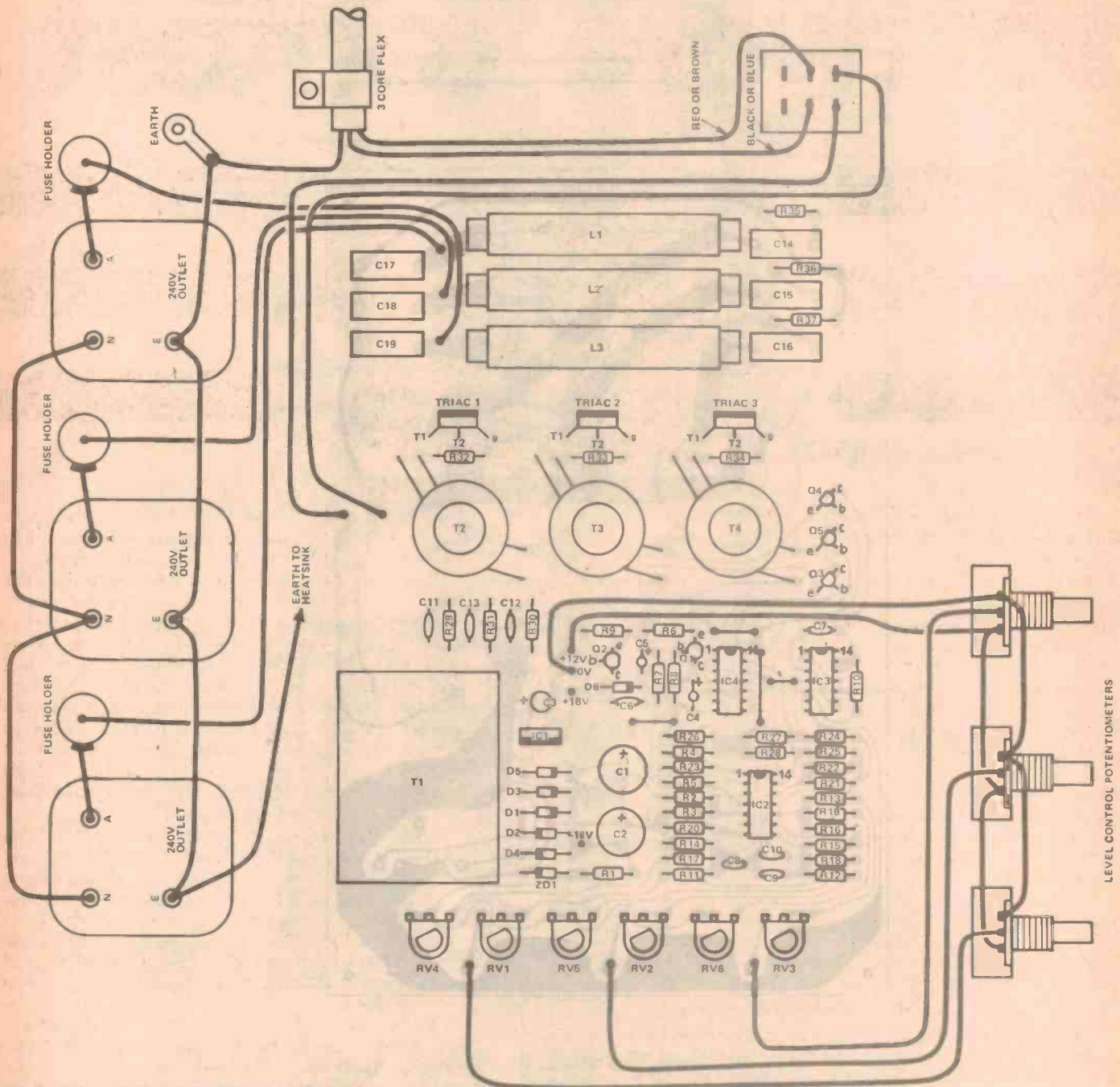
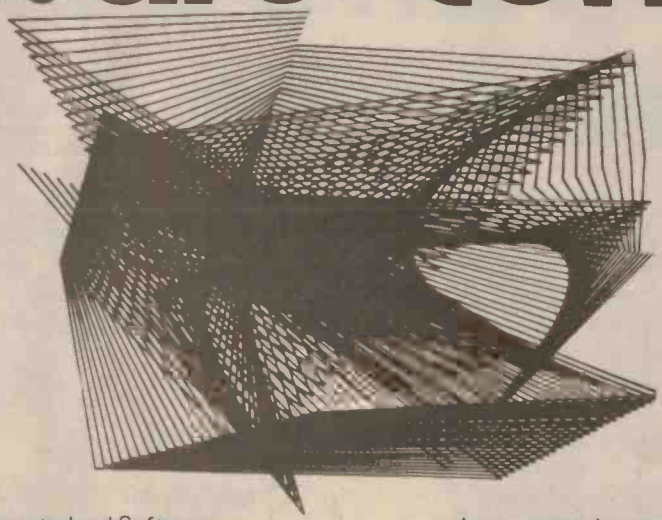


Fig.4. Point-to-point wiring diagram. The earth wire should be continuous so that if it comes adrift at any point, connections further down the wire will not be left floating. Note also that on the prototype the heatsink is earthed.

eti/computerland software contest



In April we launched the ETI/Computerland Software Contest, and already the entries are starting to come in. There is still plenty of time to finish your entry, as the closing date is in November. We regret that we are unable to answer queries regarding proposed software individually, as this would give some entrants an unfair advantage, but we may answer questions on the contest organisation through ETI's Print Out Column, so that all entrants have the same information.

For the benefit of readers who may have missed the original announcement, and to refresh your memories, we'll repeat here full information on the contest.

We reckon by now most of you have written games and disassemblers till you pretty well know the game backwards, and now you're looking for something to really get your teeth into. So, we decided to offer a little encouragement and the chance to prove you can do it.

Computerland and ETI are searching for applications oriented software, and we want you to write some, or submit some you've already written. The application you choose to implement is entirely up to you; however, here are a few suggestions which illustrate the kind of thing we're looking for:

* *Mailing list processor.*
* *Address/telephone file.*
* *Point of sale terminal.*
* *Recipe file.*
* *Inventory control.*
* *Circuit analysis.*
* *Music synthesis.*
* *Calendar/clock/reminder list.*
* *Chequebook balancing program.*
* *Applications to help the handicapped.*
* *Small business accounting package.*
* *Computer communications set.*
* *Amateur radio station control.*
* *Burglar alarm with police notification.*

The idea is to get your computer doing something that is in some way useful. The only stipulation we'd like to make is that software must be written either in BASIC or in the form of a well-annotated assembly language listing for one of the popular microprocessors such as Z-80, 8080, 6800, 6502 and 2650. This means that we stand some chance of running your software to check it out. For the same reason, specialised hardware should be kept to an absolute minimum.

The criteria the judges will use to decide upon the winning entries will be: the value of the software to the user; its complexity, i.e. the size of the program; the 'elegance' of the software; the degree of 'human engineering' in the design of software features; and the quality, amount and presentation of the documentation supplied. It is likely that other factors will also influence the judges to some extent, as different criteria will apply in varying degree to different programs. The judges will be Dr R Graham, of NSW Institute of Technology, Rudi Hoess, of Computerland, and Collyn Rivers and Les Bell of ETI.

The prizes? Overall first prize is a Cromemco ZPU Z-80 CPU card while the second prize winner will receive a Vector Graphics 8K RAM kit. Third prize is a Vector Graphics 260 x 260 graphic display generator and fourth prize is a PROM/RAM card from Vector Graphics. In addition, each of the prizewinners will receive a two year airmail subscription to the US computer magazine of their choice and a two year subscription to ETI.

There will also be three special prize categories – the awards for 'Best Documentation' and 'Most Original Application' will each be a two year subscription package, while the 'Most Marketable Software' winner will, subject to agreement, be marketed on a royalty basis. In addition, the winning entries will be published in ETI, and payment for this will be made at our usual (excellent!) rates.

The closing date for this contest will be Friday, 3 November 1978, which should give plenty of time for development of some good software. The winners will be announced in the January or February 1979 issue, but if there are a lot of entries to be checked this may be delayed.

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Offer closes 29 September, 1978 and is open to Australian residents only. Apologies to our overseas readers.

ETI data sheet

ICL8063 Power Transistor Driver-Amplifier

INTERSIL

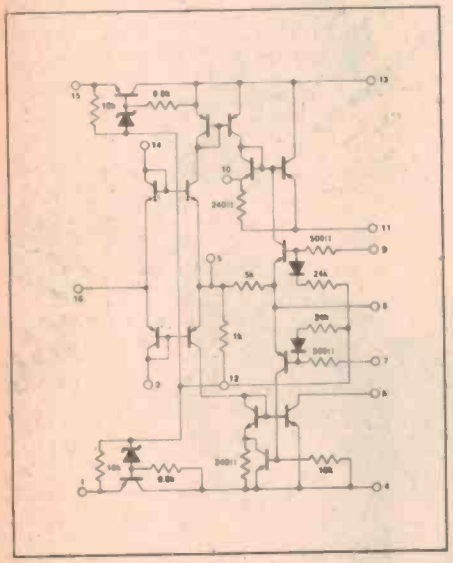


Fig.1. Schematic diagram.

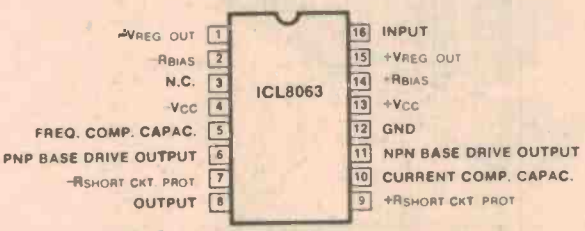
The ICL8063 is a unique monolithic power transistor driver and amplifier that allows construction of minimum chip power amplifier systems complete with safe operating area circuitry, short circuit protection and built-in voltage regulators, without adding extra power supplies. It is primarily intended for complementary symmetrical outputs.

Designed to operate with all varieties of operational amplifiers, two external power transistors of any construction technique and 8 to 10 passive components, the ICL8063 is ideal for use in such applications as linear and rotary actuator drivers, stepper motor drivers, servo motor drivers, power supplies and power DACs.

The ICL8063 takes the output levels (typically +/- 11V) from an op amp and boosts the levels up to +/- 30V to drive any power transistors, (e.g. 2N3055 (NPN) and 2n3789 (PNP)). The outputs from the ICL8063 drive the external power transistors' base leads with up to 100 mA of current.

This amplifier-driver contains internal positive and negative regulators to drive an op amp, or other circuits; thus, only +/-30V supplies are needed for a complete power amp.

The ICL8063 provides built-in power supplies and will operate from inputs generated by most of the op amps in use today - regardless of technology - as well as many other linear functions, such as timers, comparators and waveform generators. And it will drive almost all power transistors with breakdown voltages up to 70 volts.



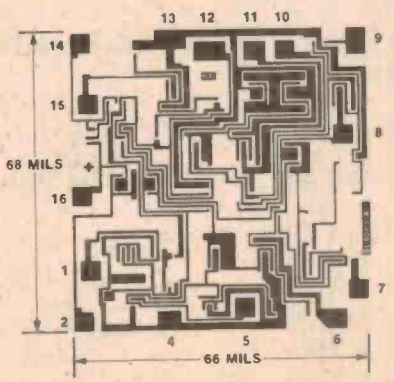


Fig.2. (a) Connection diagram. (b) What's inside - the chip topography.

ICL8063 Power Amplifier

As Figure 3 shows, using the ICL8063 allows the circuit designer to build a power amplifier block capable of delivering +/-2 amperes at +/-25 volts (50 watts) to any load, with only three additional discrete devices and 8 passive components. Moreover, the circuit draws only about +/-30 milliamperes of quiescent current from either of the +/-30V power supplies. A similar design using discrete components would require anywhere from 50 to 100 components.

Slew rate is about the same as that of a 741 op amp by itself, except that the output current can slew up to 2 amps at roughly 1V/μs (that's a 10 ohm load to ground and +/-20V output across this resistance). Input current, voltage offset, CMRR and PSRR are also the same. Use of 1,000 picofarad compensation capacitors (three in this configuration) allows good stability down to unity gain non-inverting (the worst case). This circuit will drive a 1000pF C_L to Gnd, with no significant problems. In other words the circuit can drive 30 feet of RG-58 coaxial cable for line driver applications with no problems.

As figure 4 indicates, setting up a current limiting (safe area) protection circuit is straightforward. The 0.4 ohm, 5 watt resistors set the maximum current one can get out of the output. The equation this SOA circuit follows is:

$V_{OUT} + I_L \times 0.4\Omega = 0.7V + I(24.5k)$. When $I_L R_3 - IR_2 = 0.7V$ safe area protection is achieved.

As these equations indicate, maximum power delivered to a load is obtained when $V_{OUT} > 24V$, the optimum voltage one needs when driving any DC motor, actuator, etc.

When buying external power transistors, careful attention should be paid to beta values. For 2N3055 and 2N3789 transistors used in this circuit, beta should be no more than 150 max at I_C = 20 mA and V_{CE} = 30V. This beta value sets the quiescent current at less than 30 mA when not delivering power to a load.

The design in Figure 3 will tolerate a short to ground indefinitely, provided adequate heat sinking is used. However if V_{OUT} is shunted to +/-30V the output transistors (2N3055 and 2N3789) will be destroyed. But since the safe operating area for both devices is 4 amps at 30 volts, the problem does not occur for V_{CC} = +/-15V.

Simple Function Generator

Using a variation of the fundamental power amplifier building block described in the previous section, the ICL8063 can be utilised in the design of a simple, low cost function generator (Figure 6). It will allow generation of sine waves, triangular waves and square waves at the output from 2 hertz to 20 kilohertz. V_{OUT} will be up to +/-25V (50V p-p) across loads as small as 10 ohms (that's about 2.5 amps maximum output current).

All capacitor working voltages should be greater than 50V DC. All resistors should be 500 mW, unless otherwise indicated. Keep the interconnecting leads from pin 2 of the 741 to the 10k-ohm feedback resistor and 10k-ohm amplitude adjust potentiometer as short as possible. Less than 2 inches long is best, since this point is the summing junction of an operational amplifier. Failure to do so results in oscillation problems. Because of the slewing of the 741, the generator will not produce a 56V p-p amplitude all the way up to 20 kHz. Full output swing is possible up to about 5 kHz. Beyond this point slewing begins and undistorted p-p output will diminish. Due to this effect, amplitude at 20 kHz is about 20V p-p (+/-10V). This could be remedied by using a higher slew rate op amp such as the LF156.

ELECTRICAL CHARACTERISTICS (@ 25°C; V_{CC} = ±30V)

SYMBOL	CHARACTERISTIC	TEST CONDITIONS	MIN/MAX LIMITS ICL8063C			UNITS
			0°C	+25°C	+70°C	
V_{OS}	Max. Offset Voltage	See Figure 1	150	75	75	mV
I_{OUT}^{+}	Min. Positive Drive Current	See Figure 2	40	40	40	mA
I_Q^{+}	Max. Positive Output Quiescent Current	See Figure 3	600	300	300	µA
I_{OUT}^{-}	Min. Negative Drive Current	See Figure 2	20	20	20	mA
I_Q^{-}	Max. Negative Output Quiescent Current	See Figure 4	600	300	300	µA
$V_{REG}^{\pm}$	Regulator Output Voltages Range	See Figure 5	±13.7 ±1.0V	±13.7 ±1.0V	±13.7 ±1.0V	V
Z_{IN}	A.C. Input Impedance	See Figure 6	400	400	400	kΩ
V_{CC}	Power Supply Range			±5 → ±35V		V
I_{CC}	Power Supply Quiescent Currents		12	7	7	mA
A_V	Range of Voltage Gain	See Figure 7 V_{IN} = 8Vp-p	6±2	6±2	6±2	V/V
$V_{OUT(MIN)}$	Minimum Output Swing	See Figure 7; Increase V_{IN} until V_{OUT} flattens	±27	±27	±27	V
I_{IN}	Input Bias Current	See Figure 8	100	100	100	µA

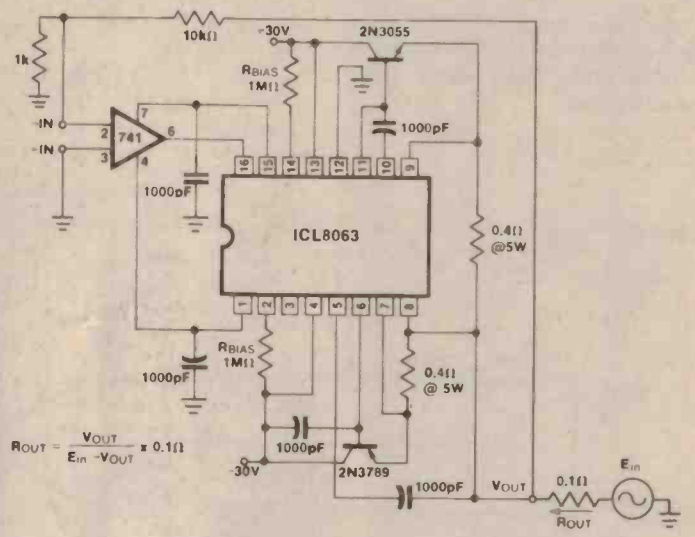


Fig.3. Power Amplifier System.

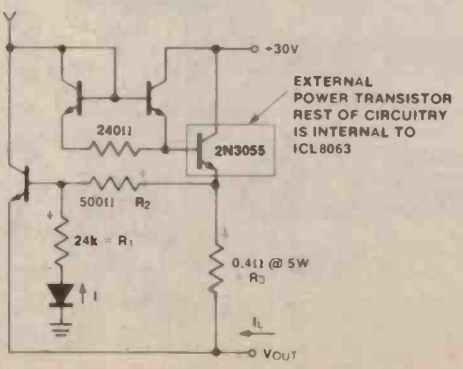


Fig.4. Overload protection circuitry.

ETI data sheet

Low Cost Hi-fi Amplifier

For about $20 per channel, it's possible to build a high fidelity amplifier using the ICL8063 capable of driving 8 ohm speakers. A channel is defined here as all amplification between turntable or tape output and power stage to drive 8 ohm speakers (Figure 7).

The input 741 stage is a preamplifier with RIAA equalisation for records (disc). Following the first 741 stage is a 10k-ohm control pot, whose wiper arm feeds into the power amplifier stage consisting of a second 741, the ICL8063 and the power transistors. To achieve good listening results, selection of proper resistance values in the power amplifier stage is important. Best listening is at a gain value of 6[(5kΩ + 1kΩ)/1kΩ = 6]. Don't go below 3, since the first stage 741 preamp puts out only +/-10 volt maximum signals. So, if maximum power is necessary this value must be multiplied by 3 to get +/-30 volt levels at the output of the power amp stage.

Each channel delivers about 56 volts p-p across an 8 ohm speaker and this converts to 50 watts RMS power. This is derived as follows:

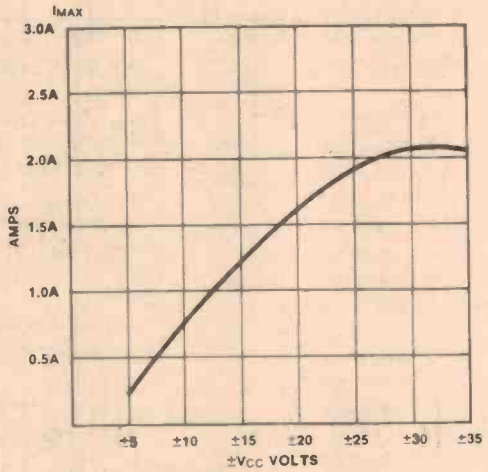


Fig.5. Output current capability for varying supply voltages.

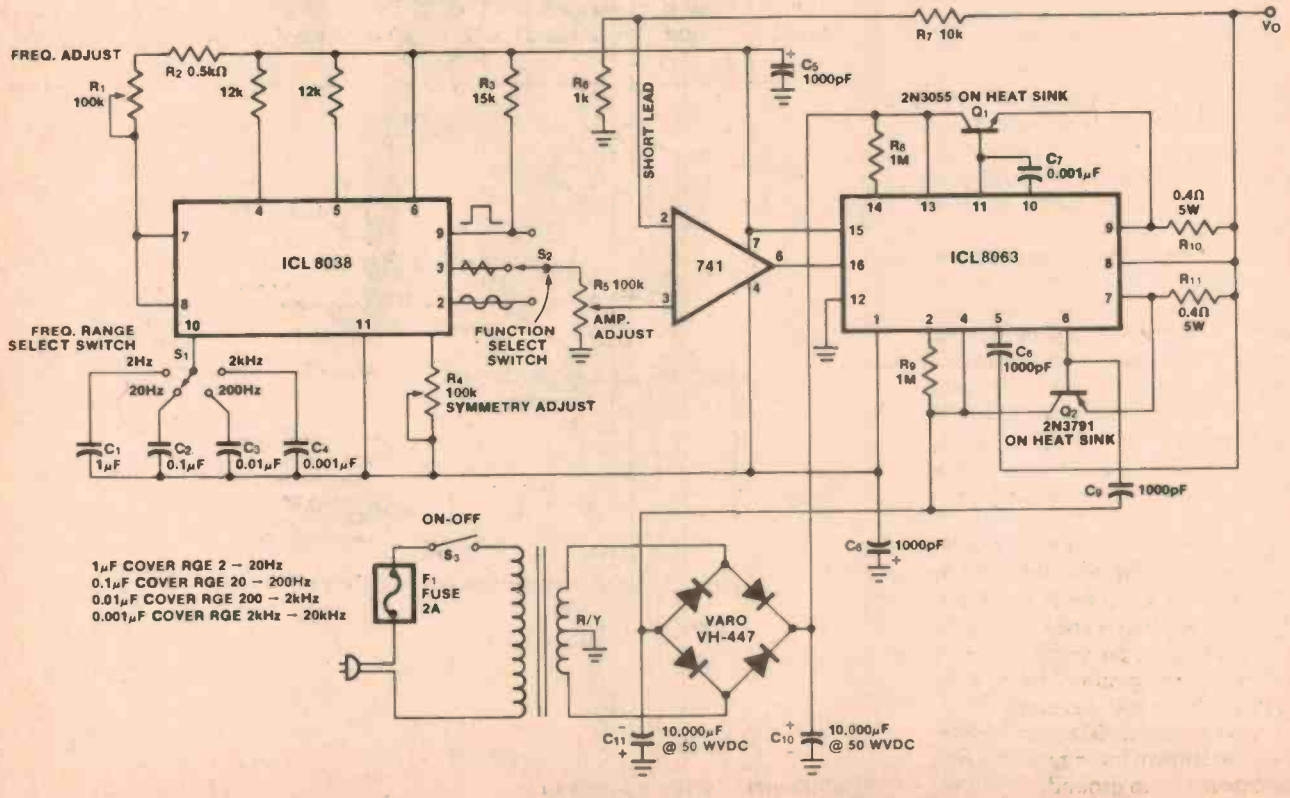


Fig.6. Power function generator.

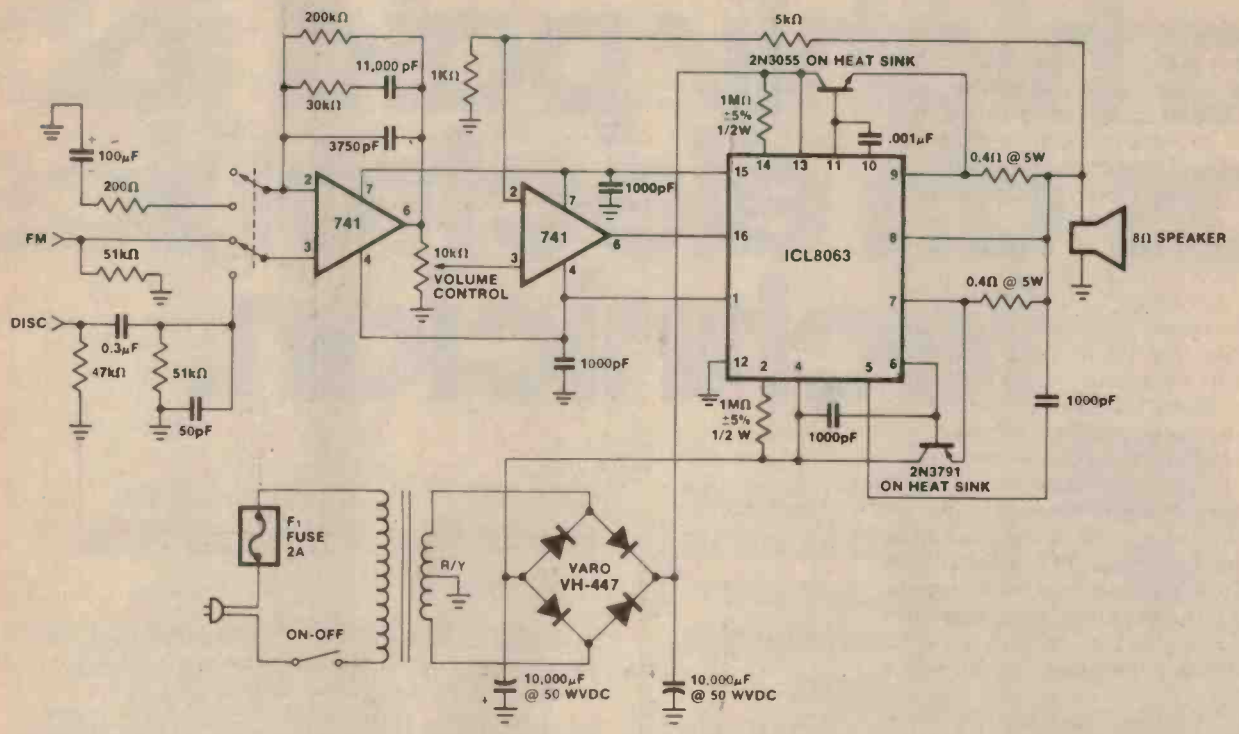


Fig.7. One channel of a hi-fi amplifier.

The ICL8063 is available from R & D Electronics Pty Ltd, at 23 Burwood Road, Burwood, Vic. 3125 or 133 Alexander Street, Crows Nest, NSW 2065.

Power = $\frac{Vrms^2}{8 \text{ ohms}}$

Vrms = $\frac{56V \text{ p-p}}{2.82} = 20V$,

$20V^2 = 400V^2$

$\therefore$ Power = $\frac{400^2}{8 \text{ ohms}} = 50$ watts RMS Power

Distortion will be < 0.1% up to about 100 Hz, and then it increases as the frequency increases, reaching about 1% at 20 kHz.

The ganged switch at the input is for either disc playing or FM, either from an FM tuner or a tape amplifier. Assuming DC coupling (not capacitive coupling) on the outputs, there is no need for a DC reference to ground (resistor) for FM position. To clear the signal in the FM position, place a 51k-ohm resistor to ground as shown in Figure 7 (from FM input position to ground).

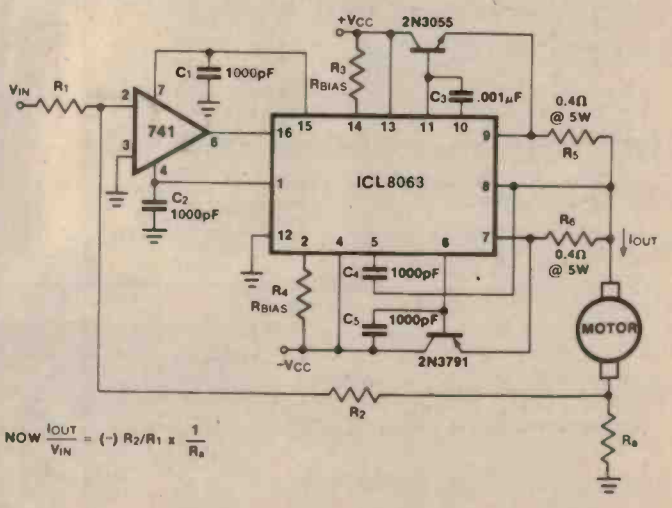


Fig.8. Constant current motor drive.

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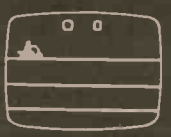
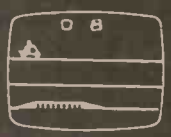


Drag Race



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DIGITAL DIAL

Most transistor radio dials are pretty hopeless these days, so we thought we'd do something about it.

WITH MODERN RADIOS which are designed to be operated anywhere in the world, the local station call signs are no longer marked on the dial. Instead the dial is marked with frequencies making it more universal. Unfortunately the scaling on many receivers leaves a little to be desired, with many car radios lucky to have 3 or 4 markings. The use of pushbutton selection helps but when a cassette is fitted or you are out of your local area there is still the problem of knowing to what station you are tuned.

This project gives a direct readout of the station being received allowing for easy identification and selection. The display is remote from the receiver allowing it to be mounted on the dashboard for easy viewing.

SPECIFICATION – ETI 550

Frequency range	500-1700 kHz
Accuracy	∓ 5 kHz
Sensor	pickup coil or direct connection
Power supply	7–20 V dc @ 80 mA or 240 V ac
Display	4 digit LED

Design Features

While this project has a real use its main purpose is to illustrate how the up/down counter module published in last month's issue can be put to use. We will be publishing a number of projects based around this module over the next few months.

If this module is to be used outdoors i.e. in the car, it is recommended that high brightness displays, such as the Hewlett Packard HDSP 4133, be used. As these have a different pin-out a new display board is presented in this article.

The theory of operation is that we actually measure the frequency of the local oscillator in the radio and subtract the IF frequency. While we could have subtracted this using digital logic we chose to do it by resetting the display not to zero but to 9545 (10 000 - 455). The first 455 pulses in the timing period are then used getting to zero and in effect, only pulses after this are counted and displayed. This number can be loaded into the counter by selecting the appropriate diodes and using the "load counter" input instead of the reset line. The only difference is that as the data is

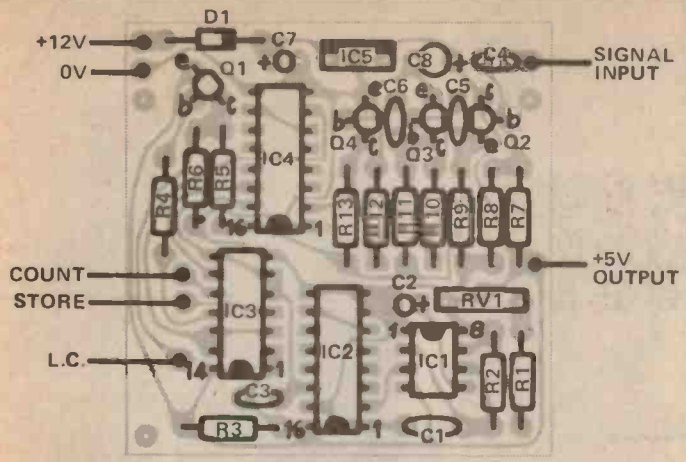


Fig. 1. The component overlay for the control card.

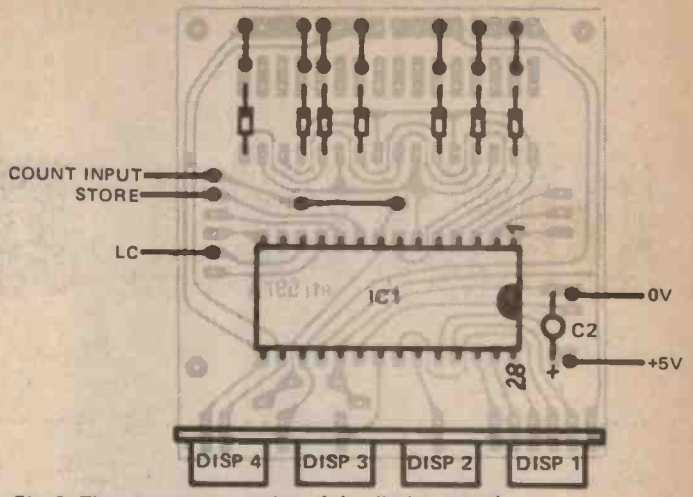


Fig. 2. The component overlay of the display module showing the diodes and links required.

PARTS LIST – ETI 550

Resistors all ½W, 5%
R1 . . . . . 39k
R2 . . . . . 8k2
R3 . . . . . 1M
R4 . . . . . 10k
R5, 6 . . . . . 1k
R7, 8 . . . . . 47k
R9 . . . . . 1k
R10. . . . . 2M2
R11. . . . . 10k
R12. . . . . 220k
R13. . . . . 1k

Potentiometer
RV1 . . . . . 5k trim

Capacitors
C1. . . . . 47n polystyrene
C2. . . . . 1μ0 tantalum
C3. . . . . 2n2 polyester
* C4. . . . . 10p ceramic
C5, 6 . . . . . 10n polyester
* C7. . . . . 33μ tantalum
C8. . . . . 10μ 25V electro

Semiconductors
IC1 555
IC2 4520
IC3 4001
IC4 4520
IC5 7805

Q1 . . . . . BC558
Q2–Q4. . . . BC548

D1 . . . . . 1N4004

Miscellaneous
PC board ETI 550
Display module ETI 591
* Transformer 240V–12.6V, 150mA

* For 12V operation delete transformer. For 240V version C7 should be 220μ 25V. For use with pickup coil increase C4 to 1n0.

entered into the counter serially the pulse used must be longer than 4 times the internal oscillator period. Also as the LC input is a three state input it cannot be driven by conventional two-state.

We initially tried capacitive coupling onto the tuning capacitor of our portable radio (oscillator section!) but the loading detuned the set too much. We then tried a pickup coil and found enough signal with it in the correct place not to require any electrical connection to the set. With the car radio however the coils are shielded so well that reliable operation was not possible. However it was found that we could tap onto one side of the oscillator coil without affecting the operation.

We use a NE555 as the time base with its output being divided by 128 to improve stability. However if an accuracy of ± 5kHz is to be maintained its frequency has to be better than ¼% and a polystyrene capacitor for C1 and 2% resistors for R1 and R2 are recommended.

Construction

The display board should be built according to the overlay in Fig. 2 which shows which diodes are required. Note that R1, 2 and C1 are not used in the display module and a link is used in place of R1.

The control card can now be assembled and wired to the display module. The two boards are mounted one above the other using 9.6 mm spacers. Check that these screws do not touch any tracks and insulate them if too close.

Depending on whether the unit is going to be used with a car radio or portable the values of C4 and C7 will vary. The pickup coil is made by winding about 80 turns of 0.25 mm enamelled wire onto a 25 mm long piece of 10 mm ferrite rod with the end terminated onto a twisted pair of plastic covered wires long enough to go between the radio and the position of the display. Do not use coaxial cable for this as the capacitance is too high.

The case chosen has been left to the individual with our own being from a discarded digital clock. If you use the 240V powered version be careful with the high voltage wiring. For the 12V version the power can come from the radio via a twisted lead (3 wires).

When connecting into a car radio, tune the set to a local station and try the pickup wire on the terminals of the tuning coils in turn until one is found which will give a reading without moving it off station. Permanently connect to this point. With a portable radio try moving the pickup coil around the set, probably in line with the aerial coil, until the best results are obtained.

Calibration

Place the pickup coil in position such that reliable operation is obtained and tune to a know station (preferably near the top end of the dial). Now adjust RV1 until the digital dial agrees with that station. Check then with other stations.

Alternately feed a known signal of between 1 and 2MHz from an oscillator into the input and adjust RV1 until it reads 455 less than that frequency.

Power Supply

The unit can be powered by an ac or dc voltage of between 7 and 20 volts. If an ac voltage is used the capacitor C7 should be increased to 220 μF. A 240V to 12.6V, 150 mA transformer is recommended.

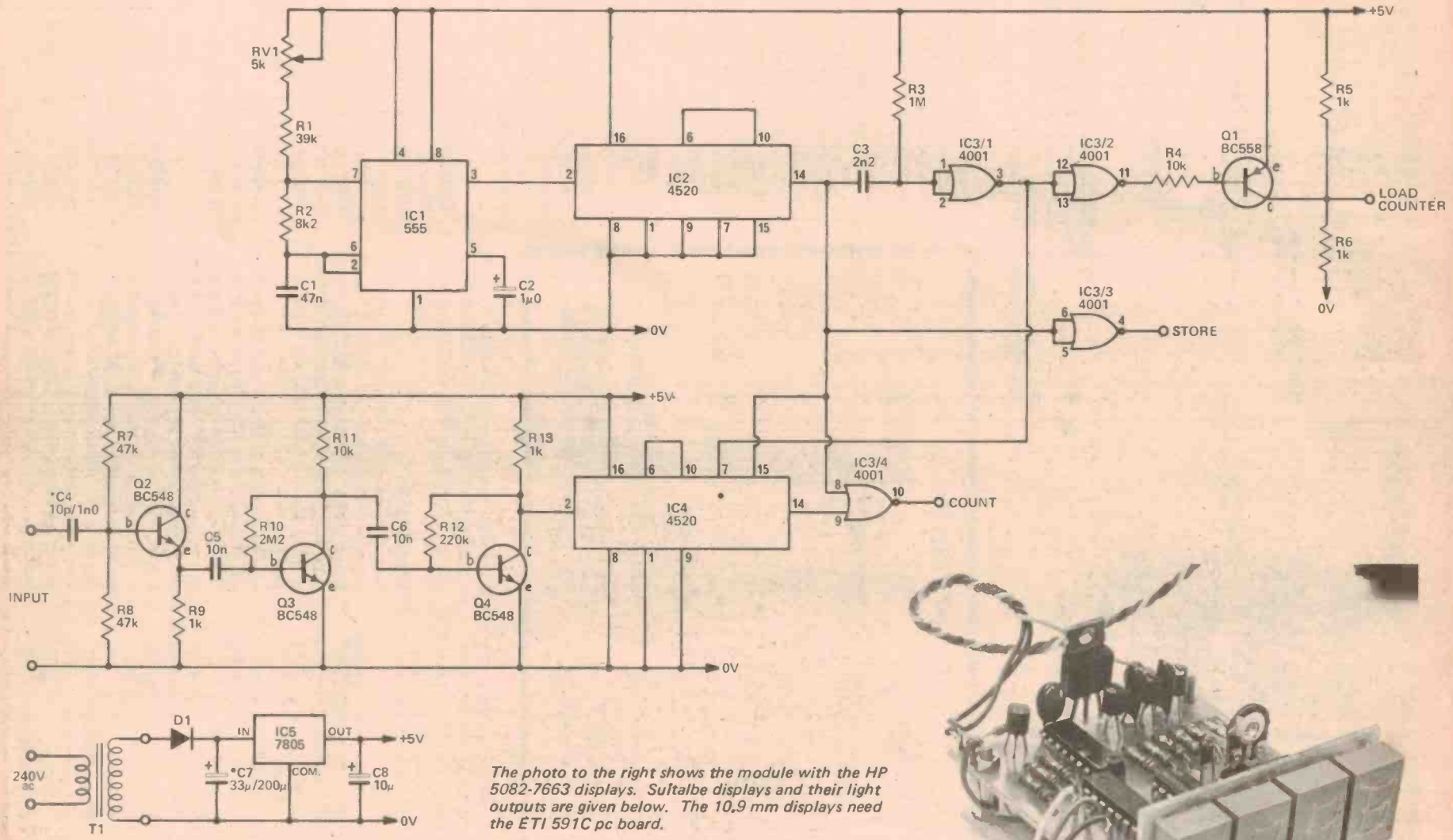
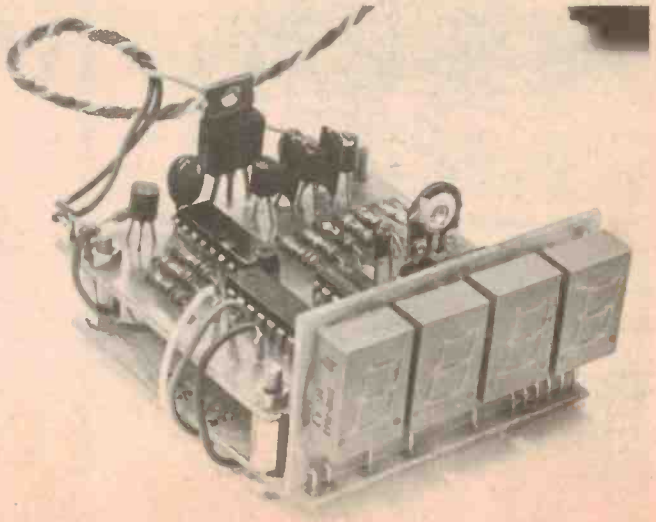


Fig. 3. The circuit diagram of the control logic.

The photo to the right shows the module with the HP 5082-7663 displays. Suitalbe displays and their light outputs are given below. The 10,9 mm displays need the ETI 591C pc board.

Type	Colour	Size	Light output
HDSP 4133	yellow	10.9 mm	2100μCd @ 20mA
HDSP 3733	red	10.9 mm	1800μCd @ 20mA
5082-7663	yellow	10.9 mm	1500μCd @ 20mA
5082 -7653	red	10.9 mm	1720μCd @ 20mA
DL704	red	7.6 mm	320μCd @ 25mA



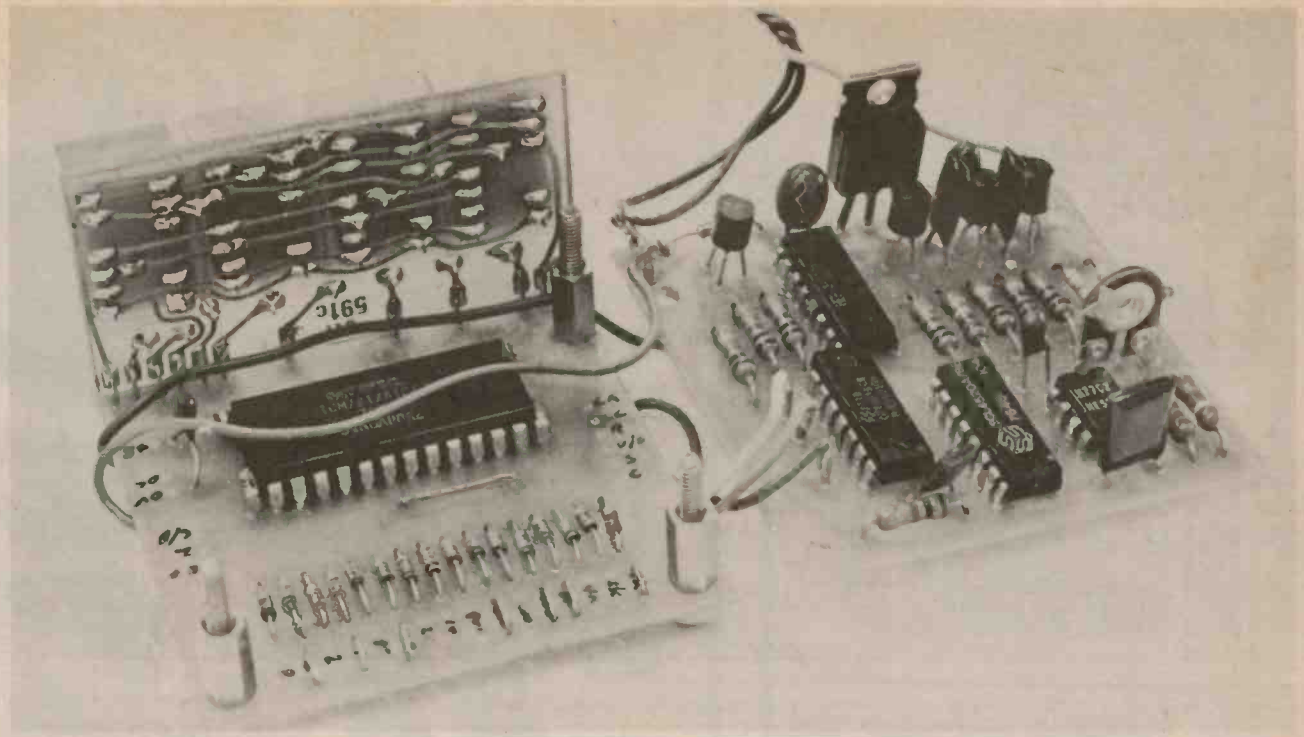
HOW IT WORKS - ETI 550

A signal from the local oscillator in the tuner is picked up either by a pickup coil or by direct connection to the set. It is then amplified by Q2-Q4 to give a square wave on the collector of Q4. The gain of this amplifier is about 250 (48 dB). The frequency of this signal will vary from around 1 MHz to about 2 MHz and this signal is then frequency divided by 256 (2^8) in IC4. This is used to clock the display module.

To measure the frequency we have to count the number of these pulses for 256/1000 seconds (256 because we divided the input by 256 and 1000 as we want a 1 kHz resolution). We used a 555 oscillator for the time base and its output is also divided by 256 (by IC2). This improves the stability of the time base by averaging out any short term variations in the 555 frequency.

The output of IC2 is a symmetrical square wave and when the output goes low a 1.5 ms wide pulse is generated by R3, C3 and IC3/1. This is then inverted by IC3/2 which turns Q1 on for the 1.5 ms period. Two resistors are used to bias the output of Q1 to 2.5V to ensure that the three level input will work.

This pulse "loads" 9545 into the counters (in the display module). Counting now starts from this number and after 455 pulses it is passing through zero. 256 ms after the load pulse ended the output of IC2 goes high. This resets IC4 back to zero, inhibits any further clocking via IC3/4 and opens the latches via the strobe line allowing the total in the counter to be displayed. 257.5 ms later when the output of IC2 goes low again, the store is closed, the counter is once again preset to 9545 with the process starting again.



The two boards which make up the complete dial. Note the links on the display board. The diodes where the links are not used may be deleted.

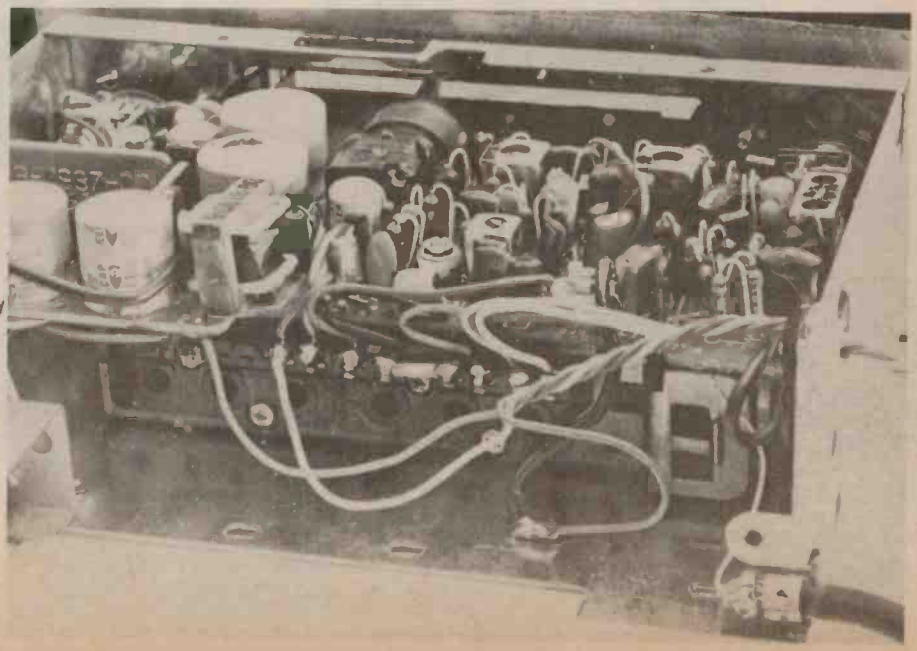


Photo showing where we tapped into the car radio.

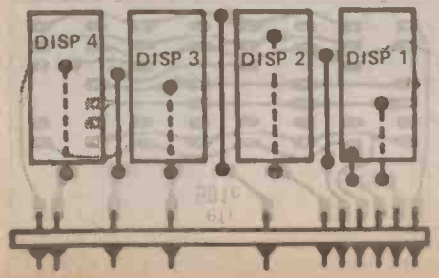


Fig. 4. The component overlay of the display when using the HP display.

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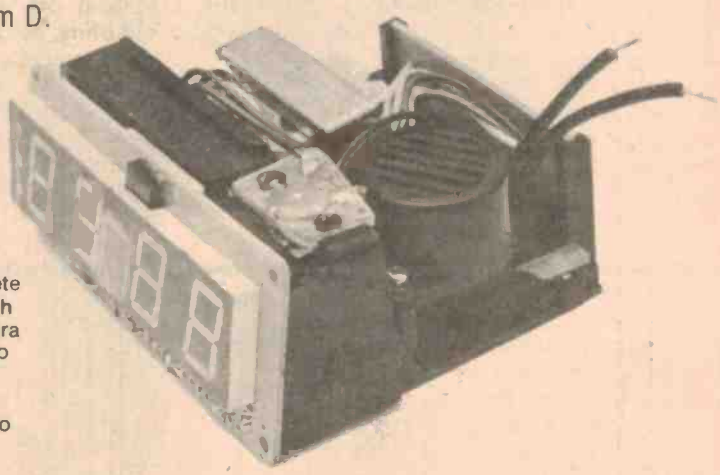

Assembled and tested, including power supply and switches — just add a power cord and case for a complete alarm clock. May be converted to switch a radio, in which case the 59 minute sleep function may be used — one extra switch required. Second count may be held, or reset to zero and held. Unaffected by momentary power cuts. Longer power cuts are indicated by flashing LED and alarm sounding. Units will be sent by certified mail at no extra charge. **COD $2.50 extra.**

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Speed Transistor Radio Service

HERE ARE TEN effective ways to help you locate transistor radio faults faster. They are usually obvious (though often unremembered) ideas that have been used and proved profitable. By Terry L. O'Connor.

1. Check Battery Voltage and Current.
Make this a regular procedure. Test receiver battery voltage with it turned ON. Check the current drain with the volume control turned down. The current drain may be checked by placing a milliammeter (most VOM's have a milliamp range) across the receiver's on/off switch terminals (set off). The average transistor radio may draw some 5 to 15 mA if it uses Class B output stages and somewhat more if the output stage is Class A.

Excessive current drain may be caused by shorted or leaky bypass capacitors, incorrect biasing of one or more transistors or by a defective transistor.

2. Find the Obvious Faults
Possibly more than anything else, transistor radios suffer from broken wires and terminals usually caused by the owner dropping the radio. Broken wiring may be quite difficult to analyse, either by signal tracing or voltage readings. A lot of time can be saved by eyesight checking. The use of an illuminated magnifier will help find broken conductors.

Try slightly flexing the printed circuit board to find tracks that are broken or intermittent. The small ¼ and 1/8 watt resistors are easily cracked and often go open circuit.

Heavy components, such as transformers, often pull away from the printed board and break their connecting leads in the process. Try moving each part from side to side gently and listen for a pop in the speaker. Use a jumper wire with needle point probes at each end to check if the printed track is open.

3. Don't worry about transistors or IC's.
Not at first anyway. It is just an advertising agency's dream – bad transistors or IC's *do* account for only 2 to 3% of all transistor radio defects – check other things first.

4. Don't rely on transistor gain checks.
Unless there is laboratory equipment available your chances of learning anything from a gain check are nil. The DC gain has almost nothing to do with the manner in which a transistor will perform in a practical RF circuit. There are too many other factors involved, such as input and output impedance or biasing.

5. Check transistors with an in-circuit transistor.
As the transistors used in portables usually are not plugged in we must have some exploratory method for checking that does not mean unsoldering the transistor. The quickest way is to use an in circuit transistor tester, available from many radio components retailers. However, if you do not own a transistor tester (in circuit variety) you can use a VOM instead.

With the radio off, place an ohmmeter (20,000 ohms per volt or better) across the Base and Collector of the transistor; and reverse the test leads. There should be more resistance in one direction than in the other. Do the same from Base to Emitter. Typical readings may be 3,000 ohms in one direction and 20 ohms in the other. This usually indicates that the transistor is good, as there is evidence of diode action.

A transistor can also short circuit from Collector to Emitter, without affecting the apparent diode action of the Base-Collector, Base-Emitter paths.

6. Signal Trace or Signal Substitute
You can use a signal generator for signal tracing. Start with the audio and successively trace backwards towards the front end. Never be tricked, though, by the low-impedance base circuit of a transistor. It will greatly attenuate the signal generator's output. Always inject the signal into the higher impedance collector circuit, if possible.

7. Never Be Tricked by Gain of Receiver.
A transistor radio may appear to be operating normally especially on strong local stations, but refuse to work when taken to a fringe area. If you work quite a lot on the same kind of radio, you may set up tests with an output meter and your signal generator to determine if the gain is up to scratch. If it is not, check the tuning and tracking (as detailed in Step 10). Use a substitute capacitor and *shunt* each and every bypass and coupling capacitor in the radio.

Capacitors and IF transformers can cause more weak radio faults than anything else. Transistors often short or open. Try to check IF's by retuning them. If they cannot be peaked, they

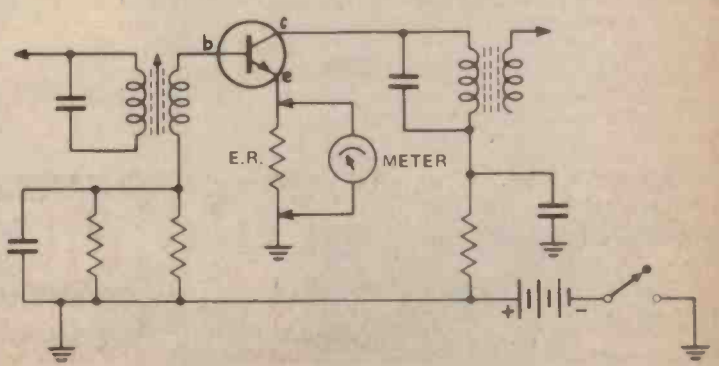

Fig. 1. Base and collector of different polarity means transistor is cut off.

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are faulty. If the tuning has to be changed drastically (unless the radio has been tampered with by someone), it is likely the IF transformer is defective and will have low gain, even though it may appear to peak at some position of the slug.

8. Check the Oscillator With Another Radio.

Position a working radio, tuned to a station at the high end of the band, near the radio with a suspected oscillator stage. Sweep the defective radio through its tuning range. At some point a whistle or squeal should be heard in the good radio if the defective radio's oscillator is operating. This whistle or squeal should be heard at approximately 455 KHz below the station tuned in on the good radio, if the good radio uses a 455 kHz IF. This allows you to know that the oscillator tuning circuit on the defective radio is operating.

It is also possible to use a peak-to-peak meter or a wide-band oscilloscope (even some narrow band scopes) to test oscillator action. Most radios should develop approximately 0.2 to 0.8 volt pp at the base of the oscillator transistor.

9. Take Accurate Voltage Readings and Reason Out the Fault.

More than half of the tough transistor radio faults may be diagnosed by voltage readings. Remember, with respect to the Emitter, the base is the *same* polarity as the Collector. If the collector is positive then the base will be positive; if it is negative the base will be negative, unless there is a fault. The bias voltage between the emitter and base is often 0.2 volt or less, but the base must have the same polarity as the collector. In a typical example: Base to Emitter 0.2 volts, Collector to Emitter 3.5 volts. Another example: Base to Emitter –0.4 volt, Collector to Emitter –5.5 volts.

Now let us suppose that these readings were obtained:–

Base to Emitter	plus 0.2 volts
Collector to Emitter	minus 6 volts

It is obvious that the base and the collector are not of the same polarity. The transistor cannot operate; it is cut off. Figure 1 illustrates how this may be detected.

An open transistor can be found because there is no voltage drop across the emitter resistor. Of course, you shall always check the bias first, as incorrect bias will cause the emitter resistor voltage to drop to zero. Figure 2 illustrates how a leaky capacitor may cause this.

CAUTION: When taking bias readings, watch out, for some receivers will have practically no (or even reverse) DC bias on the converter stage, when it is also used as an oscillator. You may think that the transistor cannot operate, but it does so because of the AC bias developed by the oscillatory circuit.

10. Use a Noise Source to Align Oscillator and Antenna Circuits

Firstly align the IF's with an accurate signal generator to their specified frequency.

Second, use a Noise Generator (or a fluorescent lamp), and placing the radio close to the noise source, tune in to the low frequency end of the band and adjust the oscillator coil for maximum noise.

Third: now tune the radio to the high frequency end of the band and adjust the antenna trimmer for maximum noise.

If calibration is off somewhat, you can touch up the oscillator trimmer, then repeat the above steps.

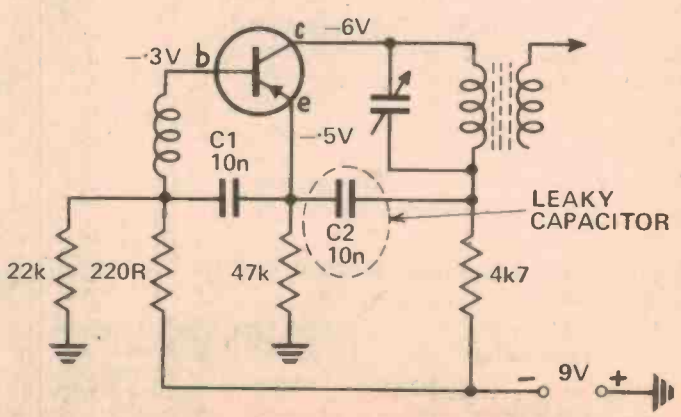

Fig.2. Leaky capacitor pulls emitter negative, cutting off transistor.

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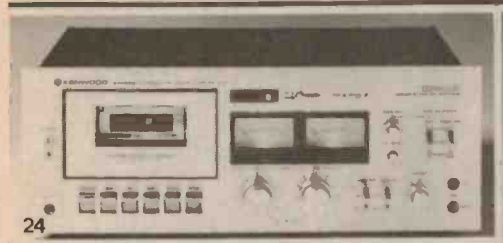

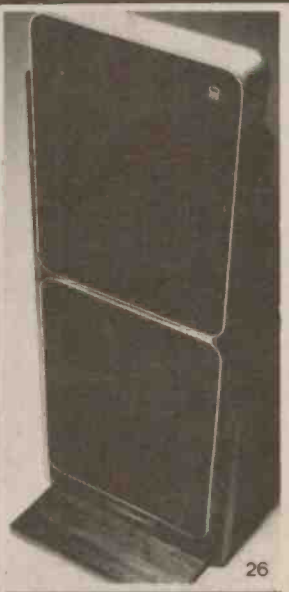

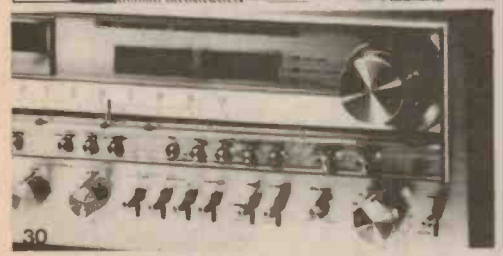

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1. The Problem of King Nashidnezzar

ONCE upon a time in the kingdom of Langri-Shaan, there lived a king named Nashidnezzar. In his kingdom people were of many different religions, races, skin-colors, creeds, and cultures; and many persons of very different backgrounds would apply from time to time for employment in His Majesty's service.

Now King Nashidnezzar was a scrupulously fair and non-discriminating monarch, with a high sense of social responsibility and old-fashioned honour. He wanted to hire good people, no matter what their background might be. He did not want to rely on arithmetical tests, because some of the cultures in his kingdom were weak in arithmetic. He did not want to rely on verbal tests or tests using words because there were many different languages spoken in his kingdom. He decided he wanted to test observation, reasoning, and judgment, and choose those people who scored high on these qualities And he was puzzled what to do.

2. Information Engineer Zoomiyie

So he sent for his Grand Vizier, whose name was Bundolowitz, and explained the problem to him, and what kind of a selection test he wanted.

The Grand Vizier listened carefully, and then he said: "Your Majesty, I have just the thing. It is a newly created test or game made by one of my bright young Information Engineers, whose name is Zoomiyie. Sire, I will get him and his game at once."

In a few minutes Vizier Bundolowitz and Engineer Zoomiyie came again into the presence of the King, and Zoomiyie opened the case which he had with him. There scattered on a dark cloth background were a very large number of dice.

"Oh," said the King. "A gambling game! I am NOT pleased."

Zoomiyie quickly said: "No, Sire, there are 60 dice here, and it is almost impossible to gamble with 60 dice — what happens when the dice are tossed, though randomized, is rather regular. No, I have here a game of observation, and reasoning, and judgment; and I will explain it."

He explained the game. The King and the Vizier listened and started to play it. The King found the game so fascinating that he cancelled his appointments for the next two hours; and played the game with the Vizier, and both were laughing and interested. Zoomiyie watched intently, took notes, and answered questions.

Then the King said to Zoomiyie, "Well done, young man, I am pleased. I think this game will meet my objective. I hereby name the game Zoonayman, and I shall direct the Treasurer of the Kingdom to give you an inventor's award of 1000 gofars."

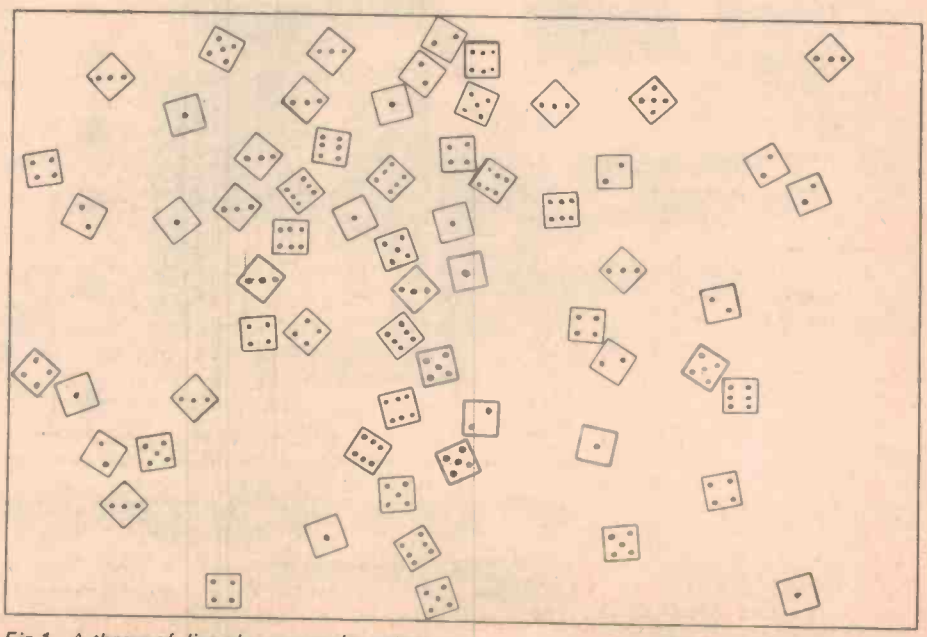

Fig. 1. A throw of dice plus a move by nature.

3. Zoomiyie's Game

And here is Zoomiyie's Game:

Rule 1. There are two players whom we shall call Nature and Man. (But for tests in Langri-Shaan they were called the Examiner and the Applicant). A game consists of a number of rounds in which the two players alternate as Nature and Man. (But in Langri-Shaan, the Examiner and the Applicant did not alternate roles).

4. Nature's Turn

Rule 2. In each round Nature plays first. Nature takes the 60 dice and tosses them, producing a random pattern of random outcomes. During this throw, Man has to shut his eyes and not look.

Rule 3. With Man's eyes still shut, Nature then performs what is called a Definite Systematic Operation which has the following properties:

a. The operation must be performed on all the dice of a definite class, such as "all 3's" or "all central dice".
b. The operation has to be expressible in not more than four words (Examples: Turn 1's over. Make 2's touch 5's. Etc.).
c. The operation must produce a result that displays some kind of evident, systematic rational order and completely removes some kind of randomness.
d. The operation must change at least four dice significantly (i.e. not trivially) from their original position or outcome 1 to 6.
e. The position and outcome 1 to 6 of all dice not in that definite class must remain exactly as they fell when they were tossed.

Rule 4. Nature writes this operation on a slip of paper and folds it up so that what Nature wrote cannot be seen.

There is now a cross-classification of interesting possibilities:

(a) The operation that Nature chose may be allowed or not allowed according to the rules.
(b) Nature's description of the operation in words may be correct or not.
(c) Nature's carrying out of the operation may be correct or not.

5. Man's Turn

Man studies what he sees in front of him, and asks himself questions, such as: "What is the number of 1's? Is this number usual? Where are they located? Are the locations apparently random? How are they arranged? is the arrangement apparently random? What is the number of 2's?" and so on.

Finally, Man notices, we suppose, that something is not usual, something is not random, and so he describes what he notices, what appears to be Nature's operation. He writes his rule on a slip of paper; but he does not have to express Nature's operation in four words or less — only Nature has to.

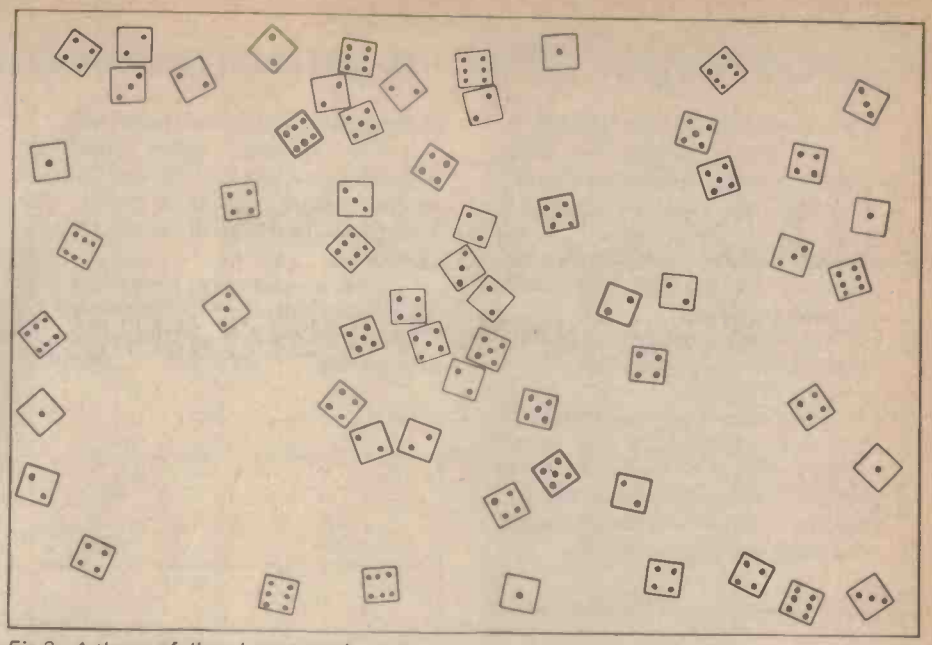

Fig.2. A throw of dice plus a move by nature.

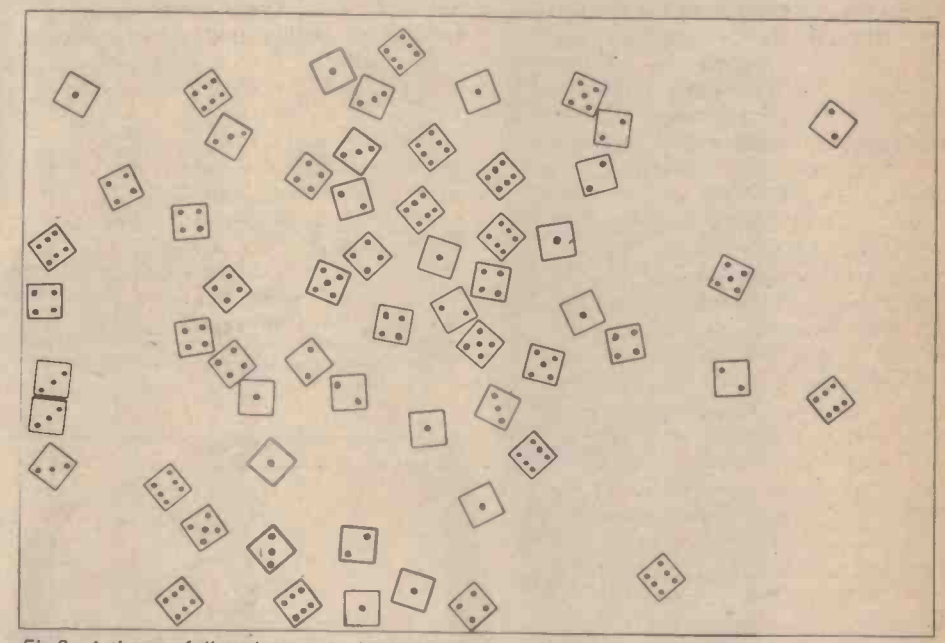

Fig.3. A throw of dice plus a move by nature.

If after a reasonable time, like three to five minutes, depending on agreement, Man cannot decide what Nature did, then he says he gives up — but he does not necessarily score zero because Nature may be penalized for making mistakes.

6. Scoring

Rule 6. Now the two players, Nature and Man, compare the rules which they have written down on slips of paper. There are several cases:

a. If Man figures out what Nature

actually did, he scores 2 points.

b. If Man did not figure out what Nature actually did, but he figured out Nature's rule, he scores 2 points.
c. If Nature did not actually do what Nature's rule required, Man scores 1 point as penalty.
d. If what Nature actually did was a disallowed operation, Man scores 1 point as penalty.
e. If Nature's rule described an allowed operation, and what Nature did is in agreement with Nature's rule, and if Man did not figure it out, then Nature scores 2 points, and Man scores 0.

TABLE 1

Binomial Frequency Distribution for $(q + p)^n$ $q = 5/6, p = 1/6, n = 60$

No. of Outcomes*	Expected Frequency (percent)	Cumulative Expected Frequency (percent)
0	0.002	0.002
1	0.021	0.023
2	0.126	0.149
3	0.486	0.635
4	1.384	2.019
5	3.102	5.121
6	5.687	10.808
7	8.773	19.581
8	11.625	31.206
9	13.433	44.639
10	13.702	58.341
11	12.457	70.798
12	10.173	80.971
13	7.512	88.483
15	3.094	96.621
16	1.740	98.361
17	0.901	99.262
18	0.430	99.692
19	0.190	99.882
20	0.078	99.960
21	0.030	99.990
22	0.010	100.000

*This is the "number of outcomes" of a given face of a die. For example, in a throw of 60 dice, to obtain nine occurrences of the face 2 (or outcome 2) is to be expected 13.433 per cent of the time.

7. Examples, and Some Comments

The following pages show six examples of a throw of 60 dice followed by Nature making a move. We invite our readers to solve the six puzzles.

Dice in quantity, instead of just singles or pairs, can provide an exciting "learn-as-you-play" introduction to probability, statistics, scientific observation, and pictorial reasoning.

The mathematical advantage of using 60 dice (instead of any fewer) is that complete nonappearance of any single outcome (1, 2, 3, 4, 5, or 6) is so remote as to be negligible. In fact, the expected frequency of any given outcome (such as 1 or 5) is as shown in Table 1. (This is the binominal distribution of $(q + p)^n$ where $q = 5/6$, $p = 1/6$, and $n = 60$).

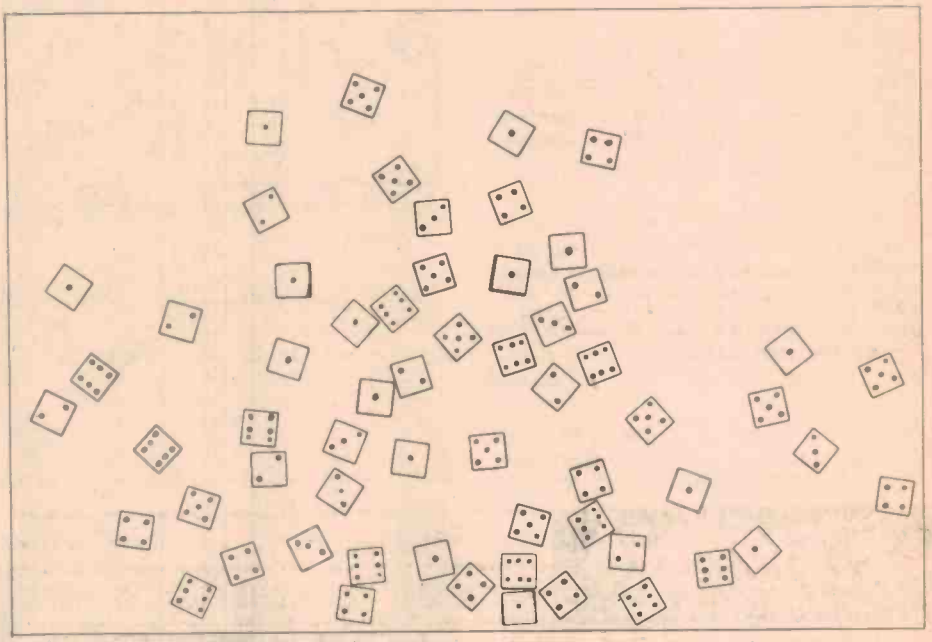

Fig.4. A throw of dice plus a move by nature.

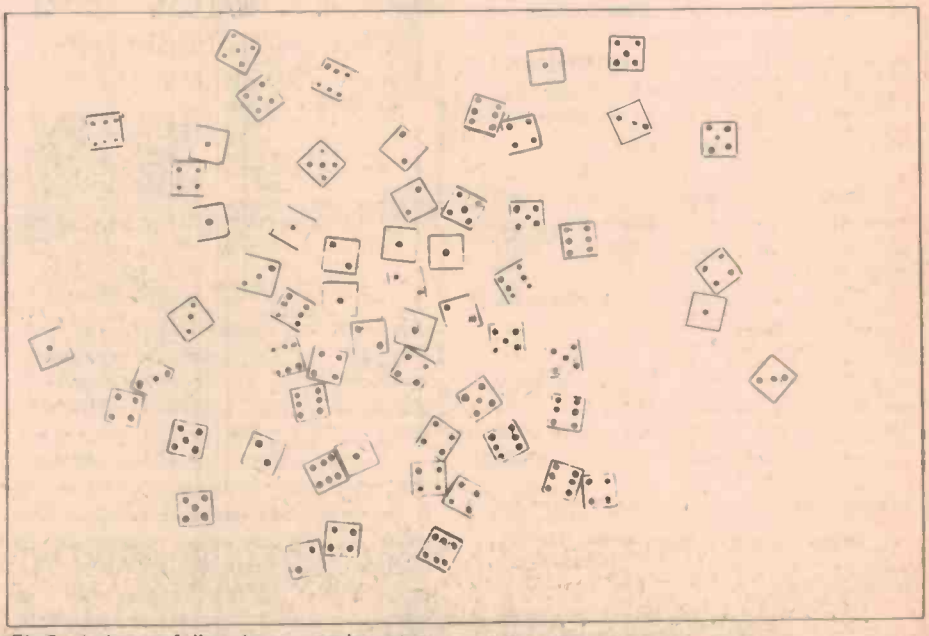

Fig.5. A throw of dice plus a move by nature.

This kind of game can easily be programmed on a computer using a pseudo-random number generator. The program should determine the location, the orientation, and the outcome of the die. Then a computer program or a person or both together can make Nature's move. There appear to be some 30 to 40 interesting operations that can be expressed with one English verb; then the remaining three words of Nature's rule can express arguments or modifications for the operation.

This game requires 60 dice which are available from any reputable game shop or from Eyes and Hands Games of 259 Pitt Street, Sydney.

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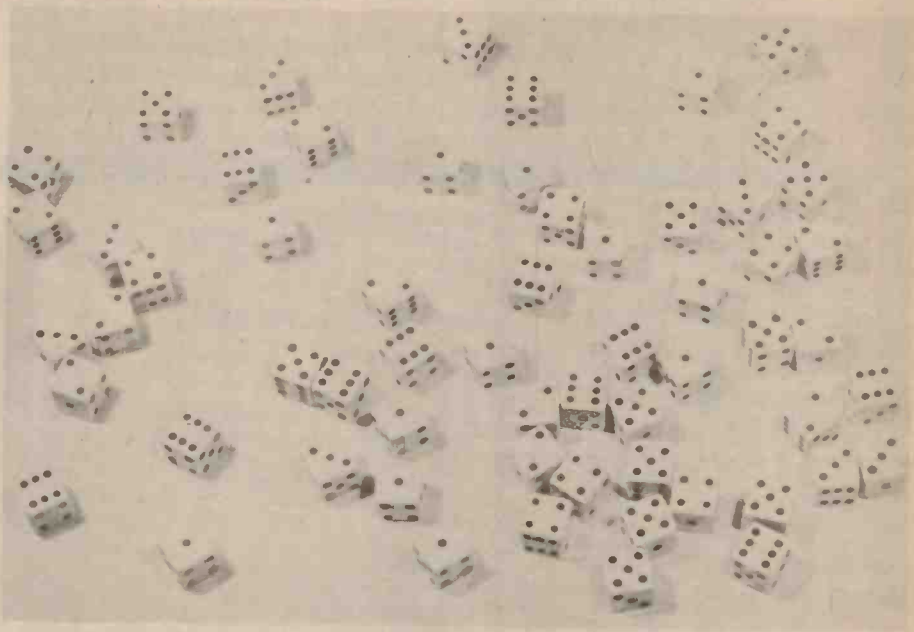

Fig.6. A throw of dice plus a move by nature.

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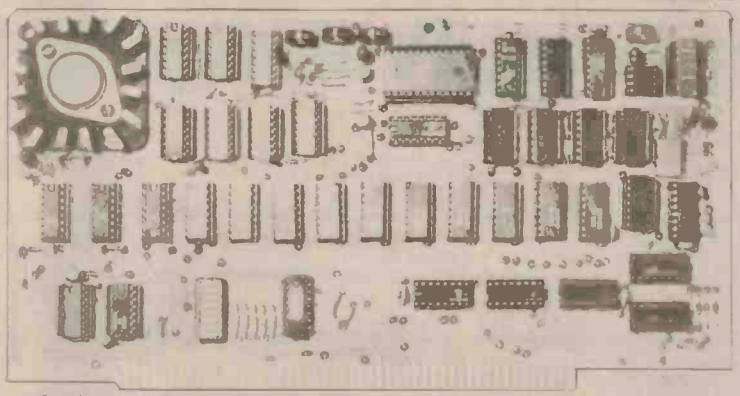
DG 640 SOFTWARE CONTROLLED VDU



This superb design by David Griffiths and described in ELECTRONICS TODAY April, May, and June issues is possibly one of the most useful peripherals you can add to any microprocessor system.

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ATTENTION 2650 USERS: Ian Binnie has written a special operating system called "BINBUG" which is specifically designed to operate with the DG640 VDU and emulate "PIPBUG" thus ensuring that all software in the 2650 USERS GROUP is fully compatible and no I/O changes need be made. BINBUG is documented in the DG640 users manual and occupies 1K of RAM. Cassette tapes and a preprogrammed 2708 EPROM are available on request.

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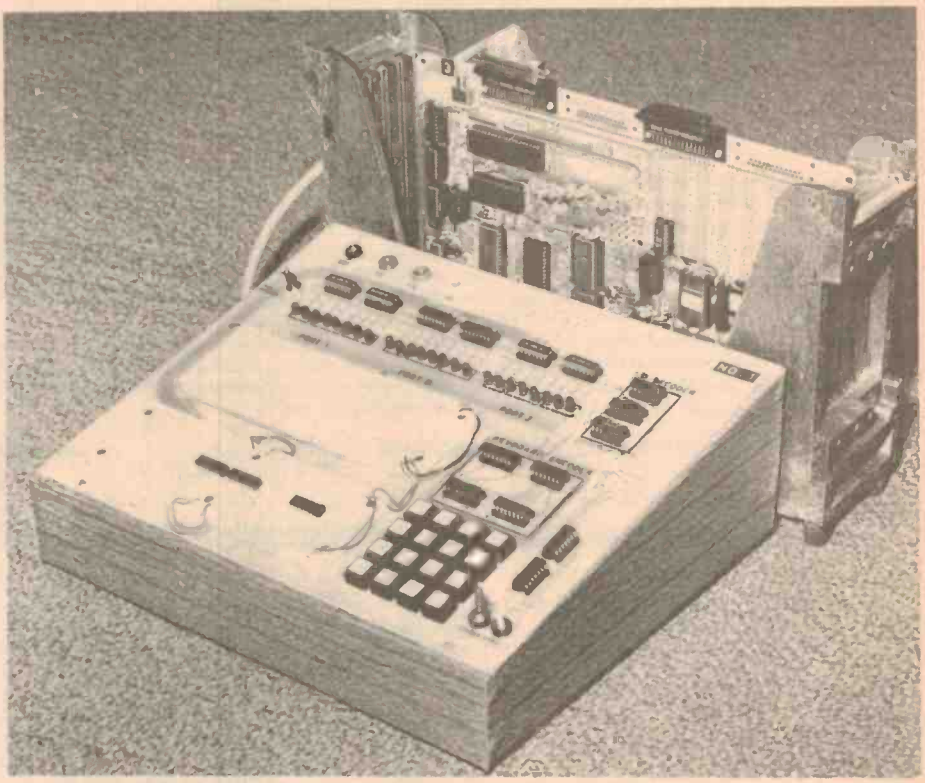
8080 Educational/Prototyping Interface

Part two of this paper by Dr Paul Goldsborough, of Canberra College of Advanced Education, gives initial testing and operation details for the 8080 Interface board as well as some ideas for expansion.

Initial Testing

With the PPI and USART removed, set the bus-monitor/Port 1 function switch to "Port 1" and the single-step/full speed computer operation switch to 'full speed'. External power supplies of +5 V, +12 V and −12 V should be wired to the 4 mm sockets S1 – S4 on the Educational Interface. Minimum current requirements are 1.5 A, 250 mA and 100 mA, respectively. I recommend that before switching on the power, you check your wiring (a continuity check of the data, address and control bus lines from the P-1 edge connector of the SK-10 to the line destinations at chip pins on the educational interface is useful), IC orientation and that there are no obvious solder bridges. Apply power and press the reset button. If your equipment is operating, HI memory address, 023_8 should be displayed at Port 1, LO memory address, 000_8 should be displayed at PORT Ø, and PORT 2 should display the contents of memory address 023_8 000_8 which, at this stage will be random. If you do not observe this effect, switch off the power immediately and check for wiring errors, dry joints, mis-oriented IC's solder bridges etc. If you do observe the required effect, so far so good!

The next step is to test the other keyboard keys. The function of these keys has been described in detail elsewhere [3], but if you are unfamiliar with the characteristics of this interface, the following test procedure should provide sufficient insight. First, check the "S" key whose function is to display, at PORT 2, the contents of the memory address displayed at PORT 1 and PORT Ø. Each time the S key is pressed, the current contents of PORT 2 are stored at the currently displayed memory address, the LO memory address is incremented by one (at Port Ø)



and the contents of this new address are displayed at Port 2. If this key is not operating, check your keyboard encoder circuit. If this key is functioning as described above, there is a good chance that your educational interface is operating correctly.

Next, attempt data entry by depressing one of the keys marked 0-7. You should see a three bit, binary representation of this octal digit appear at the right of the Port 2 LED display and shift left as further data keys are pressed. Once a desired three digit octal byte (say 303) has been registered at Port 2, it can be stored at the memory address displayed at PORT 1/PORT Ø by pressing S. You should be able to use the data register (PORT 2) contents to specify a high or low memory address byte by pressing the H or L keys respectively. If the L key is pressed after entering 303_8 in the data register, the contents of address 023_8 303_8 should be displayed in the data register. The H key should function similarly for altering the HI address byte and therefore, for examining memory address outside the range 023_8 000_8 to 023_8 377_8.

To test the G key, enter the program given in Table 4 in memory commencing at 023_8 000_8. To verify that the program is correctly stored in memory locations 023_8 000_8 to 023_8 006_8, reset the microcomputer by pressing R and then press the S key six times. The program bytes should be displayed

in sequence at PORT 2. Execute the program by pressing the R and then the G buttons. All the LEDs of Port Ø should light up since the computer is incrementing the accumulator, outputting the result and looping to increment etc. so fast that the individual bytes are indistinguishable to the eye. To slow things down, go to "single-step" (SS) computer operation by changing the single-step/full-speed switch to "single step". Now repeatedly press the SS button, until you see the accumulator contents change at Port Ø. The PORT Ø LED display should now change every eighth time. If this does not happen, check your single step circuit to ensure that a *pulse* is generated at the ready input of 8224 clock chip each time you press the single step button.

To observe program instructions etc. on the *data bus* using the bus monitor function of Port 1, switch the bus-monitor/Port 1 switch to "bus monitor". Note that the bus monitor is only effective when the computer is being single stepped since the data on the data bus changes too rapidly to observe when the computer is operating at full speed.

Finally, computer interrupt operation can be checked as follows: ground the INT line at the SK-10 breadboarding socket. Insert instruction 373_8 (interrupt enable) at address 023_8 000_8. Push the reset key and then the G key to run our program. If INT is now raised to +5 V, you should observe that microcomputer control has reverted to KEX. The reason for this is that the 8228 system controller automatically loads the vector interrupt instruction, RST7, on to the data bus at the proper time. This vectors program control to memory location 000_8 070_8 which is within KEX! The 8228 behaves in this way because the INTA output at pin 23 is connected to +12 V through a 1k resistor. If this resistor is removed, other vector interrupt instructions may be gated onto the bus using additional, external logic.

Prototyping

The microcomputer which has been developed to this point is adequate for most educational exercises in interfacing and for the development of small (less than 50 bytes) assembly language programs. For the system to be useful as a prototyping microcomputer, several additional features are necessary, viz., a good software de-bugging program which has teletype and paper tape input, access to the PPI, access to the data bus, address bus and control signal lines and ideally, a software editor/assembler program.

Test Program

Memory Address	Instruction Byte	Mnemonic	Description
023 000	000 START,	NOP	/No operation
023 000	074	INR A	/Increment accummulator by one
023 002	323	OUT	/Output accummulator contents
023 003	000	000	/Device code of output port
023 004	303	JMP	/Unconditioned jump
023 005	001	START	/LO memory address of jump
023 006	023	0	/HI memory address of jump

Table 4 - Test Program.

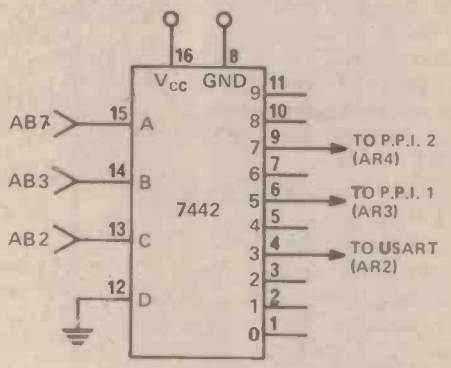


Fig.7. Decoder circuit used to decode PPI and USART device codes which do not conflict with those of the educational interface.

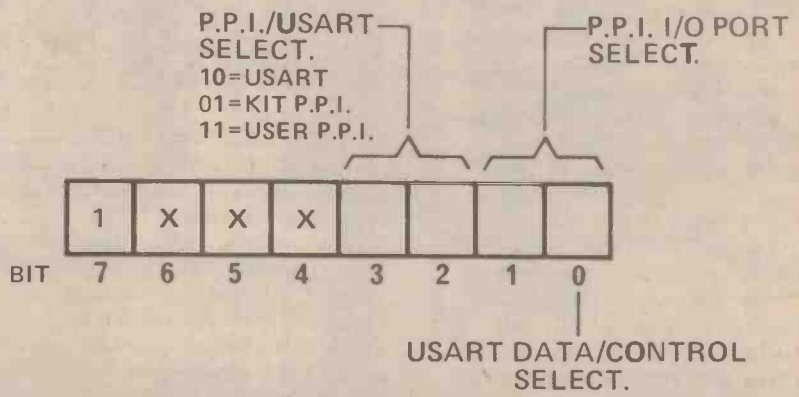
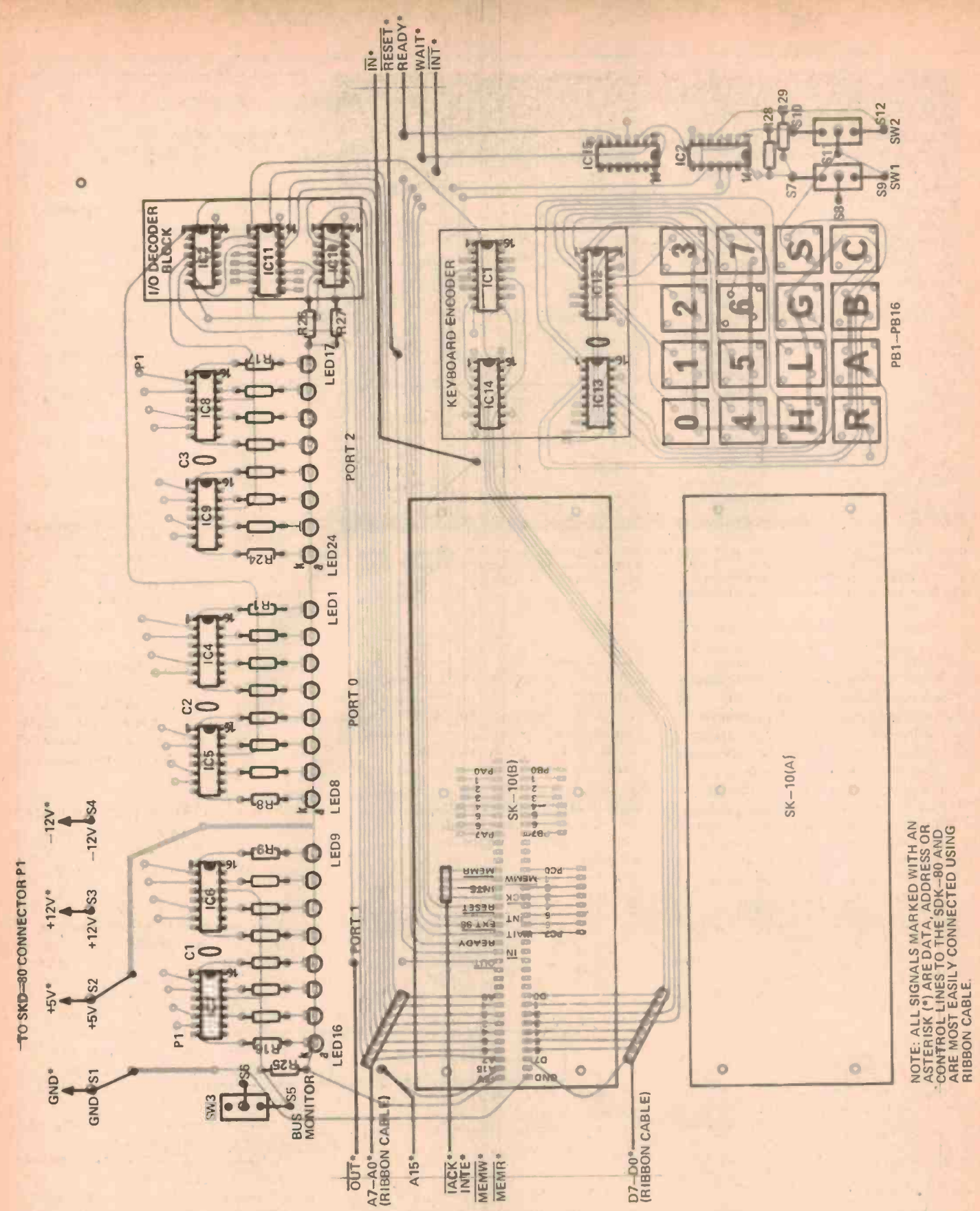


Fig.8. Erroneously reproduced in the lower half of Figure 6 last month, this drawing shows the SDK-80 PPI and USART device code format which results from incorporating the decoder circuit of Figure 7. Both the PPI/O port select bits (0 and 1) and the USART data/control select bit (0) remain the same as in the upper drawing of Figure 6.



The component overlay of the 8080 interface. Only the lower side of the double-sided pc board is shown here for convenience.

Photocopies of the listings of Keyboard Executive Program, KEX or tape dump program HTAPE, with some documentation are available directly from ETI at a charge of $2.50.

Fig.9. Breadboarding and debugging of quite large interfaces is facilitated with the educational/prototyping microcomputer by the availability of both hardware (single machine cycle) and software (single instruction) single step; together with easy access to the data, address, control and 24 PPI lines at the SK-10 solderless breadboarding socket.

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- IC3 7402
- IC4 - IC9. 7475
- IC10 . . . . . 74LS05
- IC11 . . . . . 74L42
- IC12, 13 74148
- IC15 7474
- LED1 - LED24 . . HP5082 or similar

Miscellaneous
- SW1. . . . . SPDT toggle switch
- SW2. . . . . SPDT pushbutton switch
- SW3. . . . . SPST toggle switch
- PB1 - PB16. . . . SPST keyswitches
- S1 - S4 . . . . . 4 mm sockets
- S5 - S12 . . . . . AJB pin (GES Pty. Ltd.)
- SK10a . . . . . SK-10 solderless breadboarding socket
- SK10b SK-10-1F36
- P1. . . . . Harwin Track Connecting Pins (T1551-01 from GES Pty. Ltd.)

Beginning with the software, a debugging program called, predictably enough, D-BUG, was used in our system. D-BUG is a teletype oriented program which requires 1K of memory. The program includes paper tape and punch routines so that programs being developed can be stored on paper tape and then read in later for further development. A software single step feature is also included which permits program execution one step at a time. At each step, the contents of all internal registers and the stack are output. D-BUG is described and listed in a book entitled 'DBUG: AN 8080 INTERPRETIVE DEBUGGER' by C.A. Titus and J.A. Titus (E &L Instruments, Inc.).

An alternative to D-BUG is the SDK-80 monitor which has the advantage of coming with the SDK-80 kit, but does not have paper tape read and punch subroutines. While a 6K EPROM stored editor/assembler program was available [5] to complete the software, it has not been incorporated at this stage since it extends total EPROM requirements to 8K when KEX and D-BUG are included. An extra RAM/ROM memory board is required.

To incorporate D-BUG and to begin meaningful prototyping work, the PPI and USART are required. As discussed earlier, their device codes must be altered and/or uniquely decoded so that they do not conflict with the educational interface device codes. As a further constraint, the USART device codes (372_8 and 373_8) must be retained since the SDK-80 monitor might be required. For convenience and economy, I thought it desirable to use on-board SDK-80 components such as the RAM or ROM 3 to 8 line decoders, or possibly spare on-board inverters to uniquely decode the USART codes and some convenient PPI device codes. Unfortunately none of these possibilities is in any way suitable and so a decoder circuit (shown in Figure 7) must be wired on the SDK-80 general purpose kluge area. Wiring details are given in Fig. 2. Note that the chip enable lines (CS) to the two PPI's and the USART must be broken at the three points indicated by crosses in Figure 2. Address bit A7 was used in the decoding to ensure that PPI/USART device codes are *above* 200_8, leaving codes *below* this for the educational interface. Figure 8 shows the resulting combined PPI and USART device code format.

Finally, a teletype should be wired to the SDK-80 for full duplex, 20 mA current loop operation as described in the SDK-80 manual. In more sophisticated microcomputers such as the SBC-80/10, an on-board teletype reader pulse facility, under software control, is incorporated; and this requires a special reader relay board addition [6] to the teletype. The SDK-80 does not have this feature, and so both the reader and punch must be operated manually. The reader relay teletype modification is not necessary.

An Educational/Prototyping Sequence

In conclusion, I believe the microcomputer described here is useful for the following educational/prototyping sequence:

- The educational interface is used to learn the basics of microcomputer interfacing and programming. During this educational phase, KEX replaces the SDK-80 monitor at memory location 000_8 000_8. The user advances with this interface until he is competent to write small microcomputer programs (up to say 50 bytes), and to interface to the microcomputer using the 8255 PPI.
- For larger programs (100-200 bytes), paper tape program input with D-BUG is used. With memory expansion, a resident editor/assembler can be incorporated for large programs (greater than 200 bytes). If finance is limited, the SDK-80 monitor can be used to replace D-BUG; but with increasing difficulty as program size goes up.

```
TYCHON EDITOR-ASSEMBLER V-2                          PAGE 01-001

                  /THIS IS THE DRIVER FOR PROGRAM "HTAPE".
                  /"START" DEFINES BEGINNING OF MEMORY REGION TO BE DUMPED.
                  /"END" DEFINES THE END OF MEMORY REGION TO BE DUMPED.
                          DW START 000 000
                          DW END 000 150
                          DW HTAPE 001 000
                          *021 000
021 000 041               LXIH    /LOAD H,L WITH "START"
021 001 000               START
021 002 000               0
021 003 021               LXID    /LOAD D,E WITH "END"
021 004 150               END
021 005 000               0
021 006 303               JMP
021 007 000               HTAPE
021 010 001               0
021 000 G

:10000000C33800000000000C308130000000000017
:10001000C3101300000000000C318130000000000C
:10002000C3201300000000000C328130000000000DC
:10003000C31C0E000000000031001421001 34E7C90
:10004000D3017DD30079D302CDCD00FE08D25C0070
:10005000477917171 7E6F8B04FC3450 0FE09C26588
:090060000069C33E00FE08C26EF7
:00000001
```

Table 5 - Teletype printer image of output of "HTAPE".

- At the equipment/prototyping stage, the SK-10 plus control lines and PPI I/O lines are conveniently available for breadboarding interface and control circuitry. This is illustrated in Fig.9. DBUG is available for software development. Once the PPI based interface is completed and software developed, the user can test his prototype and easily make hardware and software changes.
- With system development and testing complete, it is probably most efficient to purchase a second SDK-80 and to wire the P-1 and J-1 edge connectors with only the required SDK-80 control signals. The original microcomputer described here is then retained for further prototyping work. The developed interface and control circuitry is hard wired to the SDK-80 kluge area and an EPROM or ROM programmed, with the developed software, to operate from memory location 000_8 000_8. The on-board or panel mounted RESET switch is then used to start the microcomputer based system.

A major problem in prototyping work is programming the EPROM. A program, HTAPE, was written by the author and incorporated in the SDK-80 KEX PROM to ease this problem. HTAPE dumps any area of memory (presumably your program) to paper tape in Intel MDS format. This tape may then be input to any Intel MDS system for PROM programming. Table 5 shows the driver for HTAPE and the teletype printer image of the tape produced when a portion of KEX was dumped to paper tape. With the PROM programmed, the on-board or panel mounted RESET switch is then used to start the microcomputer based system.

Further System Expansion

The essential software aid which is required for serious medium to large scale prototyping work is an editor/assembler program. A 6K (5K EPROM, 1K RAM) program, TEA (Tychon Editor Assembler), written also by Dr. Chris Titus of Tychon, Inc., has been incorporated into the system described here. Typical output from the three pass assembler is shown in Tables 1 and 5.

Because of limited memory space on the SDK-80, a 12K RAM, 8K ROM memory board was designed and constructed by the author, Dr. B. Stone and Mr. L Spencer of Canberra CAE. This board and the TEA EPROMS are shown in Figure 9. Through using two connectors, one of which may be removed during construction, the board is suitable for either the Intel or Motorola buses. Depending upon interest, the board design and the incorporation of TEA into the Educational/Prototyping system may be described later.

Supply of KEX, DBUG and HTAPE

Both KEX and DBUG originated from Tychon, Inc. SDK-80 versions of these programs and HTAPE, for use in the Educational/Prototyping Microcomputer are available locally from Electronic Development Sales Pty, Ltd., 90 Chandos St., St. Leonards 2065.

References

(1) "Bugbooks 5 & 6: 8080A microcomputer programming and interfacing", P. Rony, D. Larsen & J. Titus, E & L Instruments Inc., Derby, Connecticut (1977).

(2) Intel MCS-80 System Design Kit Users Guide. Intel Corporation, 3065 Bowers Av., Santa Clara, California 95051.

(3) "Build dyna-micro: an 8080 microcomputer" J. Titus, Radio-Electronics, May to July, 1976.

(4) "Teaching Microcomputer Interfacing to Non-Electrical Engineers" Computer, p.53, January 1977.

(5) Available from Tychon Inc., P.O. Box 242, Blacksburg, VA. 24060.

(6) SBC 80/10 Single Board Computer Hardware Reference Manual: Intel Corporation3065 Bowers Av., Santa Clara, California 95051.

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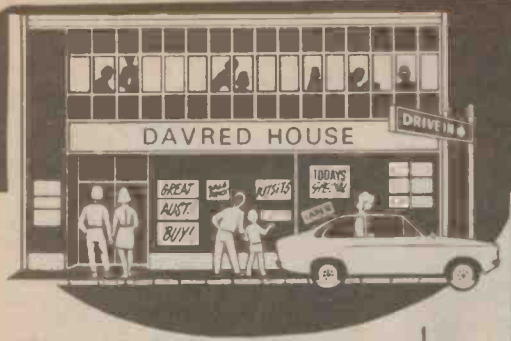

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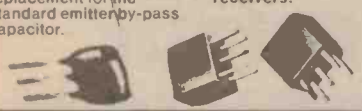

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22 mfd 16 volt	12c	10c	10 mfd 25 volt	15c	12c	3.3 mfd 50 volt	18c	13c
33 mfd 16 volt	15c	12c	22 mfd 25 volt	15c	12c	4.7 mfd 50 volt	20c	18c
47 mfd 16 volt	15c	12c	33 mfd 25 volt	20c	18c	10 mfd 50 volt	20c	18c
100 mfd 16 volt	22c	17c	47 mfd 25 volt	20c	18c	22 mfd 50 volt	20c	18c
220 mfd 16 volt	35c	30c	100 mfd 25 volt	20c	18c	33 mfd 50 volt	20c	18c
470 mfd 16 volt	45c	40c	220 mfd 25 volt	40c	35c	47 mfd 50 volt	20c	18c
1000 mfd 16 volt	60c	55c	470 mfd 25 volt	50c	45c			
			1000 mfd 25 volt	65c	55c			

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3K9, 4K7, 5K6, 8K2, 10K, 15K, 22K 45c

Wirewound M10 watt

2.2, 3.3, 4.7, 5.6, 6.8, 8.2, 10, 12, 15, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3. 45c
3K9, 4K7, 5K6, 6K8, 7K5, 8K2, 10K, 12K, 15K, 18K, 20K 50c

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MF80T	8"	4 holes	2¾	3 or 8	1"	F	7.3 oz	55Hz	Fo-15KH	15W system wide range	$10.90
MF100	10"	4 holes	4¼"	8	1"	F	10 oz	35Hz	35Hz-7KH	25W system woofer	$12.50
MF100T	10"	4 holes	4¼"	8	1"	F	10 oz	45Hz	45Hz-15KHz	20W system wide range	$12.99
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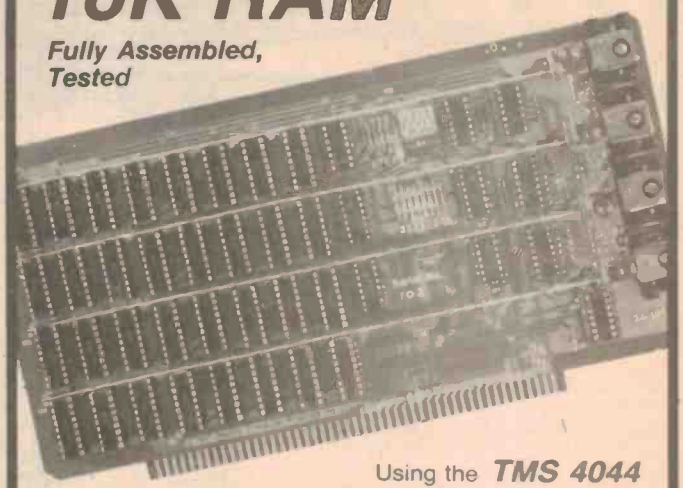

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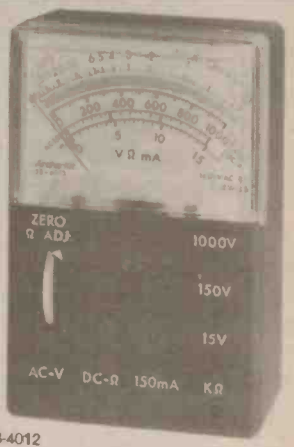

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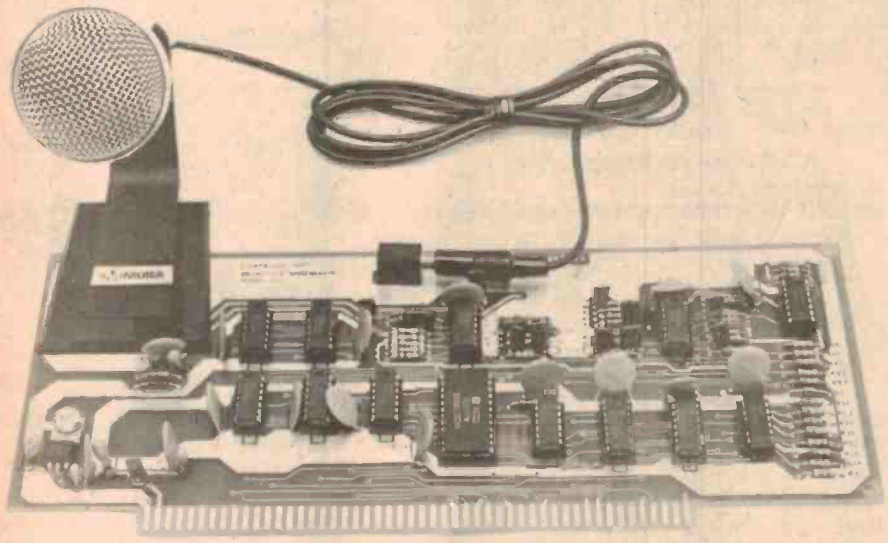


Speech Recogniser

The Heuristics Inc. Speechlab Model 20S is a speech recognition board designed for S100 computers, which enables the user to enter data or commands into his computer via spoken words. On the board, apart from some filter hardware, is a ROM containing assembly language routines which can be used to train the computer to recognise, and act on, spoken words. The software is compatible with BASICs which have an assembly language CALL function, and can build up a vocabulary of up to 32 words. We hope to have more information on the Speechlab next month, but meanwhile, for more details contact Pitt Street Microcomputer Shop, PO Box 105, Marrickville 2204.

Z80 Software

Zilog have released a BASIC interpreter for their Z80 microprocessor development systems. The interpreter, which is designed for interactive programming, handles real, interger, and string data. Both binary and BCD arithmetic routines are included.

"Intelligent" Display Controller ICs

A unique pair of complementary MOS "intelligent" display controller integrated circuits, designed to replace as many as five to 10 discrete tran sistors and medium scale ICs, has been developed by National Semiconductor Corporation and are available from N S Electronics.

Designated the MM74C911/12 series, the display controllers are designed to serve as the interface elements between a machine controller – such as a microprocessor – and a light emitting diode, or gas discharge, numeric or alphanumeric display.

Available in volume now, the devices are about half the cost required to implement the same functions with discrete transistors and logic circuits.

The MM74C911, will multiplex four digits with 8 bits of input information. In many cases, it is capable of both digit and segment expansion, the MM74C912, will multiplex six digits with on-chip read only memory (16 by 7 bits), with the ROM addressed by four data bits.

continued on page 90

COMPUTER CLUB DIRECTORY

Sydney: Microcomputer Enthusiasts Group, P.O. Box 3, St. Leonards, 2065. Meets at WIA Hall, 14 Atchison St., St. Leonards on the 1st and 3rd Mondays of the month.

Melbourne: Microcomputer Club of Melbourne, meets at the Model Railways Hall, opposite Glen Iris Railway Station on the third Saturday of the month at 2 p.m.

Canberra: MICSIG, P.O. Box 118, Mawson, ACT 2607 or contact Peter Harris on 72 2237. Meets at Building 9 of CCAE, 2nd Tuesday of month at 7.30 p.m.

Newcastle: contact Peter Moylan, Dept. of Electrical Engineering, University of Newcastle, NSW 2308. (049) 68–5256 (work), (049) 52–3267 (home).

Brisbane: contact Norman Wilson, VK4NP, P.O. Box 81, Albion, Queensland, 4010. Tel. 356 6176.

New England: New England Computer Club, c/- Union, University of New England, Armidale, NSW 2351. (New club; not restricted to students)

Auckland: Auckland Computer Club, P.O. Box 27206, Auckland, N.Z.

Computer clubs are an excellent way of meeting people with the same interests and discovering the kind of problems they've encountered in getting systems 'on the air'. In addition, some clubs run hardware and software courses, and may own some equipment for the use of members. Try one – you'll like it!

If your club is not listed here, please drop us a line, and we'll list you. The same applies if you are interested in starting a club in your area. Also, if established clubs know their programme of forthcoming events, we can publicise them.

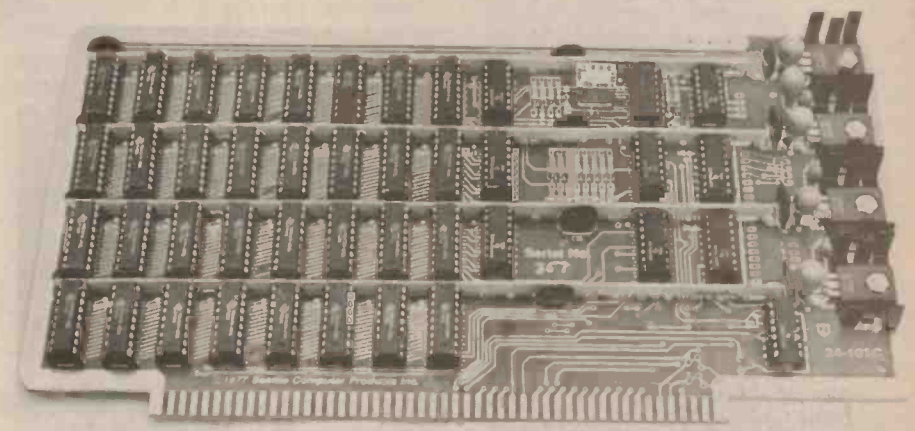
The Seattle Computer Products, Inc. Model 24-101 16K RAM Board.

IN MOST microcomputer systems, the organisation of the computer can be broken down into the classical divisions: central processor unit, core memory, off-line mass storage, and input/output. The fact that physically these sections of the microcomputer bear little or no resemblance to the classical textbook computer (magnetic core memory, disk or drum storage 6 ft-high CPU, etc.) does not invalidate this parallel. For an S100-based computer, the CPU would be a single card carrying an 8080 or Z-80 microprocessor and (basically) some logic to electrically interface it to the bus. The off-line mass storage of programs or data is achieved by using a single card cassette interface and standard tape recorder, and I/O to the user's terminal is through a single UART IC and a scattering of other components which may even be on the same board as the cassette interface.

But if you look at the bulk of S100 systems and count the boards, you will find two or more memory boards - more than any other part of the system. If the CPU is the heart of the system, then memory (and the software it contains) are the brains.

Systems with small amounts of memory, say 2K or less, limit the user to programming in machine code, and believe me, brother, that's no joke when you want to solve some problems, or even play games. With 4K in your system, you can now contemplate running a Tiny BASIC interpreter, or an assembler program to let you write programs in assembly language. Up to 8K and you can run quite good BASIC interpreters, though your programs are still quite limited in length.

12K permits the use of what used to be known as Extended BASIC, 16K really letting you take advantage of this with quite lengthy programs. Now once you've got that much memory, loading 16K from a cassette interface becomes a time consuming process, so a floppy disk is usually brought in to solve that problem - except that, to get the full value of the Disk Operating System and the fancy Text Editor and Macro Assembler that came with it, you now need 24K or even 32K.



Memory is a finite resource; there is never enough of it in your system. More memory allows the use of bigger and better software tools in the creation of bigger and better programs for your system. And as many of our readers will know, there is no law of diminishing returns with regard to software - a new program can increase the value of your system to you many times over.

Adding Memory

If your system does not have a bus structure, unless it has been well designed you are going to find it difficult to add memory as and when you want to. This is one of the major advantages of the S100 and SS50 busses - you can just flick the switches to set the memory to the correct memory location and plug it straight in with reasonable confidence that it will work. You don't have to spend hours wirewrapping and then, with great care, removing your memory card again when it doesn't work.

Several different sizes of memory card are available for the S100 bus - from 2K up to 64K (yes, we did say 64K on a single card!). The one we are reviewing here is a fairly big one - 16K.

The Seattle Computer Products, Inc. Model 24-101 16K RAM card is a static memory constructed using Texas Instruments TMS4044 4K x 1 static RAMs. The fact that the memory is static is important for several reasons,

There are two basic types of MOS RAM chips: static and dynamic. In a static memory, each of the memory cells is made from a flip-flop and so is stable, holding its condition for as long as power is applied. It is also, in a restricted sense, asynchronous in operation - you can change its state at any time, and it does not require any clocks or other timing signals or constraints.

Dynamic memory, on the other hand, uses a single transistor and a capacitor as a memory cell. This has its advantages, because each cell is smaller, it is four times as dense as static RAM, making 16K chips available; but it also has its disadvantages, since there is no such thing as a perfect capacitor, especially one of sixteen thousand on a piece of silicon one-eighth the size of your fingernail.

The capacitors in dynamic RAM lose their charge slowly, which is not really a problem if each memory location is being accessed every 2 ms or less, as reading or writing from a cell has the fortuitous side effect of 'topping up' the capacitor. But if the RAM contains infrequently accessed data, then external logic has to take over the refresh of the memory. Fortunately the cells are arranged in rows and columns, and internal circuitry makes it possible to

refresh all the capacitors in a particular column at the same time, so that the refresh logic only has to refresh 64 or 128 groups of cells every 2 ms. But it has to do this while the CPU is not 'looking', otherwise the RAM might be placed in the embarrassing position of trying to respond to two addresses at the same time, not to mention the address buffers destroying their output stages. For further information on this topic see our 'Data Sheet Special on Memories' in ETI December 1977.

Practical Consequences

Well, I hear you all say, that's only a bit of extra logic, besides you've saved so much space by using dynamic RAM's you've plenty room left on the board, what's the problem?

The problem is that most dynamic memory boards for the S100 bus are designed to run with 8080 CPU's. By looking at the timing of the bus signals generated by the 8080, the refresh logic can tell when the CPU is not addressing memory, nip in, do a quick bit of refreshing, and be 'off the air' before it clashes with the 8080. But put a Z-80 into the system, which generates signals with slightly different timing from the 8080, and the refresh circuitry may get slightly confused, to say the least. Add a device such as the Cromemco Dazzler, or a Digital Systems disk controller, which both take over from the CPU and perform direct memory access (DMA), and unless the refresh logic is very sophisticated (as some are), it will trip and fall flat on its face. That's the problem. And the Seattle 16K board (remember the Seattle 16K board?), being static does not suffer from it.

The board which was supplied for review was fitted with 250 ns chips, which means that it will run full speed (4 MHz) with a Z-80A. A version of the board is also available with 450 ns ICs, suitable for use with the 8080 or other, slower CPU's.

Each of the four 4K blocks on the board can be independently set to respond to a particular address range by means of wire links. As supplied, the board covers the first 16K of memory, but it is easy, following the instructions in the manual, to reorganise this. In addition, each of the four blocks can be independently write protected.

To further increase the versatility of the board several other jumpers allow selection of various S100 signals, notably SINP, SOUT, MWRITE and the memory disable signal which some systems use on pin 67. It is claimed that, through the use of these signals, this memory board is compatible with any S100 system.

Performance

We tried the board out in an S100 system based on the Morrow front panel previously reviewed in ETI. The signals provided by this CPU are the same as the IMSAI, and so no relinking was necessary to get the board to work; it ran first time.

We were impressed by the quality of construction of the board; the PCB itself is through hole plated with a well-aligned solder mask, and screen printing to indicate the position of all components, even though this is not a kit, permitting easy servicing. All IC's are socketed (except the regulators) and the supplies are run on bus bars, rather than PCB tracks, to minimise voltage drop and noise. Incidentally, the board draws 1.7A at 8V.

Running a couple of memory test programs did not turn up any errors, and we have run the board in our system for one month without any problems. The nine-page manual explains the operation of the board and how to customise it for your system in considerable detail, and also gives specifications and warranty details.

The 250 ns version of the board is $495 and the 450 ns version if $445. Both are available from *Centaur Industries, PO Box 37243, Winnellie, NT 5789.*

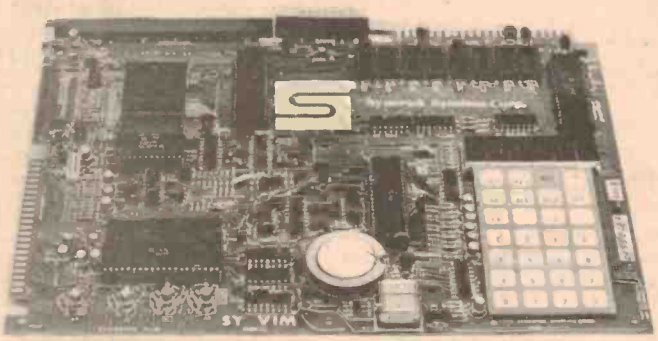
Continued from page 88.

It is capable of digit expansion, with the decimal point input going directly to the output.

Designed for easy interfacing to microprocessor and bus-oriented systems, the display controllers can be addressed like a random access memory.

The MM73C911/12 display controllers will drive microprocessor latch elements with or without ROM. Applications include electronic pinball machines, microprocessor display buffers, clock systems, silent hospital paging systems, and personalised message receivers.

Further details from N S Electronics, PO Box 89, Bayswater, Vic, 3153, phone (03) 729.6333.



The latest in 6502-based microcomputers is the VIM-1, which is manufactured by Synertek, MOS Technology's second-source for the 6502. The VIM-1 will be imported by CEMA, and we expect to have a full report in a future issue.

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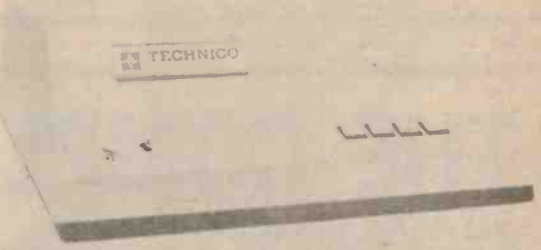

- Attractive appearance
- Solid steel base
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- Each fitted board is hinged within the chassis, and can be lifted up for service, even while in operation.
- Provision in chassis for fitting of power supply
- Four control switches on the front panel (and this is all you need — everything else is automatic).
- Supplied complete with fan, switches, barrier terminal strips and connectors, fusebox, line filter, power socket, all connecting wiring, and all nuts, bolts, hinges, etc.

PRICE: $285 (unassembled) or $395 (assembled)

NOTE: **This chassis is optional equipment for the Technico T-9900-SS Single-board Stand-alone microcomputer, and T-9900-MA memory add-on boards, which can be operated without using any chassis at all. Prices for the T-9900-SS start at $440 (kit) and $550 (assembled). The T9916 microcomputer system is 16-bit, not 8-bit, and has more features than any other microcomputer that you can buy. Want to find out the facts about it for yourself?** *Prices shown apply now - there will be an increase in September.*

Send for further details to:

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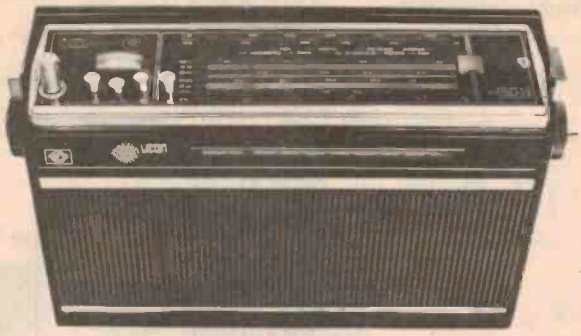

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7412	.25	7492	.45	74198	1.45	74L47	1.95
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7444	.45	74153	.75	74H15	.45	74S10	.35
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RIPPLE COUNTERS are useful and simple, but they are not ideal for high counting speeds, nor for large counter chains. The problem arises from the use of the output of each flip-flop as the clock for the next flip-flop, so that changes must "ripple through" all the stages of the counter. This, as indicated in the previous section, causes difficulties with time delays.

Although these delays are not large, perhaps 60 ns or less per flip-flop, they accumulate to a significant amount over a large number of counter stages and can cause the race hazards mentioned earlier.

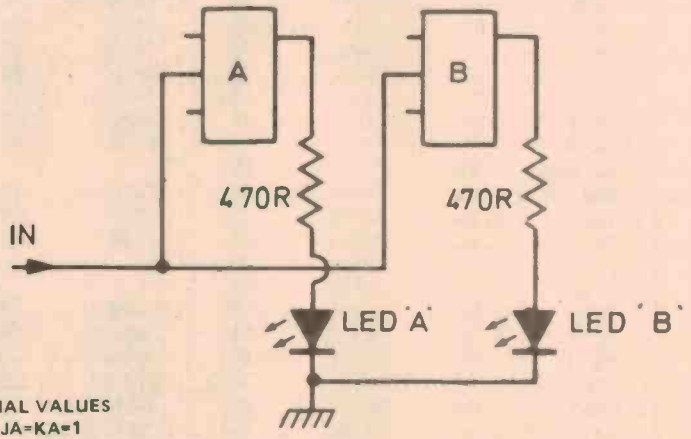
Synchronous Counters

A different principle is used for synchronous counters. The input pulses are used to clock *each* flip-flop of a chain, hence the name synchronous. The count sequence is then determined by voltages applied to the J and K terminals, and these voltages must be obtained in such a way that any given count on the flip-flop will cause the J and K inputs of the next digit up or down to be set correctly.

This is much more easily illustrated by an example which we can test on our board. In this example we shall follow the pattern of design steps (with some modifications) which is usually used for synchronous counters.

Basic Two-Step

Let us imagine a very basic counter using two flip-flops and resetting at the count of four. We must start by making a table showing the count, the present state, and the next state for each flip-flop. This means that for each number of the count we list the value of Q (1 or 0) and also the value to which Q will change at the next count. For example, when the count is 1 (01), the next count is 2 (10) and both outputs will change – A from 1 to 0, and B from 0 to 1. On the next count (3).



FINAL VALUES
JA=KA=1
JB=KB=QA

	A		B		J K VALUES			
COUNT	Q PRESENT	Q NEXT	Q PRESENT	Q NEXT	JA	KA	JB	KB
0	0	1	0	0	1	X	0	X
1	1	0	0	1	X	1	1	X
2	0	1	1	1	1	X	X	0
3	1	0	1	0	X	1	X	1

Fig.1 (Above). A simple synchronous counter, no J-K connections shown. (a) Circuit. Note that the input clock is taken to each stage. (b) Table of changes, with J and K values for the changes.

A changes from 0 to 1, and B does not change. The complete table for two flip-flops is shown in Fig. 1(b).

Now we have to decide what voltages are needed at J and K of each flip-flop to carry out the changes from present state to next state. Here we have some options – for example, if we want to change from 1 to 0, we may have J=K=1, or J=0 and K=1; either state will carry out the change. When this is possible, we can write J=X, K=1, where X means don't care, since either value of J is equally suitable.

Add more columns to the table to indicate these values of J and K for each flip-flop, and we are ready to start designing. The object now is to obtain the J and K voltages for each flip-flop from somewhere else in the circuit in such a way that all the J and K voltages are correct for each stage of the count. The formal method of doing this involves a technique called *Karnaugh mapping*, but is seldom necessary for only a few counter stages. It is rather difficult to apply for a large number of stages, so only the 'intuitive' look-and-see method will be discussed here.

Table Talk

At the zero count, Qa=0, Qb=0 and the change at the end of the clock pulse will be from Qa=0 to Qa=1. This will happen if Ja=1 and for Ka=0, or Ka=1. We therefore fill in a 1 in the Ja column, and an X (either value) in the K column.

Still at the zero count, Qb=0 and does not change at the end of the

clock pulse. This can be done if Jb=0, Kb=X, so that these values 0 and X appear in the Jb and Kb columns.

These columns are filled in similarly for each change listed – remembering to use X in any case where a value is unimportant – using the J-K table that we used in Part 4 of this series of articles.

We can now inspect the complicated tables to see if any values can be fixed or derived from values of Qa or Qb. The tables for Ja and Ka are easily dealt with – since the values are either 1 or X, we can use 1 for all these values, and make Ja=1, Ka=1, as for the ripple counter. The Jb, Kb tables are slightly more involved, but for each definite value of one quantity (J or K) there is an X for the other, so that we can again connect J and K. We then find that the values of J and K are identical to the values of Qa, so that Jb and Kb can be connected to Qa.

For practical work on synchronous counters it is useful to have a lock pulse line, and one of the spare lines on the board can be used. Connect up the circuit as shown, with a slow clock pulse taken to each clock input, and wire connections linked from Qa to Jb and Kb. Use LEDs as before to check the state of each flip-flop output. Connect a common reset line to each flip-flop and to a switch so that the counter can be reset. Switch on and check that the count is correct and that resetting to zero is possible.

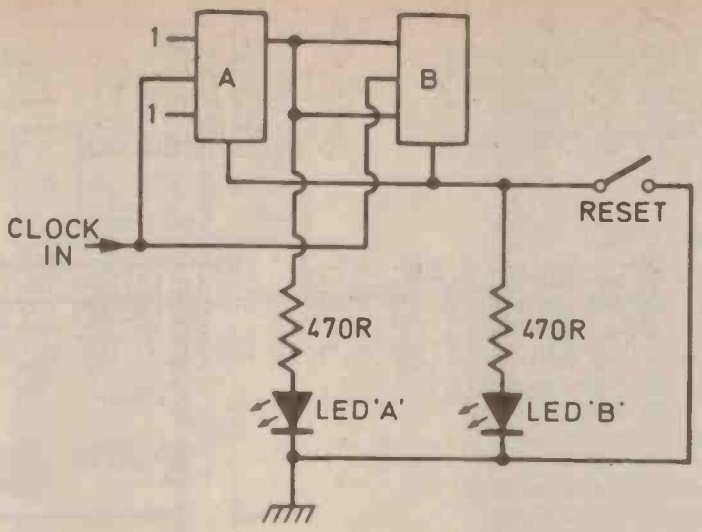


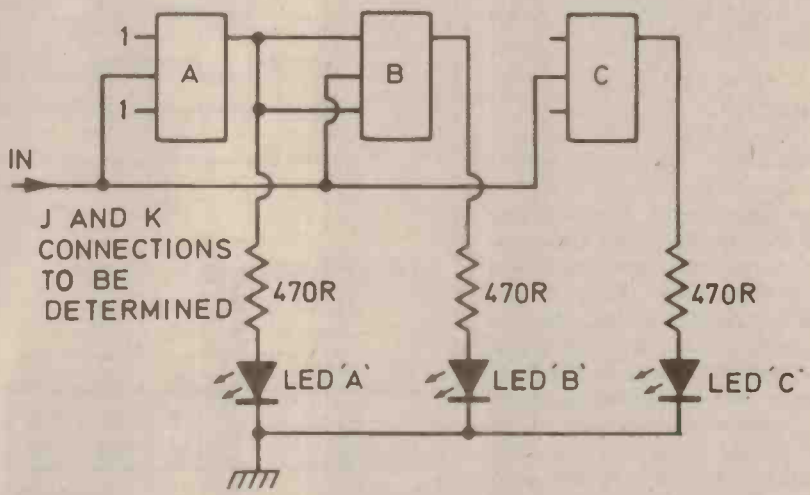
Fig.2 (Above). Complete two-stage synchronous counter circuit, with J-K connections shown. Try this out on your blob-board.

Third Stage Development

Let us now extend this to a third stage, building on what we have done before. Once again we can build up a table of values of Q, J and K for each stage, but we have made life easier for ourselves by having done the two stage counter, so we can ignore the Ja, Ka and Jb, Kb columns and concentrate on the Jc, Kc column.

Using the same principles as before, we fill in the values of J and K which will be needed at each clock pulse or flip-flop, concentrating on the necessary values, and putting an X where the value is immaterial. When we do this (Fig. 3b) we find two important states. One is at the count of 3, where Jc must change from 0 to 1; the other is at the count of when Kc similarly changes from 0 to 1.

The change of Jc from 0 to 1 occurs when the count changes to 110 so that we could use an AND gate connected to Qa and Qb. The output of this gate will be zero for any count up to 2 and then will be 1 at a count of 3. It will change to zero again to become 1 at the count of 7, but the value of Jc is unimportant beyond the count of 3 anyway.



COUNT	PRESENT QA	QB	QC	NEXT QA	QB	QC	JA	KA	JB	KB	FIRST JC	KC	FINAL JC	KC
0	0	0	0	1	0	0	1	1	QA	QA	0	X	0	0
1	1	0	0	0	1	0	1	1	QA	QA	0	X	0	0
2	0	1	0	1	1	0	1	1	QA	QA	0	X	0	0
3	1	1	0	0	0	1	1	1	QA	QA	1	X	1	1
4	0	0	1	1	0	1	1	1	QA	QA	X	0	0	0
5	1	0	1	0	1	1	1	1	QA	QA	X	0	0	0
6	0	1	1	1	1	1	1	1	QA	QA	X	0	0	0
7	1	1	1	0	0	0	1	1	QA	QA	X	1	1	1

JC=QA AND QB
KC=JC

Fig.3 (Above). A three-stage synchronous counter. Top: (a) Circuit, J and K connections still to be determined. Bottom: (b) Table of changes, showing how J and K values are determined. The "first" Jc-Kc table shows possible values of Jc and Kc, the "final" table shows the most convenient values to use.

Looking at Kc we find that the important value of 1 occurs at a count of seven when Jc may also be 1. We can therefore connect Jc and Kc together and feed from an AND gate supplied with Qa *and* Qb.

Third Stage On Board

Making up a three-stage synchronous counter on the circuit board needs some additional connections. Since we are not using AND gates, the gate used will have to be made up from a NAND gate and an inverter. As the 7400 contains four two-input NAND gates and the 7414 contains six inverters, one of which is used as the clock oscillator, there is no shortage of gates. We are working with a low frequency clock, so there should be no ill-effects caused by the number of wires soldered across the board, but a high speed counter would have to be built on a PCB designed for the purpose, using copper tracks on each side and with decoupling capacitors between +ve and –ve lines close to each flip-flop.

Can you now go one step further to design a four stage synchronous counter and try it out on the board?

Twisted Logic

A different type of synchronous counter is shown in Fig. 5. This is a Johnson, or 'twisted-ring', counter and consists of four flip-flops connected so that the output of one drives the J and K inputs of the next. Three of the connections are made up with Q to J and $\overline{Q}$ to K, but the feedback connection is made with Q to K and $\overline{Q}$ to J — hence the alternative name of twisted-ring. Remembering the $\overline{Q}$ is always the inverse of Q, can you plan out the values of Q and $\overline{Q}$ for each counter? Use the table headings shown in Fig. 5(b) and remember that Qa=Jb, Qb=Jc, Qc=Jd, Qd=Ka and so on.

A Johnson counter uses a completely different count sequence from conventional binary counters, and the maximum count number is twice the number of flip-flops. The counters are synchronous, very easy to design and also very simple to decode for use with lamp indicators.

Build up the four stage (count of 8) Johnson counter of Fig. 5(c) on your circuit board and check that your calculations are correct.

Next month, we shall delve into decimal counting.

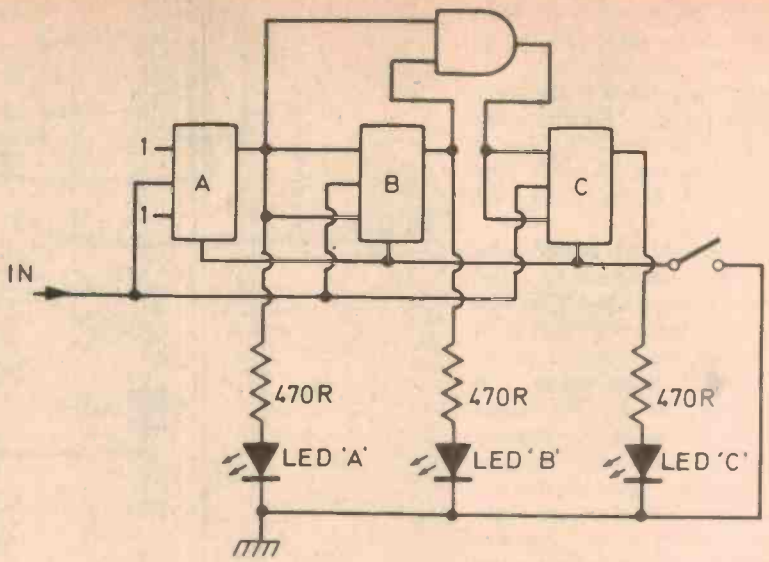


Fig.4 (Above). The circuit of the three-stage synchronous counter. Try this out on your blob-board.

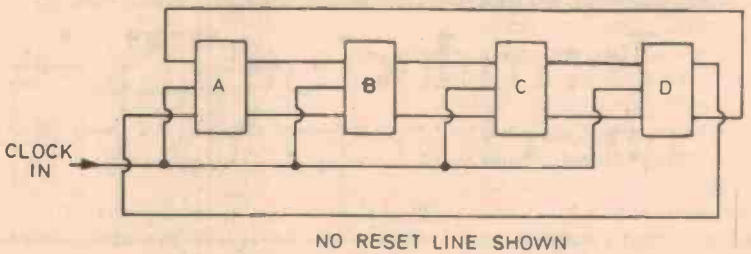
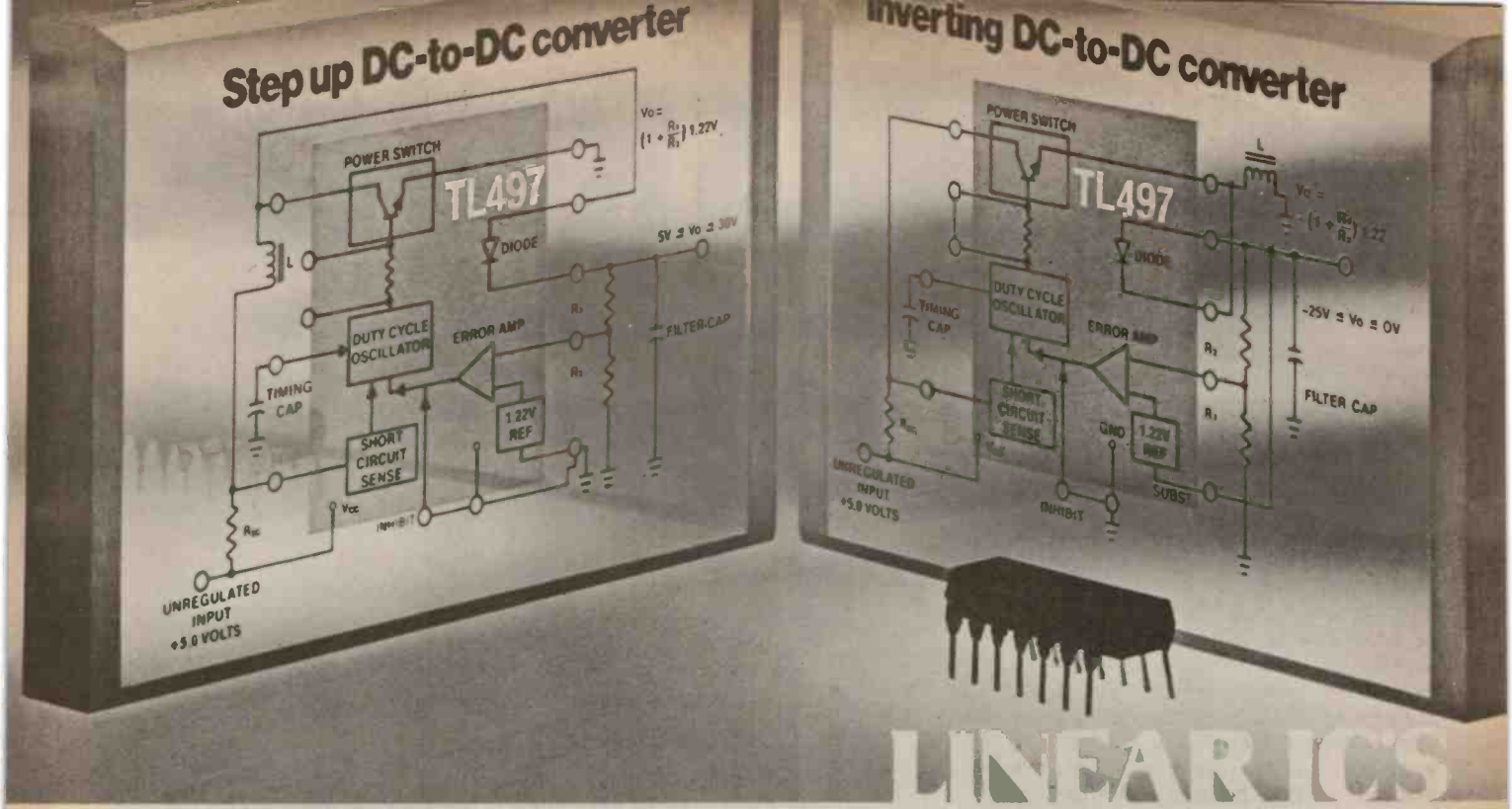


Fig.5. A Johnson counter of four stages.

CLOCK	JB QA	KB $\overline{QA}$	JC QB	KC $\overline{QB}$	JD QC	KC $\overline{QC}$	KA QD	JA $\overline{QD}$
0								
1								
2								
3								
4								
5								
6								
7								

COUNT	A	B	C	D
0				
1				
2				
3				
4				
5				
6				
7				

Fig.6. Top: (a) The circuit, note the "twisted ring" connection. Bottom: (b) Table to complete so that the counter action can be predicted. Below: (c) Truth table. Build the circuit on your blob-board and complete this table.



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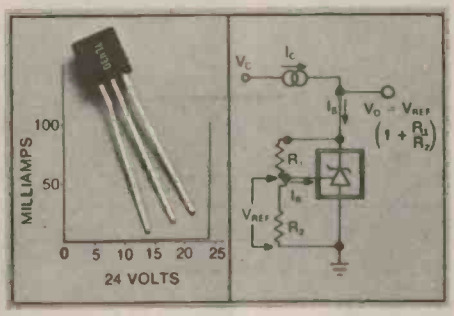

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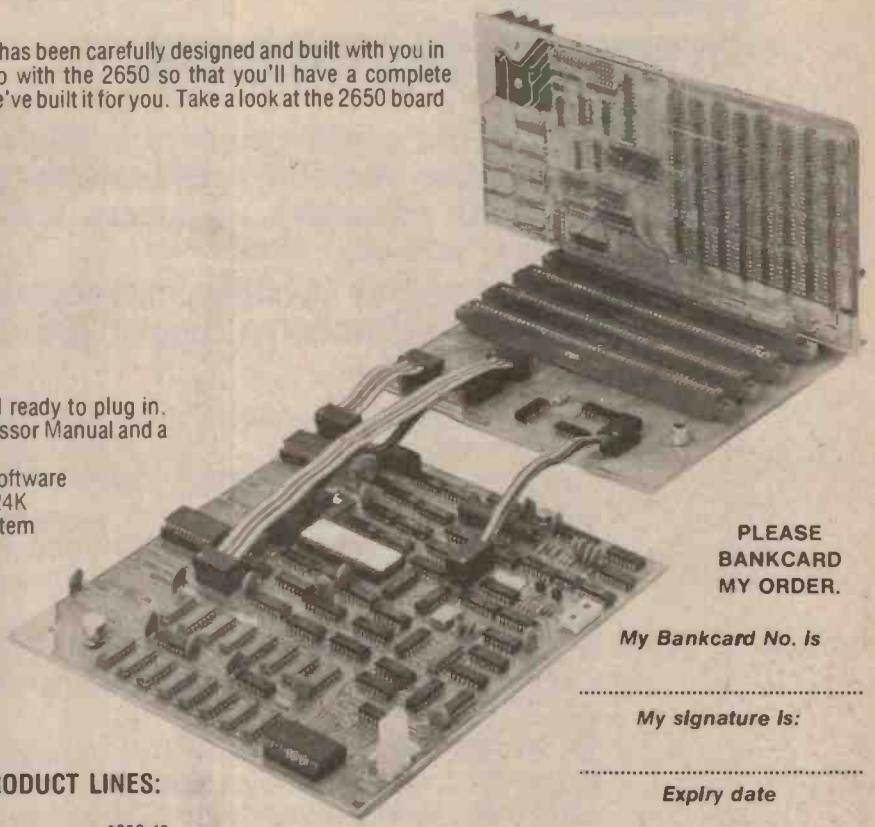

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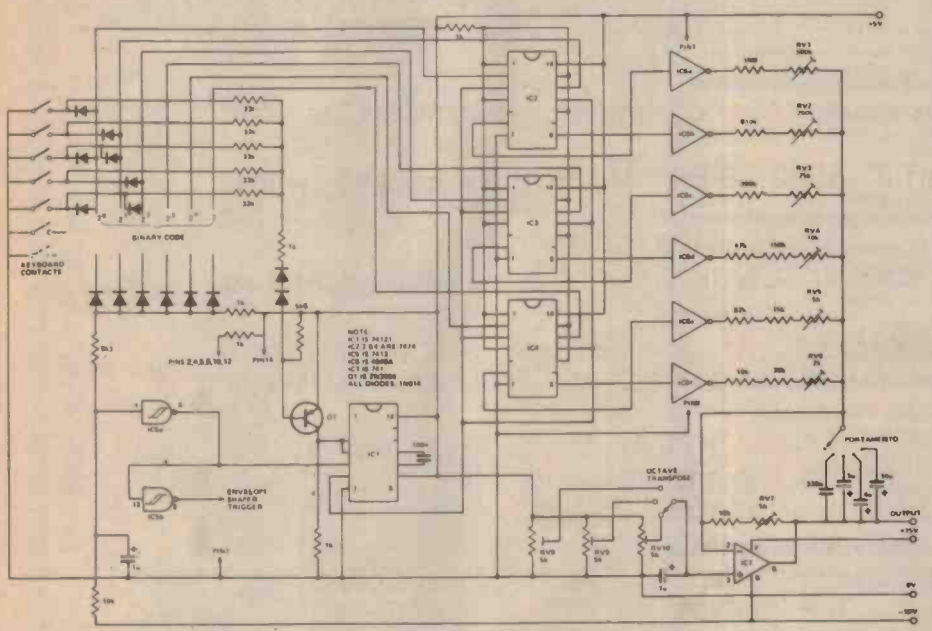
Ideas for experimenters

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.



Digital Keyboard Controller

This circuit was designed to overcome all the problems associated with resistor ladders and analogue memories normally found in synthesisers. The key depressions cause a diode matrix to set up binary patterns which are memorised on a bank of flip-flops.

The main advantages of this method are infinite memory hold; more accurate output since there are only six main tuning resistors (it is economical to make them variable). If more than one key is depressed at a time, no "out of tune" notes will be produced because of a multiple key depression detector. Only one set of single make contacts is required for the keyboard. Octave transpose and portamento is included.

When a key is depressed, the binary code set up by the diodes is clocked into the flip-flop (IC2-IC4) by the monostable (IC6). IC7 along with its associated resistors forms a D/A converter. The 33K resistors along with Q1 form a circuit which inhibits further data being clocked into the flip-flops if more than one key edge to trigger envelope shapers.

Up to 63 semitones (over five octaves) can be catered for using six data bits as shown, although more bits can be added.

RV1 to RV6 should be adjusted so that each successive bit causes twice as much change in the output voltage. RV7 adjusts the voltage/frequency relationship. RV8-10 adjust the starting voltage; they should be set to give the required octave shifts on the transpose control.

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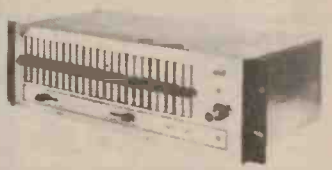

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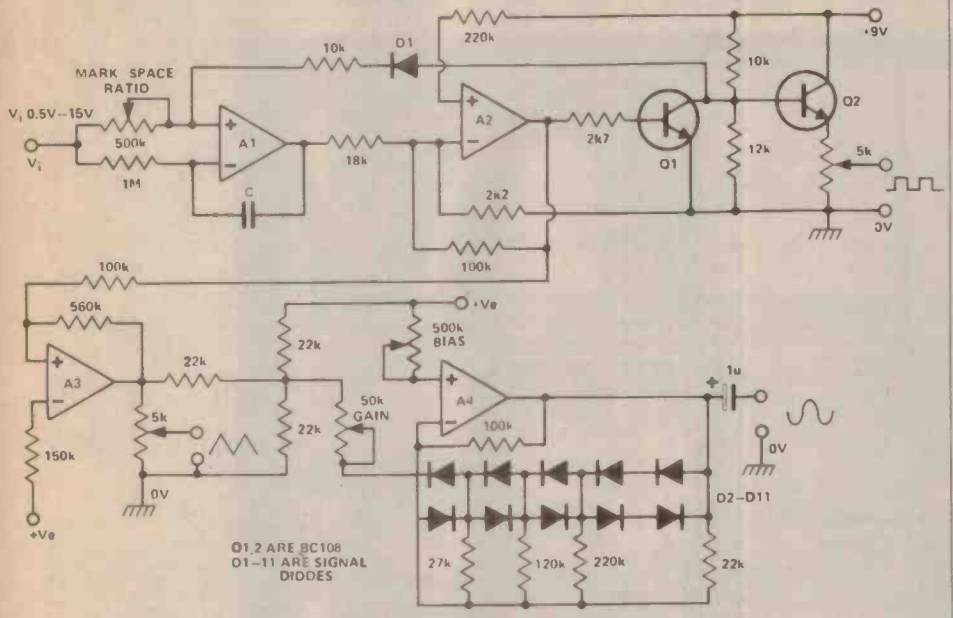


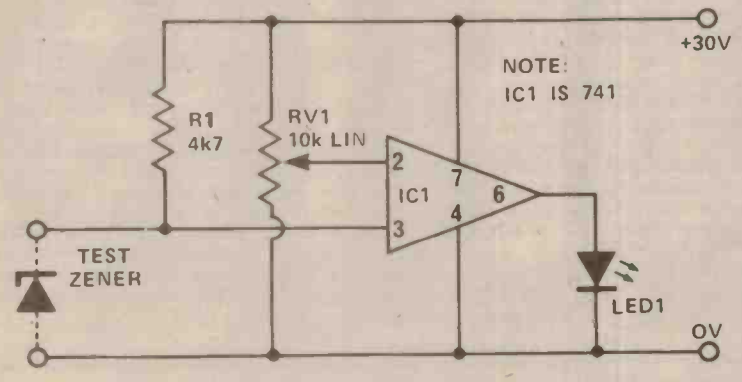
Battery Operated VCO

By using the LM3900N quad-op-amp, a simple portable battery operated VCO can be made very cheaply. A2 forms a integrator, the ramp rate depending on the voltage Vi and capacitor C. This ramp is fed to a Schmidt trigger which switches at about 5V8, making A1 ramp down, generating a triangular wave of about 0V85.

The Schmidt trigger feeds a transistor switch and an emitter follower.

The triangular wave is then fed to A3 which acts as an inverting amplifier, and the output is fed to A4 which is an exponential integrator set at a pseudo-ground of 4V5. The bias and gain pots must be adjusted to give the best sine waveform.

Vi can be any positive voltage from +0.5 ↔ + 15.0 V, giving a frequency range of about 1:100. Capacitor C can be any value from 10n ↔ 47n and the outputs have a low distortion up to about 20 kHz.



Zener Tester

This circuit is to provide a cheap and reliable method of testing zener diodes.

RV1 can be calibrated in volts, so that when LED1 just lights, the voltage on pins 2 & 3 are nearly equal. Hence the zener voltage can be read directly from the setting of RV1.

The supply need only be as high a value as the zener itself. For a more accurate measurement, a precision pot could be added and calibrated.

TRIO

Dual Trace, Triggered Sweep

SCOPES

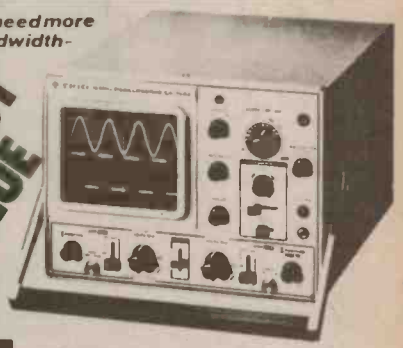
10MHz CS1562

- 130mm CRT
- DC 10MHz 10mV
- Automatic sweep (AUTO FREE RUN)
- Full sensitivity X-Y
- Display modes (CH1 CH2 DUAL)

• SPECIFICATIONS

Bandwidth	DC to 10MHz (−3dB)	Calibrator	1Vpp AC (square wave)
Deflection factor	10mV/div to 20V/div	Intensity modulation	Less than 5Vpp
Input R,C	1MΩ, 22pF	Phosphor	P31
Risetime	35nsec	Power	AC 100 120 220 240V 50 60Hz, 20W
Overshoot	Better than 3	Dimensions	W260 × H190 × D375 (mm)
Sweep time	1µs/div to 0.5s/div	Weight	8.0kg
Magnifier	× 5		
Linearity	Better than 3%		

If you need more bandwidth-



BEST VALUE

15MHz CS1560A

The 15MHz dual trace

- 130mm CRT
- DC 15MHz 10mV
- Automatic sweep (AUTO FREE RUN)
- Display modes (CH1 CH2 DUAL ADD SUB)
- Full sensitivity X-Y operation

• SPECIFICATIONS

Bandwidth	DC to 15MHz (−3dB)	Calibrator	1Vpp (1kHz square wave)
Deflection factor	10mV/div to 20V/div	Intensity modulation	More than 20Vpp
Input R,C	1MΩ, 22pF	Phosphor	P31
Risetime	23nsec	Power	AC 100 120 220 240V 50/60Hz, 23W
Overshoot	Better than 3%	Dimensions	W260 × H190 × D385 (mm)
Sweep time	0.5µs/div to 0.5s/div	Weight	8.4kg
Magnifier	× 5		
Linearity	Better than 3%		

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- Auto level triggering
- Display modes (CH1 CH2 DUAL ADD)
- Trigger modes (AC LF Rej HF Rej DC)

• SPECIFICATIONS

Bandwidth	DC to 30MHz (−3dB)	Calibrator	0.5Vpp (1kHz square wave)
Deflection factor	5mV/div to 5V/div	Intensity modulation	More than 5Vpp
Input R,C	1MΩ, 24pF	Phosphor	P31
Risetime	11.7nsec	Power	AC100/120/220/240V 50/60Hz, 25W
Overshoot	Better than 3%	Dimensions	W260 × H190 × D375 (mm)
Signal delay	160nsec	Weight	8.5kg
Polarity	CH2 can be inverted		
Sweep time	0.2µs/div to 0.5s/div		
Magnifier	× 5		
Linearity	Better than 3%		

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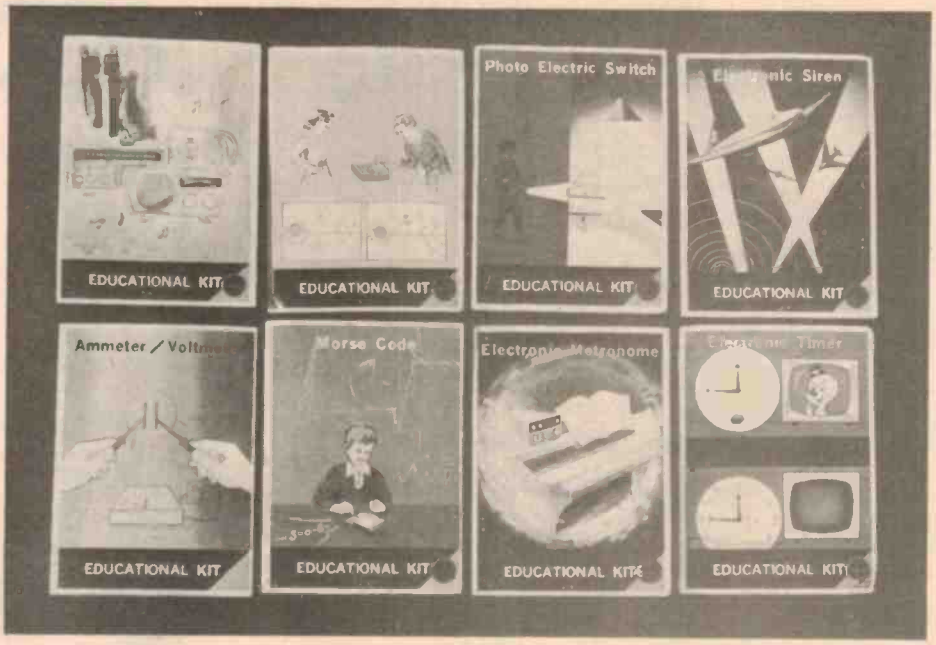
KITS for KIDS!



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H. ELECTRONIC RAIN ALARM. This kit would better be called a "water" alarm. Unit has many uses in homes where the entry of water must be detected, use for bed wetting **$4.50**

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K. MORSE CODE PRACTICE SET. A must for all who want to obtain their Novice Amateur Licence. Kit gives clean crisp tone into 2" speaker **$4.90**

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N. TRANSISTOR RADIO. Kit makes a simple one transistor radio with ferrite aerial, wire, earphone — Works well **$4.50**

O. ELECTRONIC METRONOME. This kit is used by many music students to set a tempo to play against. Controlled tempo speed, very small, easy to hear — 2" speaker **$4.50**

P. AMMETER/VOLTMETER. A very simple test set for measuring both voltages and current. Very good for testing these kits **$4.50**

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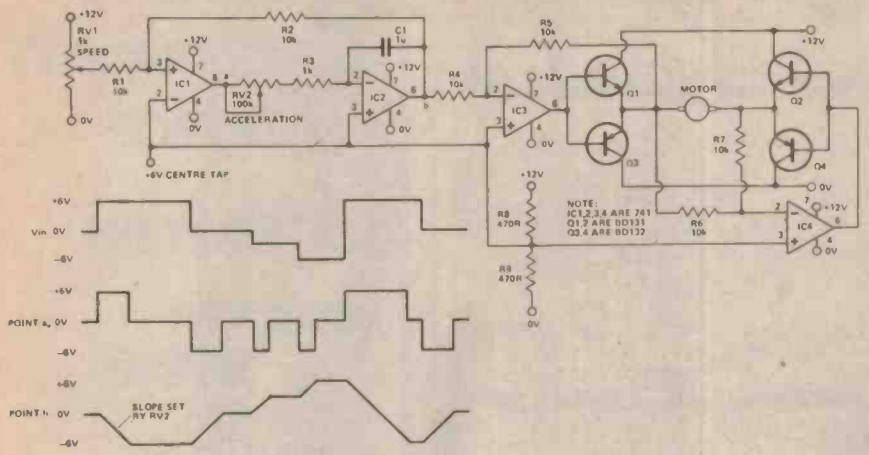


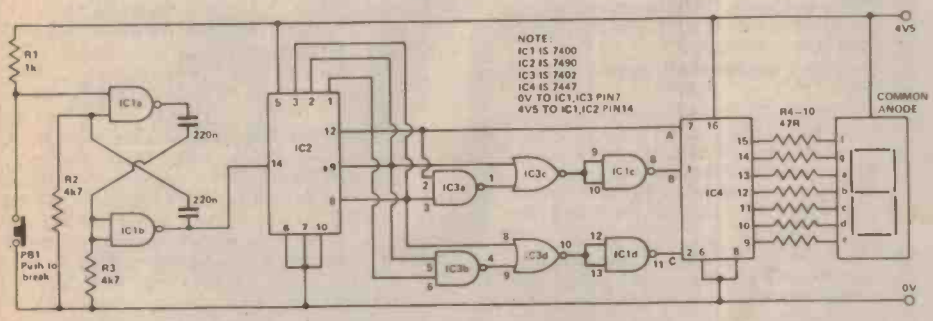
Controller For Model Trains

Most model railway controllers have the unfortunate characteristics of giving instant starts and stops to the train which would be very unnerving for the model passengers. The circuit described gives a steady acceleration or deceleration on speed changes, and the speed and acceleration controls do not interact.

The power supply is 12V split by R8 and R9 so it appears to the op amps as a ± 6 V supply. Voltages in this description are referenced to the 6 V centre tap. IC1 and IC2 together form a unity gain inverting amplifier, with the gain determined by R1 and R2. The slope of IC2's output, is determined by C1 and R3/RV2. The output of IC1 will thus take up one of three states: +6 V (hard positive), 0 V (balanced), −6 V (hard negative) dependent on the output voltage being more positive than equal to or more negative that the output voltage set by RV1. The output voltages will thus ramp up or down at a constant rate until it is equal in magnitude (but opposite in sign) to the voltage on RV1). This is summarised on the waveform drawing.

Voltage b drives buffer amplifiers IC3 and IC4 to give a push pull 12 V drive to the motor for forwards and reverse. Note that the feedback resistors R5 and R7 are taken from the transistor emitters to compensate for the transistor V_{be} drops. The motor should have some current cut-out or limit connected in series with it to protect the transistors.

In use RV1 sets the speed, and RV2 the acceleration. It gives a very realistic train control, although much more skill is needed to stop a train accurately at a station platform. In this respect it is very close to driving a real train.



Digital Die

ICla and ICIb form an oscillator running at a few kilohertz. The output is fed to a 7490 binary counter which is wired to produce an output of 0 to 5 in BCD. So that the display is the same as a dice the display must read 1-6 and not 0-5, when the output of the 7490 is all '0's, the display must be made to show 6. ICIc, d and IC3 perform this task, and convert an output of 000 from IC2 to 110 (b). IC4 is a BCD to 7-segment decoder which drives the display through the current limit resistors R4-R10.

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PL24/20VA	24 volts at 0.83 amps	12 volts at 1.67 amps
PL30/20VA	30 volts at 0.67 amps	15 volts at 1.33 amps
PL40/20VA	40 volts at 0.50 amps	20 volts at 1.00 amps

40VA CHASSIS OR FRAME MOUNTING

Type No.	Series Connections	Parallel Connections
PL12/40VA	12 volts at 3.33 amps	6 volts at 6.67 amps
PL15/40VA	15 volts at 2.67 amps	7.5 volts at 5.33 amps
PL18/40VA	18 volts at 2.22 amps	9 volts at 4.44 amps
PL24/40VA	24 volts at 1.67 amps	12 volts at 3.33 amps
PL30/40VA	30 volts at 1.33 amps	15 volts at 2.67 amps
PL40/40VA	40 volts at 1.00 amps	20 volts at 2.00 amps

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Type No.	Series Connections	Parallel Connections
PL12/60VA	12 volts at 5.00 amps	single secondary
PL15/60VA	15 volts at 4.00 amps	winding only
PL18/60VA	18 volts at 3.33 amps	9 volts at 6.67 amps
PL24/60VA	24 volts at 2.5 amps	12 volts at 5.00 amps
PL30/60VA	30 volts at 2.0 amps	15 volts at 4.00 amps
PL40/60VA	40 volts at 1.5 amps	20 volts at 3.00 amps

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Sansui's new amplifiers

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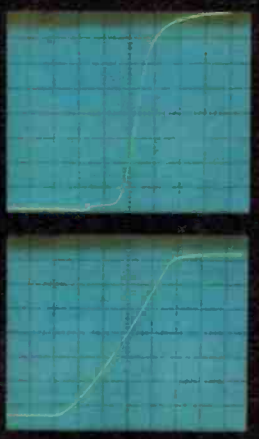
Take response speed, for example. Your amplifier doesn't move, but it does respond. The more rapid its response, the cleaner and the more accurate the sound. That's why the AU-717, for example, features an advanced DC power amplifier design. Sansui's DC amplifier eliminates all capacitors in the signal path and even in NFB loop so amplification is direct without coloration and phase delay. Response is astoundingly rapid — the proof is in the ultra-high (60v/μsec.) slew rate and ultra-rapid rise time (1.4μsec).

But Sansui didn't strive for such outstanding specs just to be able to print impressive figures. On the contrary, Sansui research showed that to achieve accurate reproduction and reduce signal loss, lightning-fast response was essential.

In addition, special circuits were incorporated to achieve new levels in stamping out TIM (transient inter-modulation distortion), a type of distortion that is now receiving high priority. Still another important benefit of Sansui's DC amplifier is the ultra-wide frequency response from zero (DC) to 200,000 Hz.

The final result is music with a purity and clarity that must be heard to be believed. All the dimensions of complex musical sounds — the wide dynamic range, the sudden pulsive signals, the nuances of barely perceptible but critical overtones in the ultra-high frequencies — all these are now crystal clear, all are proof of Sansui's new levels in superior sound quality. Impressive power is 85 RMS watts per channel, 20 — 20k Hz, and total harmonic distortion at rated output is 0.015%. That means it can be considered non-existent as far as the human ear is concerned.

SLEW RATE & RISE TIME



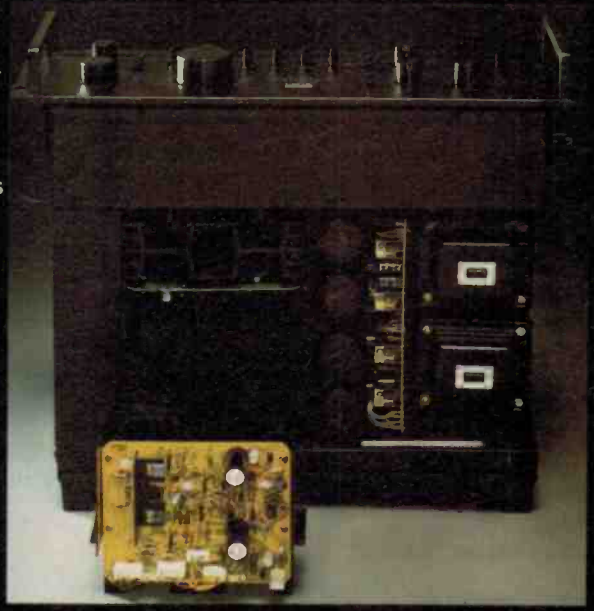
AU-717
Slew Rate: 60V/μsec.
Rise Time: 1.4 μsec.
V: 10V/div.
H: 1 μsec./div.

A CONVENTIONAL AMP.
V: 10V/div.
H: 1 μsec./div.

Keep in mind that though the AU-717 is special, it's not special for Sansui. Each and every amplifier on the left-hand page embodies the same Sansui commitment to outstanding sound quality. All controls have been carefully thought out and designed for their specific purposes. Sansui has no place for gadgets and gimmicks in its dedication to the ultimate in hi-fi.

The AU-517 and AU-317 also feature the same DC power amplification as the AU-717, and offer 65 and 50 RMS watts respectively. The AU-217 and AU-117 offer 30 and 20 RMS watts respectively, but are not to be under-rated. In fact, they represent exceptional values in low distortion and true hi-fi performance.

Sansui for specs with a purpose — outstanding musical quality.



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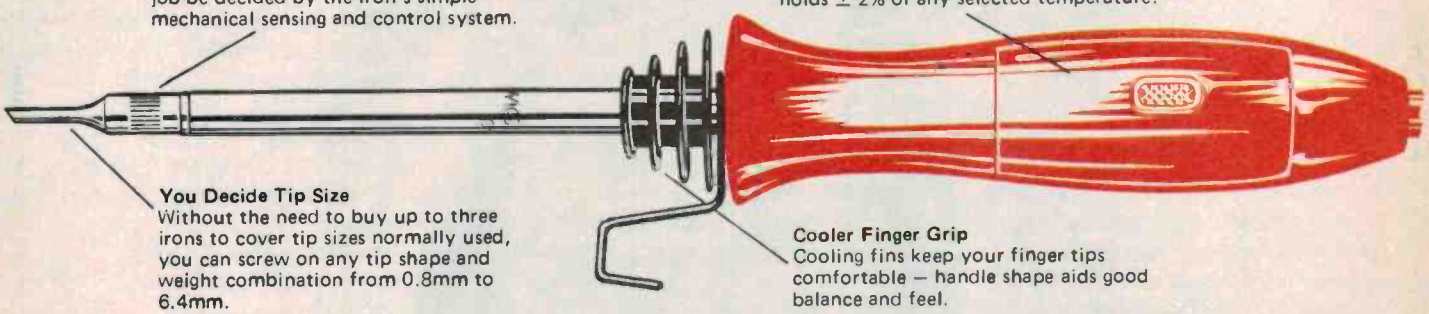
Now–one automatic iron replaces any size 10w–60w.

SCOPE TC60

- Variable Wattage
- Variable screw on tips
- Variable Temperature 200°–400°
- 240V Mains Operated

Automatic Wattage Selection
Let the actual wattage required for the job be decided by the iron's simple mechanical sensing and control system.

Automatic Temperature Control
Dial any intermediate temperature 200°–400°C without changing the tip; holds ± 2% of any selected temperature.



You Decide Tip Size
Without the need to buy up to three irons to cover tip sizes normally used, you can screw on any tip shape and weight combination from 0.8mm to 6.4mm.

Cooler Finger Grip
Cooling fins keep your finger tips comfortable – handle shape aids good balance and feel.

Have you experienced the frustration of starting to use your 15 watt iron only to realize the tip is going cold before the solder flows – alternatives?

(a) Wait 5–10 minutes to heat up your 30 watt (even though the tip on it is really too big). (b) Be a supreme optimist and hope your 15 watt will eventually heat up the joint before you cook the component and lift the track. (c) Switch on your SCOPE TC60 and while waiting the 45 seconds to heat – screw on the tip size you really want.

The SCOPE TC60 will decide the wattage required for each joint.

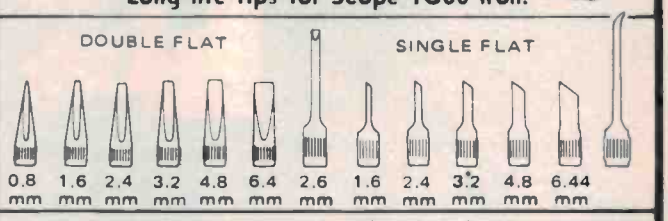
Some other SCOPE TC60 features –

- **Component Protection** is aided by earthed tip and barrel. Critical components and operator can then be earthed to common point.
- **Simplicity** of temperature control system suggests less maintenance. An expanding metal probe detects temperature variations inside each tip and operates a mini micro switch in the handle.
- **Temperature Key** is inserted into handle. 40°C variations per quarter turn. Key is removable to discourage unwanted alteration to temperature setting.
- **Neon** indicates when power is being applied to elements – monitors control system.

50V, 24V Versions are available with 50W element.

SOLDERING–DESOLDERING STATION

Long life tips for Scope TC60 iron.



Iron plated screw-on pre tinned. *This tip is fitted as standard.

SCOPE TC60

The iron you completely adjust to your job.

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PCB's

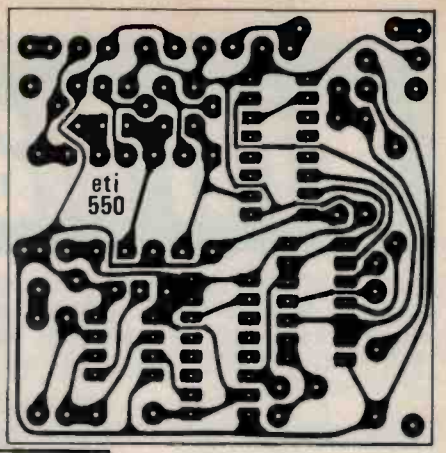
Using ETI PCB Artwork

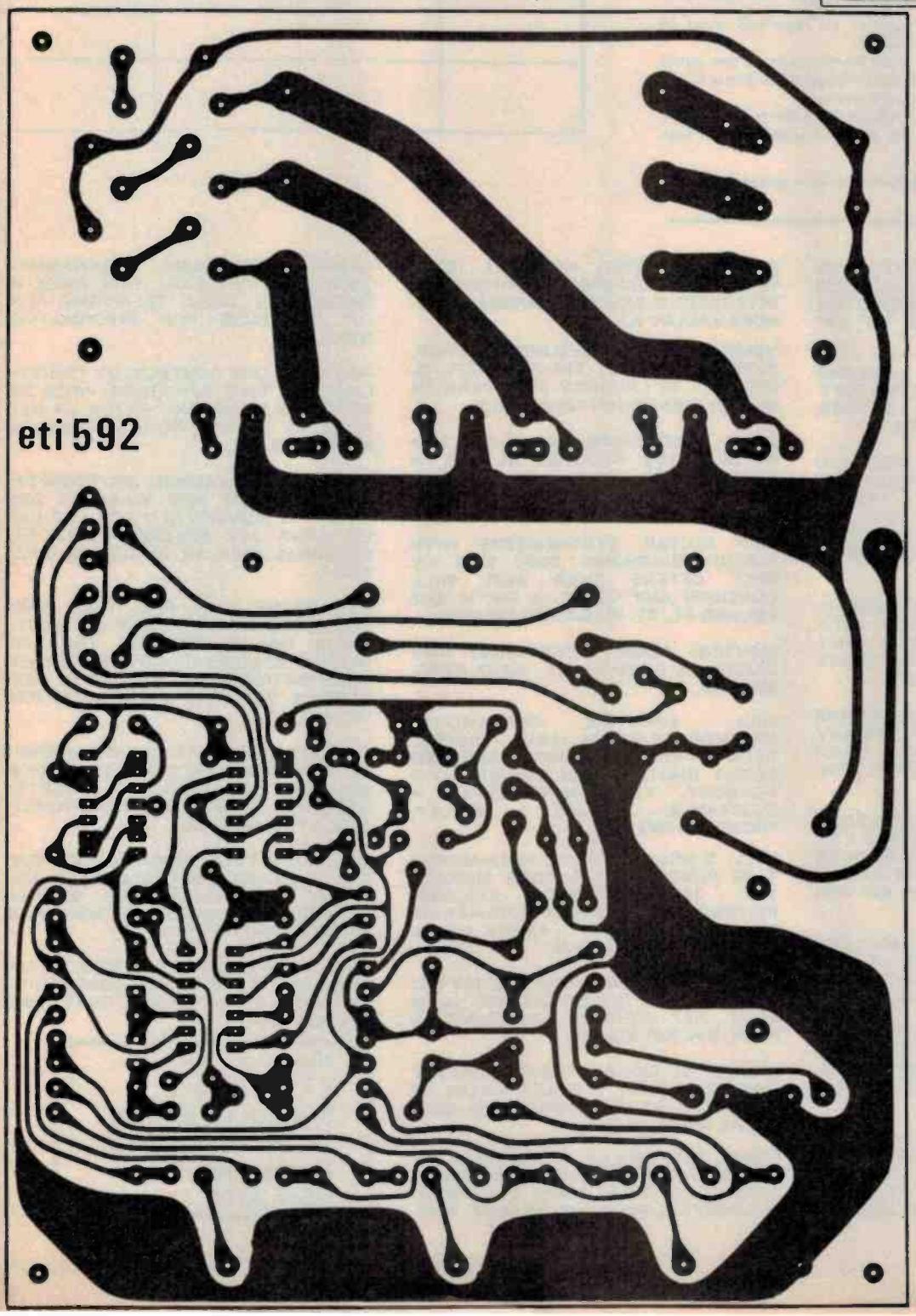
This method can be used to make negatives of ETI artwork from October 1977 on, provided the reverse of the page is printed in blue. The film used is Scotchcal 8007 which is UV sensitive and can be used under normal subdued light.

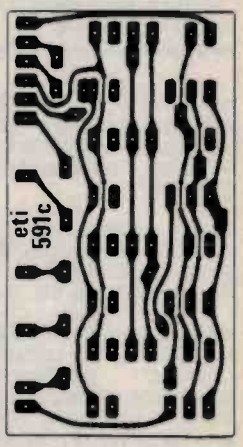
Cut a piece of film a little larger than the PC board and expose it to UV light through the magazine page. The non emulsion side should be in contact with the page. This surface can be detected by picking the film up by one corner - it will curl towards the emulsion side. Exposures of about 20 minutes are normally necessary.

The film can now be developed by placing it emulsion side up on a table, pouring some Scotchcal 8500 developer on the surface and rubbing it with a clean tissue.

Further information on Scotchcal and PCB manufacture can be found in the September and December 1977 issues of ETI. Please note also, that occasionally pressure on space may unfortunately prohibit the printing of blue type behind all PCB's, in which case the reader must resort to more conventional photographic techniques for PCB manufacture.







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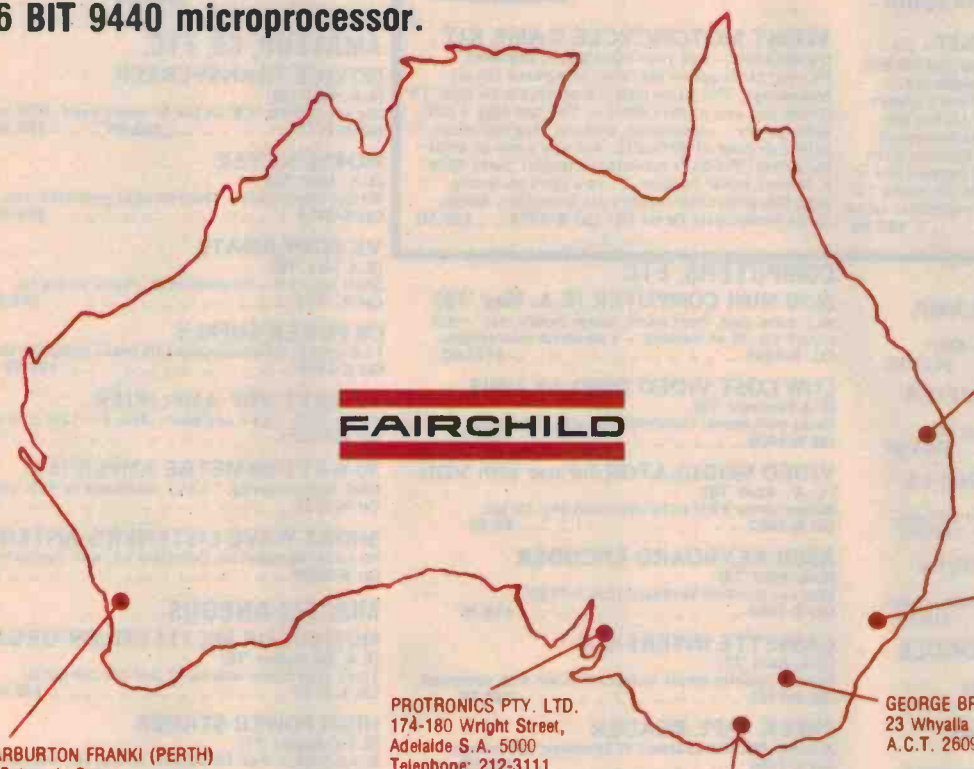

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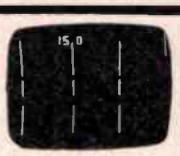

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SWL COMMUNICATIONS

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

The Australian Radio DX Club is a non-profit body with headquarters in Melbourne. For further information on shortwave radio, and on the activities of the ARDXC, please write to the General Secretary, PO Box 67, Highett, Vic. 3190, enclosing a 30c. stamp for return postage.

Our column is known as "SWL Communications", SWLing (shortwave listening) is concerned with tuning to overseas and distant broadcasting stations for their programme content. A shortwave listener (SWLer) therefore would mainly tune to stations broadcasting in English, though of course he may enjoy some of the music programmes in foreign language transmissions.

There is another aspect of the shortwave hobby which has developed from SWLing, and is a logical progression from SWLing, I speak of the hobby known simply as "DXing". A "DXer" may, like an SWLer, enjoy programmes he hears on his shortwave set for their content alone. For the DXer however, programme content is of only secondary importance. He tunes to any particular station in order to identify that station. A DXer will tune to all manner of stations, in both English and all other languages, in the course of his systematic monitoring of overseas and distant broadcasts.

The aim of the DXers monitoring may be that he enjoys the study of the various propagation patterns which are evident with the changing seasons, or he may wish to compile reception reports for despatch to selected stations to which he tuned during his monitoring sessions. A reception report would include the date and time of reception in GMT, the frequency on which the station was heard, a description of reception conditions, details of the receiver used by the DXer to monitor the station, and details of programmes heard. Should the station then judge that the DXer has indeed tuned to them following a comparison of the report with the station's log, a verification may be forwarded to the DXer in the form of a card or letter as a written record of the DXer's reception of the station. The DXer always is mindful of the fact that the station is under no obligation to answer his reception report, and so he attempts to provide as much detail within his report as may be useful to the station. A reception report will *never* be accompanied by a *demand* for verification (QSL). Many DX clubs including the ARDXC here in Australia, offer their members reception report forms which, when properly completed, aid the DXer in sending the most comprehensive and easily read reception report possible to broadcasting stations.

New Schedules

On Sunday September 3, most of the international broadcasting stations will introduce their S-'78 schedules for services until November. Period "S" is used by most stations to test frequency selections prior to the main Northern Hemisphere winter season. It is anticipated that September 3 will see a general move to lower frequencies (49 metre band to the 31 metre band), from the higher frequencies of 25 to 13 metres.

Norway

Advance information received from Radio Norway in Oslo regarding transmissions during Period "s" shows programmes beamed at the following convenient times for Australian reception:

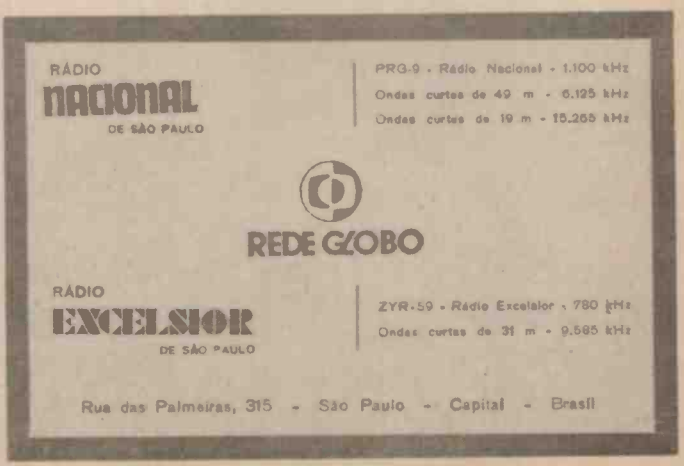
0700-0830 for the Pacific, Far East, Australia and New Zealand on 11850, 15175 and 15135 kHz.
1100-1230 for Western Australia and Indonesia on 17800 and 21730 kHz.
1900-2030 for the Pacific and Africa on 11860, 15175, and 15345 kHz.

All programmes are in Norwegian, except on Sundays when there are half-hour English segments at 0800, 1200 and 2000 in the above services.

Time To Hear Brasil!

If you want to hear this large and exciting country, then September is the time. Around the September equinox, and into October, reception of Brasilian stations is at its peak, especially on the 49 metre band around 0800 to 1000 when Brasil stations are opening transmission for the day. If you are fortunate, and gaps exist in this time period on the 31 metre band, several Brasil stations may also appear there. Here are some of the stations to watch out for:

On 5965 kHz, Radio Guaiba at Porto Alegre, which usually signs on for the day at 0900, when you will hear full station identification and other details given in Portugese.
On 6045 kHz, Radio Clube Paranaense at Curitiba, also opens transmission at 0900.
On 6185 kHz, Radio Bandeirantes at Sao Paulo, signs on daily at 0800.
On 6135 kHz, Radio Gaucha at Porto Alegre, another one which opens programming at 0800.



KITS and COMPONENTS FROM JAYCAR

NEW!

A complete 100 watt Slave Amp kit based on the ETI 480 module. Kit comes complete with robust anodised case with handles, cannon mains input socket, input and output sockets, fuse protection, heatsink, etc.

Complete Kit $105.00
plus freight $3.50

Makes an ideal PA amplifier, foldback amp and more.
SAE for more information.

445 GENERAL PURPOSE PREAMP $6.50 plus 90c post.

446 AUDIO LIMITER $9.00 plus 90c post.

449 BALANCED MIC PREAMP $5.00 plus 90c post.

485 STEREO EQUALISER $105.00 plus $3.00 post.

486 FREQUENCY SHIFTER $25.00 plus 90c post.

414 MASTER MIXER $254.00 plus $6.00 post.

4600 SYNTHESISER WITH FAIRLIGHT KEYBOARD $1054.00.

443 COMPRESSOR EXPANDER $98.00 plus $3.00 post.

NEW!

ETI 489 SPECTRUM ANALYSER

A complete kit based on the ETI 489 is now available. Featuring 10 columns of leds one octave apart, it makes an ideal addition to your test gear range, or an impressive novelty addition to your hi-fi.

SAE for more information.

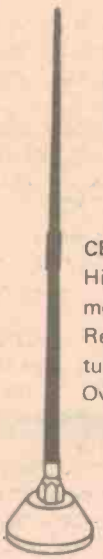
Allow 2-3 weeks delivery on all kits.
All enquiries must include SAE.

jaycar PTY LTD

Tel: 211-5077. PO Box K39 Haymarket. NSW. 2000. 405 Sussex Street, Sydney.

UHF/CB Antennas Citizens Band radio

CB470
6 dB gain co-linear base antenna.
Enclosed in fibreglass radome.
Length 8'.

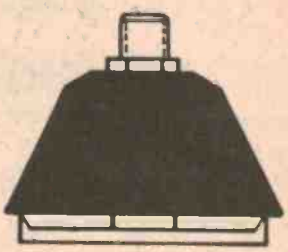


CB410
High Performance mobile whip.
Requires no tuning.
Overall height 21".

CB421
High Performance Dual Channel 477 and 27 MHz mobile co-linear.
Use with DX50 signal combiner
overall height 42".

DX50 Signal Combiner
For simultaneous reception and transmission on both 27 MHz and 477 MHz.

Scalars UHF Mobile mount for correct termination of Co-Ax at UHF frequencies
Pat. Pending No. 20506/76



Model OB

TRADE ENQUIRIES WELCOME

SCALAR INDUSTRIES PTY LTD

VIC. 20 Shelley Avenue, Kilsyth, 3137. Tel: 725-9677. Cables: WELKIN. Telex: AA34341
N.S.W. 20 The Strand, Penshurst, 2222. Telephone: 570-1392. Telex: AA27067
QLD. Scalar (Qld.) P/L., 969 Ann St., Fortitude Valley, 4006. Tel: 52-2594. Telex: AA43007
DESIGNED AND MANUFACTURED IN AUSTRALIA.

Depending on frequency usage by international broadcasters, you may be fortunate to hear some of these outlets on the 31 metre band:

On 9585 kHz, Radio Excelsior at Sao Paulo, which runs a 24 hour schedule but the best opportunity for reception in Australia is between 0800 and 0930.

On 9635 kHz, Radio Aparecida opens transmission at 0900.

On 9645 kHz, Radio Bandeirantes is probably the most consistent 31 metre band signal from Brasil, and often shows in Australia between 0900 and 1030.

Remember that Brasilian reception is highly seasonal, so that by November there will be far too much daylight on the route over the Antarctic by which signals from that part of the world propagate to Australia. Signals on the 49 and 31 metre bands will thus be well below the absorption limiting frequency.

India

The General Overseas Service of All India Radio, in Delhi, broadcasts in English to Australia at the following times, according to the BBC Monitoring Service:

1000-1100 on 17705, 15205, 15190, 11775 kHz, the transmission beginning with a news bulletin.

A further service to Australia is aired 2045-2230 on 11740, 11620, 9912, 9535, 9525 and 7225 kHz. This service is also intended for listeners in the UK and West Europe.

Uganda

The Uganda Broadcasting Corporation at Kampala, has for some time been carrying out test transmissions to North America between 0300 and 0400 on 15325 kHz using a 250 kilowatt transmitter at Soroti. Programmes have consisted of musical selections, with announcements in both English and French requesting reception reports. Reception of these test transmissions has been very good here in Australia, and the address for any reports from listeners is: Chief Engineer, Box 2038 Kampala.

Turkey

The Voice of Turkey brought two new 250 kilowatt transmitters into operation during July. The station's English language service is currently aired between 2130 and 2300 on 9665, 9515, 7170 and 7270 kHz. Readers are reminded that amendments will possibly be made to this schedule after September 3. The above schedule was provided by the BBC Monitoring Service.

Sierra Leone

The Sierra Leone Broadcasting Service at Freetown, is presently heard on 5980 kHz between 0700 and 0730. Reception is possible after the Peruvian station leaves the frequency at 0700. Freetown relays the news from the BBC at 0700, and local programming is heard from 0710. It is believed that Freetown is now using a higher power transmitter on 5980 kHz. Sierra Leone is also heard around 2200-2225 on this frequency.

All times are given in Greenwich Mean Time (GMT) and you should add 10 hours to calculate Australian Eastern Standard Time.

AMATEUR COMMUNICATIONS

New Yaesu receiver

Successor to the now-famous FRG-7 general coverage receiver is Yaesu's latest addition to their range of communications equipment – the FRG-7000.

Advertised as a high performance general coverage receiver, the FRG-7000 features the Wadley-Loop method of band selection as used on the FRG-7, and features a digital frequency readout.

The FRG-7000 covers from 250 kHz right up to 29.9 MHz – digital dial readout being to the nearest 1 kHz.

Selectable reception modes, as per usual, are available giving USB, LSB and AM. The appropriate IF filter is switched in for optimum selectivity on the mode chosen.

Also featured is a digital clock with front panel display. It can be set to show local or 'universal' (GMT) time and incorporates a presettable timer so that you can switch the receiver on and off automatically.

Available from Bail Electronic Services, the FRG-7000 retails at around $670. For more information, contact Bails at 60 Shannon St, Box Hill North, Vic. 3129, phone (03) 89-2213.

Receiver from USA

A new general coverage communications receiver has recently been released by the McKay Dymek Corporation of California.

Designated the model DR33C, it features a PLL synthesizer, a six-digit LED digital readout and coverage from 50 kHz to 29.7 MHz.

The DR33C incorporates a special AM detector claimed to have extremely low distortion to provide high quality AM reception.

The receiver is a triple-conversion superhet and includes crystal filters in the first two IFs. Optional mechanical filters are available for SSB, CW and RTTY reception.

McKay Dymek claim very good figures for crossmodulation, blocking and overload – essential for good reception in today's crowded shortwave spectrum. Additional features included in the DR33C are an AM noise limiter and an audio notch filter for removing annoying heterodynes.

Available options include 483 mm (19") rack mounting hardware, 600 ohm zero-dBm balanced audio output and the previously-mentioned mechanical filters for narrowband (400 Hz) CW reception as well as a 1200 Hz bandwidth one for RTTY reception. An RF preselector, model DP 40, is also

AMATEUR COMMUNICATIONS

available as an accessory.

Styling is very similar to many hi-fi tuners on the market and the DR33C would certainly not look out of place amongst the hi-fi gear in the lounge-room.

McKay Dymek are seaking local distribution and can be contacted by writing to them at 111 South College Avenue (P.O. Box 5000), Claremont, California USA 91711.

Quad antenna hub

By far the simplest and most economical method to build a cubical quad, particularly multiband models, is to use the 'spider' form of construction. The only drawback is the special 'spider hub' required.

However, a Sydney foundry company Ashpoint Pty Ltd, has come to the rescue with a very versatile spider hub casting made from "corrosion resistant" grade aluminium.

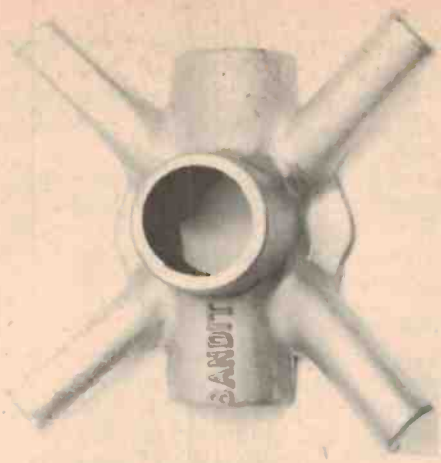
The casting comes in two halves, as shown in the photographs, and accepts four 75 mm diameter dowels, glass-fibre rods or tubing of appropriate length in the spider 'legs'. These are held in place via bolts through the assembly or with hose clamps.

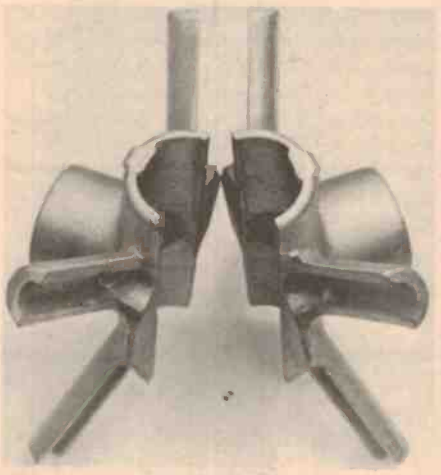
The spider legs are designed to suit the use of a simple clamp to securely hold the quad arms. (Arms and legs – gee, this can get confusing!)

The two halves of the hub are also not half-round and can be clamped to a mast with two bolts through the flanges at the sides of the castings.

For making quad-yagis, the half-section casting can be used for the parasitic elements.

The whole casting retails for $25, or a half-section for $12.50. Interested? – contact Ashpoint Pty Ltd (dealer enquiries welcome) at 43 Moxon Rd, Punchbowl, NSW 2196, phone 707-1929.





New Bearcat scanner

Keeping an eye on the VHF/UHF bands? Then the Bearcat scanner should interest you.

The model 210 is the latest scanning VHF/UHF receiver from Bearcat. It is a fully programmable scanner featuring operation on six bands between 32 and 512 MHz, keyboard control, a ten-channel memory and digital frequency readout.

Frequency ranges covered are as follows:

1) 32 – 50 MHz low band
2) 146 – 148 MHz top end of two-metres
3) 147 – 174 MHz high band
4) 450 – 470 MHz UHF band
5) 470 – 512 MHz UHF band

It will also receive signals in the range 416 – 450 MHz, covering the 70 cm amateur band.

A ten-channel memory is included which can 'store' data even though the mains supply is off.

Frequency selection is entered on the keyboard – similar to a standard calculator keyboard. Other key pads provide scan and frequency 'search' facilities.

A telescoping antenna is included. The 210 will operate from ac mains or from 13.8 Vdc supply. It measures a compact 270 mm wide by 76 mm high by 194 mm deep. Price is $485.

For more information, contact Vicom at 68 Eastern Road, South Melbourne Vic., phone (03) 699-6700.

Antenna tuners

Daiwa Corporation of Japan have released two new high quality antenna tuning units each incorporating a built-in SWR and RF power meter.

One is capable of handling 500 W PEP and the other 200 W PEP. Both units cover the frequency range from 1.8 to 30 MHz and provide an unbalanced output of between 10 and 30 ohms.

The SWR/PWR meter incorporated in each uses a direct-reading twin needle meter the sensing circuit for which features bandwidth and low insertion loss.

The tuning unit circuitry employs a three-position antenna selector switch for connecting different antennas and features good quality construction as usual with Daiwa products.

For further information, contact the Australian distributors, Vicom International Pty Ltd, 68 Eastern Road, South Melbourne Vic., Phone (03) 699-6700.

CB COMMUNICATIONS

Versatile Half-wave

A versatile new half-wave antenna has recently been announced by HI-Q Television from Newcastle. The antenna is designated the CB 1/27.

The antenna may be used for either vertical or horizontal polarisation and covers the full 27 MHz band. It can be erected in minutes as it simply unfolds and only requires adjustment of the tuning coil for best SWR.

Retailing for an economical $29.50, the HI-Q CB 1/27 is available from dealers or direct from the manufacturer.

Send for the brochure if you want further information. HI-Q Television are located at 69 Maitland Road, Islington, NSW 2269; phone (046) 61-5317.

Coax Switch

If you want to switch your CB rig between three antennas or three rigs onto one antenna - or whatever - then this nifty little switch from Jackson should do the trick.

If features simple push-button operation and is provided with standard SO239 connectors.

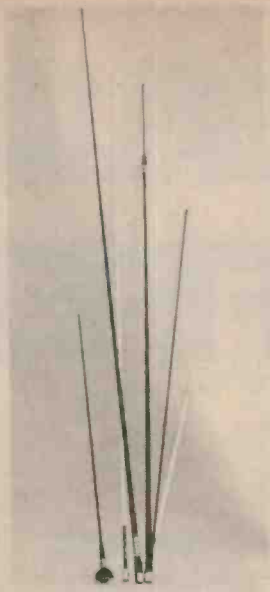
Available through all IFTA dealers and agents. Ask at your local CB shop.

CB COMMUNICATIONS

UHF Colinear

Mobile UHF CB antennas that have a little gain can improve performance markedly. Scalar's CB405 is a high-performance mobile colinear measuring just over one-metre high, made from stainless steel and including a heavy duty protective spring and UHF base. As it provides some gain over a quarter-wave whip you get improved performance.

Scalar have branches in Sydney and Brisbane, their head office being at 18 Shelley Avenue, Kilsyth, Vic., 3137, phone (03) 725-9677.



Austenna CB Antennas

Melbourne antenna manufacturers, Austenna have produced a range of CB antennas for the 27 MHz band.

Their 'Spectre' quarter-wave ground-plane features three radials and a loop matching system which provides a dc ground for the vertical radiator - claimed to reduce static problems.

Their ABS half-wave and 'Starburst' five-eighth feature easy-assemble components and simple matching adjustments.

These last two retail in the $60-$70 range, while the quarterwave ground-plane sells for about half that.

Available through major CB retail outlets, or you can get more information from Austenna Pty Ltd, 11 Stewart Street, Richmond, Vic; phone (03) 42-1148.

SOME OF AUSTRALIA'S LOWEST COMPONENT PRICES

NOTE: REGULAR PRICES – NOT TEMPORARY SPECIALS – KEEP US IN MIND FOR THAT NEXT ORDER

POLYESTER FILM CAPS
E12 10% 100V
All values .001 to .01 — 7c ea.

.01	—	7c .1	—	13c
.012	—	8c .12	—	14c
.015	—	8c .15	—	14c
.018	—	8c .18	—	14c
.022	—	8c .22	—	16c
.027	—	8c .27	—	16c
.033	—	8c .33	—	18c
.039	—	9c .39	—	19c
.047	—	9c .47	—	22c
.056	—	9c	All values in uF	
.068	—	10c		
.082	—	10c		

10% off 100 same uF

ELECTROCAPS (UPRIGHT)
(per 100 prices in brackets)

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

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

LEDS: $12 per 100, $110 per 1000, or 17c each, 10 for $1.50 clips 3c each all quantities. LEDS superb — 5mm red — well diffused. Wide viewing angle — sample 40c stamp.
TO3 MOUNTING KITS: 10 for $1 or $4 box of 50. Generous kit includes mica, screws, nuts, washers, tag, nylon brushes.

Potentiometers: 50c ea. rotary carbon sing. gang) log or lin: 1K, 5K, 10K, 25K, 50K, 100K, 25K, 500K, 1M, 2M (metal shafts) Trim Pots: 17c ea. — 10mm 1W horiz. or vert: 100 Ohm to 2M

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

2c RESISTORS — our 2 year old price still current. Opposition hoped we would go broke but our price remains at 2c ea.
1 Ohm to 10 M ¼W 5% E12 carb. film $1.80 per 100 same value (or ½W 3c, $2.50 per 100 same value)

Keep electronics a hobby and not a luxury, compare our prices and buy from us. Same day turnaround service (unless swamped). All goods top quality and new. No minimum order. One P/P charge of 40c regardless of quantity. Advert current 3 months for late readers.

DIGGERMAN ELECTRONICS
P.O. BOX 33, CORAMBA NSW. 2466.

SCRs:

0.8A	30V	C103Y	15
0.8A	200V	C103B	60
4A	30V	C106Y1	40
4A	400V	C106D1	75
8A	400V	C122D	$1.05
8A	500V	C122E	$1.20
25A	400V	C37D	$2.50

TRIACS:

2A	400V	ESP240	65
6A	400V	SC141D	$1.30
10A	400V	SC146D	$1.50
25A	400V	SC260D	$2.50

DIAC ST2 — 35
Chart to identify leads
Plus trigger info.

DIODES:

1N4001	—	7c (1A 50V)
1N4002	—	8c (1A 100V)
1N4004	—	9c (1A 400V)
1N4007	—	12c (1A 1000V)
1N4148	—	6c $4.50/100 $38/1000

It's about time! — a truly

SOLAR POWERED WATCH LCD WITH RECHARGEABLE BATTERY

SUPERB QUALITY — features:

- Digits constantly displayed.
- HR, Min, Sec, Day, Date, Month.
- Inbuilt light, owners manual.
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- Big window — Wide angle view.
- Stainless steel case and band.
- Quartz crystal accuracy factory set within 0.2 sec/day.

Operation: Press once for day and date and month auto follows, auto returns to time. Press twice for seconds.

Worth over $100 but our price only:

$59 Includes cert. post. CHEQUE OR MONEY ORDER G'TEES RETURN MAIL.

WORLD'S CHEAPEST RECHARGEABLE WE'VE SEEN.

Definitely worth much more. Satisfaction guaranteed BEYOND EXPECTATION on all features or returnable within 14 days as new. SAE for colour photo — **TO SEE IS TO BUY.**
TRULY SOLAR POWERABLE — daily requirement 2 minutes full sunlight. Electric light also will recharge. Recharges energy used by backlight — making "solar assisted" models obsolete. Battery holds a year's reserve. Manuf. says battery rechargeable life up to 5 years or more. Currently stock spares at $5. SAE for quote 1984. Competable trade discounts.

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ETI READER OFFER

ONLY $29.95
Plus $1.00 p&p

The biggest little
Wrist Calculator Kit
calculator in the world.

Specifications

Height	37 mm
Width	46 mm
Depth	10–17 mm
Weight	30 gm
Weight Kit	150 gm
Number of parts in kit	30 inc. batteries
Estimated construction time	1–3 hours
Number of Batteries	6
Type of Batteries	RM 13H
Battery Life (intermittent use)	20 hours approx.

Display Type	Magnified LED 0.1"
Keyboard Type	Non click conductive silicone rubber
Controls	On/off and 3 posn. Keyboard lever switch
Functions	$+ - \times \div$ constant % x^2 $\sqrt{x}$ [ ] $\frac{1}{x}$ π cm/in in/cm etc.
Construction	Upper case Magenta acrylic with printed plate. Lowercase black ABS. Printed circuit board double sided gold on nickel through–hole–plated fibre glass. Chip Mostek 50231

WRIST CALCULATOR

SINCLAIR are respected world-wide for their innovative electronic designs. The company's tiny 50 mm screen pocket-sized TV is just one of their brilliant miniature pieces of electronic hardware.

The company has now introduced a quite superb little Wrist Calculator and is offering it exclusively (in Australia) to our readers.

What's more the unit is offered only in kit form — you can build the sophisticated little beauty in less than three hours — at the very low price of $29.95 plus a mere dollar for postage and packing.

The Wrist Calculator measures just 37 mm by 43 mm and weighs a featherweight 30 gm — yet there's nothing lightweight about its performance. You get all the features of calculators many times the size — plus all the fun and pride of building it yourself.

The 30 piece kit comes complete with all assembly instructions, wrist band and six batteries — sufficient for 20 hours average use.

The kit is simple to build — you'll need a very fine tip soldering iron and a pair of tweezers — but if you've built a project before you'll find this one a breeze.

WHAT IF IT WON'T WORK!!

The odds are a hundred to one on that you'll get it right first time but if you're one of the really unlucky ones the sponsors will see you right. They've offered to fix all non-working units for a fixed price of $11 including return certified mail postage and packing. Just pack the unit securely and send it to the following address. Calculator Service, Consolidated Marketing Corporation 308-312 High St, Kew, Vic. 3101.

DELIVERY

The sponsors have 250 units in stock and can obtain further supplies from Sinclair within two weeks. Delivery should be expected within four weeks of sending your order whilst stocks last. If demand exceeds supply delivery time may extend to five weeks or so.

NOTE: This offer is made by the Consolidated Marketing Corporation and this magazine is acting as a clearing office for orders only. Cheques should be made out to 'Sinclair Offer' and sent together with the order form or a copy thereof to 'Sinclair Offer' Electronics Today International, 15 Boundary St, Rushcutters Bay, NSW, 2011.

This magazine will process the orders and send them on to the sponsor who will send out the goods by certified mail.

Please note that the goods cannot under any circumstances be obtained directly from Consolidated Marketing.

SINCLAIR OFFER

15 Boundary Street, Rushcutters Bay, NSW. 2011.

Please supply:

Quantity

..... Sinclair Wrist Calculator kit/s @ $29.95 each .....

Post and packing @ $1.00 per unit .....

Total .....

Name .....

Address .....

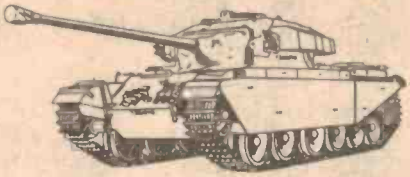
.....

.....P/code.....

Please make cheques/postal notes payable to 'Sinclair Offer'.

NEW

tank battle ic



AY-3-8700

625 line PAL version

This new chip from GI is the latest technological breakthrough in video electronics. Features 2 individually steerable tanks with 3 forward and reverse speeds — tanks fire Shells with realistic shell fire, explosion, tank track noises and video explosions. Of course on-screen scoring, tank barriers and mines are standard features. Note: when shell is in flight, tank may be rotated to curve trajectory path — all this and MORE from a SINGLE 28 pin CHIP. We have designed a special PCB to adopt this ic to ETI 804 and other video game units.

ATTENTION NEW ZEALAND

PRICE including ic, PCB and full data only $39.95

ONLY AVAILABLE FROM:

4th Floor, 127 York Street, Sydney. 2000. Telephone: (02) 29-6755, 29-6770.

orbit electronics

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A STAMP AND A FEW MINUTES WILL SAVE YOU DOLLARS – PRICE INCLUDING SALES TAX SHOWN IN BRACKETS

TEXAS PROGRAMMABLE CALCULATORS

FOR VALUE AND POWER

Ti 59	~~$328~~	$265	($294)
Ti 58	~~$141~~	$115	($127)
Ti 57	~~$92~~	$75	($83)
Ti 55	~~$87~~	$57	($63)
MBA	~~$90~~	$75	($83)

Accessories for Ti 58 & 59

MODULES ~~$35~~ $32 ea.

(Marine Navigation • Aviation • Surveying • Applied Statistics • Real Estate and Investment • Leisure Time)

PC 100 A and Ti 58

PC 100 A PRINTER

~~$278~~ $225 ($250)

40 magnetic cards – Ti 59 $15

DESK MODELS

and adding machines.

TEXAS SR60 A – BUSINESS, RESEARCH, PERSONAL COMPUTER

Basic model with extra memory options – up to 7920 program steps or up to 990 memories. Pre-programmed card libraries available for: Finance, Electrical Eng, Maths (2), Statistics, Surveying, Payroll. (Write for details and prices)

DESK MODELS FROM

$100 to $3000 of

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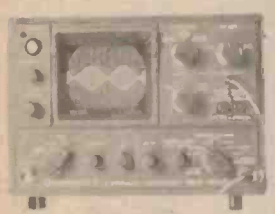

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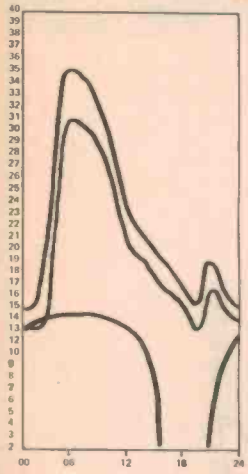
predictions

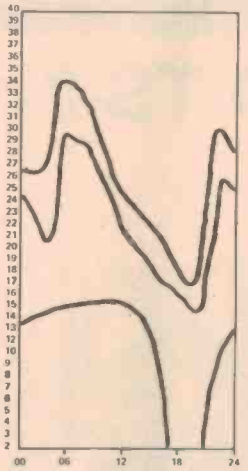
Ionospheric Predictions for the month of August

THESE PREDICTION GRAPHS have been prepared courtesy of the Ionospheric Prediction Service Division of the Department of Science. Any enquiries about these predictions should be directed to ETI, not to the Ionospheric Prediction Service.

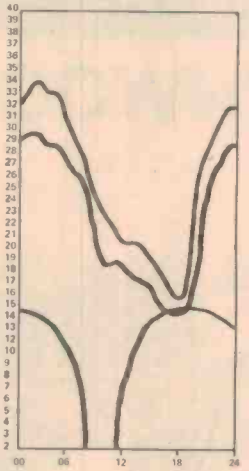
The graphs indicate the maximum usable frequency (MUF) on HF circuits between various centres in Australia and selected points overseas. For less than 50% of the days of the month the highest frequencies propagated will be at least as high as the uppermost curve. Between 50% and 90% of the days of the month the MUF will be at least as high as the curve beneath the upper curve. The absorption limiting frequency (ALF), which affects the lowest frequencies that will be propagated, is indicated by the lower curves on the graphs.



East Coast – South Africa (also serves South Central)

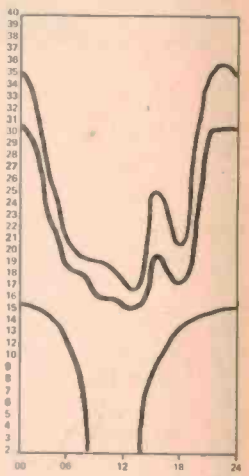


East Coast – North Africa (also serves South Central)



East Coast – South America (also serves South Central)

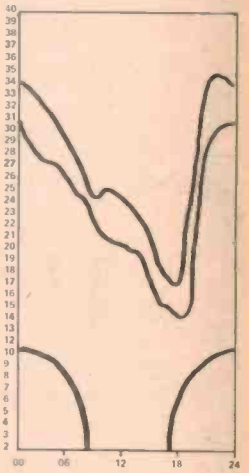
East Coast – Central USSR (also serves South Central)



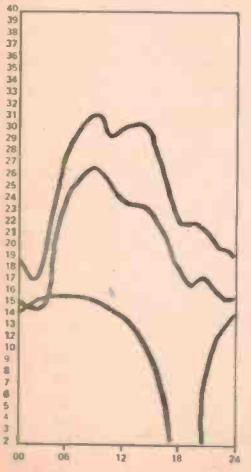
East Coast – North America (also NE and South Central)

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

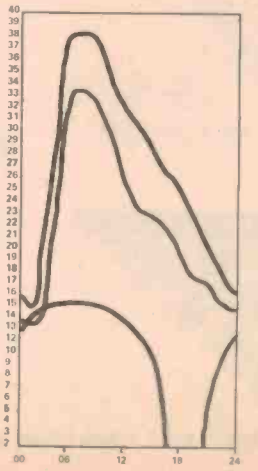
East Coast – South Pacific



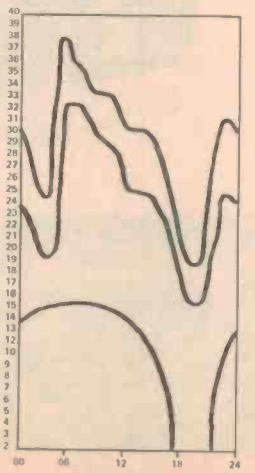
SWL and AMATEUR COMMUNICATIONS



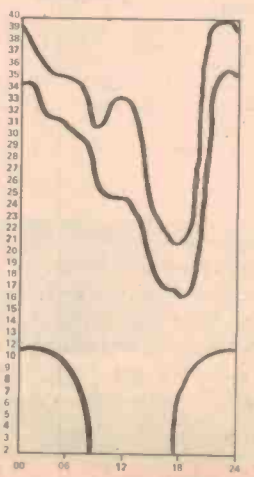
East Coast – Europe (Short Path)



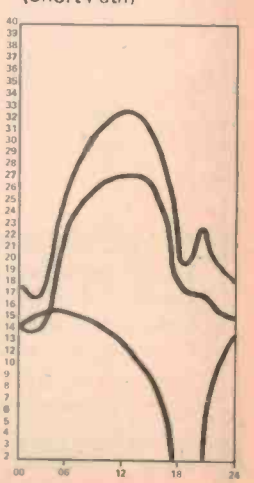
North East – South Africa



North East – North Africa

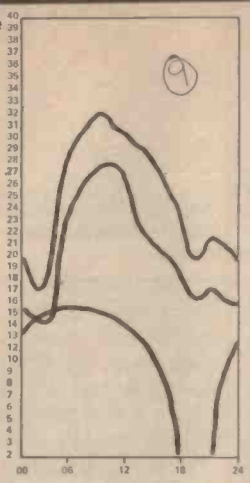


North East – South Pacific (also serves South Central)

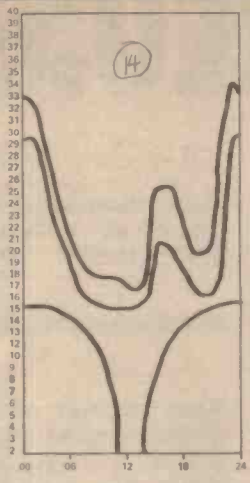


North East – Europe (Short Path)

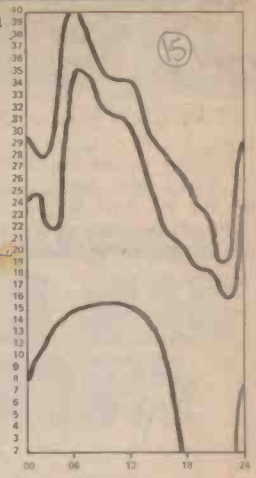
South Central – Europe (Short Path)(also West Coast)

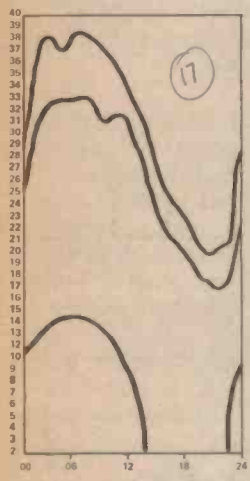


West Coast – North America

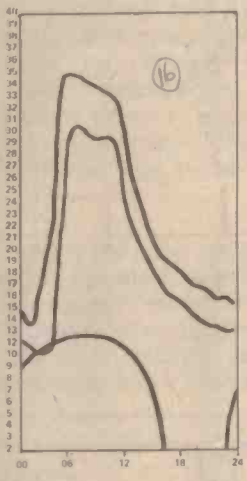


West Coast – North Africa

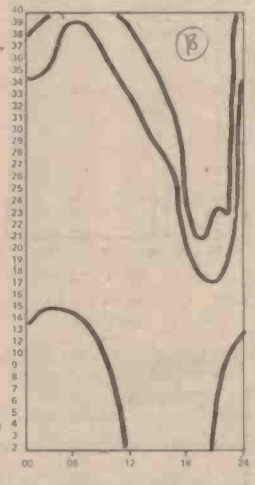




West Coast – Central USSR



West Coast – South Africa



West Coast – Japan

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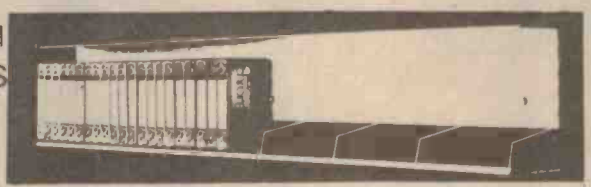

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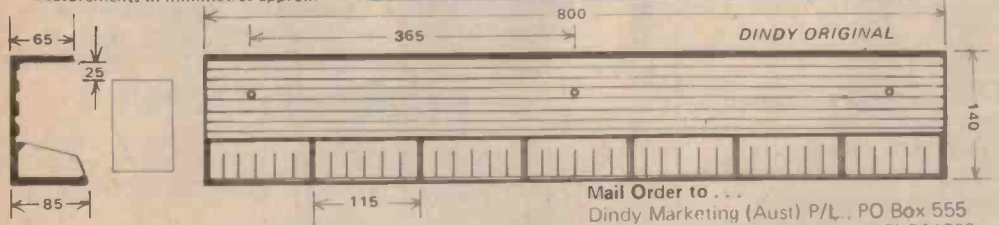

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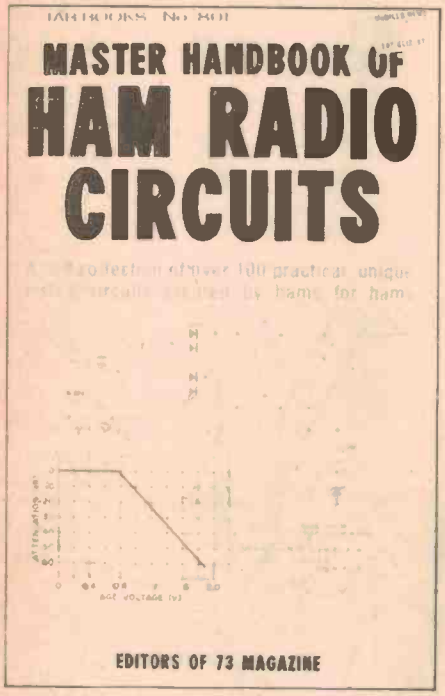
BOOK REVIEW



Master Handbook of Ham Radio Circuits, Editors of 73 Magazine, TAB Books, 1977, $12.50.

Radio amateurs are constantly in need of small circuits to just finish off that project, or modify some piece of gear. Often, they can't find one, or don't even bother to look, simply designing their own circuit to do the job. Some of these circuits are published in magazines, but of course, it seems to be a corollary of Murphy's Law that you can never find that circuit you remember seeing.

This book collates over 100 circuits, broken down into eight categories - CW circuits; amateur receivers and converters; SSB, DSB, AM and voice communications; RF Power Amplifiers; 50 MHz and above; RTTY, SSTV and specialised communications; amateur accessories; and power supplies.

The only real criterion for evaluation of a book of this kind is how well the circuits in it work. We cannot really say anything about these, as we have not yet had a chance to build any of them - but there are quite a few we'd like to tackle in the next few months! The circuits range in complexity from a simple LC audio filter to an SSTV monitor, so there's something to suit all levels of technical prowess.

There is no constructional information for most of the circuits, but individual construction techniques will vary to suit the application, so this is not a problem. This is an excellent publication for the bookshelf in your shack - it probably won't spend much time on the shelf, however! Our review copy was kindly supplied by McGill's Authorised Newsagency, of 187-193 Elizabeth Street, Melbourne 3000.

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¼W and ½W, 5% tol	1 ohm – 10 meg	ea	3c
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Buy 25, – 10%; Buy 50, – 50%; Buy 100, – 20%

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.068, .082, .1 uF — ea 20c

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.47, .56, .68 uF

1 uF ea 70c — 1.5 uF ea $1.00 — 2.2 uF ea $1.50

Buy 25, – 10%; Buy 50, – 15%; Buy 100, – 20%

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		Price
1pf pref. values to 820pf	ea	8c
.001 uF pref. values to .033 uF	ea	9c
.047 uF ea 10c — .1 uF ea 14c — .22 uF	ea	20c

Buy 25, – 10%; Buy 50, – 15%; Buy 100, – 20%

TAG TANTALUM CAPACITORS

			Price
.1, .22, .33, .47, 1 uF	35VW	ea	30c
2.2, 3.3, 4.7, 6.8 uF	35VW	ea	35c
10, 15 uF	25VW	ea	40c
22 uF 20 VW ea 40c 33 uF	16VW	ea	40c

Buy 25, – 10%; Buy 50, – 15%; Buy 100, – 20%

POLYSTYRENE CAPACITORS 125V

		Price
10pf – 820 pf, pref. values	ea	20c
.001 uF – .0033 uF, pref. values	ea	22c
.0047 uF – .01 uF, pref. values	ea	32c

Buy 25, – 10%; Buy 50, – 15%; Buy 100, – 20%

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		Price
Non-polarised capacitors for crossover networks; small size		
1, 2.2, 3.3, 4.7, 6.8, 10 uF	ea	40c
1, 2.2, 3.3, 4.7, 6.8, 10 uF	ea	40c
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	Prices 16V	25V	50V
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4.7 uF	12c	15c	18c
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22 uF	12c	15c	20c
33 uF	15c	20c	25c
47 uF	16c	22c	28c
100 uF	20c	25c	40c
220 uF	40c	55c	70c
330 uF	35c	45c	70c
470 uF	40c	50c	—
1000 uF	60c	70c	—

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	Prices 18V	75V	50V	63V
2.2 uF	18c	20c	22c	25c
4.7 uF	18c	20c	22c	25c
10 uF	20c	22c	25c	30c
22 uF	20c	22c	25c	30c
33 uF	20c	25c	30c	35c
47 uF	20c	25c	30c	35c
100 uF	25c	30c	40c	50c
220 uF	40c	55c	70c	85c
330 uF	50c	60c	80c	$1.00
470 uF	55c	70c	90c	$1.20
1000 uF	75c	80c	$1.20	$1.60
2000 uF	90c	$1.40	$2.20	—
2200 uF	63VW insulated can ea			$2.60
2500 uF	100VW insulated can ea			$4.75
4000 uF	75VW insulated can ea			$5.50
4700 uF	35VW pigtail	ea		$2.50

Buy 25, – 10%; Buy 50, – 15%; Buy 100, – 20%

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SINGLE ROTARY POTS — MEAR "A"

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SINGLE ROTARY POTS — LOG "C"

1K, 2.5K, 5K, 10K, 25K, 50K, 100K, 250K, 500K, 1M — ea 50c

SWITCHED ROTARY POTS — LINEAR "A"

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SWITCHED ROTARY POTS — LOG "C"

5K, 10K, 25K, 50K, 100K, 250K, 500K, 1M — ea $1.25

DUAL GANGED POTS — LINEAR "A"

10K, 25K, 50K, 100K, 250K 500K, 1M — ea $1.25

DUAL GANGED POTS — LOG "C"

10K, 25K, 50K, 100K, 250K 500K, 1M — ea $1.25

Buy 25, – 10%; Buy 50, – 15%; Buy 100, – 20%

WIRE WOUND POTS — LINEAR "A"

10, 25, 50, 100, 250, 500
1K, 2.5K, 5K, 10K, 25K, 50K
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5W rating — ea $4.50

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Smallest size, suits 0.1" grid PCB
100, 200, 500, 1K, 2K, 5K, 10K
20K, 50K, 100K, 200K, 500K, 1M — ea 22c

PRESET POTS — LINEAR "A"

Philips 0.25W rating
100, 200, 500, 1K, 2K, 5K, 10K,
20K, 50K, 100K, 200K, 500K, 1M — ea 26c

Buy 25, – 10%, Buy 50, – 15%, Buy 100, – 20%

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Type	complete iron	tip
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Adcola D-30 dual temp	$20.50	35c
Adcola D-50 dual temp	$21.75	40c
Adcola T-30 thermostatic	$34.75	35c

Type	complete iron	tip	element
Mica 4V 10 watt	$ 3.75	60c	$ 4.50
Mica 6V 10 watt	$ 3.75	60c	$ 4.50
Mica 6V 20 watt	$11.15	98c	$ 5.25
Mica 12V 10 watt	$ 3.75	80c	$ 4.50
Mica 12V 20 watt	$11.95	98c	$ 5.25
Mica 10 watt transformer ea			$10.50
Mica 20 watt transformer ea			$18.00

Type	complete iron	tip	element
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Miniscope 60W	$16.50	45c	46c

Scope Transformer 3.3V 30A ea $18.50

HOBBY IRON 12V 1.5A SPECIAL *$3.50

Solder, hobby pack, 1 metre 60/40	ea	50c
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CAR SPEAKERS

Heavy duty, dust-proofed, dual 4/8 ohms

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7" x 5"	6W elliptical ea	$6.50
9" x 6"	6W elliptical ea	$7.50

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DOME 8" MID 8" 10" 12"

12"	30W bass driver, 28-3000Hz	ea	$29.90
10"	25W bass driver, 34-6,000Hz	ea	$19.75
8"	20W bass driver, 40-6,000Hz	ea	$11.90
8"	20W dual cone, 40-18,000Hz	ea	$12.95
5"	30W mid-range, 600-5,000Hz	ea	$ 8.95
5¼"	15W mid-range, 800-9,000Hz	ea	$ 4.50
1"	20W dome tweeter, 400-20,000Hz	ea	$ 8.95
1"	50W dome tweeter, 2 – 20 kHz	ea	$11.00
3"	25W cone tweeter, 1 – 20 kHz	ea	$ 5.80
5" x 3"	30W horn tweeter, 2 – 20 kHz	ea	$10.80

CROSSOVERS

2 Way 30W RMS, 6 kHz, 6dB/Oct	ea	$ 3.95
3 Way 40W RMS, 1 kHz, 6 dB	ea	$ 6.95
3 Way 50W RMS, 600 Hz, 3 kHz, 12 dB	ea	$12.50

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Vinyl covered lids, strong 18 gauge aluminium

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E	Heavy speaker cable, 23 x 0.14mm	18c	$ 13.00
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- TVI FILTERS REVIEWED - just how close do the filters approach the claims like '100 dB attenuation' etc.?
- NEW GENERATION GEAR - new rigs will incorporate microprocessors, and just released models include new features.
- NOVICE HAM SECTION - completion of offical Novice syllabus plus details of WIA study guide for Novices. We publish predictions for world-wide DX too!
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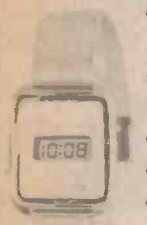

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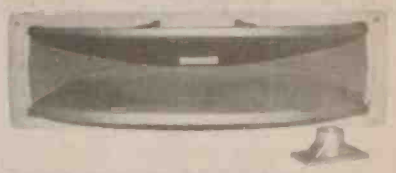

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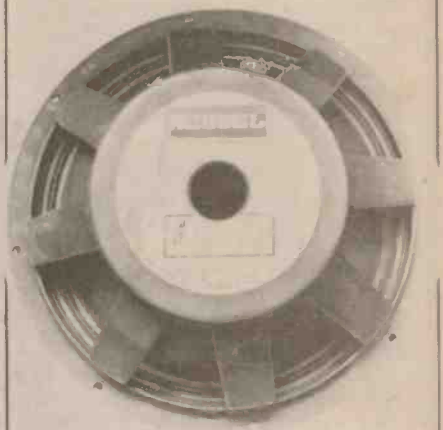

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